University Of Kerala

Four Year Under Graduate Programme

(UoK FYUGP)

Syllabus

Major Discipline Microbiology

May 2024

About the Discipline

Microbiology is a diverse scientific discipline dedicated to studying microorganisms, including bacteria, viruses, fungi, protozoa, and algae. These microscopic organisms play critical roles in various aspects of life, from contributing to the environment and human health to impacting industries such as agriculture, food production, and pharmaceuticals.

Graduate Attributes

Graduate attributes bridge the gap between academia and the real world, fostering lifelong learning and meaningful contributions. They denote the skills, competencies and high-level qualities that a student should acquire during their university education. Apart from gathering content knowledge, these attributes go beyond the assimilation of information to its application in various contexts throughout a graduate's life. It aims in inculcating the art of critical thinking, problem solving, professionalism, leadership readiness, teamwork, communication skills and intellectual breadth of knowledge. The University of Kerala envisages to pave the path in guiding the student's journey to shape these attributes uniquely, making them integral to personal growth and success in various spheres of life. The University strives to ensure that these graduate attributes are not just checkboxes, but they play a pivotal role in shaping the students into capable, compassionate and responsible individuals with a high degree of social responsibility.

Programme Outcomes

No.	Programme Outcomes (POs)
PO-1	**Critical thinking** • analyze information objectively and make a reasoned judgment • draw reasonable conclusions from a set of information, and discriminate between useful and less useful details to solve problems or make decisions • identify logical flaws in the arguments of others • evaluate data, facts, observable phenomena, and research findings to draw valid and relevant results that are domain-specific

PO-2	**Complex problem-solving** • solve different kinds of problems in familiar and no-familiar contexts and apply the learning to real-life situations • analyze a problem, generate and implement a solution and to assess the success of the plan • understand how the solution will affect both the people involved and the surrounding environment
PO-3	**Creativity** • produce or develop original work, theories and techniques • think in multiple ways for making connections between seemingly unrelated concepts or phenomena • add a unique perspective or improve existing ideas or solutions • generate, develop and express original ideas that are useful or have values
PO-4	**Communication skills** • convey or share ideas or feelings effectively • use words in delivering the intended message with utmost clarity • engage the audience effectively • be a good listener who are able to understand, respond and empathize with the speaker • confidently share views and express himself/herself
PO-5	**Leadership qualities** • work effectively and lead respectfully with diverse teams build a team working towards a common goal • motivate a group of people and make them achieve the best possible solution. • help and support others in their difficult times to tide over the adverse situations with courage
PO-6	**Learning 'how to learn' skills** • acquire new knowledge and skills, including 'learning how to learn skills, that are necessary for pursuing learning activities throughout life, through self-paced and self-directed learning • work independently, identify appropriate resources required for further learning • acquire organizational skills and time management to set self-defined goals and targets with timelines • inculcate a healthy attitude to be a lifelong learner

PO-7	**Digital and technological skills** • use ICT in a variety of learning and work situations, access, evaluate, and use a variety of relevant information sources • use appropriate software for analysis of data • understand the pitfalls in the digital world and keep safe from them
PO-8	**Value inculcation** • embrace and practice constitutional, humanistic, ethical, and moral values in life including universal human values of truth, righteous conduct, peace, love, nonviolence, scientific temper, citizenship values • formulate a position/argument about an ethical issue from multiple perspectives • identify ethical issues related to work, and follow ethical practices, including avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data, or committing plagiarism, and adhering to intellectual property rights • adopt an objective, unbiased, and truthful actions in all aspects of work

Programme Specific Outcomes (PSO)

PSO1	Develop foundational understanding of various branches of Microbiology and apply the knowledge in areas like Medical Science, Environmental Science, Agriculture, Food & Pharma Industries, and Biotechnology.
PSO2	Demonstrate expertise in laboratory techniques, enabling individuals to effectively apply their expertise in quality assurance and promote awareness of biosafety levels and Good Laboratory Practices and cultivate a strong understanding of microbiology in a business context.
PSO3	Develop expertise in advanced microbial applications and gain hands-on experience in cutting-edge microbial techniques, enabling students to stay ahead in the field.
PSO 4	Prepare for pursuing higher studies in microbiology by developing essential professional skills, such as leadership, scientific communication and effective teamwork, enabling personal and career growth.
PSO 5	Understand the ethical and societal implications of microbiological research and develop research proficiency, critical thinking and problem-solving skills.
PSO 6	Create a scientific temperament and develop technological proficiency across multidisciplinary domains related to Microbiology, ensuring adaptability and the ability to contribute to the ever-evolving landscape of the field.

Outline of Courses

Semester	Type of course	Course Code	Course Title	Academic Level
I	**DSC**	UK1DSCMBY101	Introduction to Microbial world	100-199
	DSC	UK1DSCMBY102	Introduction and Scope of Microbiology	100-199
	MDC	UK1MDCMBY101	Microbes in Daily Life	100-199
II	**DSC**	UK2DSCMBY101	Basic Techniques in Microbiology	100-199
	DSC	UK2DSCMBY102	Applied Microbiology	100-199
	MDC	UK2MDCMBY101	Basic Food Microbiology	100-199
	MDC	UK2MDCMBY102	Entrepreneurial Microbiology	100-199
III	**DSC**	UK3DSCMBY201	Food and Dairy Microbiology	200-299
	DSC	UK3DSCMBY202	Microbial Diversity	200-299
	DSC	UK3DSCMBY203	Microbes and Environment	200-299
	DSE	UK3DSEMBY201	Microbiology in Business	200-299
	VAC	UK3VACMBY201	Microbial Waste Management	200-299
IV	**DSC**	UK4DSCMBY201	Microbial Genetics	200-299
	DSC	UK4DSCMBY202	Microbial Physiology and Metabolism	200-299
	DSE	UK4DSEMBY201	Environmental and Sanitation Microbiology	200-299
	DSE	UK4DSEMBY202	Microbial Physiology and Systematics	200-299
	VAC	UK4VACMBY201	Microbes in sustainable agriculture and development	200-299
	VAC	UK4VACMBY202	One Health Approach for Emerging Pathogens	200-299
	SEC	UK4SECMBY201	Food Quality Control	200-299
	SEC	UK4SECMBY202	Food Quality Assurance	200-299

V	**DSC**	UK5DSCMBY301	Industrial Microbiology	300-399
	DSC	UK5DSCMBY302	Instrumentation in Microbiology	300-399
	DSC	UK5DSCMBY303	Food Microbiology	300-399
	DSC	UK5DSCMBY303	Fermentation Technology	300-399
	DSE	UK5DSEMBY301	Cell Biology	300-399
	DSE	UK5DSEMBY302	Agriculture Microbiology	300-399
	DSE	UK5DSEMBY303	Dairy Microbiology	300-399
	DSE	UK5DSEMBY304	Nano-biotechnology	300-399
	SEC	UK6SECMBY301	Mushroom Cultivation	300-399
VI	**DSC**	UK6DSCMBY301	Medical Microbiology	300-399
	DSC	UK6DSCMBY302	IPR and Bioethics	300-399
	DSC	UK6DSCMBY303	Medical Bacteriology and Virology	300-399
	DSC	UK6DSCMBY304	Mycology and Parasitology	300-399
	DSC	UK6DSCMBY305	Environmental and Agricultural Microbiology	300-399
	DSE	UK6DSEMBY301	Immunology	300-399
	DSE	UK6DSEMBY302	Bioinformatics and Biostatistics	300-399
	SEC	UK6SECMBY301	Scientific Writing and Presentation	300-399
VII	**DSC**	UK7DSCMBY401	Molecular Biology and rDNA technology	400-499
	DSC	UK7DSCMBY402	Research Methodology	400-499
	DSC	UK7DSCMBY403	Biophysics and Instrumentation	400-499
	DSC	UK7DSCMBY404	Biostatistics& Bioinformatics	400-499
	DSC	UK7DSCMBY405	Microbial Biotechnology	400-499
	DSE	UK7DSEMBY401	Diagnostic Microbiology	400-499
	DSE	UK7DSEMBY402	Biosafety measures in Laboratory	400-499

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	**UK1DSCMBY101**				
Course Title	**Introduction to Microbial World**				
Type of Course	**DSC-P**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic understanding of life sciences and microbiology gained during HSE.				
Course Summary	This course provides a solid foundation in microbiology by covering the ubiquity of microbes, the historical development of the field, the structural diversity of major microbial groups, basic microbiological techniques and instrumentation and the broad scope of microbiology in various applied sectors and entrepreneurial ventures.				

Detailed Syllabus: Total hours- 75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
	Module 1: Microbes in Daily Life		**8**
	1	Microbes in household products: Idli, Curd, Appam, Pickles (Brief account)	
	2	Microbes in industrial products: Cheese, Yoghurt, Bread, Wine, Distilled beverages & Antibiotics (Brief account)	

I	3	Microbes in Agriculture & Environment: Biofertilizer, Biopesticides, Biogas (Brief account)	
	4	Microbes as pathogens: Typhoid, Botulism, Traveler's diarrhea, Nipah, Dengue, COVID-19, AIDS, Nail infection, Dandruff (Causative agent, transmission & symptoms only)	
II	**Module 2: History of Microbiology**		**7**
	1	Spontaneous generation theory, Biogenesis & Abiogenesis	
	2	Contributions of Anton Van Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Fleming, Joseph Lister & Edward Jenner	
III	**Module 3: Structural diversity of Microorganisms**		**8**
	1	Morphology, arrangement and ultrastructure of bacteria	
	2	Morphology & structure of Virus: T4, TMV	
	3	Morphology of Fungi: *Aspergillus sp, Penicillium sp, Rhizopus sp.*	
IV	**Module 4: Basic Requirements in Microbiology**		**7**
	1	Culture media: Solid, Liquid, Semi-solid, Synthetic, Complex, Enriched, Enrichment, Selective, Differential & Anaerobic	
	2	Instruments: Autoclave, Hot air oven, Incubator, Laminar Air Flow, Colony counter	
V	**Module 5: Scope of Microbiology**		**15**
	1	Industrial Microbiology, Food Microbiology, Dairy Microbiology, Agriculture Microbiology, Environmental Microbiology, Medical Microbiology	
	2	Microbiology-based entrepreneurship	
	3	Industrial/Institute Visit	
		Practicals	**Hrs 30**
Course Type: Practical, Total credits: 1, Contact hours/week: 2			
VI	1	Laboratory precautions -General rules and regulations	
	2	Cleaning and sterilization of glass wares and media	

VI	3	Preparation of media: Solid medium, Broth, Preparation of Agar plates, Slants, Deeps	
	4	Enumeration of bacteria from air	
	5	Demonstration of hand microflora	

REFERENCES:

- Microbiology - Pelczar, Chan and Kraig (ISBN 0-07-462320-6)
- Microbiology -Prescott, Harley and Klein (ISBN 0-07-111217-0)
- Microbiology-Bernard D Davis
- Foundations in Microbiology-Talaro and Talaro
- Essentials of Microbiology (Sixth edition) - Purohit and Singh (ISBN 81-85031-67-3)
- Ananthanarayanan R and CK Jayaram Panicker. (2017). Textbook of microbiology, 10thEd. Orient Longman.
- Dubey, R.C. & D.K. Maheshwari, (2010). A TextBook of Microbiology. S. Chand & Co.
- Tauro P., Kapoor, K.K. Yadav, K.S. An introduction to Microbiology 1st Ed., New Age International Publishers
- Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15th
- Edition. Pearson Education. 2018. 3. Alcamo's Fundamentals of Microbiology by J. C. Pommerville. 10th Edition. Jones and Bartlett Learning. 2013.

E-RESOURCES:

- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1089622/pdf/amjphealth00130-0063.pdf
- https://nptel.ac.in/courses/102/103/102103015/
- https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Kaiser)/Unit_1%3A_Introduction_to_Microbiolgy_and_Prokaryotic_Cell_Anatomy/1%3A_Fundamentals_of_Microbiology
- http://www.wales.nhs.uk/sitesplus/888/agordogfen/149787
- http://ecoursesonline.iasri.res.in/course/view.php?id=108
- https://www.cliffsnotes.com/study-guides/biology/microbiology/microbial-cultivation-and-growth/microbial-cultivation
- https://nios.ac.in/media/documents/dmlt/Microbiology/Lesson-04.pdf
- https://www.bellarmine.edu/faculty/dobbins/Secret%20Readings/Lecture%20Notes%20113/chapt13_lecture1.pdf

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understanding the useful and harmful impacts of microbes in daily life	U	PSO 1
CO-2	Understanding and remembering history of microbiology	R, U	PSO 1
CO-3	Understanding structural details of virus, fungus and bacteria	U	PSO 1
CO-4	Understanding basic requirements in microbiology	U	PSO 1
CO-5	Understanding scope of microbiology	U, Ap, E, C	PSO 1, 4
CO-6	To learn basic laboratory skills in microbiology	U, Ap, An, C	PSO 1, 2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understanding the useful and harmful impacts of microbes in daily life	PO2// PSO 1,6	U	F, C	L	
CO-2	Understanding and remembering history of microbiology	PO6/ PSO 1	R, U	F, C	L	
CO-3	Understanding structural details of virus, fungus and bacteria	PO6/ PSO 1	U	F , C	L	

CO-4	Understanding basic requirements in microbiology	PO4/ PSO 1	U	F ,C	L	
CO-5	Understanding scope of microbiology	PO1,4/ PSO 1,4	U, Ap, E, C	P,M	L	
CO-6	To learn basic laboratory skills in microbiology	PO2/ PSO 1,2	U, Ap, An, C	P,M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	2	-	-	-	-	-	-	2	-	-	-	2	-	-
CO2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
CO3	1	-	-	-	-	-	-	-	-	-	-	2	-	-
CO4	1	-	-	-	-	-	-	-	-	2	-	-	-	-
CO5	2	-	-	1	-	-	2	-	-	2	-	-	-	-
CO6	1	1	-	-	-	-	-	1	-	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6				✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK1DSCMBY102				
Course Title	**Introduction and Scope of Microbiology**				
Type of Course	**DSC-P**				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5 hours
Pre-requisites	Basic understanding of life sciences and microbiology gained during HSE.				
Course Summary	This course lays a strong foundation in microbiology by covering its origins, basic techniques, microbial diversity, cutting-edge applications across multiple sectors and the future scope of this continually evolving and expanding field.				

Detailed Syllabus: Total hours- 75

Course Type: Theory, Total credits: 4, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
	Module 1:Evolution And History Of Microbiology		**8**
	1	The evolution of the field of microbiology, spontaneous generation and biogenesis	

I	2	The contributions of Robert Koch, Joseph Lister, Alexander Fleming, Louis Pasteur, and Anton von Leeuwenhoek, Germ theory of diseases, Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky,	
	3	Establishment of fields of medical microbiology and immunology through the work of Paul Virys Ehrlich, Elie Metchnikoff, Edward Jenner.	
II	**Module 2: Basic Requirements in Microbiology**		**8**
	1	Culture media: Solid, Liquid, Semi-solid, Synthetic, Complex, Enriched, Enrichment, Selective, Differential & Anaerobic	
	2	Instruments: Autoclave, Hot air oven, Incubator, Laminar Air Flow, Colony counter	
III	**Module 3: Diversity of Microorganisms**		**7**
	1	Systems of classification Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility	
	2	General characteristics of different groups: Acellular microorganisms, Viruses-bacteriophage, Viroids, Prion (Brief account)	
	3	General characteristic Morphology, mode of reproduction and economic importance of : Bacteria, Algae, Fungi and Protozoa (Brief account)	
IV	**Module 4: Microbiology in Multidisciplinary Aspects**		**7**
	1	Aero microbiology, Geomicrobiology, extra-terrestrial microbiology, Clinical research	
	2	Pharmaceutical Microbiology -Vaccines, Antibiotics, Gene Therapy Ecology and Microbiology: Bioremediation, Biopesticides, Biofertilizers (Brief account)	
	3	Quality checking: Water quality, Food and Diary products, Mining and Metallurgical operations	
	4	Microbial Fuel Cells, Biosensors	
	Module 5: Scope of Microbiology		15

V	1	Branches in microbiology: Industrial microbiology, Dairy microbiology, Environmental microbiology, Agricultural microbiology-disease-resistant crops, Medical microbiology -drugs and therapeutics	
	2	Advances in microbiology: Genetic Engineering, Microbial Biotechnology, Nanotechnology, Genomics, Metagenomics, Microbiology in sustainable development.	
	3	Career advancement in Microbiology: Pharmacologist, Bacteriologist, Virologist, Protozoologist, mycologist, Quality controller, Research and Development	
		Practicals	**Hrs 30**
Course Type: Practical, Total credits: 1, Contact hours/week: 2			
VI	1	Laboratory precautions -General rules and regulations	
	2	Cleaning and sterilization of glass wares and media	
	3	Preparation of media: Solid medium, Broth, Preparation of Agar plates, Slants, Deeps	
	4	Enumeration of bacteria from air	
	5	Demonstration of hand microflora	

Referance

1. Engelkirk, P. G., Duben-Engelkirk, J. L., & Burton, G. R. W. (2011). Burton's microbiology for the health sciences. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins.
2. Sastry A.S. & Bhat S.K. (2016). Essentials of Medical Microbiology. New Delhi : Jaypee Brothers Medical Publishers.
3. Trivedi P.C., Pandey S, and Bhadauria S. (2010). Textbook of Microbiology. Pointer Publishers; First edition
4. Jeffery C. Pommerville. Alcamo's Fundamentals of Microbiology (Tenth Edition). Jones and Bartlett Student edition.
5. Gerard J. Tortora, Berdell R. Funke, Christine L. Case. Pearson – Microbiology: An Introduction. Benjamin Cummings.
6. https://www.careerindia.com/courses/unique-courses/what-is-microbiology-its-scope-career-opportunities-011665.html
7. http://nexusacademicpublishers.com/uploads/portals/History_and_Branches_of_Microbiology.pdf

8. https://www.slideshare.net/naveebimal/scope-of-microbiology

E Resources

https://open.umn.edu/opentextbooks/textbooks/404

https://openstax.org/details/books/microbiology

https://libguides.colostate.edu/MIP/books

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the historical evolution of microbiology	U,R	/PSO1
CO-2	Understand the Basic Requirements of Microbiology	U,R	PSO1
CO-3	Identify and recognise microbial diversity	U,R	PSO1
CO-4	Illustrate and describe (a multidisciplinary aspect of Microbiology	U, Ap, C	PSO4,6
CO-5	Understand the Scope of Microbiology	U, Ap, C	PSO 2,4
CO6	Apply hands-on techniques in Microbiology	An,An	PSO 2,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO1	Understand the historical evolution of microbiology	PO6 / PSO1	U,R	F, C	L	
CO2	Understand the Basic Requirements in Microbiology	PO6 / PSO1	U, R	F,C	L	
CO3	Identify and recognise	PO1,6 / PSO1	U,R	C,M	L	
CO4	Describe the scope of microbiology (multidisciplinary aspect)	PO6 / PSO4,6	U, Ap, C	C,M	L	
CO5	Understand the concepts of basic microbiology techniques	PO 3,6 / PSO 2,4	U, Ap, C	F,C,P	L	
CO6	Apply hands-on techniques in Microbiology	PO 3,6 / PSO 2,4	An,An	P,M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 3	3	-	-	-	-	-	2	-	-	-	-	2	-	-
CO 4	-	-	-	3	-	3	-	-	-	-	-	2	-	-
CO 5	-	2	-	2	-	-	-	-	3	-	-	2	-	-
CO 6	-	3	-	2	-	-	-	-	3	-	-	2	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO6	✓			✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK104DSCMBY				
Course Title	**Basic Techniques in Microbiology**				
Type of Course	**DSC-P**				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge of microorganisms acquired during the first semester of this programme.				
Course Summary	This course provides a comprehensive overview of the instrumentation used in microbiology research, diagnosis, and analysis. It explores the principles, applications, and operation of various instruments essential for studying microorganisms, their characteristics and their interactions with the environment. Through theoretical lectures, laboratory demonstrations, and hands-on practice, students gain proficiency in utilizing these instruments for microbiological research and clinical diagnostics.				

Detailed Syllabus: Total hours 75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
	Module 1: Microscopy		**7**
	1	Introduction to Microscopy	

I	2	Light Microscopy: Principles and applications of bright field, dark field, phase contrast & fluorescent microscopes	
	3	Electron microscopy: Principles and applications of TEM & SEM	
II	**Module 2: Staining**		**8**
	1	Stains: Types, basic principles of staining	
	2	Preparation of bacterial smear, Simple & Negative staining,	
	3	Differential staining: Gram's staining, Acid fast staining (Ziehl Neelsen staining)	
	4	Special staining: Endospore, Volutin granules, Capsule	
III	**Module 3: Sterilization**		**8**
	1	Physical methods of sterilization: Dry heat, Moist heat, Filtration (Membrane & HEPA), Radiation	
	2	Chemical methods of sterilization: Alcohols, halogens, aldehydes, phenols and their mode of action	
	3	Assessment of sterility: Biological methods	
	4	Testing of disinfectants -Phenol coefficient test, Rideal walker test	
IV	**Module 4: Culture & preservation techniques**		**7**
	1	Pure culture techniques – Serial dilution, Pour, Spread and Streak plate.	
	2	Anaerobic culture technique –Mclntosh filde's jar method, gas pak jar, candle jar.	
	3	Preservation of culture-short term- serial sub culturing, overlay with mineral oil, long term- lyophilization, cryopreservation, storage in soil	
V	**Module 5: Good laboratory practices, & Biosafety levels**		**15**
	1	Good laboratory practices	
	2	Biosafety measures	
	3	Biohazards	
	4	Biosafety cabinets: Class I, Class II & Class III	
	5	Biosafety levels: Level I, Level II, Level III & Level IV	
		Practicals	**Hrs 30**
	Course Type: Practical, Total credits: 1, Contact hours/week: 2		

VI	1	Good laboratory practices	
	2	Isolation of pure cultures by quadrant streaking from the given sample	
	3	Isolation of pure cultures by pour plate technique from the given sample	
	4	Isolation of pure cultures by spread plate technique from the given sample	
	5	Preparation of bacterial smear & Simple staining	
	6	Gram staining	
	7	Negative staining	
	8	Spore staining	
	9	Lactophenol cotton blue staining of fungi	
	10	Isolation and culturing of *Rhizobium* from root nodules of higher plants	

REFERENCES:

- Microbiology - Pelczar, Chan and Kraig (ISBN 0-07-462320-6)
- Microbiology -Prescott, Harley and Klein (ISBN 0-07-111217-0)
- Microbiology-Bernard D Davis
- Foundations in Microbiology-Talaro and Talaro
- Essentials of Microbiology (Sixth edition) - Purohit and Singh (ISBN 81-85031-67-3)
- Ananthanarayanan R and CK Jayaram Panicker. (2017). Textbook of microbiology, 10thEd. Orient Longman.
- Dubey, R.C. & D.K. Maheshwari, (2010). A Textbook of Microbiology. S. Chand & Co.
- Tauro P., Kapoor, K.K. Yadav, K.S. An introduction to Microbiology 1st Ed., New Age International Publishers
- Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15th
- Edition. Pearson Education. 2018. 3. Alcamo's Fundamentals of Microbiology by J. C. Pommerville. 10th Edition. Jones and Bartlett Learning. 2013.
E-RESOURCES:
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1089622/pdf/amjphealth00130-0063.pdf
- https://nptel.ac.in/courses/102/103/102103015/

- https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Kaiser)/Unit_1%3A_Introduction_to_Microbiolgy_and_Prokaryotic_Cell_Anatomy/1%3A_Fundamentals_of_Microbiology
- http://www.wales.nhs.uk/sitesplus/888/agordogfen/149787
- http://ecoursesonline.iasri.res.in/course/view.php?id=108
- https://www.cliffsnotes.com/study-guides/biology/microbiology/microbial-cultivation-and-growth/microbial-cultivation
- https://nios.ac.in/media/documents/dmlt/Microbiology/Lesson-04.pdf
- https://www.bellarmine.edu/faculty/dobbins/Secret%20Readings/Lecture%20Notes%20113/chapt13_lecture1.pdf

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Demonstrate a comprehensive understanding various microscopic techniques	U	PSO 1
CO-2	Apply various staining techniques various staining techniques	U , Ap	PSO 2,3
CO3	Evaluate and employ various sterilization techniques	U, Ap,E	PSO 2,3
CO4	Execute culture culturing and preservation of microbes	U, Ap	PSO 2,3
CO5	Identify and understand the functioning of biosafety levels	U, C,Ap	PSO 2,5
CO6	Practice various techniques on culturing and staining of microbes	U,Ap,An,E	PSO 3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)

CO1	Demonstrate a comprehensive understanding various microscopic techniques	PO 1,6/PSO 1	U	F, C	L	
CO2	Apply various staining techniques various staining techniques	PO 1,6/PSO 2,3	U , Ap	C,P	L	
CO3	Evaluate and employ various sterilization techniques	PO 1,6/PSO 2,3	U, Ap,E	C,P	L	
CO4	Execute culture culturing and preservation of microbes	PO 1,6/PSO 2,3	U, Ap	C,P	L	
CO5	Identify and understand the functioning of biosafety levels	PO 1,6/PSO 2,5	U, C,Ap	C,P	L	
CO6	Practice various on culturing and staining of microbes	PO 1,6/PSO 3,5	U,Ap,An, E	P,M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	1	-	-	-	-	-	2	-	-	-	-	2	-	-
CO2	2	-	3	-	-	-	2	-	-	-	-	2	-	-
CO3	2	-	3	-	-	-	2	-	-	-	-	2	-	-

CO 4	2	-	3	-	-	-	2	-	-	-	-	2	-	-
CO 5	2	-	3	-	-	-	2	-	-	-	-	2	-	-
CO 6	2	-	-	-	3	-	2	-	-	-	-	2	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓

CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6				✓

University of Kerala

Discipline	**MICROBIOLOGY**				
Course Code	UK2DSCMBY102				
Course Title	Applied Microbiology				
Type of Course	**DSC-P**				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5 hours
Pre-requisites	Basic knowledge on Microbiology gained during HSC and first semester of this programme.				
Course Summary	The course provides a foundational understanding of the field of microbiology, exploring the basics of microbial life, their significance in various ecosystems, and their impact on human health, industry, and the environment. It covers the application of microbiology in various fields.				

Detailed Syllabus: Total hours-75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
I		**Module 1 : Agricultural Microbiology**	**7**
	1	PGPR – General account of the microbes used as biofertilizers for crop plants and their advantages:	
	2	Plant growth-promoting bacteria- symbiotic - *Rhizobium*	
	3	Plant growth-promoting bacteria- non-symbiotic - Mycorrhizae	

	4	Bio Pesticides: Bacterial, Viral and Fungal pesticides and their importance	
II	**Module 2 : Aquatic Microbiology**		**8**
	1	Water quality criteria-Indicator organisms	
	2	Bacteriological examination of drinking water-membrane filtration, MPN.	
	3	Sewage microorganisms, BOD and COD.	
	4	Purification and disinfection of water	
III	**Module 3 : Food Microbiology**		**7**
	1	Microbiology of fermented foods – Wine, vinegar, idly, bread, fermented vegetables	
	2	Microorganisms as food: single cell protein, edible mushrooms. Probiotics.	
	3	Fermented Dairy Products- Yoghurt, Dahi, Butter, Ghee and Cheese	
	4	Food sanitation- Good Manufacturing Practices	
IV	**Module 4 : Industrial Microbiology**		**8**
	1	Fermentative Production of organic acid: acetic acid	
	2	Production of amino acid: lysine	
	3	Production of enzyme: proteases.	
	4	Production of antibiotic: Penicillin	
	5r	Production of vitamin -Vitamin B12	
V	**Module 5 : Entrepreneurship in Microbiology**		**15**
	1	Identification of Business Opportunities, Qualities, skills and attributes that successful Microbiology entrepreneurs possess.	
	2	Role of government and schemes, financial institutions in fostering Bioentrepreneurship.	
	3	Skills in bio-entrepreneurship-Personality and attitude, Organizational behavior, Leadership, Principles of effective communication, Body language, public speaking, presentations, business proposal writing.	
		Practical	**30**

Course Type: Practical, Total credits: 1, Contact hours/week: 2			
VI	1	Isolation and Cultivation of *Rhizobium* from root nodules	
	2	Determination of Dissolved Oxygen (DO) in water	
	3	Bacteriological analysis of drinking water – MPN Technique	
	4	Isolation and Enumeration of bacteria from food – a) Curd b)Idli c) fruits and vegetables	
	5	Wine production from grapes.	

REFERENCES

1. Madigan, M.T. and Martinko, J.M.2006. *Brock's Biology of Microorganisms*. 11thEdition. Pearson Education Inc.
2. Pelczar, M. J. Jr., Chan, E. C. S. and Krieg, N. R. 1993. *Microbiology*, 5th Edition, Tata Mac Graw Hill Press.
3. Prescott, L.M, Harley, J.P. and Klein, D.A.2005.Microbiology.9th Edition. Mac Graw Hill Companies Inc.
4. Mitcheli Reed. (1992). Environmental Microbiology. John Wiley and Sons, New York
5. A.H. Patel, (2005). Industrial Microbiology. Published by Macmillan India Ltd., New Delhi
6. L.E. Cesida, Industrial Microbiology, New Age International Publishers.
7. Michael J. Waites, Neil L. Morgan, John S. Rockey. Industrial Microbiology: An Introduction
8. Frazier WC and West off DC. (1988) Food microbiology, TATA McGraw Hill Publishing Company Ltd. New Delhi.
9. Adams MR and Moss MO. (1995). Food Microbiology, The Royal Society of Chemistry, Cambridge
10. Dubey, R. C. and Maheswari, D. K. 2002. Practical Microbiology. 2nd Edition, S. Chand &Co., New Delhi.
11. Kannan, N. 2002. Laboratory manual in general microbiology. 2nd Edition, Panima Publishing Co., New Delhi
12. Introduction to Biotech Entrepreneurship: From Idea to Business.A European

Perspective. Matei, Florentina, Zirra, Daniela (Eds.).Springer nature publication.2019

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	To describe the role of microbes as biofertilizers and review their application in agriculture	U	PSO1
CO-2	Demonstrate and apply the various techniques used for assessing water quality as well as analyze and interpret the findings.	U,Ap	PSO1, 2
CO -3	To describe the beneficial role of microbes in fermented foods and fermented dairy products and other indigenous fermented foods.	U	PSO1
CO – 4	Summarize and give examples of fermentative production of organic acids, amino acids, enzymes and antibiotics.	U	PSO1, 2
CO - 5	Understand the importance of Bio-entrepreneurship and its scope and understand the important aspects of establishing bio-industries.	U,Ap	PSO2, 3
CO - 6	To learn hands-on techniques in Applied microbiology	U,Ap,An	PSO 2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	To describe the role of microbes as biofertilizers and review their application in agriculture	PO1/ PSO1	U	F	L	

2	Demonstrate and apply the various techniques used for assessing water quality as well as analyze and interpret the findings.	PO1. 2/ PSO1 ,2	U,Ap	F,C	L	
3	To describe the beneficial role of microbes in fermented foods and fermented dairy products and other indigenous fermented foods.	PO1/ PSO1	U	F	L	
4	Summarize and give examples of fermentative production of organic acids, amino acids, enzymes and antibiotics.	PO1/ PSO1 ,2	U	C	L	
5	Understand the importance of Bio-entrepreneurship and its scope and understand the important aspects of establishing bio-industries.	PO2/ PSO2 ,3	U,Ap	F,C	L	
6	To learn hands-on techniques in Applied microbiology	PO1/ PSO2 ,3	U,Ap,A n	P,M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	1	-	-	-	-	-	2	-	-	-	-
CO 3	2	-	-	-	-	-	1	-	-	-	-	-
CO 4	2	1	-	-	-	-	1	-	-	-	-	-
CO 5	-	1	1	-	-	-	-	1	-	-	-	-

CO 6	-	2	1	-	-	-	2	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6				✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	**UK3DSCMBY201**				
Course Title	**Food and Dairy Microbiology**				
Type of Course	**DSC-P**				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge of microorganisms acquired during the first year of this programme.				
Course Summary	This course is designed to explore the intricate relationship between microorganisms and food, covering essential concepts in food microbiology, food fermentation and preservation techniques. Through theoretical learning and practical applications, students will develop a comprehensive understanding of the factors influencing microbial growth in food, methods for assessing food quality and strategies for extending shelf life to ensure the production of safe and high-quality food products.				

Detailed Syllabus:Total Hours- 75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
I		**Module 1: Introduction to Food microbiology**	**7**

	1	Food as a substrate for microorganisms, Primary sources of contamination	
	2	Factors influencing microbial growth in foods:- (a) Extrinsic factors- temperature, moisture, modified and controlled atmosphere (b) Intrinsic- nutrient content, water activity, Redox potential, inhibitory substances and biological structure.	
	3	Important microorganism in food- (a) Bacteria- *Bacillus, Clostridium, Alcaligenes and Propionibacterium* (b) Fungus - *Aspergillus, Rhizopus, Mucor and Penicillium* (c) Yeast – *Saccharomyces* sp	
	4	Microflora of milk-*Lactobacillus , Lactococcus, Streptococcus, Leuconostoc*	
II	**Module 2: Fermented products**		**8**
	1	Starter culture and its importance	
	2	Fermented food- Bread	
	3	Fermented vegetables- Sauerkraut, pickles	
	4	Alcoholic beverages- Beer, wine	
	5	Fermented milk products- cheese, yogurt, Kefir and Acidophilus milk	
	6	Microorganisms as food- SCP, Edible mushrooms, Probiotics	
III	**Module 3: Food spoilage**		**8**
	1	General principles underlying spoilage (a) Persihable food (b) Semi-perishable food (c) Non-persihable food	
	2	Spoilage of different kinds of foods- cereals, vegetables and fruits, meat, fish, eggs, poultry, Contamination and spoilage of canned foods.	
	3	Spoilage of milk and milk products - Off flavors, Gas production, Souring, Proteolysis, Lipolysis, sweet curdling and Production of abnormal colour in milk	

	4	Food borne diseases:- Food intoxication- *Clostridium botulinum,* Staphylococcal infection Fungal: Mycotoxins Food infections (a) Bacterial -*Escherichia, Salmonella* (b) Viral: Hepatitis A (c) Protozoa – Amoebiasis	
	5	Milk borne infections- *Brucella*, *Mycobacterium bovis*	
IV	**Module 4: Bacteriological examination of milk**		**7**
	1	Enumeration of viable bacteria:- (a) Standard plate count (b) Direct microscopic count	
	2	Milk reduction test- Methylene Blue Reduction Test and Resazurin test	
	3	Phosphatase test	
	4	Turbidity test	
V	**Module 5: Food preservation**		**15**
	1	Principles of food preservation **(a)** Physical - irradiation, drying, heat processing, chilling and freezing, high pressure and modification of atmosphere **(b)** Chemical preservation- Sodium benzoate Class I & II.	
	2	Preservation of Milk- Pasteurization and types	
	3	Food Sanitation: Personnel hygiene, Good manufacturing practices (GMP), Hazard Analysis Critical Control Points (HACCP).	
		Practicals	**Hrs 30**
Course Type: Practical, Total credits: 1, Contact hours/week: 2			
	1	Determination of number of bacteria in milk by standard plate count.	
	2	Determination of quality of milk samples by MBRT	

VI	3	Isolation and enumeration of bacteria and fungi from fermented food:- Idly batter and curd	
	4	Isolation and enumeration of bacteria and fungi from fish	
	5	Isolation and enumeration of bacteria and fungi from meat	
	6	Isolation and enumeration of bacteria and fungi from soft drink	
	7	Comparison of bacteria and fungi isolated from raw and spoiled vegetables	
	8	Comparison of bacteria and fungi isolated from raw and spoiled fruits	
	9	Bacteriological Examination of water by Multiple Tube Fermentation Test	

REFERENCES

- Food Microbiology by Adams, M.R. and Moss, M.O.1995. The Royal Society of Chemistry, Cambridge.
- Food Microbiology by Frazier, W.C. and Westhoff, D.C.1988. TATA McGraw Hill Publishing company ltd., New Delhi.
- Modern Food Microbiology by Jay, J.M.1987. CBS Publishers and distributors, New Delhi.
- A Modern Introduction to Food Microbiology by Board, R.C.1983. Blackwell Scientific Publications, Oxford.
- Dairy Microbiology by Robinson, R.K.1990. Elsevier Applied Science, London.
- Food Poisoning and Food Hygiene, Hobbs, B.C. and Roberts, D.1993. Edward Arnold. London
- Dubey R C and Maheswari, D K (2002). Practical Microbiology. S. Chand & Co Ltd. (ISBN 81-219-2153-8)
- Experiments in Microbiology Plant Pathology and Biotechnology- K. R. Aneja.

E-RESOURCES:

- http://www.midnaporecollege.ac.in/RemoteClass/

  Microbial%20spoilage%20of%20milk.pdf
- https://foodsafetyhelpline.com/what-are-the-different-methods-of-food-preservation/
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6723656/

- http://faculty.weber.edu/coberg/class/3853/3853%20mos%20and%20food%20spoilage%20notes.htm
- https://www.intechopen.com/books/poisoning-from-specific-toxic-agents-to-novel-rapid-and-simplified-techniques-for-analysis/food-poisoning-caused-by-bacteria-food-toxins
- https://www.biotechnologynotes.com/food-biotechnology/microorganisms-in-food/growth-ofmicroorganisms-in-food-intrinsic-extrinsic-factors-biotechnology/14135

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the significance and activities of microorganisms in food and milk, the role of intrinsic and extrinsic factors on growth and survival of microorganisms	U	PSO-1
CO-2	Examine the role of starter cultures in fermentation. Understand the types of different fermented food and milk products and analyse the values of probiotics, SCP	U, An, C	PSO-1
CO-3	Role of different microorganisms in food spoilage, food fermentation and food borne diseases. Understand the role of microorganism in milk and milk product spoilage and milk borne diseases	U and R	PSO-1
CO-4	Describe the concepts behind bacteriological examination of milk.	U and An	PSO-1,2

CO-5	Understand different food preservation techniques and employ the techniques to improve the shelf life of food products. Demonstrate proper personal hygiene procedures with regard to food handling, GMP and HACCP.	U, R and Ap	PSO-1,2
CO-6	Application of laboratory techniques for food quality control	U, Ap, An, C	PSO-1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the significance and activities of microorganisms in food and milk, the role of intrinsic and extrinsic factors on growth and survival of microorganisms	PO 6/ PSO-1	U	F, C	L	
CO-2	Examine the role of starter cultures in fermentation Understand the types of different fermented food and milk products and analyse the values of probiotics, SCP	PO 1/ PSO-1	U, An, C	F, P	L	

CO-3	Role of different microorganisms in food spoilage, food fermentation and food borne diseases. Understand the role of microorganism in milk and milk product spoilage and milk borne diseases	PO 1/ PSO-1	U and R	F, C	L	
CO-4	Describe the concepts behind bacteriological examination of milk.	PO 1/ PSO-1,2	U and An	F, P		
CO-5	Understand different food preservation techniques and employ the techniques to improve the shelf life of food products. Demonstrate proper personal hygiene procedures with regard to food handling, GMP and HACCP.	PO 1/ PSO-1,2	U, R and Ap	F,C and P	L	
CO-6	Application of laboratory techniques for food quality control	PO 1/ PSO-1,2	U, Ap, An, C	P,M	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	1	-	-	-	-	1	-	-	-	-	-

CO 2	2	2	-	-	-	-	2	-	-	-	-	-
CO 3	2	2	-	-	-	-	2	-	-	-	-	-
CO 4	2	2	-	-	-	-	2	-	-	-	-	-
CO 5	2	3	-	-	-	-	2	-	-	-	-	-
CO 6	3	3	-	-	-	-	2	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6		✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK3DSCMBY202				
Course Title	Microbial Diversity				
Type of Course	**DSC-P**				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5 hours
Pre-requisites	Basic knowledge on microbial diversity acquired during the first year of the course.				
Course Summary	Microbial diversity considers the vast array of microorganisms -the smallest form of life which exists everywhere. The topic helps the students to acquire in-depth knowledge of structure and organization, cultivation methods and growth patterns of different groups of microbes and the student gains insights into the vastness of bacterial diversity and its significance.				

Detailed Syllabus:Total hours-75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
I		**Module 1: Microbial Systematics**	**8**
	1	Definition	
	2	Classification and Linnaean System, Natural System of Classification, Binomial nomenclature, International code of nomenclature of prokaryotes, Taxon, species, strain	

	3	Classification Systems: Haeckel's three kingdom of classification, Whittaker's five kingdom classification, Three domain and five domain classification concept Classification and salient features of bacteria according to Bergey's Manual of Systematic Bacteriology	
	4	Classification of bacteria: Criteria for classification-morphological, nutritional, ecological,biochemical and molecular.	
II	**Module 2: Diversity protozoa**		**7**
	1	General characters and classification up to order level	
	2	Biodiversity and economic importance	
	3	Parasitic protozoans: Life cycle of *Entamoeba histolitica, Trypanosoma brucei, Leishmania donovani* and *Giardia lamblia*	
III	**Module 3: Diversity in virus**		**7**
	1	History, Morphology and fine structure of virus	
	2	Size, shape capsid and capsomeres. Capsid symmetry - helical, icosahedral and complex. Classification of virus-nucleic acid diversity, Nomenclature and ICTV classification	
	3	Structure of bacteriophage	
	4	Viral multiplication-lytic and lysogenic cycle	
IV	**Module 4: Diversity in Fungi and Algae**		**8**
	1	General features, classification and economic importance of fungi.	
	2	Characteristics of Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes	
	3	Distinguishing characteristics - *Rhizopus* sp*., Mucor* sp*., Aspergillus* sp*., Penicillium* sp. and *Fusarium* sp	
	4	Yeasts – a brief account of *Candida* sp and *Saccharomyces* sp	
	5	General characters, classification and economic importance of Algae	
	6	Ultrastructure of the cyanobacterial cell.	
V	**Module 5: Diversity in microbes**		**15**
	1	Archaea bacteria and extremophiles	
	2	General characteristics and classification of Actinomycetes	

	3	Microbial diversity with Cultivated vs Uncultivated microorganisms. Cultivation independent methods to assess microbial diversity	
	4	Human microbiome	
		Practicals	**Hrs 30**
VI		**Practical: Total credit: 1, contact hours/week: 2**	**Hrs 30**
	1	Capsule staining	
	2	Volutin granule staining	
	3	Staining of yeast	
	4	Cultivation of anaerobic bacteria by candle jar method	
	5	Isolation and morphological identification of actinomycetes	
	6	Isolation of bacteria from water sample	
	7	Evaluation of microbial growth in various pH	
	8	Evaluation of microbial growth in various temperature	
	9	Isolation of halophilic bacteria	

References

1. Aneja, K.R. (2001). Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom Production Technology, 3rd Edition, New Age International (P) Ltd., New Delhi
2. Dubey, R.C. and Maheswari, D.K. (2002). Practical Microbiology, S. Chand & Co., New Delhi
3. Burns, R.G. and Slater, J.H. (1982). Experimental Microbiology and Ecology. Blackwell Scientific Publications, USA.
4. Peppler, I.L. and Gerba, C.P. (2004). Environmental Microbiology – A Laboratory Manual. Academic Press. New York.
5. Prescott, Harley and Klein Wim. Microbiology, C. Brown Publishers
6. Kannan N (2003).Hand Book of Laboratory Culture Medias, Reagents, Stains and Buffers. Panima Publishing Co., New Delhi.
7. Frazier WC and West off DC. (1988) Food microbiology, TATA McGraw Hill Publishing Company Ltd. New Delhi.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand about microbial systematics and different classification methods	R,U	PSO1
CO-2	Create information on protozoan diversity	U,C	PSO1
C0-3	Understand and create information on viral structure	U,C	PSO1
C0-4	Understand fungal and algal structure	U,C	PSO1
C0-5	Understand microbial diversity with Cultivated vs Uncultivated microorganisms	U,An	PSO1,3
C0-6	To learn hands-on practical knowledge in the topic	U,C,Ap	PSO 2,3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand about microbial systematics and different classification methods	PO1/ PSO1	R,U	F,C	L	
CO-2	Create information on protozoan diversity	PO1/ PSO1	U,C	F,C	L	
C0-3	Understand and create information on viral structure	PO1/ PSO1	U,C	F,C	L	

C0-4	Understand fungal and algal structure	PO1/ PSO1	U,C	F,C	L	
C0-5	Understand microbial diversity with Cultivated vs Uncultivated microorganisms	PO1,2/ PSO1,3	U,An	F,C	L	
C0-6	To learn hands-on practical knowledge in the topic	PO1,2,6/ PSO2,3,5	U,C,Ap	C,P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	1	-	-	-	-	-
CO 2	1	-	-	-	-	-	1	-	-	-	-	-
CO 3	1	-	-	-	-	-	1	-	-	-	-	-
CO 4	1	-	-	-	-	-	1	-	-	-	-	-
CO 5	1	-	2	-	-	-	1	2	-	-	-	-
CO 6	-	1	1	-	2	-	1	2	-	-	-	2

Correlation Levels:

Level	**Correlation**
-	Nil

1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6				✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK3DSCMBY203				
Course Title	**Microbes and Environment**				
Type of Course	**DSC-P**				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	A foundational understanding of microbiology acquired during previous semesters.				
Course Summary	This course delves into the vast realm of microbiology, focusing on the interactions between microorganisms and the environment. Students will gain insights into the diverse roles that microbes play in ecosystems, air, soil, water, and extreme habitats. The course emphasizes the significance of microorganisms in various environmental processes, including bioremediation, pollution control, and pharmaceutical production.				

Detailed Syllabus: Total hours -75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
I		**Module 1:Influence of Microbes in Environment**	**7**
	1	Microorganisms in nature and their importance	
	2	Natural habitats of microorganisms	
	3	Microorganisms as components of ecosystem-as producers and decomposers	

	4	Microbes on food production	
II	**Module 2: Microbes in air and soil**		**8**
	1	Composition of Air; Number and kinds of organisms in air	
	2	Distribution and sources of air borne organisms	
	3	Assessment of air quality	
	4	some important air borne diseases: influenza, chickenpox, tuberculosis, mumps, aspergillosis; their symptoms and preventive measures.	
	5	Soil and plant microbiomes	
	6	Importance of microorganisms for agriculture: beneficial and pathogenic	
III	**Module 3: Aquatic Microbiology**		**8**
	1	Distribution of Microorganisms in the Aquatic Environment- fresh water (ponds, lake, River)	
	2	Sources and Types of Water Pollution, Biological Indicators of Water Pollution	
	3	Determination of the quality of Water - MPN Index, Membrane Filtration, Biological Oxygen Demand.	
	4	water borne diseases: amoebiasis, cholera, typhoid fever and preventive measures.	
IV	**Module 4: Microbial Bioremediation**		**7**
	1	Principles and degradation of common pesticides, organic -hydrocarbons, oil spills and inorganic matter, biosurfactants	
	2	synthetic polymers	
V	**Module 5: Extremophiles**		**15**
	1	Extreme Habitats: Microbes thriving at high & low temperatures, high hydrostatic & osmotic pressures, pH, salinity, Radiation & low nutrient levels	
	2	Antibiotic-resistant bacteria	
	3	Biomining	
	4	Microbes and production of pharmaceuticals	

		Practical	Hrs 30
VI		**Practical: Total credit: 1, contact hours/week: 2**	
	1	Isolation and enumeration of microbes from air	
	2	Isolation and enumeration of microbes from water sample	
	3	Assessment of microbiological quality of water	
	4	Determination of BOD of waste water sample	

References

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
2. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
3. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
4. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
5. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
6. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
7. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the concept of microbes and environment	U	PSO 1
CO-2	Create information and understand about microbes in our air	U,C	PSO 1

C0-3	Understand about aquatic microbes	U,C	PSO 1
C0-4	Understand and anlyse the use of microbes in environment cleaning	U , An	PSO 1
C0-5	Understand the importance of microbes in environmental processes and the ability to survive in harsh conditions	U,An	PSO 1
CO -6	To leran hands -on practical knowledge in the topic	U,C,Ap	PSO 2,3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the concept of microbes and environment	PO 1/PSO 1	U	F,C	L	
CO-2	Create information and understand about microbes in our air	PO 1/PSO 1	U,C	F,C	L	
C0-3	Understand about aquatic microbes	PO 1/PSO 1	U,C	F,C	L	
C0-4	Understand and anlyse the use of microbes in environment cleaning	PO 1/ PSO1	U , An	F,C	L	
C0-5	Understand the importance of microbes in environmental processes and the ability to survive in harsh conditions	PO 1/PSO 1	U,An	F,C	L	
CO -6	To leran hands -on practical knowledge in the topic	PO1,2,6/ PSO2,3,4	U,C,Ap	C,P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-	1	-	-	-	-	-
CO 2	1	-	-	-	-	-	1	-	-	-	-	-
CO 3	1	-	-	-	-	-	1	-	-	-	-	-
CO 4	1	-	-	-	-	-	1	-	-	-	-	-
CO 5	1	-	-	-	-	-	1	-	-	-	-	-
CO 6	-	1	1	2	-	-	1	2	-	-	-	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓

CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6				✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK4DSCMBY201				
Course Title	**Microbial Genetics**				
Type of Course	**DSC-P**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge of microorganisms, DNA & RNA acquired during HSE and previous semesters of this programme.				
Course Summary	The course familiarizes students with the basic concepts of microbial genetics and inculcates the importance of DNA replication, gene transfer mechanisms, genetic engineering and its applications.				

Detailed Syllabus:Total hours- 75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Module 1:Mendelian Genetics**	**Hrs 45**
I			**7**
	1	Introduction to the history of genetics, Mendel's laws of genetics, alleles, multiple alleles	
	2	Basic idea about Genotype, phenotype, dominance, co-dominance, Test cross, back cross, linkage, crossing over, Mapping and Sex-linked inheritance	
	3	A brief idea about population genetics-Hardy Weinberg law	

II	**Module 2: DNA Replication and Mutation**		**7**
	1	Evidence of DNA as genetic material- Griffith's transformation experiment, Hershey and chase experiment.	
	2	DNA replication- Proposed models of DNA replication- Conservative, semi conservative and dispersive models Mechanism of DNA replication: Enzymes and proteins involved in DNA replication	
	3	Prokaryotic replication & its types: φ- Theta mode and σ-sigma mode or rolling circle model of replications.	
	4	Mutagens: Chemical and physical mutagens, Ames test, Chromosomal aberrations- structural aberrations, and numerical aberrations. Gene mutations.	
III	**Module 3:Basic tools in Genetic Engineering**		**8**
	1	Plasmids-Property and function of plasmids, Types of plasmids- F-plasmids, resistance plasmids, virulence plasmids, degradative plasmids Col plasmid and Ti plasmid.	
	2	Restriction enzymes, Ligases: Brief account	
	3	Cloning vectors: pBR, pUC series, Phagemids, Cosmids, BAC, YAC	
	4	Gene Delivery-Different methods used for introducing foreign DNA into the cell: DNA direct transformation, electroporation, Microinjection and biolistic methods (gene gun)	
IV	**Module 4: Gene Transfer Mechanisms**		**8**
	1	Transformation - Discovery, mechanism of natural competence	
	2	Conjugation - Discovery, mechanism, F-factor, high-frequency recombination, Hfr strains; F+, F-, F prime (F')	
	3	Transduction - generalized transduction; abortive transduction; specialized transduction	
V	**Module 5: Genetically Modified Organisms**		**15**
	1	Transgenic plants- Brief account on transgenic plants, Herbicide resistant plants (Glyphosate tolerant plants), Flavr Savr tomato insect-resistant plants (transgenic plants with Bt Toxin)	
	2	Transgenic animals: General Introduction to transgenic animals- transgenic mice, transgenic cows, sheep and goats, Animal biopharming	

	3	GMOs- Applications of genetically modified organisms	
	4	Positive and Negative Impacts of Genetically Modified Organisms (GMOs)	
		Practicals	**Hrs 30**
Course Type: Practical, Total credits: 1, Contact hours/week: 2			
VI	1	Isolation of antibiotic-resistant bacterial population by gradient plate method	
	2	Isolation of streptomycin-resistant mutant by replica plate technique	
	3	Isolation of genomic DNA from bacteria	
	4	Demonstration of agarose gel electrophoresis	
	5	Demonstration of genetic recombination in bacteria by conjugation.	
	6	Demonstration of Bacterial transformation	

REFERENCES:

Molecular Biology of the Gene by Watson, JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AAM.

Genes V by Lewin B, 1994. Oxford University press.

Molecular Cell Biology by Lodish, H, Baltimore D, Berk A, Zipursky SL, Matsudaira P, Darnell J.

Molecular Biology by Freifelder D., 1991 Narosa Publishing Home.

Principles of Gene Manipulation, 4th Ed., by R.S.Old and S.B.Primrose.

Principles of Genetics by Gardner EJ, Simmons MJ, Snustad DP.

Genes and Genomes by Singer M, Berg P.1991 University Science Books.

Dubey R C and Maheswari, D K (2002). Practical Microbiology. S. Chand & Co Ltd. (ISBN 81-219-2153-8)

Experiments in Microbiology Plant Pathology and Biotechnology- K. R. Aneja

Molecular Cloning: A Laboratory Manual, Volume 1& 2: Joseph Sambrook, David William Russell

E-RESOURCES:

https://www.cliffsnotes.com/study-guides/biology/microbiology/microbial-genetics/introduction-to-microbial-genetics

https://asutoshcollege.in/new-web/Study_Material/microbial_genetics_07042020.pdf

https://open.oregonstate.education/generalmicrobiology/chapter/microbial-genetics/

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understanding the history of genetics and basic concept of classical Mendelian genetics	U	PSO-3,5
CO-2	Understand various mechanisms of DNA Replication	R, U	PSO-3,5
CO-3	Acquiring knowledge in the techniques, tools, and application of Genetic Engineering.	U, An	PSO-3,5
CO-4	Acquire knowledge about different gene transfer Mechanisms	An, E	PSO-3,5
CO-5	Understand the historical context, production and application of GMOs. Gain knowledge about transgenic plants and transgenic animals and its production	U, Ap,	PSO-3,5
CO-6	Familiarization and use of molecular biology techniques	U, Ap, C	PSO 2,6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understanding the history of genetics and basic concept of classical Mendelian genetics	PO-6/ PSO-3, 5	R,U	F, C	L	
CO-2	Understand various mechanisms of DNA Replication	PO-6/ PSO-3, 5	R,U	F,C	L	
CO-3	Acquiring knowledge in the techniques, tools, and application of Genetic Engineering.	PO-6/ PSO-3, 5	R,U,Ap	F, C	L	
CO-4	Acquire knowledge about different gene transfer Mechanisms	PO-6/ PSO-3, 5	R,U,Ap	F, C	L	
CO-5	Understand the historical context, production and application of GMOs. Gain knowledge about transgenic plants and transgenic animals and its production	PO-6/ PSO-3, 5	R,U,Ap, An	F, C	L	
CO-6	Familiarization and use of molecular biology techniques	PO-4,5, 6/ PSO-3, 5	R,U,Ap, An	F, C, P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-	-	-	-	-	-	
CO 2	2	3	-	-	-	-	-	-	-	-	-	
CO 3	-	-	1	-	-	-	-	-	-	-	-	2
CO 4	-	-	2	3	-	-	-	-	-	-	-	2
CO 5	-	1	-	-	-	-	-	-	-	-	-	2
CO 6	-	-	-	3	-	-	-	-	-	2	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments

- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6				✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK4DSCMBY202				
Course Title	**Microbial Physiology and Metabolism**				
Type of Course	**DSC-P**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5 hours
Pre-requisites	Basic knowledge of microorganisms acquired during the previous semesters of this programme.				
Course Summary	This course explores the fundamental principles governing the growth, nutrition, and metabolism of microorganisms. It covers a wide range of topics, from the nutritional requirements of bacteria to the intricate pathways involved in energy generation and substrate utilization. Students will gain insight into the diverse strategies employed by microorganisms to adapt to different environmental conditions and thrive in various habitats.				

Detailed Syllabus:Total hours 75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
	Module 1 : Microbial Nutrition		**8**
	1	Nutritional requirements – importance of various macro, micro elements and growth factors in bacterial growth	

I	2	Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe),barophilic	
	3	Microbial growth in response to nutrition and energy – Autotroph/ Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.	
	4	Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media	
II	**Module 2: Microbial Growth**		**7**
	1	Bacterial growth curve and generation time. Measurement of microbial growth – SPC, direct microscopic count, gravimetry, turbidometry and nephlometery.	
	2	Batch, Fed batch, Continuous culture. Synchronous and diauxic growth curve. Sporulation. Primary and secondary metabolite of microbes	
III	**Module 3: Transport of nutrients**		**7**
	1	Transport of nutrients	
	2	Passive and facilitated diffusion	
	3	Primary and secondary active transport, concept of uniport, symport and antiport Group translocation, Iron uptake	
	4	Role of osmoregulatory proteins – permiomics	
IV	**Module 4: Microbial catabolic pathways**		**8**
	1	Glycolysis, hexose monophosphate pathway, Entner Doudoroff pathway	
	2	Tricarboxylic acid cycle	
	3	Electron transport system–components	
	4	Adenosine tri phosphate structure and their generation types- Oxidative and substrate level phosphorylation	

	5	Fermentation: Alcoholic, homo and hetero lactic fermentation. Propionic acid and mixed acid fermentation, Pasteur effect	
V		**Module 5: Chemolithotrophic and Phototrophic Metabolism**	**15**
	1	Introduction to aerobic and anaerobic chemolithotrophy with an example each	
	2	Methanogenesis: definition and reaction	
	3	Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria	
		Practical	
VI		**course type: Practical: Total credit: 1, contact hours/week: 2**	Hrs 30
	1	Study and plot the growth curve of E. coli by turbidometric and standard plate count methods	
	2	Effect of temperature on growth of bacteria: E. coli	
	3	Effect of pH on growth of bacteria: E. coli	
	4	Effect of salt on growth of bacteria: E. coli	
	5	Demonstration of alcoholic fermentation	

References

1. Aneja KR (2003). Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom Production Technology, 4th Edition, New Age International (P) Ltd., New Delhi
2. Dubey, R.C. and Maheswari, D.K. (2002). Practical Microbiology, S. Chand & Co., New Delhi
3. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education

4. Pelzar M.J.Jr, Chan E.C.S and Krieg N.R. 1986. Microbiology, McGraw Hill Book Company, London
5. Gupte, S. (1995). Practical Microbiology. Jaypee Brothers Medical Publishers Pvt. Ltd
6. Kannan, N. (2003). Hand Book of Laboratory Culture Medias, Reagents, Stains and Buffers. Panima Publishing Co., New Delhi.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the nutrition requirements and growth media	U,An	PSO-1,2
CO-2	Create and analyse information on microbial growth pattern.	C,An	PSO-1,3
C0-3	Understand microbial uptake of nutrients for the growth	U	PSO-1,3
C0-4	Understand and create information on microbial metabolism	R,U, C	PSO-1,5
C0-5	Understand phototrophic microbial metabolism	R,U	PSO-1,3,5
CO-6	To learn hands-on techniques in microbiology	U,Ap,An	PSO-2,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the nutrition requirements and growth media	PO1/ PSO 1,2	R,U	F,C	L	
CO-2	Create and analyse information on microbial growth pattern.	PO1/ PSO1,3	U,C	F,C	L	

C0-3	Understand microbial uptake of nutrients for the growth	PO1,2,3/ PSO1,3	U,C	F,C	L	
C0-4	Understand and create information on microbial metabolism	PO1,2,3/ PSO1,3	U,C	F,C	L	
C0-5	Understand phototrophic microbial metabolism	PO1,2/ PSO1,3	U,An	F,C	L	
CO-6	To learn hands-on techniques in microbiology	PO1,2,6/ PSO 2,3,5	U,C,Ap	C,P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	1	-	-	-	-	1	-	-	-	-	-
CO 2	1	-	2	-	-	-	1	-	-	-	-	-
CO 3	1	-	2	-	-	-	1	1	2	-	-	-
CO 4	1	-	2	-	-	-	1	2	2	-	-	-
CO 5	1	-	2	-	-	-	1	1	-	-	-	-
CO 6	-	1	1	-	2	-	1	2	-	-	-	2

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6				✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK5DSCMBY301				
Course Title	**Industrial Microbiology**				
Type of Course	**DSC-P**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Knowledge of microorganisms during the first & second year of this programme.				
Course Summary	Industrial Microbiology covers different aspects of fermentation technology, including the design and operation of fermenters, optimization of fermentation processes, and scale-up considerations for industrial production, recovery and various immobilization techniques.				

Detailed Syllabus: Total hours- 75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
I		**Module 1: Fermentation Technology**	**15**
	1	History and scope of Industrial microbiology	
	2	Introduction to fermentation technology	
	3	Types of fermentation: Solid State, Submerged, Batch, Fed batch, Continuous fermentation	
		Module 2: Upstream Processing	**15**

II	1	Screening techniques- Primary and Secondary	
	2	Strain improvement of industrially important microorganisms- Mutation, Recombination and protoplast fusion	
	3	Inoculum preparation	
	4	Cell and enzyme immobilization	
	5	Media for industrial fermentation	
	6	Sterilization of fermenter and media	
III	**Module 3: Design And Parts Of Fermenter**		**15**
	1	Basic design and parts of Fermenter	
	2	Fermenter construction- Construction materials, agitator/impeller, sparger, baffles, pH control sensor, stirrer glands and bearings, temperature control, pressure control, foam control, inoculation and sampling ports	
	3	Types of fermenters: Continuous stirred tank, Bubble Column, Packed bed, Fluidized bed, Airlift & Tower fermenter	
IV	**Module 4: Downstream Processing**		**15**
	1	Recovery of fermentation product: Intracellular & Extracellular product	
	2	Cell disruption	
	3	Solid liquid separation	
	4	Concentration	
	5	Purification	
	6	Formulation	
V	**Module 5: Microbial Products**		**15**
	1	Industrial process involved in the production of antibiotics: Penicillin, Streptomycin	
	2	Industrial process involved in the production of Vitamins: Vitamin B12, Riboflavin	
	3	Microbial enzymes, Industrial process involved in the production of Enzymes: Amylase, Protease, Pectinase	
	4	Industrial process involved in the production of Solvents: Ethanol, Acetone and butanol	
	5	Industrial process involved in the production of Organic acids: Citric acid and acetic acid	

		PRACTICALS	**30 hrs**
Course Type: Practical's, Total credit: 1, Contact hour/week:2			
VI	1	Immobilization of yeast cells by sodium alginate method	
	2	Screening for amylase producers	
	3	Screening for lipolytic microbes	
	4	Screening for protease producers	
	5	Screening of antibiotic producers by crowded plate technique	
	6	Production of wine from grapes	
	7	Determination of total acidity of wine	
	8	Determination of volatile acidity of wine	
	9	Determination of Dissolved Oxygen (DO) of water	
	10	Determination of Chemical Oxygen Demand (COD) of water	

REFERENCES:

- Industrial Microbiology - L.E. Casida,JR (ISBN 0 85226 1012).
- Industrial Microbiology-A.H.Patel (ISBN 0333 90842 2).
- Prescott & Dunn's Industrial Microbiology Reed G (Ed) ISBN 81-239-1001-0) (Fourth
- Edition).
- Food Microbiology-William C.Frazier Dennis .C Westhoff (ISBN 0-07-46210147).
- Fermented foods Economic Microbiology Vol 7 Rose A (ed).
- Manual of Industrial Microbiology And Biotechnology, Demin & Davis.
- Applied Microbiology-Musharraffudde.
- Nduka Okafor. Modern Industrial Microbiology and Biotechnology. (2007). CRC Press.
- Michael J. Waites, Neil L. Morgan, John S. Rockey, Gary Higton. Industrial Microbiology: An Introduction, (2013). Wiley Blackwell Publishers.
- Crueger W and Crueger A. Biotechnology: A Textbook of Industrial Microbiology.2ndEd. (1991). Sinauer Associates Inc.,U.S.

- Srivastva, M.L. 2008. Fermentation Technology, Narosa Publ. House, New Delhi. 2. Michael 12.J. Waites, Neil L.Morgan, John S. Rockey and Gray Higton. 2001. Industrial Microbiology An Introduction, Replika Press Pvt Ltd. New Delhi.
- Wulf Crueger and Anneliese Crueger. 2000. A textbook of Industrial Microbiology II Ed. Panima Publishing Corporation, New Delhi.

E-RESOURCES:

- https://www.biologydiscussion.com/industrial-microbiology-2/strain-improvement-of-microorganisms-microbiology/66010
- http://www.generalmicroscience.com/industrial-microbiology/fermentor-design/
- https://www.biotechnologynotes.com/industrial-biotechnology/fermentation-process/downstream-process-in-fermentation-with-methods-industries-biotechnology/13671
- https://www.onlinebiologynotes.com/different-fermentation-pathway-bacteria/
- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000444FN/P000551/M012164/ET/1463034230Q-I.pdf
- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000002BI/P001357/M021492/ET/1501755459BioprocessenggPGPthshala.pdf
- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000015FT/P000057/M000079/ET/1455710283ET21.pdf
- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/food_technology/technology_of_fruits_and_vegetables/29.technology_of_vinegar_production/et/2860_et_m29.pdf
- http://www.fao.org/3/x0560e/x0560e10.htm
- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000014ER/P000284/M026024/ET/1514784562Paper15EMB_Module18__etext.pdf

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand history and scope of Industrial Microbiology	R,U	PSO-1
CO-2	Screen and isolate beneficial microorganisms from environment	U,Ap	PSO-1,3
CO-3	Understand design and parts of fermenter	R,U	PSO1
C0-4	Gain knowledge about different techniques of product recovery	U,Ap	PSO1,2
CO-5	Gain theoretical knowledge on production of microbial products	U,Ap	PSO1,6
CO-6	To learn different laboratory techniques to screen industrially useful microorganisms	E,C	PSO2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand history and scope of Industrial Microbiology	PO6,PSO-1		F, C	L	
CO-2	Screen and isolate beneficial microorganisms from environment	PO3,PSO-1,3		F,P	L	
CO-3	Understand design and parts of fermenter	PO3,PSO1		F	L	

C0-4	Gain knowledge about different techniques of product recovery	PO6,PSO1,2		F,P	L	
CO-5	Gain theoretical knowledge on production of microbial products	PO6,PSO1,6		F,P	L	
CO-6	To learn different laboratory techniques to screen industrially useful microorganisms	PO1,6,PSO2,3		P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-						1
CO 2	2	-	2	-	-	-			2			
CO 3	2	-	-	-	-	-			1			
CO 4	2	1	-	-	-	-						1
CO 5	2	-	-	-	-	1						2
CO 6	-	2	2	-	-	-	2					2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓			

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK5DSCMBY302				
Course Title	**Instrumentation in Microbiology**				
Type of Course	**DSC**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	4 hours	-		4 hours
Pre-requisites	Basic knowledge of bio-instrumentation techniques acquired during the first year of this programme.				
Course Summary	This course is designed to equip students with the practical skills and theoretical knowledge necessary to perform microbiological experiments and analyses in laboratory settings safely and efficiently.				

Detailed Syllabus: Total hours-60

Course Type: Theory, Total credits: 4, Contact hours/week: 4			
Module	**Unit**	**Content**	**Hrs 60**
I	**Module 1: General Laboratory practices**		**12**
	1	Biosafety in microbiological laboratories: General safety measures, Personal protection, Chemical and Biological hazards, Spillage and Waste disposal, First aid.	
	2	Laboratory safety symbols, signs and meanings	
	3	Theory, principle and working of micropipettes, pH meter and Distillation unit	

II	**Module 2: Separation & Identification of Biomolecules**		**12**
	1	Concept of Chromatography ; Partition Chromatography, Paper Chromatography, Adsorption Chromatography, TLC, GLC, Ion Exchange Chromatography, Gel Chromatography, HPLC, Affinity Chromatography	
	2	Electrophoresis : Gel Electrophoresis-AGE and SDS-PAGE, Paper Electrophoresis and its application.	
III	**Module 3: Centrifugation**		**12**
	1	Basic Principle of Centrifugation, Factors affecting Sedimentation velocity, Standard Sedimentation Coefficient	
	2	Rotor types	
	3	Types of centrifugation: Rate-Zonal, sedimentation equilibrium and density gradient centrifugation	
	4	Instrumentation of Ultracentrifuge -Preparative and Analytical	
IV	**Module 4: Spectroscopy**		**12**
	1	Basic principle of spectrometry	
	2	Theory and application of UV and Visible spectrophotometer, IR Spectroscopy, Raman Spectroscopy, NMR spectroscopy, Fluorescence spectroscopy, atomic absorption spectroscopy	
	3	Colorimetry	
V	**Radio isotopic techniques**		**12**
	1	Use of radioisotopes in life sciences	
	2	Radioactive labelling, principle and application of tracer techniques	
	3	Detection and measurement of radioactivity: Geiger- Muller and Scintillation counters	
	4	Autoradiography and its applications	

References

1. Chatwal G and Anand, S (1989). Instrumental Methods of Chemical Analysis.Himalaya Publishing House, Mumbai
2. Williams, B.L. and Wilson, K (1975). A Biologists Guide to Principles and Techniques of Practical Biochemistry
3. Hanes. Gel Electrophoresis of Proteins- A Practical Approach

4. James Miller (1988). Chromatography: Concepts and Contrasts.John Wiley and Sons.Inc., New York
5. R R. J. Hamilton and P. A. Sewel. Introduction to High Performance Liquid Chromatography

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the general laboratory practices	U	PSO-1
CO-2	Understand the different separation techniques used in microbiology	U,Ap	PSO-2,3
C0-3	Understand different centrifugation techniques	U , Ap	PSO-2,3
C0-4	Understand and apply different spectrometric techniques in microbiological studies	U, AP	PSO-2,3
C0-5	Understand radioactivity and its detection in biological samples	U, An	PSO-2,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the general laboratory practices	PO 1,6/ PSO 1	U	F,P	L	
CO-2	Understand the different separation techniques used in microbiology	PO 1,6/ PSO 2,3	U,Ap	F,C,P	L	

C0-3	Understand different centrifugation techniques	PO 1,6/ PSO 2,3	U , Ap	F,C,P	L	
C0-4	Understand and apply different spectroscopic techniques in microbiological studies	PO 1,6/ PSO 2,3	U, AP	F,C,P	L	
C0-5	Understand radioactivity and its detection in biological samples	PO 1,6/ PSO 2,3,5	U, An	F,C,P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	1	-	-	-	-	1
CO 2	-	1	2	-	-	-	2	-	-	-	-	2
CO 3	-	1	2	-	-	-	2	-	-	-	-	2
CO 4	-	2	2		-	-	2	-	-	-	-	2
CO 5	-	1	2	-	2	-	2	-	-	-	-	2

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam

- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK5DSCMBY303				
Course Title	**Food Microbiology**				
Type of Course	**DSC-P**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge of microbes as food acquired during the first year of the programme.				
Course Summary	The course on Food Microbiology provides students with a comprehensive understanding of the microbial aspects of food safety, preservation, and quality control. Through a series of modules, students will explore the importance of studying food microbiology, microbial growth in foods, food spoilage mechanisms, methods of food preservation, and the prevention of foodborne diseases.				

Detailed Syllabus:Total hours 75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrss 45**
	Module 1: Introduction To Food Microbiology		**7**
	1	Importance of studying food microbiology	

I	2	Microbial growth in foods: principles, intrinsic and extrinsic factors that affect growth and survival of microbes in foods– hydrogen ion concentration (pH), water activity, oxidation reduction potential, nutrient content, inhibitory substances	
	3	Microorganisms important in food microbiology – (a) Bacteria: Genus- Acetobacter, *Bacillus, Clostridium, Alcaligenes,Clostridium, Corynebacterium, Erwinia, Escherichia, halobacterium, Flavobacterium, Lactobacillus,Propionibacterium, Psedomonas, serratia* (b) Molds : *Aspergillus, Rhizopus, Mucor and Penicillium, trichothecium, Neurospora,Cladosprium,, Alternaria,Fusarium, Sclerotinia* (c) Yeast : Genus - *Saccharomyces*, *Kluyveromyces,Pichia, Hansenula, Torulopsis, Candida, Rhodotorula*	
II	**Module 2: Fermented Foods**		7
	1	Microbiology of fermented foods – Wine, Beer, vinegar, idly, bread, Curd, fermented vegetables-Sauerkraut, pickles	
	2	Nutritional value of fermented foods	
	3	Microorganisms as food: single cell protein, edible mushrooms	
	4	Probiotics: definition and uses	
III	**Module 3: Food Spoilage**		**8**
	1	General principles underlying spoilage of food - Causes of spoilage	
	2	Classification of food by ease of spoilage	
	3	Contamination and spoilage of milk, vegetables and fruits	
	4	Contamination and spoilage of meat and meat products, sea foods	
	5	Contamination and spoilage of canned foods	
IV	**Module 4: Principles And Methods Of Food Preservation**		**8**
	1	Principles of preservation	
	2	Asepsis, removal of microorganism, maintenance of anaerobic conditions.	
	3	Preservation by the use of high temperature-Pasteurization, Ultra heat treatment and canning	
	4	Preservation by the use of low temperature-Cellar storage, Chilling and Freezing	

	5	Preservation by drying - Solar drying, Drying by Mechanical Dryers, Freeze Drying, Drying During Smoking and Intermediate moisture foods	
	6	Preservation by food additives-Propionates, Benzoates,Acetates, Nitrates and nitrites,Sulfur dioxide and sulfites, Ethylene and propylene oxide, Sugar and salt, Woodsmoke, Spices, Natural and synthetic colorants and Antibiotics	
	7	Preservation by irradiation-gamma rays, x-rays, electron beams	
V	**Module 5: Food Borne Disease And Sanitation**		**15**
	1	Definition of food poisoning	
	2	Food borne infections and intoxication - Bacterial– *Staphylococcus aureus, Clostridium botulinum, Clostridium perfringens, Salmonella typhi, Vibrio cholerae, E. coli, Shigella sp., Listeria monocytogenes, Yersinia Enterocolitica*	
	3	Non bacterial: Fungal – Mycotoxins, Viruses- Hepatitis A and E, viral gastroenteritis. Food borne parasites - Amoebiasis, Beef tapeworm, Fish tapeworm, Pork tapeworm, Trichinosis	
	4	Food sanitation- good manufacturing practices, Hazard Analysis Critical Control Points (HACCP)	
		Practical	**Hrs 30**
	Course type: Practical: Total credit: 1, contact hours/week: 2		
VI	1	Isolation and Enumeration of bacteria from fermented food–a) Curd b) Idly batter c) milk	
	2	Isolation and Enumeration of bacteria from fermented food-a) fruits and vegetables b) meat c) fish	
	3	Isolation and Identification of fungi from fermended food	
	4	Isolation and identification of spoilage microorganisms from bread	
	5	Determination of quality of milk samples by MBRT	
	6	Comparision of number of bacteria in raw and spoiled milk by standard plate count.	
	7	Production of wine from grapes	
	8	Determination of total acidity of wine	
	9	Determination of volatile acidity of wine	

	10	Immobilization of yeast cells by sodium alginate method	

References

1.Frazier WC and West off DC. (1988) Food microbiology, TATA McGraw Hill Publishing Company Ltd. New Delhi

2. Adams MR and Moss MO. (1995). Food Microbiology, The Royal Society of Chemistry, Cambridge

3. R.C Dubey, D.K Maheshwari, Practical Microbiology, S Chand and Company, New Delhi.

4. Prescott, Harley and Klein Wim. Microbiology, C. Brown Publishers

5. Cappuccino, Sherman, Microbiology Laboratory Manual, Pearson Education

6. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India

7. Alexander M. (1977) Introduction to soil microbiology. John Wiley & Sons, Inc., New York

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the significance and activities of microorganisms in food, the role of intrinsic and extrinsic factors on growth and survival of microorganisms	U	PSO-1
CO-2	Understand the types of different fermented food products and analyse the values of probiotics, SCP and Edible mushrooms.	R,U	PSO-1
C0-3	Create information on microbial food spoilage	R,U,C	PSO-1
C0-4	Understand and remember the principles in traditional food preservation techniques	R,U, An	PSO-1,2
C0-5	Understand and remember the microbes causing food intoxications and food infections and food sanitation methods	R,U	PSO-1

CO-6	Application of laboratory techniques for food quality control	U,Ap,An	PSO-2,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the significance and activities of microorganisms in food, the role of intrinsic and extrinsic factors on growth and survival of microorganisms	PO 1/ PSO1	U	F,C	L	
CO-2	Understand the types of different fermented food products and analyse the values of probiotics, SCP and Edible mushrooms.	PO 1,2/ PSO 1	R,U	F,C	L	
C0-3	Create information on microbial food spoilage	PO 1,2/ PSO 1	R,U, C	F,C	L	

C0-4	Understand and remember the principles in traditional food preservation techniques	PO 1,2/ PSO1,2	R,U, An	F,C	L	
C0-5	Understand and remember the microbes causing food intoxications and food infections and food sanitation methods	PO 1,2/ PSO 1	R,U	F,C	L	
CO-6	Application of laboratory techniques for food quality control	PO-1,2,6/ PSO2,3,5	U,Ap,An	F,C,P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	1	-	-	-	-	-
CO 2	1	-	-	-	-	-	1	1	-	-	-	-
CO 3	1	-	-	-	-	-	1	2	-	-	-	-
CO 4	1	2	-	-	-	-	1	2	-	-	-	-
CO 5	1	-	-	-	-	-	2	2	-	-	-	-
CO 6	-	1	2	-	2	-	1	2	-	-	-	2

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium

3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6				✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK5DSCMBY304				
Course Title	**Fermentation Technology**				
Type of Course	**DSC**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	4 hours	-		4 hours
Pre-requisites	Knowledge of microorganisms during the first & second year of this programme.				
Course Summary	This course covers different aspects of fermentation technology, including the design and operation of fermenters, optimization of fermentation processes, and scale-up considerations for industrial production, recovery and various immobilization techniques.				

Detailed Syllabus: Total hours- 60

Course Type: Theory, Total credits: 4, Contact hours/week: 4			
Module	**Unit**	**Content**	**Hrs 60**
I	**Module 1: Introduction to Fermentation Technology**		**10**
	1	History and scope of Industrial microbiology	
	2	Introduction to fermentation technology	
	3	Types of fermentation: Solid State, Submerged, Batch, Fed batch, Continuous fermentation	
	Module 2: Upstream Processing		**12**

II	1	Screening techniques- Primary and Secondary	
	2	Strain improvement of industrially important microorganisms- Mutation, Recombination and protoplast fusion	
	3	Inoculum preparation	
	4	Cell and enzyme immobilization	
	5	Media for industrial fermentation	
	6	Sterilization of fermenter and media	
III	**Module 3: Design And Parts Of Fermenter**		**13**
	1	Basic design and parts of Fermenter	
	2	Fermenter construction- Construction materials, agitator/impeller, sparger, baffles, pH control sensor, stirrer glands and bearings, temperature control, pressure control, foam control, inoculation and sampling ports	
	3	Types of fermenters: Continuous stirred tank, Bubble Column, Packed bed, Fluidized bed, Airlift & Tower fermenter	
IV	**Module 4: Downstream Processing**		**13**
	1	Recovery of fermentation product: Intracellular & Extracellular product	
	2	Cell disruption	
	3	Solid liquid separation	
	4	Concentration	
	5	Purification	
	6	Formulation	
V	**Module 5: Microbial Products**		**12**
	1	Industrial process involved in the production of antibiotics: Penicillin, Streptomycin	
	2	Industrial process involved in the production of Vitamins: Vitamin B12, Riboflavin	
	3	Microbial enzymes, Industrial process involved in the production of Enzymes: Amylase, Protease, Pectinase	
	4	Industrial process involved in the production of Solvents: Ethanol, Acetone and butanol	
	5	Industrial process involved in the production of Organic acids: Citric acid and acetic acid	

REFERENCES:

- Industrial Microbiology - L.E. Casida,JR (ISBN 0 85226 1012).
- Industrial Microbiology-A.H.Patel (ISBN 0333 90842 2).
- Prescott & Dunn's Industrial Microbiology Reed G (Ed) ISBN 81-239-1001-0) (Fourth
- Edition).
- Food Microbiology-William C.Frazier Dennis .C Westhoff (ISBN 0-07-46210147).
- Fermented foods Economic Microbiology Vol 7 Rose A (ed).
- Manual of Industrial Microbiology And Biotechnology, Demin & Davis.
- Applied Microbiology-Musharraffudde.
- Nduka Okafor. Modern Industrial Microbiology and Biotechnology. (2007). CRC Press.
- Michael J. Waites, Neil L. Morgan, John S. Rockey, Gary Higton. Industrial Microbiology: An Introduction, (2013). Wiley Blackwell Publishers.
- Crueger W and Crueger A. Biotechnology: A Textbook of Industrial Microbiology.2ndEd. (1991). Sinauer Associates Inc.,U.S.
- Srivastva, M.L. 2008. Fermentation Technology, Narosa Publ. House, New Delhi. 2. Michael 12.J. Waites, Neil L.Morgan, John S. Rockey and Gray Higton. 2001. Industrial Microbiology An Introduction, Replika Press Pvt Ltd. New Delhi.
- Wulf Crueger and Anneliese Crueger. 2000. A textbook of Industrial Microbiology II Ed. Panima Publishing Corporation, New Delhi.

E-RESOURCES:

- https://www.biologydiscussion.com/industrial-microbiology-2/strain-improvement-of-microorganisms-microbiology/66010
- http://www.generalmicroscience.com/industrial-microbiology/fermentor-design/
- https://www.biotechnologynotes.com/industrial-biotechnology/fermentation-process/downstream-process-in-fermentation-with-methods-industries-biotechnology/13671
- https://www.onlinebiologynotes.com/different-fermentation-pathway-bacteria/
- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000444FN/P000551/M012164/ET/1463034230Q-I.pdf

- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000002BI/P001357/M021492/ET/1501755459BioprocessenggPGPthshala.pdf
- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000015FT/P000057/M000079/ET/1455710283ET21.pdf
- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/food_technology/technology_of_fruits_and_vegetables/29.technology_of_vinegar_production/et/2860_et_m29.pdf
- http://www.fao.org/3/x0560e/x0560e10.htm
- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000014ER/P000284/M026024/ET/1514784562Paper15EMB_Module18__etext.pdf

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand history and scope of Industrial Microbiology	R,U	PSO-1
CO-2	Screen and isolate beneficial microorganisms from environment	U,Ap	PSO-1,3
CO-3	Understand design and parts of fermenter	R,U	PSO1
C0-4	Gain knowledge about different techniques of product recovery	U,Ap	PSO1,2
CO-5	Gain theoretical knowledge on production of microbial products	U,Ap	PSO1,6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand history and scope of Industrial Microbiology	PO2/ PSO-1		F, C	L	

CO-2	Screen and isolate beneficial microorganisms from environment	PO3/ PSO-1,3		F,P	L	
CO-3	Understand design and parts of fermenter	PO3/ PSO1		F	L	
C0-4	Gain knowledge about different techniques of product recovery	PO6/ PSO1,2		F,P	L	
CO-5	Gain theoretical knowledge on production of microbial products	PO6/ PSO1,6		F,P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	-	1	-	-	-	-
CO 2	2	-	2	-	-	-	-	-	2	-	-	-
CO 3	2	-	-	-	-	-	-	–	1	-	-	-
CO 4	2	1	-	-	-	-	-	-	-	-	-	1
CO 5	2	-	-	-	-	1	-	-	-	-	-	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK6DSCMBY301				
Course Title	**Medical Microbiology**				
Type of Course	**DSC-P**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Knowledge of microorganisms during the first & second year of this programme.				
Course Summary	This course instills the basic concepts of medical microbiology and microbial pathogenesis: study of microbes, antimicrobial agents, epidemiology, and virulence factors associated with pathogenic microorganisms. It will also provide opportunities for a student to develop diagnostic skills in clinical microbiology, including the practical application and interpretation of laboratory tests for the diagnosis of infectious diseases.				

Detailed Syllabus: Total hours 75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
	Module 1: Introduction of Medical microbiology		**7**

I	1	Normal Microbial flora- Resident flora and transient flora, Beneficial and harmful effects of normal flora.	
	2	Brief account of the normal flora of skin, conjunctiva, upper respiratory tract, mouth, teeth, stomach, upper and lower intestine, genitourinary tract.	
	3	**Infections:** Source of infection, **Nosocomial infections**:-Introduction and its types, pathogenicity and laboratory diagnosis of nosocomial infection, prevention and control of nosocomial infections **Types**: Epidemic, Pandemic and Endemic diseases.	
	4	**Antimicrobial chemotherapy:** Antibiotics and their mode of action (a) Inhibition of Cell wall - Penicillin and Bacitracin (b) Inhibition of Cell membrane -Tyrosidine and Gramicidin (c) Inhibition of Protein synthesis- Tetracycline and chloramphenicol (d) Inhibition of nucleic acid synthesis- Ciprofloxacin (e) Metabolic antagonism-Sulphonamides. Antimicrobial sensitivity tests- diffusion and dilution techniques	
II		**Module 2: Medical Bacteriology**	**8**
	1	**A brief account of morphological characteristics, pathogenicity, laboratory diagnosis, prevention and control of the disease caused by:** *Staphylococcus aureus, Streptococcus pyogenes*	
	2	**A brief account of morphological characteristics, pathogenicity, laboratory diagnosis, prevention and control of the disease caused by** *Escherichia coli, Salmonella typhi* and *Vibrio cholera*	
	3	**A brief account of morphological characteristics, pathogenicity, laboratory diagnosis, prevention and control of the disease caused by** *Neisseria gonorrhoeae, Treponema pallidum* and *Chlamydia trachomatis*	
	4	**A brief account of morphological characteristics, pathogenicity, laboratory diagnosis, prevention and control of the disease caused by** *Corynebacterium diptheriae, Mycobacterium tuberculosis, Klebsiella pneumonia* and *Clostridium tetani*	
III		**Module 3: Medical Mycology**	**7**
	1	**Superficial mycoses-** *Pityriasis versicolor, Tinea nigra*	
	2	**Cutaneous Mycoses**- Dermatophytosis, Candidiasis	

	3	**Subcutaneous mycoses-** Mycotic mycetoma and Rhinosporidiosis	
	4	**Systemic mycoses-** Cryptococcosis, Histoplasmosis	
	5	**Opportunistic mycoses-** Aspergillosis, Penicilliosis	
IV	**Module 4: Medical Virology**		**8**
	1	**Morphology, epidemiology, transmission, clinical importance and lab diagnosis of** Influenza virus, measles virus, mumps virus, rubella virus	
	2	**Morphology, epidemiology, transmission, clinical importance and lab diagnosis of** Poliovirus, Dengue virus, Rabies virus	
	3	**Morphology, epidemiology, transmission, clinical importance and lab diagnosis of** Hepatitis B virus, HIV	
	4	**Morphology, epidemiology, transmission, clinical importance and lab diagnosis of** SARS, Nipah virus	
V	**Module 5: Medical Protozoology**		**15**
	1	**Vector Borne disease-Pathogenic mechanisms, Disease transmission and life cycle** – Plasmodium and Trypanosoma	
	2	**Water borne infection- Pathogenic mechanisms, Disease transmission and life cycle of** *Entamoeba histolytica*	
	3	**Zoonotic infection- Pathogenic mechanisms, Disease transmission and life cycle of** Toxoplasma	
		Practicals	**Hrs 30**
Course Type: Practical, Total credits: 1, Contact hours/week: 2			
	1	Antibiotic sensitivity testing- Kirby-Bauer method	
	2	Determination of MIC of antibiotics	
	3	Identification of common bacterial pathogens by using morphological, cultural and biochemical characters ● *Staphylococcus* ● *Escherichia coli* ● *Pseudomonas* ● *Klebsiella* ● *Proteus*	
	4	ASO latex agglutination test	

	5	RA latex agglutination test	
	6	RPR card test for syphilis	
	7	ABO blood grouping	
	8	WIDAL test-Card Test	

References:

- Ananthanarayan and Panicker's Textbook of Microbiology- ISBN 81 250 2808 0
- Notes on Medical Bacteriology – J. Douglas SleighMorag C.Timbury
- Parasitology –B.Dasgupta
- Medical Mycology – Rippon
- Principles of Bacteriology Virology and immunity Vol 4 Lopka and Wilson
- Fundamentals of medical Virology by Kucera and Myrvik
- Lab manual in Biochemistry, Immunology and biotechnology-Arti Nigam, Archana Ayyagari (ISBN 13:978-0-07-061767-4)
- Medical Laboratory technology –*Methods and interpretation* (ISBN 81-8448-449-6)
- Mackie & McCartney Practical Medical Microbiology (ISBN 0 443 04906 8)
- Diagnostic Microbiology, Bailey and Scott's, (2013). 13thEd. The Mosby Company
- Talib. V.H, (2008). Handbook of Medical Microbiology, 2ndEd. CBS Publishers.
- **E-RESOURCES:**
- https://www.ncbi.nlm.nih.gov/books/NBK7617/
- https://www.ncbi.nlm.nih.gov/books/NBK8448/
- https://www.ncbi.nlm.nih.gov/books/NBK8103/
- https://www.ncbi.nlm.nih.gov/books/NBK8149/
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4095053/
- https://www.ncbi.nlm.nih.gov/books/NBK7986/
- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/zoology/08._biology_of_p
- parasitism/10._plasmodium__morphology_and_life_cycle/et/7829_et_et.pdf
- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000035ZO/P000888/M0
- 2 7 3 5 1 / E T / 1518784193M05Morphology,lifecyclemodeofinfectionofToxoplasmaQuad1.pdf
- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000035ZO/P000888/M0
- 2 7 3 5 2 / E T / 1519016883M18Morphology,Lifecycle,PathogenecityEntamoebaPart1Quad1.pdf
- https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000035ZO/P000888/
- M020579/ET/1498557406MorphologyTrypanosomaQuad1.pdf

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	State the significance of normal human flora Assess the mode of action of antibiotics	U	PSO-1,2
CO-2	Discuss the pathogenicity, epidemiology, laboratory diagnosis, treatment, and prevention of important bacterial diseases	R, U	PSO-1,2
CO-3	Illustrate the pathogenicity, epidemiology, laboratory diagnosis, treatment, and prevention of significant viral diseases.	R, U	PSO-1,2
CO-4	Illustrate the features of several human diseases caused by fungi	R, U	PSO-1,2
CO-5	Illustrate the features of several human diseases caused by protozoans	R, U	PSO-1,2
CO-6	To learn laboratory techniques in medical microbiology and immunology	U, Ap, An, C	PSO-1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	State the significance of normal human flora Assess the mode of action of antibiotics	PO2, 6/ PSO-1,2	U	F, C	L	

CO-2	Discuss the pathogenicity, epidemiology, laboratory diagnosis, treatment, and prevention of important bacterial diseases	PO 2, 6/ PSO-1,2	R, U	F,C	L	
CO-3	Illustrate the pathogenicity, epidemiology, laboratory diagnosis, treatment, and prevention of significant viral diseases.	PO 2,6/ PSO-1,2	R, U	F,C	L	
CO-4	Illustrate the features of several human diseases caused by fungi	PO 2,4, 6/ PSO-1,2	R, U	F, C	L	
CO-5	Illustrate the features of several human diseases caused by protozoans	PO 2, 6/ PSO-1,2	R, U	F,C	L	
CO-6	To learn laboratory techniques in medical microbiology and immunology	PO2,6/ PSO 1,2	U, Ap, An, C	F,C,P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	2	-	-	-	-	-	2	-	-	-	2
CO 2	2	2	-	-	-	-	-	2	-	-	-	2
CO 3	3	2	-	-	-	-	-	2	-	-	-	2
CO 4	3	2	-	-	-	-	-	2	-	-	-	2
CO 5	3	3	-	-	-	-	-	2	-	-	-	2
CO 6	3	3	-	-	-	-	-	3	-	-	-	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK6DSCMBY302				
Course Title	**IPR and Bioethics**				
Type of Course	**DSC**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	4 hours	-	-	4
Pre-requisites	Knowledge of basic lab skills and research activities				
Course Summary	The course creates awareness of legal rights, responsibilities, regulatory affairs and the ethical standpoint of intellectual assets in the field of biological research. Helps to acquire a basic understanding of the concepts of ethics essential for different disciplines of science and the protection of intellectual property and related rights.				

Detailed Syllabus: Total hours 60

Course Type: Theory, Total credits: 4, Contact hours/week: 4			
Module	**Unit**	**Content**	**Hrs 60**
I	**Module 1: Intellectual Property Rights**		**12**

	1	Intellectual property: Introduction and the need for intellectual property rights (IPR) Types of IPR- Patent, Copyright, Trade Mark, Trade Secret, Design, Geographical Indication, Plant Varieties and Traditional Knowledge. IPR in India: Important examples	
	2	Patents- Types of patents, Criteria for patentability- World Intellectual Property Rights Organization (WIPO)	
	3	Patent Application procedure, Drafting of a Patent Specification. Objectives, Filing of a patent, Granting of a patent. Rights of a patent.	
	4	Protection of patents and its significance, Searching for a patent	
II	**Module 2: Copyright & Trademark**		**12**
	1	Copyright, need for copyright protection	
	2	Related rights, Distinction between related rights and copyright	
	3	Trade Mark- Kinds of signs that can be used as trademarks. Types of trademark, Trade secrets	
III	**Module 3: Geographical Indications & Industrial Designs**		**12**
	1	Design Rights, Geographical indications and Traditional Knowledge	
	2	Industrial design-need for protection, Biotechnology and International Treaties such as Convention on Biological Diversity and TRIPs	
	3	Plant variety protection in India- Plant breeders' rights, Experimental use exemption	
	4	The patentability of microorganisms, Patentability of vectors	
IV	**Module 4: Bioethics**		**12**
	1	Introduction to bioethics, The principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity Applications of bioethics	

	2	Bioethics in the laboratory, Ethical issues associated with the use of animals as research models	
	3	Federal Laws, Role of: Food and Drug Administration, Centers for Disease Control and Prevention, United States Department of Agriculture, Environmental Protection Agency, Importance of State and Local Agencies	
V	**Module 5: Ethics and Diagnosis**		**12**
	1	Molecular detection of pre-symptomatic genetic diseases and its importance in healthcare	
	2	Ethical, legal and social implications of the human genome project, Genetic studies on ethnic races	
	3	Ethical issues of Prenatal diagnosis and genetic manipulations, Genetic Testing and Concerns about Eugenics, GM Foods and the rise of environmental movements, owning genes, genomes, and living beings.	

Reference

1**.** T. M Murray, M.J. Mehlman. 2000. Encyclopaedia of Ethical, Legal and Policy issues

in Biotechnology, John Wiley & Sons.

2. P.N. Cheremisinoff, R.P. Ouellette and R.M. Bartholomew.1985. Biotechnology

Applications and Research, Technomic Publishing Co., Inc.

3. D. Balasubramaniam, C.F.A. Bryce, K. Dharmalingam, J. Green and K. Jayaraman, 2002. Concepts in Biotechnology, University Press (Orient Longman Ltd.).

4. Ajit Parulekar, Sarita D' Souza. 2006. Indian Patents Law – Legal & Business Implications; Macmillan India,

6. B.L. Wadehra. 2000. Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd

7.N.S. Gopalakrishnan, T.G. Agitha. 2009. Principles of Intellectual Property. Eastern Page 9 of 11 Book Company.

8. T. Ramakrishan (Ed.). 2003. Biotechnology and Intellectual Property Rights. CIPRA, NLSIU, Bangalore.

9. N.K. Acharya. 2012. Text Book on Intellectual Property Rights, 6th ed. Asia Law House. M. M. S. Karki. 2009. Intellectual Property Rights: Basic Concepts. Atlantic Publishers.

10. N. S. Sreenivasalu. 2007. Intellectual Property Rights. Neha Publishers & Distributors.

11. Pal P. 2008.Intellectual Property Rights in India: General Issues and Implications. Regal Publications.

12. https://www.wipo.int/edocs/pubdocs/en/intproperty/932/wipo_pub_b932ipb.pdf

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Appreciate the importance of Intellectual property rights and explain various types of IPR.	U	PSO-4,5
CO-2	Recognize the need for protection of new knowledge and innovations	R, U	PSO-5,6
CO-3	Understand the plant breeders rights and patentability of engineered organisms in research	U, An, E	PSO-5,6
CO-4	Create awareness of laws pertaining to control agencies and evaluate the ethical considerations and implications surrounding the patentability of biotechnological inventions	R, U,An,C	PSO-5,6
CO-5	Critically examine the bioethical principles and apply them to analyze real-world case studies in biomedical research and healthcare	U, An, C	PSO-5,6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)

CO-1	Appreciate the importance of Intellectual property rights and explain various types of IP	PO 1,6/ PSO-4,5	U	F, C	L	
CO-2	Recognize the need for protection of new knowledge and innovations	PO 1,6/ PSO-5,6	R, U	P	L	
CO-3	Understand the plant breeders rights and patentability of engineered organisms in research	PO 1,6/ PSO-5,6	R, U,An	F, C	L	
CO-4	Create awareness of laws pertaining to control agencies and evaluate the ethical considerations and implications surrounding the patentability of biotechnological inventions	PO 1,6,8/ PSO-5,6	R, U,An	F, C	L	

CO-5	Critically examine the bioethical principles and apply them to analyze real-world case studies in biomedical research and healthcare	PO 1,6,8/ PSO-5,6	U, An, C	F, C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	2	-	-	-	-	2
CO 2	2	3	-	-	-	-	2	-	-	-	-	2
CO 3	-	-	1	-	-	-	2	-	-	-	-	2
CO 4	-	-	2	3	-	-	3	-	-	-	-	3
CO 5	-	1	-	-	-	-	3	-	-	-	-	3
CO 6	-	-	-	3	-	-	3	-	-	-	-	3

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low

2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6				

University of Kerala

Discipline	MICROBIOLOGY					
Course Code	UK6DSCMBY303					
Course Title	**Medical Bacteriology and Virology**					
Type of Course	**DSC-P**					
Semester	VI					
Academic Level	300 - 399					
Course Details	Credit		Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4		3 hours	-	2 hours	5
Pre-requisites	Knowledge of microorganisms during the previous semesters of this programme.					
Course Summary	This course equips students with essential knowledge and skills to understand the complex interactions between microorganisms and human health. By studying normal flora, infectious diseases, and the mechanisms of antibacterial and antiviral agents, students gain insights into diagnosis, treatment, and prevention strategies for microbial infections. With a focus on both theoretical concepts and practical applications, this course prepares students for careers in healthcare, research, and public health.					

Detailed Syllabus: Total hours -75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Module 1: Normal Microflora of the human body**	**Hrs 45**

I	1	Normal microflora of the human body: Significance of the Normal Flora.	**7Hrs**
	2	Normal microflora of skin, throat, gastrointestinal tract and urogenital tract.	
	3	Infections -Sources of infection. Opportunistic infections and Nosocomial infections.	
	4	Epidemic, Pandemic and Endemic diseases.	
II	**Module 2: Sample collection, transport and Antibacterial agents**		**7Hrs**
	1	Collection, transport and culturing of clinical samples	
	2	Antibacterial agents: Five modes of action: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism.	
	3	Antibiotic sensitivity tests -Disc diffusion, Well diffusion and Tube dilution testing procedures and their quality control.	
III	**Module 3: Bacterial Diseases**		**8 Hrs**
	1	Systematic study - General characteristics, Pathogenicity, Symptoms, Laboratory diagnosis, mode of transmission and prophylaxis of *Staphylococcus aureus*, *Streptococcus pyogenes, Bacillus anthracis, Neisseria meningitidis, Cornybacterium diphtheriae, Mycobacterium tuberculosis, Vibrio cholerae, Enterobacteriaceae-Escherichia coli, Salmonella typhi, Shigella dysenteriae, Proteus mirabilis* and *Klebsiella pneumoniae*	
	2	General characteristics, Pathogenicity, Symptoms, Laboratory diagnosis, mode of transmission and prophylaxis of Mycoplasma, Rickettsia, Spirochetes - *Treponema* and *Leptospira*	
IV	**Module 4: Viral Diseases**		**8 Hrs**
	1	Structure, pathogenicity, mode of transmission and prophylaxis of Pox, Adeno, Herpes, Reo, Rota, Hepatitis, Rabies, HIV, Influenza and Polio virus	
	2	An overview of emerging viral diseases- Dengue, Ebola, SARS, Nipah, swine flu, H1N1 and chikungunya	
	3	Types of oncogenic DNA and RNA viruses	
V	**Module 5: Antiviral Agents**		**15 Hrs**

	1	Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine	
	2	Antiviral agents -Vaccines and interferons - Mechanisms of action of Interferons	
	3	Cultivation of Viruses	
		Practical	**Hrs 30**
Course Type: Practical, Total credits: 1, Contact hours/week: 2			
VI	1	Study of the morphology, staining characters, cultural characters and biochemical identification of a)*Staphylococcus aureus* *b)E. coli* *c)Klebsiella sp* *d)Bacillus sp* *e)Pseudomonas sp.*	
	2	Antimicrobial Sensitivity testing by disc-diffusion method.	
	3	ASO Latex agglutination test	
	4	RA Latex agglutination test	
	5	RPR card test for syphilis	
	6	Widal test- card test	
	7	ABO Blood grouping	

REFERENCES

1. Tortora, G. J., Funke, B. R. and Case, C. L. 2012. Microbiology: An Introduction. 11thEdition.Pearson education Pvt. Ltd. Singapore.

2. Black, J.G. 2005. Microbiology, Principles and exploration. 6 th Edition. John Wiley & Sons

3. Principles of Bacteriology, Virology and Immunology. 8th Edition. Edward Arnold, 41 London

4. Pelczar, M. J. Jr., Chan, E. C. S., Krieg, N. R. 1986. Microbiology. McGraw Hill Book Company, London.

5. Prescott, L. M., Harley, J. P. and Klein, D. A. 2005. Microbiology. 9th Edition. Mac Graw Hill Companies Inc.

6. Aneja, K.R.2003. Experiments in Microbiology, Plant Pathology and Biotechnology.4thEdition. New Age International (P) Limited, New Delhi. Dubey, R. C. and Maheswari, D. K. 2002. Practical Microbiology. 2nd Edition, S. Chand &Co., New Delhi.

7. Kannan, N. 2002. Laboratory manual in general microbiology. 2nd Edition, Panima Publishing Co., New DelhI

8. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.

9. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.

10. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.

11. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO- 1	Introduction to bacteriology includes the structure and properties of bacteria, both as a normal flora and as a pathogen.	R, U	PSO1
CO- 2	Explain the methods to control microbial growth. Solve problems in the context of this understanding.	U, AP	PSO1, 2
CO- 3	Define epidemiological aspects of bacterial diseases and discuss important prophylactic measures of bacterial diseases.	U	PSO1
CO- 4	To learn to differentiate between types of viruses and their role in disease and cancer.	U	PSO1
CO- 5	Explain the various antiviral agents to control viruses.	U	PSO1
CO- 6	To learn basic laboratory skills in medical microbiology	U, Ap, An, C	PSO1,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture: Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1.	Introduction to bacteriology includes the structure and properties of bacteria, both as a normal flora and as a pathogen.	PO1/ PSO1	R,U	F, C	L	
2	Explain the methods to control microbial growth. Solve problems in the context of this understanding.	PO2,6,/ PSO1	U, AP	C, P	L	
3	Define epidemiological aspects of bacterial diseases and discuss important prophylactic measures of bacterial diseases.	PO1,2/ PSO1	U	F,P		
4	To learn to differentiate between types of viruses and their role in disease and cancer.	PO1/ PSO1	U	F,C	L	
5	Explain the various antiviral agents to control viruses.	PO2,6/ PSO1	U	C,P	L	

6	To learn basic laboratory skills in medical microbiology	PO2,6/ PSO1,3,5	U, Ap, An, C	P,M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	1					
CO 2	2		-	-	-	-		2				1
CO 3	2	-	-	-	-	-	1	1				
CO 4	2	-	-	-	-	-	-	2				1
CO 5	2	-	-	-	-	-		1				1
CO 6	2	-	1	-	1	-		1				1

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6				✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK6DSCMBY304				
Course Title	**Medical Mycology and Parasitology**				
Type of Course	**DSC**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	4 hours	-	0 hours	4 hours
Pre-requisites	Knowledge of microorganisms during the first & second year of this programme				
Course Summary	This course provides a comprehensive understanding of mycology and parasitology, covering their clinical aspects, diagnostic techniques, and management strategies. It equips students with the knowledge and skills necessary to identify, diagnose, and treat fungal and parasitic infections effectively.				

Detailed Syllabus:Total hours 60

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**60 Hrs**
I	**Module 1 : Introduction to Mycology**		**8**
	1	General properties of fungi, virulence factors of fungi causing infection	
	2	Collection, transport and isolation of fungi from clinical specimens	
	3	Mycotoxins and types	
II	**Module 2 : Clinical aspects of Mycology**		**15**

	1	Classifications of fungal diseases.	
	2	Dermatophytes and agents of superficial mycoses. Opportunistic mycoses- Candidiasis and Aspergillosis. Systemic mycoses - Coccidioidomycosis and Blastomycosis. Subcutaneous mycoses – Sporotrichosis and Mycetoma.	
III	**Module 3 : Diagnostic Mycology**		**15**
	1	Host responses to fungal infection-Immunity	
	2	Laboratory diagnosis of fungal diseases - Fluorescence in situ hybridisation (FISH), Real time PCR, RAPD and Loop-Mediated Isothermal Amplification (LAMP).	
	3	Antifungal agents	
IV	**Module 4 : Introduction To Parasitology**		**10**
	1	Introduction to medical parasitology, Vectors and types	
	2	Morphology, characteristics, pathogenesis, laboratory diagnosis, prevention and control of: *Entamoeba histolytica, Giardia lamblia, Trichomonas vaginalis*	
	3	Morphology, characteristics, pathogenesis, laboratory diagnosis, prevention and control of: *Trypanosoma brucei, Plasmodium falciparum*	
V	**Module 5 : Diagnostic Parasitology**		**12**
	1	Morphology, characteristics, pathogenesis, laboratory diagnosis, prevention and control - *Leishmania donovani, Balantidium coli, Taenia solium, Ancyclostoma duodenale, Ascaris lumbricoides and Wuchereria bancrofti.*	
	2	Laboratory techniques in Parasitology - Fecal (stool) exam or ova and parasite test (O&P), Endoscopy/Colonoscopy, Blood tests, X-ray, Magnetic Resonance Imaging (MRI) scan, Computerized Axial Tomography scan (CAT)	
	3	Examination of faeces – Direct and concentration methods, examination of blood – Thin and Thick smear method.	

References

1. Kayser F. H., Bienz, K. A., Eckert, J. and Zinkernagel, R. M. (2004). Medical Microbiology. Berlin: Thieme Medical.

2. Baron, S. (1996). Medical Microbiology, 4th Edition. Galveston (TX): University of Texas Medical Branch at Galveston
3. Greenwood, D., Slack, R. C. B., Peutherer, J. F. and Barer, M. R. (2007). Medical Microbiology: A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis and Control. 17th Edition. Elsevier Health Sciences UK.
4. Emmons, C. W., Binford, C. H., Utz, J. P., Kwon-Chung, K. J. (1977). Medical Mycology. 3rd Edition. Philadelphia, Lea & Febiger.
5. Rippon, J. W. 1988. Medical mycology: the pathogenic fungi and the pathogenic actinomycetes. 3rd Edition. Saunder, Philadelphia
6. Richardson, M. D. & Johnson, E. M. (2006). The Pocket Guide to Fungal Infection. 2nd Ed. Backwell.
7. Dismukes, W. E., Pappas, P. G. & Sobel, J. D. (2003). Clinical Mycology. Oxford.
8. Ash and Orihel (1997). Human Parasitology. 4th Edition. ASCP Press,
9. Peters and Gilles (1995). Tropical Medicine and Parasitology. Mosby-Wolfe.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Develop a working knowledge of techniques and procedures commonly used in the clinical microbiology laboratory for the isolation and identification of pathogenic fungi.	R,U	PSO1
CO-2	Demonstrate an understanding of the transmission, pathogenesis, epidemiology, laboratory identification and treatment of mycological diseases.	U	PSO1
CO-3	Discuss the role of the microbiology laboratory in the diagnosis of mycological diseases.	U,Ap,An	PSO1,2
CO-4	Demonstrate an understanding of the transmission, pathogenesis, epidemiology, laboratory identification and treatment of parasitic diseases.	R,U	PSO1
CO-5	To describe structure, function, lifecycle and pathogenic capacity and laboratory identification of the most important parasitic protozoans.	U,Ap,An	PSO1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Develop a working knowledge of techniques and procedures commonly used in the clinical microbiology laboratory for the isolation and identification of pathogenic fungi..	PO1/ PSO1	R,U	F	L	
2	Demonstrate an understanding of the transmission, pathogenesis, epidemiology, laboratory identification and treatment of mycological diseases.	PO2,6,/ PSO1	U	F,C	L	
3	Discuss the role of the microbiology laboratory in the diagnosis of mycological diseases.	PO1,2/ PSO1	U,Ap,An	F	L	

4	Demonstrate an understanding of the transmission, pathogenesis, epidemiology, laboratory identification and treatment of parasitic diseases.	PO1/ PSO1	R,U	F	L	
5	To describe structure, function, lifecycle and pathogenic capacity of the most important parasitic protozoans.	PO2,6/ PSO1	U,Ap,An	F,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	1					
CO 2	2		-	-	-	-		2				1
CO 3	2	-	-	-	-	-	1	1				
CO 4	2	-	-	-	-	-	-	2				1
CO 5	2	-	-	-	-	-		1				1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

Discipline	MICROBIOLOGY				
Course Code	UK6DSCMBY201				
Course Title	**Environmental and Agricultural Microbiology**				
Type of Course	**DSC**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	4 hours	-	- hours	4
Pre-requisites	Basic knowledge of microorganisms acquired during the first year of this programme.				
Course Summary	This course covers a range of topics related to the role of microorganisms in natural and managed ecosystems, focusing specifically on their impact on agriculture, soil health and environmental sustainability.				

Detailed Syllabus:Total Hours- 60

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 60**
I		**Module 1: Microorganisms As Components Of Ecosystem**	**12**
	1	Microbial interactions- Mutualism, Protocooperation, Commensalism, Predation, Parasitism, Amensalism, Competition.	
	2	Bacterial life in extreme environments - Effect of temperature, pH, pressure, salt, radiation.	
II		**Module 2: Waste Management**	**12**
	1	Solid waste management - Composting, incineration, land filling.	
	2	Liquid waste management:- Household sewage treatment – Septic tank, imhoff tank, cess pool. Municipal sewage treatment- Primary, secondary and tertiary	
	3	Bioremediation- xenobiotic compounds	
	4	Degradation of pesticides & hydrocarbons	

III	**Module 3: Biogeochemical Cycles**		**12**
	1	Carbon cycle – Microorganisms involved, organic matter decomposition	
	2	Phosphorus cycle – Microorganisms involved	
	3	Iron cycle - Microorganisms involved, Siderophores	
	4	Sulfur cycle - Microorganisms involved, Winogradsky column	
	5	Nitrogen cycle - Microorganisms involved, Nitrogen fixation -symbiotic, non-symbiotic	
IV	**Module 4: Biofertilizer Technology**		**12**
	1	Rhizosphere and Rhizoplane concept	
	2	Mycorrhizae - Types and applications (Brief account)	
	3	Biofertilizer production – a)Bacterial biofertilizers: R*hizobium, Azotobacter* b)Cyanobacterial biofertilizer: *Nostoc, Anabaena*	
V	**Module 5: Plant Pathology**		**12**
	1	Mosaic disease of tobacco - Symptoms, etiology, epidemiology and management	
	2	Bunchy top of banana - Symptoms, etiology, epidemiology and management	
	3	Bacterial blight of paddy - Symptoms, etiology, epidemiology and management	
	4	Phytophthora disease of coconut - Symptoms, etiology, epidemiology and management	
	5	Citrus canker - Symptoms, etiology, epidemiology and management	

REFERENCES:

- Microbial Ecology Fundamentals and applications – Atlas and Bartha (ISBN 981-405-344-9)
- Environmental Microbiology- K.Vijaya Ramesh (ISBN 81-8094-003-9)
- Agricultural Microbiology- Rangaswamy G, D.J. Bhagyaraj (ISBN-81-203-0668-6)
- Soil Microbiology an *exploratory approach* – Mark S.Coyne (ISBN 981-240-203-9)
- Soil Microorganisms and Its Growth-N.S. Subba Rao (ISBN: 8120400968)
- Biofertilizers in Agriculture- Subha Rao (**ISBN**-13: 978-8120407916)

E-RESOURCES:

- https://www.soinc.org/sites/default/files/uploaded_files/417_MICROBES_AND_ECOLOGY.pdf
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4187170/#:~:text=Extremophiles%20include%20members%20of%20all,bacteria%2C%20archaea%2C%20and%20eukarya.&text=Among%20bacteria%2C%20the%20best%20adapted,ice%20to%20continental%20hot%20springs.
- https://www.thebalancesmb.com/waste-treatment-and-disposal-methods-2878113
- https://www.intechopen.com/books/biodegradation-life-of-science/pesticide-biodegradation-mechanisms-genetics-and-strategies-to-enhance-the-process
- https://openoregon.pressbooks.pub/envirobiology/chapter/3-2-biogeochemical-cycles/
- https://www.onlinebiologynotes.com/biofertilizer-advantages-types-methods-of-application-and-disadvantages
- https://www.ag.ndsu.edu/pdl/documents/common-ND-plant-diseases.pdf

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Know about basics of Microbial interactions	U	PSO-1,2

CO-2	Gain knowledge about solid and liquid waste management	U, Ap	PSO-1,3
CO-3	Gain knowledge about role of microorganisms in Biogeochemical cycling	U	PSO-1
CO-4	Gain knowledge about the application of microorganisms in agriculture	Ap	PSO-1,3
CO-5	Understand about different plant diseases and their management	U,Ap	PSO1,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture: Tutorial:Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/ Tutorial (T)**	**Practical (P)**
CO-1	Know about basics of Microbial interactions	PO1/ PSO1,2	-	F, C	L	-
CO-2	Gain knowledge about solid and liquid waste management	PO1,2/ PSO1,3	-	F,M	L	-
CO-3	Gain knowledge about role of microorganisms in Biogeochemical cycling	PO1,2/ PSO1	-	F,C	L	-
CO-4	Gain knowledge about the application of microorganisms in agriculture	PO1,2,3/ PSO1,2,3	-	F,C	L	-

CO-5	Understand about different plant diseases and their management	PO1,2,3/ PSO1,3	-	F,C	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	1					
CO 2	1	-	2	-	-	-	1		2			
CO 3	1	-	2	-	-	-	1		2			
CO 4	2	2	2	-	-	-	2	2	1			
CO 5	2	-	1	-	-	-	1	1	1			

Correlation Levels:

LeVel	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK7DSCMBY401				
Course Title	**Molecular Biology and rDNA Technology**				
Type of Course	**DSC-P**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Knowledge of microorganisms and microbiological techniques acquired during the first, second and third year of the programme.				
Course Summary	This course provides a comprehensive understanding of the structure and functions of nucleic acids as well as the techniques and tools employed in recombinant DNA technology.				

Detailed Syllabus: Total hours -75

Module	Unit	Content	Hrs 45
I	**Module 1: NUCLEIC ACIDS & REPLICATION**		**7**
	1	**Nucleic acids**: structure and functions of purines and pyrimidines	
	2	**Structure of DNA**: Forces stabilizing DNA structure, Watson –Crick base pairing, Organization of DNA into chromosomes- chromatin structure, nucleosome, histones	
	3	**RNA:** types, structure and functions	

	4	**DNA replication:** Prokaryotic and eukaryotic DNA replication, mechanism of replication. Enzymes and necessary proteins in DNA replication. Telomeres, telomerase and end replication, Role of telomerase in aging and cancer	
	5	DNA Repair	
II	**TRANSCRIPTION**		**8**
	1	RNA polymerases in prokaryotes and eukaryotes.	
	2	Transcription in prokaryotes- Transcription signals, Promoters and Enhancers, Initiation and Elongation of RNA synthesis, Rho dependent and Rho independent termination.	
	3	Post transcriptional modifications-Guanosine cap, Poly (A) Tail. Splicing-Spliceosome, lariat structure, Group 1, II and III Introns, Ribozyme, Trans-splicing, alternate splicing, RNA Editing, Guide RNA	
	4	Transcription in Eukaryotes	
	5	Inhibitors of transcription.	
III	**TRANSLATION**		**7**
	1	Eukaryotic and prokaryotic ribosomes, Genetic code, Wobble hypothesis	
	2	Translation in prokaryotes	
	3	Translation in eukaryotes	
	4	Post translational modifications.	
	5	Regulation of gene expression in prokaryotes and eukaryotes, Operon concept, structure of operon, Lac, Trp, Ara operons, catabolite repression, attenuation.	
IV	**TOOLS OF rDNA TECHNOLOGY**		**8**
	1	Restriction enzymes, cutting & joining DNA molecules, linkers, adaptors & homopolymer tailing	
	2	Cloning vectors: Plasmid vectors- pBR322, vectors derived from pBR322, Shuttle Vectors, Ti plasmid and Binary vector system, Vectors of yeast	
	3	Bacteriophage vectors- λ, M13, Cosmid, Phagemids	
	4	BAC, YAC, PAC	

	5	Promoters, Reporter systems, Fusion tagged expression system, Inducible expression system	
	6	Construction, Screening and applications of genomic DNA and cDNA library	
V	**TECHNIQUES IN rDNA TECHNOLOGY**		**15**
	1	Overview of various steps involved in cloning	
	2	Selection of recombinants- Antibiotic resistance selection, Blue white screening	
	3	Screening by hybridization: colony hybridization, plaque lift assay, Southern, Northern and Western blotting	
	4	PCR and types, DNA sequencing	
	5	DNA introduction methods	
VI	**Practicals**		**Hrs 30**
	Course Type: Total Credits: 1 Contact hours/week: 2		
	1	Isolation of plasmid from bacteria	
	2	Isolation of genomic DNA from bacteria	
	3	Estimation of DNA	
	4	Agarose gel electrophoresis of nucleic acids	
	5	Extraction of DNA from agarose gel	
	6	UV induced auxotrophic mutant production and their isolation	
	7	Demonstration of Polymerase Chain Reaction	
	8	Bacterial transformation and blue white screening	

REFERENCES: -

1. Wiley Benjamin Lewin (2013) Genes IX . Jones and Bartlett publishers.

2. Watson,J.D., Hopkins,N .H ., Roberts, J.W., Steitz,J.A and Weiner,A.M(1987).

3. Molecular Biology of the Gene . Benjamin-Cummings, Menlo Park California. Latest Edition

4. Gerald Karp (2014). Cell Biology 7 Th edition. Wiley publishers.

5. Daniel L Hartl & Elizabeth W.Jones(2011) GENETICS- Analysis of genes and Genomes 8th edition, Jones and Bartlett publication.

6. Snustard and Simmons. Principles of Genetics – Wiley plus Latest Edition.

7. Freifelder,D.,Stanley ,R.(1994).Molecular Biology and Microbial Genetics .J and B publication.

8. Maloy,S.R.,Cronan,J.E.,Freifelder,D(1994) Microbial Genetics 2nd edition J and B publication.

9. Dale, J.W(2004). Molecular Genetics of Bacteria 5 th edition. Wiley publishers.

10. Larry, S.,Henkin,T.M., Peters,J.E.and Wendy,C(2012) Molecular Genetics of Bacteria 4th edition. ASM Press.

11. Friedberg, C., Graham, C., Wolfram, S(2009) . DNA repair and mutagenesis 2nd edition. ASM Press.

12. Nicholl D.S.T(2002) An introduction to Genetic Engineering 2nd edition. Cambridge University Press.

13. Glick,B.R., Pasternak, J.J.(2003) Molecular biotechnology 3rd edition. ASM Press.

14. Primrose,S.B., Twyman,R., Old,R.W.(2002) Principles of Gene Manipulation 6 th edition. Wiley-Blackwell Publishers.

15. Brown T.A. (2010) Gene Cloning & DNA Analysis 6 th edition. Wiley-Blackwell Publishers.

16. Sambrook, J and Russell,D.W.(2001) Molecular Cloning : a laboratory manual 3rd edition. Cold Spring Harbor Laboratory Press.

17. Nair,A.J (2008) Introduction to Genetic Engineering and Biotechnology . Infinity Science Press.

18. Singh, B.D. (2010) Biotechnology 4 th edition. Kalyani Publications.

19. Rigby P.W.J. (1982) Genetic Engineering. Academic Press NY. 21. Russel G.E. (1992) Biotechnology and Genetic Engineering Reviews. Intercept Ltd.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand nucleic acid and DNA replication.	R, U	PSO1

CO-2	Learn transcription, post transcriptional modifications and inhibitors.	R, U	PSO1
CO-3	Gain knowledge on translation and regulation of gene expression.	R, U	PSO1
CO-4	Understand vectors involved in rDNA technology.	U, An, E	PSO1, 3
CO-5	Learn various techniques in rDNA technology.	U, An, E	PSO3, 4
CO-6	Perform isolation and extraction of genetic materials, transformation and mutation experiments in laboratory	Ap, An, E	PSO2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	**CO**	**PO/ PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/ Tutorial (T)**	**Practical (P)**
CO-1	Understand nucleic acid and DNA replication.	PO-1, 3 / PSO1	R, U	F, C	L	
CO-2	Learn transcription, post transcriptional modifications and inhibitors.	PO-1, 3 / PSO1	R, U	F, C	L	
CO-3	Gain knowledge on translation and regulation of gene expression.	PO-1, 3 / PSO1	R, U	F, C	L	
CO-4	Understand vectors involved in rDNA technology.	PO-1, 2, 3 / PSO1, 3	U, An, E	F, C	L	
CO-5	Learn various techniques in rDNA technology.	PO-1, 2, 3 / PSO3, 4	U, An, E	F, C, M	L	

CO-6	Perform isolation and extraction of genetic materials, transformation and mutation experiments in laboratory	PO-2, 3, 6 / PSO2	Ap, An, E	P, M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	2	-	-	-	-	-	2	-	2	-	-	-
CO 2	2	-	-	-	-	-	2	-	2	-	-	-
CO 3	2	-	-	-	-	-	2	-	2	-	-	-
CO 4	2	-	-	2	-	-	2	3	2	-	-	-
CO 5	-	-	2	3	-	-	3	2	2	-	-	-
CO 6	-	2	-	-	-	-	-	2	2	-	-	2

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium

3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6		✓		

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK7DSCMBY402				
Course Title	**Research Methodology**				
Type of Course	**DSC-P**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5 hours
Pre-requisites	Basic knowledge on research acquired during the previous years				
Course Summary	This course provides a comprehensive overview of the scientific research process, from the fundamentals of research methodology to the art of scientific writing and publication. It covers various aspects such as research design, data collection and analysis, and the use of tools and methods in scientific inquiry.				

Detailed Syllabus:Total hours -60

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
I		**Module 1:Introduction: Science and Research**	**7**
	1	Definition, History and evolution of scientific inquiry	
	2	Fundamentals of Research Methodology, Applications in Life Sciences	
	3	Types of knowledge: practical, theoretical and scientific knowledge	
	4	Science and pseudo-science; verification versus falsification	

	5	Epistemology of sciences, Science as a human activity; scientific temper and empiricism, vocabulary of science, science disciplines	
II		**Module 2: Research design**	**8**
	1	Research: meaning, Scope and significance – Types of Research	
	2	Research Process – Characteristics of good research and steps in research process	
	3	Problems in Research – selection and formulation of research problems	
	4	Research Designs – Features of good designs, inductive, deductive and development of models	
	5	Sampling design for biosciences: Meaning – Concepts – Steps in sampling	
III		**Module 3:Tools And Methods Of Science**	**7**
	1	Hypotheses; Observations, evidences and proofs	
	2	Collection of literature: News articles ,Newsletters,Magazines,Books ,Journals.	
	3	Digital library and search of articles: Internet,Google Scholar, PubMed,– Inflibnet, Science direct ,Open access Journals , virtual sources	
	4	Importance of models, simulations and virtual testing	
IV		**Module 4: Experimentation, Data Collection And Analysis In Research**	**8**
	1	Design of an experiment: experimentation; observation; data collection; interpretation and deduction.	
	2	Types of Experiments- Observational and experimental research to test a hypothesis	
	3	Sources of data: primary, secondary and tertiary	
	4	Treatment of data; data interpretation-Construction of tables,headings - footer,Tabulation	
	5	Presentation of results - Use of statistical software to analyze the results	
		Module 5: Art Of Scientific Writing	**15**

V	1	Structure and components of scientific reports-structure language and Plagiarism detection	
	2	Preparation of Summary/abstract	
	3	Writing Introduction	
	4	review of literature	
	5	Materials & Methods	
	6	Presentation of results-illustrations and tables	
	7	Discussion of Results based on literature and conclusion	
	8	Arrangement of Bibliography, reference quoting and footnotes	
	9	ISSN Number, Peer-reviewed Journals,Science citation index, impact factor and importance	
		Practical	**Hrs 30**
VI		**Practical: Total credit: 1, contact hours/week: 2**	
	1	Preparation of a review paper:Selection of journals, components, Plagiarism detection, Submission and Publication	
	2	Research Manuscript preparation for Journals: components,Plagiarism detection, Submission and Publication	
	3	Presentation of references -APA style, CSE style	
	4	Presenting research: oral and poster	

References

1.Holmes, Moody & DineResearch Methods for the Biosciences.. Oxford University Press

2.Ruxton & Colegrave.Experimental Design for the Life Sciences. Oxford University Press

3.David J. GlassExperimental Design for Biologists.. Cold Spring Harbor Laboratory.

4.C.R. Kotari, Research Methodology Methods and Techniques, Second Revised Edition, New Age International (P) Limited, Publishers

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand themselves with different aspects of research methodology	U	PSO-1
CO-2	Create information on research design.	C	PSO-1,4,5
C0-3	understand the basic concepts of hypothesis generation and experimental designing.	U	PSO-1,4,5
C0-4	Understand and create information on experimentation in research and data representation	U and C	PSO-1,4,5
C0-5	Apply knowledge in thesis writings and presentation	A	PSO-1,4,5
CO-6	Apply,create and analyse knowledge in project proposal preparation	A,C,An	PSO-1,4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand themselves with different aspects of research methodology	PO 6/PSO 1	U	F,C	l	
CO-2	Create information on research design.	PO 1,2,6/ PSO 1,4,5	C	F,C	l	
C0-3	understand the basic concepts of hypothesis generation and experimental designing.	PO 1,2,6/ PSO 1,4,5	U	F,C	l	
C0-4	Understand and create information on experimentation in research and data representation	1,2,6/PSO 1,4,5	U and C	F,C	l	

C0-5	Apply knowledge in thesis writings and presentation	PO 3,4,7/ PSO 1,4,5	A	F,C,P	l	
CO-6	Apply,create and analyse knowledge in project proposal preparation	PO 3,4,7/ PSO 1,4,5	A,C,An	,C,P,M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO 1	1	-	-	-	-	-	-	-	-	-	-	1	-
CO 2	1	-	-	1	1	-	1	2	-	-	-	2	-
CO 3	1	-	-	1	1	-	1	2	-	-	-	2	-
CO 4	1	-	-	2	2	-	1	2	-	-	-	2	-
CO 5	2	-	-	2	2	-	-	-	2	2	-	-	3
CO 6	2	-	-	3	3	-	-	-	2	2	-	-	3

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6		✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK7DSCMBY403				
Course Title	**Biophysics and Instrumentation**				
Type of Course	**DSC-P**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Knowledge of microorganisms and microbiological techniques acquired during the first, second and third year of the programme.				
Course Summary	This course provides a comprehensive understanding of key principles and techniques in biology, from thermodynamics and microscopy to instrumentation and structural biology. It offers a solid foundation for students in various fields of biology, including biochemistry, molecular biology, and biophysics.				

Detailed Syllabus: Total hours 75

Module	Unit	Content	Hrs 45
I		**BIOENERGETICS**	**7**
	1	Laws of conservation of energy-first and second laws and their relevance in the biological system, entropy, enthalpy, thermodynamic equilibrium, redox potential, Gibb's free energy.	
	2	Endothermic and exothermic reactions of biological systems- energy change in the biological reactions.	

	3	Electrical properties of biological compartments. Electricity as a potential signal, electrochemical gradients	
	4	Membrane potential, ATP synthesis, chemiosmotic hypothesis.	
II	**MICROSCOPY**		**8**
	1	Principles of microscopy	
	2	Light Microscope- working and application of simple, compound, CSLM, DICM, polarisation, Atomic force microscopy	
	3	Electron Microscope- STEM, LEEM, PEEM (brief introduction only)	
	4	Specimen preparation for electron microscopy- negative staining, shadowing, freeze – etching	
III	**INSTRUMENTATION-1**		**7**
	1	Basic principles and working of pH meter, colorimeter, Beer-Lambert's law	
	2	Spectrophotometer- UV and visible, IR, NMR, atomic absorption spectroscopy	
	3	Brief account of flame photometry, densitometry, fluorimetry, manometry, flow cytometry.	
	4	X – ray crystallography and GM counter.	
IV	**INSTRUMENTATION -2**		**8**
	1	Centrifugation-Principle, procedure and application of ultra-centrifugation, differential centrifugation and density gradient centrifugation.	
	2	Chromatography- Principle and procedure of paper chromatography, thin layer chromatography, column chromatography, ion- exchange chromatography, affinity chromatography, gel filtration, GLC, HPLC, FPLC, LC-MS	
	3	Electrophoresis-Principles and applications of paper electrophoresis, gel electrophoresis (native, SDS).	
V	**STRUCTURAL BIOLOGY**		**15**
	1	Protein structure-primary, secondary, tertiary and quaternary structures. forces stabilizing, denaturation kinetics, torsion angle, protein – ligand interactions, Ramachandran plot.	
	2	Nucleic acids- DNA structure and polymorphism. DNA supercoiling.	

	3	DNA-protein interaction, RNA-protein interaction.	
VI		**PRACTICALS**	**Hrs 30**
	1	Separation of serum proteins by electrophoresis.	
	2	Separation and identification of amino acids by paper chromatography	
	3	Separation and identification of amino acids by Thin Layer Chromatography.	
	4	Separations of proteins by SDS - PAGE.	
	5	Separation of any biomolecule by column chromatography.	
	6	Separation of any biological macro molecule by gel filtration chromatography.	

REFERENCES:

1. Martin, R.B. (1964) Introduction to Biophysical Chemistry. Mc Graw Hill

2. Banerjee,P.K. (2008) Introduction to Biophysics .S.Chand & Co

3. Nelson, D.L., Cox,M (2008) Lehninger's Principles of Biochemistry Mac Millan.

4. Voet,D and Voet, J.G (2010) Biochemistry 4th edition Wiley

5. Potter, G.W.H. and Potter, G.W. (1994) Analysis of biological molecules: An introduction to principles, instrumentation and techniques. Springer publication

6. Chatwal, G.R., Anand, S.K. (2011) Instrumental Methods of Chemical Analysis. Himalaya Publishing House

7. Watson,J.D. et al.(2014) Molecular Biology of the Gene 7th edition. Pearson publication

8. Nair, A.J. (2007) Principles of Biotechnology. Laxmi Publication (P) Ltd

9. Kumar,H.D., Gupta B.R., Engeldrum, D.(2000)Textbook of Biotechnology. East-West Press

10. Prescott L.M. Harley J.P. and Klein D.A. (2005). Microbiology (6th edition) McGraw Hill, New York.

11. Harris DA and CL Bashford (Ed.) (1987) Spectrophotometry and Spectrofluorimetry: A Practical Approach. IRL Press, Oxford.

12. Donald L.Pavia Gary M.Lipman, George S Kriz. Introduction to Spectroscopy. Harcourt brace College Publishers, Orlands, Florida. Latest edition

13. Braithwate A and Smith F J (1986) Chromatographic methods. Chapman and hall, NewYork.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the significance of energetics in biological system	R, U	PSO-1, 3
CO-2	Learn microscopy, types and specimen preparation	R, U, An	PSO-1, 2
CO-3	Understand various instruments for biochemical analysis	U, An	PSO-1, 2
CO-4	Learn the structure of proteins and nucleic acids	R, U	PSO-1, 3
CO-5	Understand interactions between proteins and nucleic acids	U, An	PSO-1, 3
CO-6	Perform various experimental techniques which can be applied in the qualitative and quantitative analysis of biomolecules in the laboratory	Ap, An, E, C	PSO-2, 3, 4, 5, 6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the significance of energetics in biological system	PO-1, 2, 3, 6 / PSO1, 3	R, U	F, C	L	

CO-2	Learn microscopy, types and specimen preparation	PO-1, 2, 4, 6, 7 / PSO1, 2	R, U, An	F, P	L	
CO-3	Understand various instruments for biochemical analysis	PO-1, 2, 4, 6, 7 / PSO1, 2	U, An	F, P	L	
CO-4	Learn the structure of proteins and nucleic acids	PO-1, 2, 3, 6 / PSO1, 3	R, U	F, C	L	
CO-5	Understand interactions between proteins and nucleic acids	PO-1, 2, 3, 6 / PSO1, 3	U, An	F, C	L	
CO-6	Perform various experimental techniques which can be applied in the qualitative and quantitative analysis of biomolecules in the laboratory	PO-1, 2, 4, 6 / PSO2, 3, 4, 6	Ap, An, E, C	P, M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	2	-	2	-	-	2	3	3	3	-	-	2

CO 2	2	2	-	-	-	-	3	3	-	3	-	2
CO 3	2	2	-	-	-	-	3	3	-	3	-	2
CO 4	2	-	2	-	-	-	3	3	3	-	-	2
CO 5	2	-	2	-	-	-	3	3	3	-	-	2
CO 6	-	2	3	2	-	3	3	3	-	-	-	3

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓

CO 2	✓			✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6		✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK7DSCMBY404				
Course Title	**Biostatistics and Bioinformatics**				
Type of Course	**DSC-P**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Knowledge of microorganisms and techniques acquired during the first, second and third year of the programme.				
Course Summary	This course provides a comprehensive overview of fundamental statistical concepts, including data collection, analysis, and hypothesis testing, as well as an introduction to bioinformatics, covering biological databases, sequence analysis, and practical applications in various fields.				

Detailed Syllabus: Total hours -75

Module	Unit	Content	Hrs 45
I		**Module 1: Statistics-I**	**7**
	1	Methods for collecting data, tabulation and representation of data	
	2	scope and concept of sampling – representative sampling and sampling size.	
	3	Data presentation – graphics, tables, histograms and pi – diagrams, frequency polygon, frequency curves and cumulative frequency curves	
		Module 2: SStatistics-II	**8**

II	1	Measures of central tendency - mean, median, mode, quartile, decile and percentile. Measures of dispersion, mean deviation and standard error.	
	2	Probability. Basic concepts related to probability theory, classical probability and probability distributions.	
	3	Tests of hypotheses. Some basic concepts, errors in hypotheses testing, critical region.	
	4	Students t – test for the significance of population mean Chi square test for population variance F- test for the equality of two population variance Analysis of variance – one way and two-way analysis.	
III	**Module 3: Introduction to Bioinformatics**		**7**
	1	Bioinformatics- definition. History and evolution of bioinformatics, impact of bioinformatics in modern biology. Genomics, proteomics.	
	2	Biological databases – NCBI, DDBJ, EBI, PROSITE, PDB, EMBL, Gene bank, Pub med, structural data bases, derived and specialized data bases,	
	3	Tools (software) in bioinformatics. Tools of sequence alignments – BLAST (nucleotide, protein) FASTA, Clustal X and RASMOL.	
IV	**Module 4: Sequence Alignments**		**8**
	1	Sequence analysis, pairwise and multiple alignments, sequence analysis software.	
	2	Phylogeny and Phylogenetic trees	
	3	Types of phylogenetic trees, Different approaches of phylogenetic tree constructionUPGMA, Neighbour joining, Maximum Parsimony, Maximum likelihood	
V	**Module 5: Applications**		**15**
	1	Applications of bioinformatics- pharmaceutical industry, immunology, agriculture, forestry, basic research, chemoinformatics in biology, geoinformatics, Legal ethical and commercial considerations.	
	2	Molecular docking-types of docking-types of interaction-search algorithm, scoring function-key stages of docking-autodock -application-Drug designing. Structure prediction and protein modelling.	
	PRACTICALS		**Hrs 30**

VI	**Course Type: Total Credits: 1 Contact hours/week: 2**		
	27	Analysis of Nucleic Acid Sequences	
	28	Sequence Similarity Searching	
	29	ORF Prediction	
	30	Multiple sequence Alignment	
	31	Pairwise sequence alignment using BLAST and FASTA	
	32	Gene Structure and Function prediction	
	33	Protein structure analysis	
	34	Phylogenetic tree construction	

REFERENCE

1. Kenney, J.F. and Keeping, E.S. (1951) Mathematics of Statistics 2nd edition. D Van Nostrand Company

2. Athel Cornish-Bowden (2000) Basic Mathematics for Biochemists 2nd edition. Oxford Press

3. Norman T.J.Bailey (1995) Statistical Methods in Biology 3rd edition. Cambridge University Press

4. Rao,P.S.S.Sundar and Richard,J.(2006) Introduction to Biostatistics and Research Methods 5th edition PHI Learning Pvt. Ltd.

5. White R, Downs,T(2007) How computers work 9th edition Pearson publishers

6. Kothekar,V(2004)Introduction to Bioinformatics 1st edition Dhruv publication

7. Baxevaris,A.D. Bioinformatics B.F Publication. Latest edition

8. Higgins, D.,Taylor,W(2000) Bioinformatics Oxford University Press

9. Persuki,Jr and Persuki (1997) The internet and new biology :tools for genomics and molecular research ASM Press

10. Beier, F.K., Crespi, R.S. and Straus, T. (1985) Biotechnology and Patent Protection-An International Review. Oxford and IBH Publishing Co. New Delhi.

11. Sasson A. (1988) Biotechnologies and Development, UNESCO Publications.

12. Singh K (1993) Intellectual Property rights on Biotechnology- A status report. BCIL, New Delhi

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	P S O addressed
CO-1	Understand the concept of Bioinformatics	U	PSO1
CO-2	Know how to use bioinformatics for protein sequence analysis through bioinformatics tools and databases	U	PSO1
CO -3	Know how to use bioinformatics for DNA sequence analysis through bioinformatics tools and databases	U,Ap	PSO1,2
CO – 4	Represent the data of experimental and field studies through graphs and diagrams and Apply statistical methods to analyse and interpret the biological data.	U, Ap	PSO2,3
CO - 5	Understand statistical concepts and learn to use variety of statistical tests.	U,Ap	PSO2,3
CO-6	To learn how to download nucleotide and protein sequence files from databases and its visualization. To compose mean, median. mode and compare different tests of significance.	U,Ap,An	PSO2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand the concept of Bioinformatics	PO1/ PSO1	U	F	L	
2	Know how to use bioinformatics for protein sequence analysis through bioinformatics tools and databases	PO1/ PSO1	U	F	L	

3	Know how to use bioinformatics for DNA sequence analysis through bioinformatics tools and databases	PO1,2/ PSO1,2	U,Ap	F,C	L	
4	Represent the data of experimental and field studies through graphs and diagrams and Apply statistical methods to analyse and interpret the biological data.	PO1,2/ PSO2,3	U, Ap	F,C	L	
5	Understand statistical concepts and learn to use variety of statistical tests.	PO2,3/ PSO2,3	U,Ap	F,C	L	
6	To learn how to download nucleotide and protein sequence files from databases and its visualization. To compose mean, median. mode and compare different tests of significance.	PO2,6/ PSO2,3	U,Ap,An	P,M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	1	-	-	-	-	-
CO 2	1	-	-	-	-	-	1	-	-	-	-	-

CO 3	2	1	-	-	-	-	2	1	-	-	-	-
CO 4	-	2	1	-	-	-	2	1	-	-	-	-
CO 5	-	2	1	-	-	-	-	1	1	-	-	-
CO 6	-	1	1	-	-	-		1	-	-	-	1

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	EndSemester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6				✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK7DSCMBY405				
Course Title	**Microbial Biotechnology**				
Type of Course	**DSC-P**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Knowledge of microorganisms and microbiological techniques acquired during the first, second and third year of the programme.				
Course Summary	The microbial biotechnology Course focuses on the exploitation of microorganisms in biotechnology for various industrial, environmental, and medical applications. This course provides an in-depth exploration of the principles, techniques, and applications of microbial biotechnology.				

Detailed Syllabus: Total hours -75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
I		**Module1: Microbial Enzymes**	**7**
	1	Microbial enzymes and- types, Factors affecting enzyme activity	
	2	Microbial enzyme production and its application	
	3	Industrial production and applications of: Cellulase, Pectinase, Protease, Lipase, Ligninase	

II	**Module 2: Microbial Metabolites**		**8**
	1	Primary and Secondary metabolites of microbes (briefly account)	
	2	Antimicrobial Metabolites: Antibiotics, lantibiotics, bacteriocins	
	3	Polymeric microbial metabolites: dextrans, xanthan gums, alginate	
	4	Microbial pigments	
III	**Module 3: Techniques in Microbial Biotechnology**		**7**
	1	Differential centrifugation and purification by density gradient centrifugation	
	2	Chromatographic methods of separation; Principles and applications of chromatography; Thin layer; Gas-liquid; HPLC and FPLC (Brief account)	
	3	Spectrophotometry- Principles and applications UV-Visible, Mass Spectrometry, MALDI-TOF, Atomic Absorption Spectrometry (Brief account)	
IV	**Module 4: Industrial Application of Microbial Biotechnology**		**8**
	1	Role of microbes in the Food Industry; nutraceutical, Prebiotic and Probiotics, organic acid production	
	2	Microbial Fuel Cells and Biosensors	
	3	Environmental application: Microorganisms involved in metal recovery, Biotransformation of heavy metals, petroleum biodegradation and Biodegradable plastics. Biosurfactants, microbial insecticides	
	4	Pharmaceutical Biotechnology: Therapeutic proteins, and vaccines (Brief account)	
V	**Module 5: Microbes in Genetic Engineering**		**15**
	1	Commercial products by recombinant microbes (brief account): Insulin, Growth hormones, BT cotton, Oil eating microbes -*Pseudomonas putida*	
	2	Metabolic Engineering (Brief account)	
	5	Ethical, Social, and Regulatory Aspects of Genetically Modified Microbes	

	6	Effluent Treatment: Need, Traditional methods disposal and disadvantage, physical, chemical and biological methods.	
VI		**Practical**	**Hrs 30**
	Course Type: Practical, Total credits: 1, Contact hours/week: 2		
	1	Isolation of industrially important enzyme: Screening of pectinase producers	
	2	Isolation of industrially important enzyme: Screening of cellulase producers	
	3	Determination of cellulase activity using carboxy-methyl cellulose assay	
	4	Protein Estimation by Lowry's method	
	5	Isolation of probiotic microorganisms from various sources	
	6	Isolation of Antibiotic Producers from soil	
	7	Visit any biotechnology industry or institute and write a report	

References:

1. Robert A Andersen. 2005. Algal Culturing Techniques. Academic Press.

2. L. M. Prescott, J. P. Harley and D. A. Klein. Microbiology-, McGraw Hill 3. N. J. Pelczar, S. Chand, R. Krieg. Microbiology- Tata McGraw Hill

4. Casida, Industrial microbiology-, L.E. New age international Ltd, Publishers. New Delhi:
5. Frazier, Food microbiology. W.C. Tata McGraw Hill.

6. Carr NG & Whitton BA. 1982. The Biology of Cyanobacteria. Blackwell.

7. Bergerson F J. 1980. Methods for Evaluating Biological Nitrogen Fixation. John Wiley & Sons.

8.Pandey A, Lasroche C, Soccol C. R and Dussop C. G. Advances in Fermentation technology (2008). Asiatech publishers Inc. 2.

9. Mathuriya A. S. Industrial Biotechnology (2009) Ane Books Pvt. Ltd.

10.Friefelder. D. (1982) Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2 nd ed. W.H. Freemen and Company, San Fransisco.

11. Griffiths, O. M. (1983). Techniques of Preparative, Zonal and Continuous Flow Ultracentrifugation.

12. William, B.L. and Wilson, K. (1986). A Biologist Guide to Principles and Techniques Practical Biochemistry, 3 rd ed., Edward Arnold Publisher, Baltimore, Maryland (USA).

13. Slater, R.J. (1990).Radioisotopes in Biology-A Practical Approach, Oxford University Press, NewYork.

14.Principles of Fermentation Technology byStanbury and Whitaker

15. Industrial Microbiology by Casida 3. Industrial Microbiology by Prescott and Dunn

16. Industrial Biotrasformations by A. Liese, K. Seelbach and C. Wandrey; Wiley – VCH

17. Role of Biotechnology in Medicinal and Aromatics Plants by Khan and Khanum Vol. 1 to 6. Plant Tissue Culture by M. K. Razdan

18. Larry Snyder and Wenndy champness ; Molecular Genetics of Bacteria ; ASM Press ; 2003 2.

19.Channarayappa ; Moleclar Biotechnology ; 2006 3. Peppler and Periman ; Microbial technology ; 2nd Ed;Academic press; 2004

20. Fundamentals of Enzymologist: Nicholes C. Price and Lewis Stevens, Oxford Univ. Press.

22 Enzyme Structure and Mechanism: Alan Fersht, Reading, USA.

23. Understanding Enzymes: Trevor Palmer

Practical Reference

Subhash Chandra Parija Practical Textbook on Microbiology 2nd Edition

RC Dubey and Maheswary Practical Textbook of Microbiology Chand Publication

Bharathy Arora and DR Arora Practical Microbiology CRC publishers

Upasana Bumbala Workbook on Practical Microbiology 2nd Edition

KR Aneja Experiments in Microbiology Plant Pathology and Biotechnology 4th Edition

https://www.mutagens.co.in/jgb/vol.06/6/060605.pdf

E-Resources

https://portal.abuad.edu.ng/lecturer/documents/1585662755MICROBIAL_BIOTECHNOLOGY__Fundamentals_of_Applied_Microbiology,_Second_Edition.pdf

https://archive.org/details/aneja-kr-experiments-in-microbiology-6-e

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain a comprehensive understanding of Microbial Enzymes and their type	U,R	/PSO1
CO2	Acquire knowledge of Microbial Metabolites	U, Ap	PSO6
CO3	Gain knowledge on various Techniques in microbial biotechnology	U, Ap	/PSO2
CO4	Acquire knowledge of Microbial Metabolites	U, Ap	PSO6
CO4	Explore various Industrial applications of Microbial Biotechnology	U , Ap,R	PSO5
CO5	Evaluate the application of Genetic engineering in various fields	U, C,Ap,E	PSO2
CO6	Acquire hands-on training in biotechnological application	U,Ap,An,C	PSO2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)

CO1	Gain a comprehensive understanding on Microbial Enzymes and their types	PO6/ PSO1	U,R	F, C	L	
CO2	Explore various Industrial Applications of Microbial Biotechnology	PO6/ PSO6	U , Ap,R	C,P	L	
CO3	Gain knowledge on various Techniques in microbial biotechnology	PO1,2 /PSO2	U, Ap	C,P	L	
CO2	Explore various Industrial Applications of Microbial Biotechnology	PO6/ PSO6	U , Ap,R	C,P	L	
CO5	Evaluate the application of Genetic engineering in various fields	PO3/ PSO5	U, C,Ap,E	C,P	L	
CO6	Acquire hands on training in biotechnological application	PO1,3 /PSO2	U,Ap,An,C	P,M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	2	-	-	-	-	-	-	-	-	-		2	-	-

CO 2	-	-	-3	-	-		-	-	-	-	-	3	-	-
CO 3	-	2	-	-	-	-	2	1	-	-	-	-	-	-
CO 4	-	-		-	-	-3	-	-	-	-	-	2	-	-
CO 5	-	-	-	-	3	-	-	-	2	-	-	-	-	-
CO 6	-	3	-	-	-	-	1	2	-	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓

CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6				✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK3DSEMBY201				
Course Title	**Microbiology in Business**				
Type of Course	**DSE**				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	4 hours	-	-	4
Pre-requisites	Elementary knowledge of Microbiology and managerial economics				
Course Summary	This course provides a comprehensive understanding of entrepreneurship in microbiology, covering the entire process from idea generation to commercialization. It equips individuals with the knowledge and skills needed to start and manage successful microbiology-based businesses, including product development, quality control, and funding acquisition.				

Detailed Syllabus: Total hours 60

Course Type: Theory, Total credits: 4, Contact hours/week: 4			
Module	**Unit**	**Content**	**Hrs 60**
I	**Module 1 : Introduction to Entrepreneurship**		**12**
	1	Entrepreneur - Meaning of Entrepreneur, Functions of an Entrepreneur.	
	2	Development of Entrepreneurship steps in the entrepreneurial process.	
	3	Identification of Business Opportunities, Qualities, skills and attributes that successful microbiology entrepreneurs possess	

II	**Module 2 : Business Development**		**12**
	1	Business development in Microbiology - Factors affecting microbiology business: finance, infrastructure, equipment, manpower, resources, project location, end product and quality analysis	
	2	Skills in bio-entrepreneurship-Personality and attitude, Organizational behavior, Leadership, Principles of effective communication, public speaking, presentations and business proposal writing	
	3	Government schemes for commercialization of technologyFunding and support mechanisms for entrepreneurship.	
III	**Module 3 : Start -up for value added products**		**12**
	1	Dairy products- Production of yoghurt, Cheese, Dry Milk	
		Fermented foods - Wine,vinegar	
	2	Single Cell Protein: *Spirullina maxima* and *Chlorella pyrenoidosa,* Mushroom	
	3	Probiotic products	
	4	Production and applications of Sanitizers, Antiseptic solutions	
IV	**Module 4 : Biofertilizers and Biopesticides**		**12**
	1	Biofertilizers and Biopesticides: Production of *Rhizobium, Azotobacter, Azospirillum*, BGA and Mycorrhiza.	
	2	Packing and Quality assurance	
	3	Bioinsecticide: production of of bacteria based bioinsecticide- *Bacillus thuringiensis* and *Pseudomonas fluorescens* Production of of fungi based bioinsecticide- *Verticillium lecanii*	
V	**Module 5 : Commercial Products**		**12**
	1	Production of enzymes – Cellulase, Protease, Amylase and lipase	
	2	Biochemistry, Industrial Production and Application of biogas, bio-diesel, hydrogen fuel, gasoline.	
	3	Bioplastics - PHB, PHA.	

	3	Biopigments – Lycopene, Beta Carotene, and its applications	

REFERENCES

1. Bell JR (2010) Handbook of bioentrepreneurship (Book Review). N Engl J Entrep 13:1–2

2. Bogoro SE (2015) Entrepreneurship for development. Convocation lecture delivered at the 2nd convocation ceremony of the Kaduna. State University Kaduna

3. Eniola AA (2018) Entrepreneur-SME manager traits and sources of financing. In: Ratten V, Dana LP, Honyenuga B (eds) African entrepreneurship: challenges and opportunities for doing business, 1st edn. Springer, Cham

4. Life Science Austria (2017) The international Biotech & Medtech Business Plan Handbook Austria Wirtschafts service GesellschaftmbH

5. Prescott LM, Harley JP, Klein DA (2005) Microbiology, 6th edn. McGraw Hill Publishers, New York. pp. 2 and 12

6. Rama VS (2009) Job prospects in microbiology.

7. Shimasaki CD (2009) The business of bioscience what goes into making a biotechnology product? Springer, pp 9–26

8. Steven MF, Uma SK (2014) Licensing the technology: biotechnology commercialization strategies using university and Federal labs. In: Biotechnology entrepreneurship. Elsevier, pp 185–206

9. Stanbury, P.F, and Whitekar. A. (1999), Principles of Fermentation Technology, 2nd Edition. Butterworth-Heinemann: Oxford.

10. Stockholm, K.T.H., Sven-OlofEnfors, and Lena Haggstrom. (2000), Bioprocess Technology: Fundamentals and Applications, Royal Institute of Technology: Sweden.

11. Ashton Acton, Q., (2012). Biological Pigments– Advances in Research and Application.Scholorly Editions: Atlanta, Georgia.

12. Crueger, W, and Crueger. A. (2000), Biotechnology: A Text Book of Industrial microbiology, 2nd Edition, SinauerAssociates :Sunderland.Mass.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the importance of Bio-entrepreneurship and its scope	U	PSO1
CO-2	Describe and apply several entrepreneurial ideas and business theories in practical framework	U,Ap	PSO1,2
CO -3	Clarify the metabolic pathways and control mechanisms of commercially important metabolites	U	PSO1
CO – 4	Express the mass production of microbial inoculants used as Biofertilisers and Bioinsecticides in response with field application and crop response	U,Ap	PSO2,3
CO - 5	Decode the significance of industrial production of Biofuels and Point out the role of Bioplastics and Biopigments	U,Ap	PSO2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand the importance of Bio-entrepreneurship and its scope	PO1/ PSO1	U	F	L	
2	Describe and apply several entrepreneurial ideas and business theories in practical framework	PO2/ PSO1, 2	U,Ap	C,P	L	

3	Clarify the metabolic pathways and control mechanisms of commercially important metabolites	PO1/ PSO1	U	F	L	
4	Express the mass production of microbial inoculants used as Biofertilisers and Bioinsecticides in response with field application and crop response	PO2,3 / PSO2, 3	U,Ap	C,P	L	
5	Decode the significance of industrial production of Biofuels and Point out the role of Bioplastics and Biopigments	PO2/ PSO2	U,Ap	C,P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	1	-	-	-	-	-	1-	-	-	-	-
CO 3	2	-	-	-	-	-	1	-	-	-	-	-
CO 4	-	2	2	-	-	-	-	1	1	-	-	-
CO 5	-	1	-	-	-	-	-	-	-	-	-	-
CO 6	-	1	-	-	-	-	-	1	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK4DSEMBY401				
Course Title	**Environmental and Sanitation Microbiology**				
Type of Course	**DSE-P**				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic understanding of general microbiology				
Course Summary	This course provides students with a comprehensive understanding of microbial ecology and its practical applications. By studying microbial interactions and their roles in agriculture, mineral recovery, pollution management, and waste conversion, students gain insights into harnessing the potential of microorganisms for sustainable environmental solutions and value-added products.				

Detailed Syllabus: Total hours -75

Course Type: Theory, Total credits: 4, Contact hours/week: 4			
Module	**Unit**	**Content**	**Hrs 45**
I		**Module 1: Microbial Ecosystem**	**8**
	1	Microorganisms as components of ecosystem- producers and decomposers, Bacterial life in extreme environments & effect of temperature, pH, pressure, salt, radiation.	

	2	Microbial interactions- Mutualism, Proto-cooperation, Commensalism, Predation, Parasitism, Amensalism, Competition	
	3	Microbe-plant interaction: Rhizosphere and Rhizoplane concept. Mycorrhizae – brief account of ectomycorrhizae, endo mycorrhizae and ecto-endo mycorrhizae	
	4	Microbe-animal interaction: Microbes in ruminants, nematophagous fungi and symbiotic luminescent bacteria	
II	**Module 2: Microbiology of Air and water**		**8**
	1	Air microbiology: Air microflora- transient nature of air flora, droplet nuclei and aerosols, Distribution and sources of airborne organisms.	
	2	Assessment of air quality: Methods of air sampling and types of air samplers–impaction on solids, impingement technique in liquid, sedimentation, centrifugation, precipitation and thermal precipitations.	
	3	Air sanitation- methods and applications	
	4`	Water Microbiology: Freshwater and marine microbial populations; potable water and indicator microorganisms	
	5	Bacteriological analysis of drinking water: MPN, membrane Filtration method, Total plate count, drinking water purification, Water quality criteria	
III	**Module 3 : Solid Waste management**		**7**
	1	Sources and types of solid waste, Methods of solid waste disposal	
	2	Treatment of solid waste- composting, vermicomposting, incineration, landfilling	
	3	Anaerobic Digestion, Biogas production	
IV	**Module 4 :Liquid waste management**		**7**
	1	Liquid waste - Conventional methods of treatment of liquid waste	
	2	Household sewage treatment – septic tank, Imhoff tank, cess pool	
	3	Municipal sewage treatment, Primary, Secondary (Activated sludge, Trickling filter, oxidation pond) and tertiary	

	4	Composition and characteristics of sewage (DO, BOD, COD)	
V	**Module 5: Microbial Bioremediation**		**15**
	1	Biodegradation of xenobiotic compounds-bioaugmentation, biostimulation	
	2	Degradation of pesticides	
	3	Degradation of oil, lignin, petroleum and hydrocarbon compounds	
	4	Microbes in mining- Bacterial leaching	
		Practicals	**Hrs 30**
Course type: practical, total credits:1 contact hours/ week			
VI	1	Determination of Dissolved Oxygen (DO) of water	
	2	Determination of Biochemical Oxygen Demand (BOD) of water.	
	3	Determination of Chemical Oxygen Demand (COD) of water.	
	4	Determination of acidity of water	
	5	Determination of alkalinity of water	
	6	Bacteriological examination of water by multiple tube fermentation test. a. Presumptive coliform test b. Confirmed coliform test c. Completed coliform test	
	7	Enumeration of microorganisms from air by settle plate method a. Outdoor air b. Indoor air	

REFERENCES:

Microbial Ecology Fundamentals and applications – Atlas and Bartha (ISBN 981-405- 344-9)
Environmental Microbiology- K.Vijaya Ramesh (ISBN 81-8094-003-9)

Agricultural Microbiology- Rangaswamy G, D.J. Bhagyaraj (ISBN-81-203-0668-6)

Soil Microbiology an exploratory approach – Mark S.Coyne (ISBN 981-240-203-9)
Introduction to Soil Microbiology –Alexander

Soil Microbiology-Waksman Soil Microorganisms And Its Growth-N.S. Subba Rao
Biofertilizers in Agriculture- Subha Rao

E-RESOURCES:

https://www.soinc.org/sites/default/files/uploaded_files/417_MICROBES_AND_ECOLOGY.pdf

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4187170/

https://www.thebalancesmb.com/waste-treatment-and-disposal-methods-2878113 https://www.intechopen.com/books/biodegradation-life-of-science/pesticide-biodegradation-mechanisms-genetics-and-strategies-to-enhance-the-process https://openoregon.pressbooks.pub/envirobiology/chapter/3-2-biogeochemical-cycles/ https://www.onlinebiologynotes.com/biofertilizer-advantages-types-methods-ofapplication-and-disadvantages

Course Outcomes

No.	**Upon completion of the course the graduate will be able to**	**Cognitive Level**	**PSO addressed**
CO-1	Know about basics of microbial interactions	U	PSO-1
CO-2	Understand Microbiology of air and water	U, Ap	PSO-1
CO-3	Gain knowledge about solid waste management	U, Ap	PSO-1
CO-4	Gain knowledge about liquid waste management	U,Ap	PSO-1
CO-5	Understand the role of microbes in biodegradation, bioremediation and environmental cleaning process	U,Ap	PSO-1
CO-6	Learn the basic lab techniques in air microbiology and water quality analysis	Ap,An,E	PSO-3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Know about basics of Microbial interactions	PO 4,6/ PSO 1	U	F, C	L	
CO-2	Understand Microbiology of air and water	PO 4,6/ PSO 1	U, Ap	F,C	L	
CO-3	Gain knowledge about solid waste management	PO 4,6/ PSO 1	U, Ap	F,C,P	L	
CO-4	Gain knowledge about liquid waste management	PO 2,4,6/ PSO 1	U, Ap	F,C,P	L	
CO-5	Understand the role of microbes in bioremediation	PO 2,4,6/ PSO 1	U, Ap	F,C,P	L	
CO-6	Learn the basic lab techniques in agriculture microbiology and water quality analysis	PO 4,5/ PSO 3	Ap,An,E	F,C,P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-	-	-	2	-	-	2

CO 2	2	3	-	-	-	-	-	-	2	-	-	2
CO 3	-	-	1	-	-	-	-	-	2	-	-	2
CO 4	-	-	2	3	-	-	2	-	2	-	-	2
CO 5	-	1	-	-	-	-	2	-	2	-	-	2
CO 6	-	-	-	3	-	-	-	-	2	3	3	3

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations

CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6		✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK4DSEMBY202				
Course Title	**Microbial Physiology and Systematics**				
Type of Course	**DSE-P**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic knowledge of microorganisms acquired during the first semester of this programme.				
Course Summary	The course provides a clear understanding of various aspects in microbial physiology, growth, nutritional requirement, nutritional classification, energy generation and understanding of taxonomic classification of Microorganisms.				

Detailed Syllabus: Total hours :75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
I	**Module1: Bacterial Growth**		**7**
	1	Types of bacterial reproduction: Budding, Fragmentation, Binary fission.	
	2	Different phases of growth, Growth curve & Generation time.	

	3	Factors affecting bacterial growth (Temperature, pH, pressure, salt concentration, oxygen concentration).	
	4	Batch, Continuous culture, Fed batch, Synchronous growth.	
II	**Module2: Bacterial Nutrition**		**8**
	1	Nutritional requirements: Micro and macro elements	
	2	Nutritional classification of bacteria	
	3	Prokaryotic photosynthetic pigments	
	4	Bacterial photosynthesis: oxygenic and anoxygenic	
III	**Module 3: Nutrient uptake of bacteria**		**7**
	1	Bacterial diffusion: Passive diffusion, facilitated diffusion	
	2	Active transport- ABC transport, symport, antiport, group translocation- sugar phosphotransferase system (PTS), Iron uptake.	
IV	**Module 4: Systematics I**		**8**
	1	Classification of bacteria: Criteria for classification-morphological, nutritional, ecological, biochemical & molecular.	
	2	Bergy's manual (Brief account)	
	3	Major systems of classification. Three-kingdom and Five kingdom classification, Three domain & Five domain classification	
V	**Module 5: Systematics II**		**15**
	1	Classification of fungi-with examples (Ascomycetes, Chytridiomycetes, Basidiomycetes, Zygomycetes, Deuteromycetes- brief account)	
	2	Classification of protozoa- Sarcodina, Mastigophora, Ciliata, Sporozoa	
VI		**Practicals**	**Hrs 30**
	Course Type: Practical, Total credits: 1, Contact hours/week: 2		
	1	Demonstration of bacterial growth curve	
	2	Effect of pH on bacterial growth	
	3	Effect of salt on bacterial growth	
	4	Effect of temperature on bacterial growth	
	5	Germicidal effect of ultraviolet light on bacterial growth	

	6	Effect of different disinfectants and antiseptics on bacterial growth	

REFERENCES:

- Microbiology - Pelczar, Chan and Kraig (ISBN 0-07-462320-6)
- Microbiology -Prescott, Harley and Klein (ISBN 0-07-111217-0)
- Essentials of Microbiology-Purohit and Singh Brock's Biology of Microorganisms-Margin Martinko And Parker
- Microbial Genetics-Frifielder
- Microbiology-Zins
- Textbook of Microbiology, Dubey R.C. and Maheshwari, (2010), S.Chand Publications.
- Bacterial Metabolism, Doelle. H.W (1975), 2ndEd. Academic Press.
- Microbial physiology, Moat. A.G. J.W.Foster, (1988). 2ndEd. Springer – Verlag.
- David White, (2011). The Physiology and Biochemistry of Prokaryotes, 4thEd.Oxford University Press.
- Atlas & Atlas. Microbiology. Pearson Publications. 4thEd.
- Microbiology - An Introduction, Gerard J. Tortora, Berdell R. Funke & Christine L. Case, (2013). 11thEd. Pearson
- Prescott‟s Microbiology, Joanne Willey and Kathleen Sandman and Dorothy Wood, (2020). 11thEd. Wm, C. Brown publishers

E-RESOURCES:

- https://facultystaff.richmond.edu/~lrunyenj/bio384/lecturenotes/ch5.pdf
- https://www.weizmann.ac.il/SAERI/sites/AERI/files/photosynthesislecture.pdf
- https://microbenotes.com/classification-of-bacteria-on-the-basis-of-nutrition/
- https://nios.ac.in/media/documents/dmlt/Microbiology/Lesson-03.pdf
- http://www.uobabylon.edu.iq/eprints/publication_10_1062_180.pdf

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed

CO-1	Gain knowledge about growth and key factors influencing the growth of microorganisms	U, An	PSO-1,2
CO-2	Distinguish the microorganisms based on their nutritional requirements	U, An	PSO-1,3
CO-3	Understand about various transport mechanisms of nutrients uptake	U	PSO-1,3
CO-4	Know about basics of microbial classification and systematics	R,U	PSO-1,5
CO-5	Explore the taxonomy, characters, life cycle and economic importance of Fungi, Protozoa with representative types.	R, U, Ap	PSO-1,3,5
CO-6	To learn hands-on techniques in microbiology	U, Ap, An, C	PSO-2,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	**CO**	**PO/ PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/ Tutorial (T)**	**Practical (P)**
CO-1	Gain knowledge about growth and key factors influencing the growth of microorganisms	PO 1/ PSO 1,2	U, An	F, P	L	
CO-2	Distinguish the Microorganisms based on their nutritional requirements	PO 1,2/ PSO 1,3	U, An	F,C	L	
CO-3	Understand about various transport mechanisms of nutrients uptake	PO 1,2,3/ PSO 1,3	U	F,C	L	

CO-4	Know about basics of microbial classification, taxonomy	PO 1,3,7/ PSO 1,5	R,U	C,M	L	
CO-5	Explore the taxonomy, characters, life cycle and economic importance of Fungi, Protozoa with representative types.	PO 1,6,7/ PSO 1 ,3,5	R, U, Ap	F,C,M	L	
CO-6	To learn hands-on techniques in microbiology	PO 1,2,6/ PSO 2,3,5	U, Ap, An, C	P,M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	1	-	-	-	-	2	-	-	-	-	-
CO 2	1	-	1	-	-	-	1	2	-	-	-	-
CO 3	1	-	1	-	-	-	1	1	1	-	-	-
CO 4	1	-	-	-	1	-	1	1	2	-	-	-
CO 5	1	-	1	-	1	-	1	2	1	-	-	-
CO 6	-	1	1	-	1	-	1	2	2	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6		✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK5DSEMBY301				
Course Title	**Cell Biology**				
Type of Course	**DSE**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	4 hours	-		4
Pre-requisites	Basic knowledge of cell and cell systems acquired during HSE and the first year of the programme				
Course Summary	Cell biology focuses on the study of cell structure and function, how cells form and divide, and how they differentiate and specialize. Students delve into the intricate mechanisms governing cell growth, reproduction, metabolism, communication, and differentiation. The course emphasizes experimental techniques, theoretical concepts, and their applications in understanding cellular phenomena.				

Detailed Syllabus: Total hours -60

Course Type: Theory, Total credits: 4, Contact hours/week: 4			
Module	**Unit**	**Content**	**Hrs 60**
I		**Module 1:Introduction and History of Cell Biology**	**12**
	1	Introduction to cell biology: Early conditions on earth, Origin of life on earth.	

	2	Damn's concept on origin of life, Haldane and Oparin theory of the origin of life, Urey-Miller experiment, Fox's experiments.	
	3	Discovery of cells and cell theory.	
II	**Module 2:Fundamentals Of Cell Biology**		**12**
	1	Cell Structure-Ultrastructure of prokaryotic cell	
	2	Eukaryotic cell- Ultrastructure and functions of subcellular organelles	
	3	Difference between prokaryotic and eukaryotic cell	
III	**Module 3:Cytogenetics**		**12**
	1	Chromosome Structure- Nucleosome, Histones, Histone like proteins Types of chromosomes, Special types- polytene, lamp brush	
	2	Chromosome preparation, Cytogenetics techniques: G-Banding, R-Banding, Q-Banding, Flow cytometry, FISH and chromosome painting	
	3	Chromosomal aberrations- structural aberrations, and numerical aberration. Gene mutations - complementation test, Disorders associated with chromosomal aberrations - Philadelphia chromosome.	
IV	**Module 4:Cell Cycle And Regulation**		**12**
	1	Cell Cycle, Cell division- mitosis, meiosis	
	2	Programmed Cell Death: Apoptosis: mechanism- intrinsic and extrinsic pathways, necrosis.	
	3	Regulation of Cell cycle- Cell cycle check points	
	4	Cancer: benign, malignant, Oncogenes and Tumor suppressor genes	
V	**Module 5: Cell- Cell Interactions**		**12**
	1	Cell-cell interactions: definition, cell junctions- tight junctions, gap junction, cell adhesion molecules (CAM's): integrins, cadherins, and selectins	
	2	Cell-cell signalling- autocrine, paracrine, juxtacrine and endocrine	
	3	Quorum sensing	

Referance

1. Voet, D., Voet, J.G (2010). Biochemistry, 4th edition, Wiley.
2. Harper's Ilustrated Biochemistry (2009), 28th edition, McGraw Hill.
3. Campbell and Reece (2005) Biology, 7th edition, Pearson Publishing.

4. Raven, Johnson, Losos and Singer (2005) Biology, 7th edition, McGraw Hill.
5. Alberts, Bray, Hopkin, Johnson, Lewis, Raff, Roberts and Walters (2003), Essential cell biology, 2nd edition, Garland.
6. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith; Roberts, Peter Walter. (2007). 7) Molecular Biology of the Cell. 5th Edition. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2005).
7. Lodish et al., Molecular cell Biology, 4thEdition, W.H. Freeman & Company, 2000
8. Smith & Wood, Cell Biology, 2ndEdition, Chapman & Hall, London, 1996.
9. Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.
10. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley- Blackwell, 2002.
11. Benjamin Lewin, Gene IX, 9thEdition, Jones and Barlett Publishers, 2007.

E RESOURCES

https://www.freebookcentre.net/Biology/Cell-Biology-Books.html#google_vignette

https://vetbooks.ir/cell-biology-3rd-edition/

https://open.oregonstate.education/cellbiology/

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	P S O addressed
CO-1	Recall history of cell biology	R,U	
CO-2	Understanding and explain cell structure and function.	U,R	
CO-3	Identify chromosomal aberrations and its application in diagnostic techniques	U,Ap,An	
CO-4	Illustrate the process of cell cycle and its regulation.	U,R	
CO-5	Define cell-cell interaction and cell signalling	U,R	

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture: Tutorial: Practical)

C O No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO1	Recall history of cell biology	P O 6 / PSO1	R,U	F,C	L	
CO2	Understanding and explain cell structure and function.	P O 6 / PSO1	U,R	C	L	
CO3	Identify chromosomal aberrations and its application in diagnostic techniques	P O 3 , 6 / PSO5	U,Ap,An	F,C,P	L	
CO4	Illustrate the process of cell cycle and its regulation.	P O 1 , 6 / PSO3	U,R	F,C	L	
CO5	Define cell-cell interaction and cell signalling	P O 1 , 6 / PSO 3	U,R	F,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	P S O2	P S O3	P S O4	P S O5	P S O6	PO 1	P O2	PO 3	PO4	PO 5	PO6	PO7	PO8
CO 1	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 3	-	-			3	-	-		2	-	-	2	-	-
CO 4	-	-	2				2	-	-	-		2	-	-
CO 5	-	-	2	-	-	-	2	-	-	-		2	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK5DSEMBY302				
Course Title	**Agricultural Microbiology**				
Type of Course	**DSE-P**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5 hours
Pre-requisites	Basic understanding of general microbiology.				
Course Summary	This subject introduces students to the diverse world of soil microbiology and the roles that microorganisms play in all aspects of agriculture, plant and soil science. The role that microorganisms play within the environment, in particular relating to plant, and soil health, will also be considered.				

Detailed Syllabus: Total hours -75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**45 Hrs**
I	**Module 1 : Soil Microbiology**		**8**
	1	Soil Microorganisms – Microbial diversity in soil.	
	2	Soil as microbial Habitat – Soil profile and properties, factors affecting microbial flora in soil.	
	3	Biogeochemical cycles- nitrogen, carbon, sulfur, phosphorus and its importance.	
	4	Role of microbes in soil fertility	

II	**Module 2 : Plant - Microbe Interactions**		**8**
	1	Soil microorganisms and microbial interactions - mutualism, synergism (protocooperation), commensalisms. Amensalism, competition, parasitism, predation, neutralism	
	2	Microorganisms of rhizosphere, rhizoplane and phylloplane concepts.	
	3	Mycorrhizae- Ectomycorrhizae, Endomycorrhizae and Vesicular Arbuscular mycorrhizae.	
III	**Module 3 : Biofertilizers**		**8**
	1	Biological nitrogen fixation- Biochemistry and physiology of nitrogen fixation, *nif* genes.	
	2	PGPR – General account of the microbes used as biofertilizers for crop plants and their advantages:	
	3	Plant growth promoting bacteria- symbiotic - Bradyrhizobium, Rhizobium and Frankia	
	4	Plant growth promoting bacteria- non-symbiotic - Azospirillum, Azotobacter, Mycorrhizae, Phosphate solubilizers and algae.	
	5	Role of biofertilizers in agriculture and forestry.	
IV	**Module 4 : Microbial Diseases of Plants**		**6**
	1	Bacterial diseases**:** Bacterial leaf blight of rice, Citrus canker.	
	2	Fungal diseases: Root rot of pepper, Downy mildew of grapes, and Tikka disease of groundnut.	
	3	Mycoplasmal diseases - Sandal spike, Grassy shoot disease of sugarcane	
	4	Actinomycetes Diseases - Potato scab disease.	
	5	Viral Disease – TMV, Bunchy top disease of banana	
V	**Module 5 : Biocontrol Mechanisms**		**15**
	1	Bio Pesticides: Bacterial, Viral and Fungal pesticides and their importance	
	2	Biocontrol mechanisms and ways; microbes used as biocontrol agents	
	3	Biological control of plant diseases.	
	4	Integrated pest management.	

VI		Practical	
		Practical: Total credit: 1, contact hours/week: 2	**30 Hrs**
	1	Isolation and enumeration of microorganisms from soil	
	2	Isolation and Cultivation of *Rhizobium* from root nodules	
	3	Isolation of microorganism from rhizosphere, and calculation of R: S Ratio	
	4	Study of antagonism between soil microorganisms.	
	5	Study the symptoms of microbial plant diseases through sample collection/field visit and prepare a report.	

REFERENCES

1. Lim, D.1998.Microbiology. 2 nd Edition; McGraw-Hill Publication.

2. Madigan, M.T. and Martinko, J.M.2006. Brock's Biology of Microorganisms. 11thEdition. Pearson Education Inc.

3. Pelczar, M. J. Jr., Chan, E. C. S. and Krieg, N. R. 1993. Microbiology, 5th Edition, Tata Mac Graw Hill Press.

4. Prescott, L.M, Harley, J.P. and Klein, D.A.2005.Microbiology.9th Edition. Mac Graw Hill Companies Inc.

5.Alcamo Fundamentalsofmicrobiology,5th Edition.

6.Gerald J. Tortora, Berdell. R. Funke, Christine L. Case, Microbiology–An Introduction. Pearson Publication

7. Salle, A.J.1971. Fundamental Principles of Bacteriology. 7 th Edition. Tata Mac Graw Hill Publishing Co.

8. Black, J. G. 2013. Microbiology: Principles and Explorations. 6th Edition, John Wiley and Sons, Inc. 65

9. Aneja, K. R. 2003. Experiments in Microbiology, Plant Pathology and Biotechnology. 4thEdition.New Age International (P) Limited, New Delhi.

10. Dubey, R.C. and Maheswari, D.K.2002.PracticalMicrobiology.2nd Edition, S. Chand & Co., New Delhi.

11. Kannan, N. 2002. Laboratory manual in general microbiology. 2nd Edition, Panima Publishing Co., New Delhi

12. Schmidt, E. L.1967. A Practical Manual of Soil Microbiology Laboratory Methods. Food and Agriculture Organization of the United Nations.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	To paraphrase on the microbiology of the soil and microbial diversity in soil.	R,U	PSO-1
CO-2	To describe the interaction of soil microbes with plants.	U	PSO-1
CO -3	Insight knowledge on nitrogen fixing organisms, and to describe the role of microbes as biofertilizers and review their application in agriculture.	U,Ap	PSO-1,2
CO - 4	Efficient in understanding the different symptoms, epidemiology and management of various plant diseases	U,E	PSO-1,2
CO - 5	To discuss the role of microbes as biopesticides and examine their role in integrated pest management. To understand plant disease mechanism and how to control plant diseases.	U	PSO-1
CO-6	To learn basic laboratory skills in Agricultural Microbiology and biofertilizers.	Ap,An,C	PSO-1,2,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)

1	To paraphrase on the microbiology of the soil and microbial diversity in soil.	PO1/ PSO 1	R,U	F	L	
2	To describe the interaction of soil microbes with plants.	PO1/ PSO 1	U	F,C	L	
3	Insight knowledge on nitrogen fixing organisms, and to describe the role of microbes as biofertilizers and review their application in agriculture.	PO1, 2/ PSO 1	U,Ap	F,C	L	
4	Efficient in understanding the different symptoms, epidemiology and management of various plant diseases	PO1/ PSO 1,2	U,E	F,P	L	
5	To discuss the role of microbes as biopesticides and examine their role in integrated pest management. To understand plant disease mechanism and how to control plant diseases.	PO1/ PSO 1	U	C	L	
6	To learn basic laboratory skills in Agricultural Microbiology and biofertilizers.	PO2, 6/ PSO 1,2,4	Ap,An,C	P,M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	1	-	-	-	-	-

CO 2	2	-	-	-	-	-	1	-	-	-	-	-
CO 3	-	-	1	-	-	-	2	-	-	-	-	-
CO 4	2	1	-	-	-	-	2	-	-	-	-	-
CO 5	1	-	-	-	-	-	1	-	-	-	-	-
CO 6	2	1	-	1	-	-	-	2	-	-	-	1

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓

CO 3	✓			✓
CO 4	✓	✓		✓
CO 5		✓		✓
CO 6				✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK5DSEMBY303				
Course Title	**Dairy Microbiology**				
Type of Course	**DSE**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	4 hours	-	-	4
Pre-requisites	Basic knowledge of microorganisms gained during the first two years of this programme.				
Course Summary	Dairy microbiology course encompasses the study of microorganisms, which have both beneficial and deleterious effects on the quality of milk and dairy products.This course covers the role of microorganisms in fermented dairy products, spoilage of milk and milk products and milk borne diseases.				

Detailed Syllabus: Total hours 60

Course Type: Theory, Total credits: 4, Contact hours/week: 4			
Module	**Unit**	**Content**	**Hrs 60**
I	**Module 1: Nutritional Importance of Milk**		**10**
	1	Composition and properties of milk	
	2	Organoleptic characteristics of Milk – appearance, taste and smell	

	3	Type of milk and milk products: whole milk, low fat milk, toned milk, skim milk, vitamin D milk, low sodium milk, homogenized milk, concentrated milk, sweetened condensed milk evaporated milk, dry milk, low lactose milk.	
	3	Fermented Dairy products - Yoghurt, Dahi, Cultured buttermilk, Bulgarian milk, Acidophilus milk, Kefir, Koumiss, Butter, Ghee and Cheese	
II	**Module 2:Microbial flora of milk**		**10**
	1	Classification of microorganisms in milk - biochemical types of Bacterial flora, Acid producers, Gas producers, Ropy or stringy fermentation types.	
	2	Proteolytic Microorganisms in milk, Lipolytic type, Acetic acid type, Butyric acid type.	
	3	Temperature characteristics of bacteria in milk	
III	**Module 3 :Bacteriological Examination of Milk**		**15**
	1	Detection of Developed Acidity.	
	2	The standard plate count, The direct Microscopic count.	
	3	Reduction Test – Methylene Blue Reduction Test, Resazurin Test.	
	4	Phosphatase test	
	5	Turbidity test	
	6	Examination of Specific Pathogens – Examination of coliform bacilli, Test for tubercle bacilli.	
	7	Bacteriological standards of Milk – grading of Milk	
	8	Preservation of Milk – Pasteurization of Milk	
	9	Sterilization of Milk, Dehydration.	
IV	**Module 4 : Spoilage of Milk and Milk Products**		**10**
	1	Sources Contamination and spoilage of milk and milk products	
	2	The defects that occur in milk due to microorganism: Off flavors, Gas production, Lactic acid production/ Souring.	
	3	Proteolysis, Lipolysis with development of rancidity and sweet curdling	
	4	Production of abnormal colour in milk	

	5	Spoilage of Milk Products – Butter, Cheese, Yoghurt and Ice cream	
V	**Module 5 : Milk Borne Diseases**		**15**
	1	Pathogenic type of bacteria in milk – Pathogens transmitted from Animals, Pathogens transmitted from humans, Pathogens transmitted from the environment.	
	2	Milk borne diseases.	
	3	Microbial diseases of dairy cattle and its control measures – Bacterial diseases, Viral diseases, Fungal diseases and Protozoan diseases.	
	4	Dairy Plant Visit	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Summarize the basic properties. Nutritional importance of Dairy products. Emphasize the role of dairy starter cultures in the manufacture of fermented dairy products.	U	PSO1
CO-2	Gain knowledge of significance and activities of microorganisms in milk and milk products..	U	PSO1
CO-3	Analyze bacteriological quality of milk by various methods	U,An	PSO1,2
CO-4	Summarize spoilage and cause of spoilage of milk and milk products.	U	PSO 1
CO-5	Classify microorganisms in milk including milk borne diseases and diseases of dairy cattle and its control measures	U,Ap	PSO1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Summarize the basic properties. Nutritional importance of Dairy products. Emphasize the role of dairy starter cultures in the manufacture of fermented dairy products.	PO1/ PSO1	U	F	L	
2	Gain knowledge of significance and activities of microorganisms in milk and milk products..	PO1/ PSO1	U	F, C	L	
3	Analyze bacteriological quality of milk by various methods	PO1,6/ PSO1,2	U,An	C, P	L	
4	Summarize spoilage and cause of spoilage of milk and milk products.	PO1/ PSO1	U	F	L	

5	Classify microorganisms in milk including milk borne diseases and diseases of dairy cattle and its control measures	PO1,2/ PSO1,2	U,Ap	F,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	2	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	-	-	-	-	-	1	-	-	-	-	-
CO 3	2	1	1	-	-	-	2	-	-	-	-	1
CO 4	1	-	-	-	-	-	1	-	-	-	-	-
CO 5	2	1	-	-	-	-	1	1	-	-	–	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK5DSEMBY304				
Course Title	**Nanobiotechnology**				
Type of Course	**DSE**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	4 hours	-	-	4
Pre-requisites	Basic understanding of physics chemistry and biology				
Course Summary	Nanobiotechnology course provides a basic overview of nanomaterials and their applications. This course begins with a review of various types of nanomaterials and an introduction to general terminologies. Subsequently the course covers synthesis, methodologies, physical and chemical characterization of nanomaterials. Finally, case studies illustrating application of nanomaterials in diverse fields will be discussed.				

Detailed Syllabus:Detailed Syllabus: Total hours -60

Course Type: Theory, Total credits: 4, Contact hours/week: 4			
Module	**Unit**	**Content**	**60 Hrs**
I		**Module 1: Introduction to Microbial Nanotechnology**	**10**
	1	Definition and scope of nanotechnology, Historical development, Significance in various fields, including microbiology.	
	2	Properties of nanomaterials - Size-dependent, Optical, Mechanical, Electrical, Magnetic, and Thermal Properties.	

II	**Module 2: Synthesis and Characterization of nanoparticles**		**12**
	1	Nanoparticles Synthesis methods: Bottom-Up Synthesis and Top-Down Synthesis.	
	2	An over view of Physical, Chemical and Biological methods for the synthesis of nanomaterials.	
	3	Biological methods- Phytosynthesis and Microbial synthesis of Nanoparticles.	
	4	Characterization techniques used in Nanobiotechnology: UV – Visible Spectroscopy, FTIR, EDS, X-ray Diffraction, AFM, SEM and HR – TEM (Brief account)	
III	**Module 3 : Nanotechnology in Healthcare**		**10**
	1	Nanomedicine: Microbial interactions with nanomaterials - Antimicrobial and Antibiofilm Potential	
	2	Treatment: Effective Drug Delivery, Targeted therapy- Cancer	
	3	Diagnostics: Biochips and Biosensors in the early diagnosis of diseases.	
	4	Nanomaterials in bone substitutes and Dentistry, Cosmetic applications, Textiles, and Paints.	
IV	**Module 4 : Nanotechnology for Food and Agriculture**		**10**
	1	Food: Detection of contaminants and pathogens in food products. Nanocomposites for Food Packaging	
	2	Nanopesticides and Nanofertilizers, Nano-biostimulants and soil enhancers, Nano-enabled technologies and abiotic stress management, Nanobiotechnology for Crop improvement (Brief account only)	
	3	Nanomaterials for Remediation: Nanoparticles for removal of pollutants through processes like adsorption and catalysis, Nanomembranes for water purification	
	Module 5: Nanotoxicology and Biosafety		**12**

V	1	Entry routes for nanoparticles in human body: lungs, intestinal tract and skin	
	2	Deposition and translocation in the body, Attributes contribute to nanomaterials toxicity.	
	3	Effect of size, shape, surface properties and composition on toxicity of nanomaterials.	
	4	Nanomaterials in environment-sources of pollution-transport through environment.	

References

1. A. L. Rogach, Semiconductor nanocrystal quantum dots synthesis, assembly, spectroscopy and applications (Springer, Wien; London, 2008).

2. E. Gazit, Plenty of room for biology at the bottom: an introduction to bionanotechnology (Imperial College Press ; Distributed by World Scientific Pub. in the USA, London : Hackensack, NJ, 2007).

3. G. E. J. Poinern, A laboratory course in nanoscience and nanotechnology (CRC Press, Taylor & Francis Group, Boca Raton, 2015).

4. C. A. Mirkin, C. M. Niemeyer, Eds., More concepts and applications (Wiley-VCH, Weinheim, 2007), Nanobiotechnology.

5. A. K. Mishra, Ed., Application of nanotechnology in water research (Wiley, Scrivener Publishing, Hoboken, New Jersey, 2014).

6. K. R. Nill, Glossary of biotechnology and nanobiotechnology terms (Taylor & Francis, Boca Raton, 4th ed., 2006).

7. J. Kim, Ed., Advances in nanotechnology and the environment (Pan Stanford, Singapore, 2012). 8. P. N. Prasad. Nanophotonics (Wiley, New York, 2003).

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Provides basic overview of nanomaterials.	U	PSO1
CO-2	Understand the nature and properties of nanomaterials	U	PSO1
CO -3	Provide scientific understanding of application of nanomaterials and nanotechnology in the clinical field.	U	PSO1
CO – 4	Provide scientific understanding of application of nanomaterials and nanotechnology in agriculture, food and environmental conservation.	U	PSO1,2
CO - 5	Understanding of the strengths, limitations and potential uses of nanomaterials.	U	PSO1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Provides basic overview of nanomaterials.	PO1/ PSO 1	U	U	L	
2	Understand the nature and properties of nanomaterials	PO1/ PSO 1	U	F	L	
3	Provide scientific understanding of application of nanomaterials and nanotechnology in the clinical field.	PO1, 2/ PSO 1	U	F	L	

4	Provide scientific understanding of application of nanomaterials and nanotechnology in agriculture, food and environmental conservation.	PO1, 2/ PSO 1,2	U	F,C	L	
5	Understanding of the strengths, limitations and potential uses of nanomaterials.	PO1/ PSO 1	U	F	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	-	-	-	-	-	1	-	-	-	-	-
CO 3	-	2	-	-	-	-	-	2	-	-	-	-
CO 4	2	1	-	-	-	-	2	1	-	-	-	-
CO 5	1	-	-	-	-	-	1	-	-	-	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low

2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK6DSEMBY301				
Course Title	**Immunology**				
Type of Course	**DSE**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	4 hours	-	-	4
Pre-requisites	Knowledge of immunology and microorganisms studied during HSE, first & second year of this programme.				
Course Summary	The course introduces the basic aspects of the immune system. It concentrates on the components, organisation and functions of the immune system. It also covers the mechanism that leads to beneficial immune responses, immune disorders, hypersensitivity reactions, immunodeficiencies and transplantation immunology.				

Detailed Syllabus: Total hours -60

Course Type: Theory, Total credits: 4, Contact hours/week: 4			
Module	**Unit**	**Content**	**Hrs 60**
I		**Module 1: Introduction to Immunology**	**12**
	1	Immunity: Types of immunity -Innate immunity Acquired immunity – natural and artificial- active and passive	
	2	Vaccines: Definition and types	

II	**Module 2: Antigens and Antibodies**		**12**
	1	Antigens: Structure, Types of antigens - endogenous,1 exogenous & super antigens. Antigenicity and immunogenicity.	
	2	Haptens, adjuvants and its types.	
	3	Antibodies: General structure Classification, structure & function of immunoglobulins: IgG, IgM, IgA, IgD & IgE.	
III	**Module 3: Immune System**		**12**
	1	Cells of immune system: Lymphocytes, Mononuclear cells, granulocytes, dendritic cell	
	2	Organs of immune system: primary and secondary lymphoid organs	
	3	Complement system: Definition and functions Activation pathways: Classical, Alternate and Lectin pathways	
	4	Major Histocompatibility Complex -MHC Class 1 and Class II: Structure, and function (brief introduction only)	
	5	Immune response: Primary and Secondary immune response, Mechanism of immune response: An outline	
IV	**Module 4: Antigen and Antibody Reactions**		**12**
	1	Precipitation reactions - Types: Immunodiffusion test, single diffusion in one-dimension, double diffusion in one-dimension, single diffusion in two-dimension, double diffusion in two-dimension, Immunoelectrophoresis Electro immunodiffusion- Counter current & Rocket electrophoresis	
	2	Agglutination reactions- Types: Slide agglutination, Tube agglutination, Latex agglutination, Complement fixation. Neutralization reactions- Schick test, ASO test	

	3	Immunoassays of diagnostic importance- ELISA, RIA, Immunofluorescence.	
	4	Production of monoclonal antibodies and its applications	
V	**Module 5: Disorders Of Immune System**		**12**
	1	Immunodeficiency disorders – Primary: X-linked agammaglobulinemia, DiGeorge's syndrome, SCID, Job's syndrome. Secondary: AIDS	
	2	Autoimmunity – Definition Autoimmune disorders: Hashimoto's thyroiditis, Haemolytic anaemia, Rheumatoid arthritis, SLE	
	3	Hypersensitivity reactions – Definition, Types: Type1, II, III, IV	
	4	Transplantation Immunology- Definition, Types of graft - Autograft, Isograft, Allograft, Xenograft	
	5	Immunohematology: Blood groups, Immunology of blood transfusion	

REFERENCES:

- Kuby Immunology by Thomas J. Kindt (2006) Publisher: W H Freeman & Co
- Immunology: An Introduction by Ian R Tizard (2006) Publisher: Cengage Learning
- Immunology and Immunotechnology by Chakravarty (2006)
- Elements of Immunology (2009) by Khan Publisher: Dorling Kindersley (India) Pvt
- Immunology by K.R. Joshi (2007) Publisher: Agrobios (India)
- Basic Immunology, 3ed by: Abbas Publisher: Elsevier
- Immunology by P.R. Yadav (2004) Publisher: Discovery Publishing House
- Immunology by David A. Marcus, Richard A. Goldsby, Barbara A. Osborne (2003) Publisher: WH. Freeman & Company

E-RESOURCES:

- https://www.medicalnewstoday.com/articles/320101#the-immune-response
- https://www.cdc.gov/vaccines/vac-gen/immunity-types.htm
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3670108/
- https://www.ncbi.nlm.nih.gov/books/NBK271
- http://www2.hawaii.edu/~johnb/micro/micro161/antigen-antibody_reactions/Chap5_Ag_Ab_reactions.htm
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4600970/
- https://www.immunology.org/policy-and-public-affairs/briefings-and-position-statements/transplant-immunology

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the basics of immunology and defense mechanisms	U	PSO-1
CO-2	Gain knowledge about antigens, antibodies and their functions	R, U	PSO-1
CO-3	Understand the cells and organs of the immune system and the mechanism of immune response	U	PSO-1
CO-4	Learn about the different types of antigen-antibody reactions	U,Ap	PSO-1,3
CO-5	Create awareness about immunodeficiency disorders, Hypersensitivity, transplantation reactions and Immunohematology	Ap,An	PSO-1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the basics of immunology and defense mechanisms	PO 6/ PSO1	U	F, C	L	
CO-2	Gain knowledge about antigens, antibodies and their functions	PO 6/ PSO1	R,U	F,C	L	
C0-3	Understand the cells and organs of the immune system and the mechanism of immune response	PO 1,6/ PSO1	U	F,C	L	
CO-4	Learn about the different types of antigen-antibody reactions	PO 6/ PSO,3	U,Ap	F,P	L	
CO-5	Create awareness about immunodeficiency disorders, Hypersensitivity, transplantation reactions and Immunohematology	PO 2,6/ PSO 6	Ap,An	F,M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-	-	-	-	-	-	1
CO 2	2	-	-	-	-	-	-	-	-	-	-	1

CO 3	2	-	-	-	-	-	-	-	-	-	-	2
CO 4	2	-	2	-	-	-	-	-	-	-	-	2
CO 5	1	-	-	-	-	-	-	1	-	-	-	2
CO 6	-	-	-	-	-	-	-	-	-	-	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓

CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	**MICROBIOLOGY**				
Course Code	UK6DSEMBY302				
Course Title	Bioinformatics and Biostatistics				
Type of Course	**DSE- P**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Knowledge of biological data bases during the first & second year of this programme.				
Course Summary	Bioinformatics and Biostatistics course encompasses the basic concepts of bioinformatics and biological databases. This course covers molecular modeling, sequence analysis and alignment and helps to gain knowledge in statistical tools in data interpretation, significance test and sampling methods.				

Detailed Syllabus:Total Hours- 75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**45 Hrs**
I		**Module 1 : Introduction to Bioinformatics**	**7**
	1	Bioinformatics**:** Introduction: Definition, Origin of concept of Bioinformatics; Brief history, Importance of bioinformatics.	

	2	Web lab and Wet lab.	
	3	Biological databases: Brief account on Model/organism databases, Biodiversity data bases and Biomolecular Databases-Nucleic acid databases Eg: EMBL, Gen Bank - Protein sequence databases. Eg: PIR, SWISS PROT.	
II	**Module 2 :Protein Data Bank**		**7**
	1	Protein structure databank- PDB	
	2	Molecular visualization- use of Rasmol- Molecular modeling (Brief account only).	
	3	Molecular docking and computer aided drug design (Brief account only)**.**	
	4	Basics of Genomics and Proteomics, Comparative genomics and Pharmacogenomics.	
III	**Module 3 :Sequence Analysis**		**8**
	1	Sequence analysis and alignment (Brief account only)	
	2	Pairwise sequence alignment.	
	3	Multiple sequence alignment - CLUSTAL	
	4	Bioinformation Tools: BLAST	
	5	Molecular Phylogeny and construction of Phylogenetic trees using web tools, Advantages of Molecular phylogeny and phylogenetic analysis.	
IV	**Module 4 :Introduction to Biostatistics**		**8**
	1	Documentation of experiments. Nature and types of data.	
	2	Significance of statistical tools in data interpretation	
	3	Presentation of data – Tables, Graphs – Line Graphs and Frequency Graphs – Histogram, Frequency Polygon, Frequency Curve, Ogive or Cumulative Frequency Graph.	
	4	Diagrams – Bar Diagrms and Pie Diagrams	
	5	Sampling methods - Simple, random, stratified, systematic and cluster sampling.	
V	**Module 5 :Testing of Hypothesis**		**15**
	1	Nature and scope of statistical methods and their limitations. Measures of Central tendency – Arithmetic mean, median and mode.	

	2	Probability Test.	
	3	Statistical testing of hypothesis, null hypothesis. Significance test -Statistics based acceptance or rejection of a hypothesis.	
	4	Tests of significance based on Chi- square test, Student T Test and F test.	
		Course Type: Practical, Total credits: 1, Contact hours/week: 2	**30 Hrs**
VI		**PRACTICAL**	
	1	Data retrieval from NCBI and PDB	
	2	Data retrieval from Nucleic acid databases - EMBL, GenBank	
	3	Sequence similarity searching using BLAST and interpretation of the result	
	4	Sequence Analysis using CLUSTAL Omega	
	5	Molecular visualization using Rasmol	
	6	Statistical representation of data using Excel	
	7	Representation of Statistical data by Tables, Graphs and Diagrams.	
	8	Determination of Statistical averages/central tendencies by Arithmetic mean, Median and Mode	
	8	Tests of Significance- using Chi- Square test	

REFERENCES

1. Cynthia Gibas & Per Jambeck (2001). Developing Bioinformatics Computer Skills: Shroff Publishers & Distributors Pvt. Ltd (O'Reilly), Mumbai.

2. H.H. Rashidi & L.K Buehler (2002). Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London.

3. Des Higgins & Willie Taylor (2002). Bioinformatics: Sequence, structure and databanks, Oxford University Press.

4. Baxevanis A.D & Ouellette B.E.F (2001) Bioinformatics: A practical guide to the analysis of genes and proteins, Wiley Interscience - New York

5. Arora P.N & Malhon P.K (1996). Biostatistics Imalaya Publishing House, Mumbai.

6. Sokal & Rohif (1973). Introduction to Biostatistics, Toppan Co. Japan.

7. Stanton A & Clantz, Primer of Biostatistics - The McGraw Hill Inc., New York.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	P S O addressed
CO-1	Understand the concept of Bioinformatics	U	PSO1
CO-2	Know how to use bioinformatics for protein sequence analysis through bioinformatics tools and databases	U	PSO1
CO -3	Know how to use bioinformatics for DNA sequence analysis through bioinformatics tools and databases	U,Ap	PSO1,2
CO – 4	Represent the data of experimental and field studies through graphs and diagrams and Apply statistical methods to analyse and interpret the biological data.	U, Ap	PSO2,3
CO - 5	Understand statistical concepts and learn to use variety of statistical tests.	U,Ap	PSO2,3
CO-6	To learn how to download nucleotide and protein sequence files from databases and its visualization. To compose mean, median. mode and compare different tests of significance.	U,Ap,An	PSO2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand the concept of Bioinformatics	PO1/ PSO1	U	F	L	

2	Know how to use bioinformatics for protein sequence analysis through bioinformatics tools and databases	PO1/ PSO1	U	F	L	
3	Know how to use bioinformatics for DNA sequence analysis through bioinformatics tools and databases	PO1,2/ PSO1,2	U,Ap	F,C	L	
4	Represent the data of experimental and field studies through graphs and diagrams and Apply statistical methods to analyse and interpret the biological data.	PO1,2/ PSO2,3	U, Ap	F,C	L	
5	Understand statistical concepts and learn to use variety of statistical tests.	PO2,3/ PSO2,3	U,Ap	F,C	L	
6	To learn how to download nucleotide and protein sequence files from databases and its visualization. To compose mean, median. mode and compare different tests of significance.	PO2,6/ PSO2,3	U,Ap,An	P,M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	-	-	-	1	-	-	-	-	-
CO2	1	-	-	-	-	-	1	-	-	-	-	-
CO3	2	1	-	-	-	-	2	1	-	-	-	-
CO4	-	2	1	-	-	-	2	1	-	-	-	-
CO5	-	2	1	-	-	-	-	1	1	-	-	-
CO6	-	1	1	-	-	-		1	-	-	-	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	EndSemester Examinations

CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6				✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK7DSEMBY401				
Course Title	**Diagnostic Microbiology**				
Type of Course	**DSE-P**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5
Pre-requisites	Knowledge of microorganisms and microbiological techniques acquired during the first, second and third year of the programme.				
Course Summary	The course equips students with advanced skills in modern molecular diagnostics, antimicrobial resistance profiling, epidemiological surveillance, and the ability to develop effective diagnostic strategies for various clinical and research applications in microbiology.				

Detailed Syllabus: Total Hours- 75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
I		**Module 1: Phenotypic and Immunological Techniques**	**7**
	1	Automated Blood Cultures, Rapid Antigen Tests, Advanced Antibody Detection methods (Brief Account)	
	2	Phenotypic Testing of Bacterial Antimicrobial Susceptibility	

	3	Biochemical Profile-Based Microbial Identification Systems	
II	**Module 2: Nucleic Acid Amplification and Probe-Based Methods**		**8**
	1	Probe-Based Microbial Detection and Identification, Pulsed Field Gel Electrophoresis	
	2	PCR: Components of PCR, Steps and factors affecting PCR. Variants of PCR: Inverse PCR, Colony PCR, Hot start PCR, Multiplex PCR, Long PCR, Nested PCR, Reverse Transcriptase PCR(RT-PCR),	
	4	Recent Advances in Probe Amplification Technologies, Signal Amplification Techniques: bDNA, hybrid capture.	
III	**Module 3: Nucleic Acid-Based Detection and Identification Methods**		**8**
	1	Agarose Gel Electrophoresis	
	2	Southern Blot Hybridization	
	3	Restriction Enzyme Digest Analysis and Enzyme-Linked Immunoassay	
	4	Direct Nucleotide Sequencing for Amplification Product Identification: Maxam & Gilbert's method, Sanger's dideoxy method, Pyrosequencing, DNA chip array based method, Nanopore sequencing, Ion torrent sequencing	
IV	**Module 4: Microarrays and Real-Time PCR Diagnostics**		**7**
	1	Microarray-Based Microbial Identification and Characterization	
	2	Diagnostic Microbiology using Real-time PCR Based on FRET Technology	
V	**Module 5: Applications**		**15**
	1	Bacterial Identification Based on 16S Ribosomal RNA Gene Sequence Analysis	
	2	Advances in the Diagnosis of *Mycobacterium tuberculosis* and Detection of Drug Resistance	
	3	Rapid screening and Identification of Methicillin-Resistant *Staphylococcus aureus*	
		PRACTICALS	**Hours 30**

Course Type: Practical, Total Credits: 1 Contact hours/week: 2			
VI	1	Rapid antigen test	
	2	Agarose gel electrophoresis of nucleic acids	
	3	Isolation and separation of genomic DNA	
	4	Purification of DNA from agarose gel	
	5	Demonstration of Polymerase Chain Reaction of desired gene	
	6	Restriction Enzyme Digest Analysis	
	7	Acid-fast staining	
	8	Real Time PCR: Virtual Lab	

References:

- Advanced Techniques in Diagnostic Microbiology -Tang, Yi-Wei; Stratton, Charles (2006) , Springer Publishers.
- Bailey and Scott's Diagnostic microbiology – Patricia M. Tille (2021), Elsevere Publishers.
- Benson's Microbiological Applications Laboratory Manual, Heidi Smith and Alfred E. Brown (2021), McGraw Hill Publishers.
- Textbook of Diagnostic Microbiology, Mahon, C. R., & Lehman, D. C. (2022), Elsevier Health Sciences.
- Introduction to Diagnostic Microbiology for the Laboratory Sciences (2014), Maria Dannessa Delost, Jones & Bartlett Publishers
- Koneman'S Color Atlas And Textbook Of Diagnostic Microbiology (2020), Jones & Bartlett Publishers
- Genetic engineering , Snita Rastogi & Neelam Pathak (2009), Oxford University Press
- Comprehensive Molecular Diagnostics and Advanced Gene Expression: NPTEL:- https://onlinecourses.nptel.ac.in/noc24_ge36/preview

- Real Time PCR Virtual Lab: https://praxilabs.com/en/3d-simulations/real-time-pcr-virtual-lab-simulation

- PCR Virtual Lab: https://www.merlot.org/merlot/viewMaterial.htm?id=403522

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Select and apply appropriate methods for specific diagnostic applications, such as rapid pathogen detection, bacterial identification, antimicrobial resistance profiling, and epidemiological studies.	U, Ap	PSO-1,2,3
CO-2	Design and optimize various nucleic acid amplification protocols, including PCR, probe-based detection, and signal amplification techniques	U, Ap	PSO-1,3
CO-3	Analyze amplified products using molecular biology techniques like nucleic acid extraction, Southern blotting, gel electrophoresis, DNA sequencing and interpretation of results.	U, Ap, An	PSO-3,6
CO-4	Utilize advanced technologies like microarray analysis and real-time PCR with FRET probes for parallel microbial identification, characterization, and quantification.	U, Ap, An	PSO-3,6
CO-5	Apply appropriate molecular methods for specific applications like bacterial identification using 16S rRNA sequencing, tuberculosis diagnosis and antimicrobial resistance profiling.	U, Ap, C, E	PSO-2,6
CO-6	Equip students with advanced knowledge and hands-on skills in using modern phenotypic, immunological, and nucleic acid-based techniques for accurate detection, identification, characterization, and epidemiological typing of microorganisms in clinical and research settings.	U, Ap, C, E	PSO-2,6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 3:0:1 (Lecture:3, Tutorial:0, Practical:1)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Select and apply appropriate methods for specific diagnostic applications, such as rapid pathogen detection, bacterial identification, antimicrobial resistance profiling, and epidemiological studies.	PO1,6/ PSO-1, 2,3	U, Ap	F, C, P	T	
2	Design and optimize various nucleic acid amplification protocols, including PCR, probe-based detection, and signal amplification techniques	PO1,6/ PSO-1, 3	U, Ap	C, P	T	
3	Analyze amplified products using molecular biology techniques like nucleic acid extraction, Southern blotting, gel electrophoresis, DNA sequencing and interpretation of results.	PO1,3/ PSO-3, 6	U, Ap, An	C,P	T	

4	Utilize advanced technologies like microarray analysis and real-time PCR with FRET probes for parallel microbial identification, characterization, and quantification.	PO1,3/ PSO-3, 6	U, Ap, An	F,P,M	T	
5	Apply appropriate molecular methods for specific applications like bacterial identification using 16S rRNA sequencing, tuberculosis diagnosis and antimicrobial resistance profiling.	PO1,3/ PSO-2, 6	U, Ap, C, E	P		P
	Equip students with advanced knowledge and hands-on skills in using modern phenotypic, immunological, and nucleic acid-based techniques for accurate detection, identification, characterization, and epidemiological typing of microorganisms in clinical and research settings.	PO1,7, 8/ PSO-2, 6	U, Ap, C, E	P	P	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**

CO 1	1	-	-	-	-	3	1	2	3	-	-	-	-	-
CO 2	1	-	-	-	-	2	1	-	3	-	-	-	-	-
CO 3	-	-	3	-	-	3	1	-	3	-	-	-	-	-
CO 4	-	-	3	-	-	2	1	-	3	-	-	-	-	-
CO 5	-	2	-	-	-	3	1	-	3	-	-	-	-	-
CO 6	-	2	-	-	-	3	1	-	-	-	-	-	3	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK7DSEMBY402				
Course Title	**Biosafety Measures in Microbiology Laboratories**				
Type of Course	**DSE-P**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	3 hours	-	2 hours	5 hours
Pre-requisites	Knowledge on microorganisms and microbial skills acquired during the previous years.				
Course Summary	This course provides students with a comprehensive understanding of biosafety principles, risk analysis, regulatory frameworks, laboratory operations, and bioethical considerations in biotechnology and microbiology. Students will learn how to implement safety measures, assess risks, and navigate regulatory frameworks in various research and application settings.				

Detailed Syllabus: Total Hours -75

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
	Module 1: Introduction To Biosafety		**7**
	1	Introduction to Biosafety	

I	2	Biosafety issues in biotechnology and microbiology. safety procedures: types; Containment for Biohazards (Primary and secondary)	
	3	Biosafety Levels of Specific Microorganisms, infectious agents and infected animals	
	4	Biosafety procedures: introduction to biological safety cabinets, selection, installation and use of biological safety cabinets. PPEs	
II		**Module 2: Risk Analysis**	7
	1	GMOs/LMOs - Concerns and Challenges	
	2	Risk Analysis, Risk Assessment, Risk management and communication.	
	3	Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture, Environmental release of GMOs.	
III	**Module 3: Biosafety Guidelines**		**8**
	1	Biosafety assessment procedures in India. Overview of national regulations and relevant international agreements including Cartagena Protocol	
	2	Use of Animals in Research and Testing, and Alternatives for Animals in Research, Animal Cloning, Human Cloning and their Ethical Aspects	
	103	Testing of Drugs on Human Volunteers Public and Non-Governmental Organizations (NGOs)	
IV	**Module 4: Laboratory Operations**		**8**
	1	Laboratory standard operating procedures- Spill cleanup, Waste disposal, Selection of disinfectants	
	2	Occupational health and immunoprophylaxis, decontamination and disinfection	
	3	transportation of infectious substances and, agriculture pathogens	
	Module 5: Bio-ethical Issues		**15**

V	1	Bioterrorism and biosafety, convention on biological weapons, Social and ethical implications of biological weapons.	
	2	Biosecurity and components of biosecurity programs. Bioethical issues	
		PRACTICAL	
VI		**Course Type: Practical, Total credits: 1, Contact hours/week: 2**	3 0 Hrs
		Laminar Air Flow- checking the functioning of UV light by colony count method	
		Standard Operating Procedure (SOP) preparation	
		Good Laboratory Practices (GLP) preparation	
		Industrial visit to a research lab/Medical lab and submit report	

References

1. Pearson. 2013. IPR, Biosafety and Bioethics. Edition by Goel

1. Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.

2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.

3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.

4. Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social Impliocations, Springer India.

5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson

6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the concept of biosafety	U	PSO-1.2

CO-2	Create information on risk assessment and different Biosafety Committee	C	PSO-1,2
C0-3	understand the concepts of national and international biosafety guidelines	U,R	PSO-1,2
C0-4	Understand and create information on standard laboratory procedures in microbiology	U,C	PSO-1,2,5
C0-5	Understand the bioethical issues in our world	U, An	PSO-1,2,5
CO-6	Understand and analyse the basic safety measures in microbiology laboratories	U, An,E	PSO-1,2,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the concept of biosafety	PO 1,6/ PSO 1,2	U	F,C	L	
CO-2	Create information on risk assessment and different Biosafety Committee	PO 1,6/ PSO 1,2	C	F,C	L	
C0-3	understand the concepts of national and international biosafety guidelines	PO 1,6/ PSO 1,2	U,R	F,C	L	
C0-4	Understand and create information on standard laboratory procedures in microbiology	PO 1,2,6/ PSO 1,2,5	U,C	C,P	L	
C0-5	Understand the bioethical issues in our world	PO 1,6/ PSO 1,2,5	U, An	F,C,P	L	

CO-6	Understand and analyse the basic safety measures in microbiology laboratories	PO 1,6/ PSO1,2,5	U,An, E	F,C,P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	1	-	-	-	-	1	-	-	-	-	2
CO 2	1	1	-	-	-	-	1	-	-	-	-	2
CO 3	1	1	-	-	-	-	1	-	-	-	-	2
CO 4	1	2	-	-	-	-	1	2	-	-	-	2
CO 5	1	2	-	-	2	-	1	-	-	-	-	2
CO 6	1	2	-	-	2	-	1	-	-	-	-	2

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓

CO 3	✓			✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO6	✓	✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK1MDCMBY101				
Course Title	**Microbes in Daily Life**				
Type of Course	**MDC**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	3	3 hrs	-	-	3
Pre-requisites	Basic knowledge of Microbiology gained during HSE				
Course Summary	The course provides a foundational understanding of the field of microbiology, exploring the basics of microbial life, their significance in various ecosystems, and their impact on human health, industry, and the environment. It covers the scope and fundamental principles of microbiology.				

Detailed Syllabus: Total hours 45

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
I	**Module 1: Microbial World**		**9**
	1	Microflora of Air: Sources of microorganisms, indoor and outdoor microorganisms, Importance of microorganisms in air. Microflora of Water: Marine, estuarine & freshwater microorganisms. Microbial diversity in soil (Brief account)	
	2	Microbes in extreme environments: Deep oceans, deserts, hot springs, Space, Volcanic & Glacier Ecosystems (Brief account)	

	3	Microflora of Human Body	
II	**Module 2: Scope of Microbiology**		**9**
	1	Branches of Microbiology: Industrial Microbiology, Food Microbiology, Dairy Microbiology, Agriculture Microbiology, Environmental Microbiology, Medical Microbiology (Brief account)	
	2	Microbiology-Based Entrepreneurship	
III	**Module 3: Microbiology In Health**		**9**
	1	Definition and examples of Endemic, Epidemic and Pandemic	
	2	Microbes as pathogens: Typhoid, Botulism, Traveler's diarrhea, Nipah, Dengue, COVID-19, AIDS, Nail infection, Dandruff (Causative agent, transmission & symptoms only)	
	3	Antibiotics, Vaccines, Immunisation schedule (Brief account)	
IV	**Module 4 :Microbiology of Fermented Foods And Beverages**		**9**
	1	Microbes in household products: Idli, Curd, Appam, Pickles(Brief account)	
	2	Fermented dairy products: Yoghurt, butter and cheese (Brief account)	
	3	Fermented Vegetables: Tempeh, Sauerkraut, Kimchi (Brief account)	
	4	Fermented Beverages: Wine,Beer, Vinegar (Brief account)	
	5	Advantages and Health Benefits of Prebiotics, Probiotics, SCP as protein supplement: *Spirulina*	
V	**Module 5 : Microbiology in Agriculture**		**9**
	1	Bacteria for crop improvement: Biological nitrogen fixation, *Rhizobium* and root nodule formation in pea plants	
	2	Microorganisms as Bio-fertilizer: *Azolla*	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the occurrence of microorganisms in various aspects of daily life.	U	PSO-1
CO-2	Recognize the scope of microbiology	R, U	PSO -1
CO-3	Application of microbiology in health	Ap	PSO-1, 3
CO -4	Connect microorganisms to their applications in fermented food and beverages	E, C	PSO 1,3
CO -5	Application of microbiology in agriculture and plant growth	Ap, U	PSO-1,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

REFERENCE

1. Ananthnarayanan, R and Jeyaram Panicker, C. K. Textbooks of Microbiology. Orient Longman. 17th edition. (2010).
2. Madigan, M.T., Martinko, J.M., Dunlap, P.V. and Clark, D.P. Brock Biology of Microorganisms, 12th edition, Pearson International edition, Pearson Benjamin Cummings. (2009)
3. Michael, J. Pelczar, Jr. E.C.S., Chan, Noel R. Krieg Microbiology Tata McGrawHill Publisher. (1998).
4. Willey, J.M., Sherwood L.M and Woolverton C.J., Prescott, Harley and Klein's. Microbiology. McGraw Hill Higher education. 9th Edition. (2013).

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the occurrence of microorganisms in various aspects of daily life.	PO 6/ PSO-1	U	F, C	L	
CO-2	Recognize the scope of microbiology	PO 6/ PSO -1	R, U	F,C	L	

CO-3	Application of microbiology in health	PO 1,6/ PSO-1, 3	Ap	F,C,P	L	
CO -4	Connect microorganisms to their applications in fermented food and beverages	PO 3,6/ PSO 1,3	E, C	F,C,P	L	
CO -5	Application of microbiology in agriculture and plant growth	PO3,6/ PSO-1,3	Ap, U	F,C,P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-	-	-	-	-	-	1
CO 2	1	-	-	-	-	-	-	-	-	-	-	1
CO 3	1	-	2	-	-	-	1	-	-	-	-	2
CO 4	1	-	2	-	-	-	-	-	2	-	-	2
CO 5	1	-	2	-	-	-	-	-	2	-	-	2

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium

3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
1	✓	✓		✓
2	✓	✓		✓
3	✓	✓		✓
4	✓	✓		✓
5	✓	✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK2MDCMBY101				
Course Title	**Basic Food Microbiology**				
Type of Course	**MDC**				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	3	3	-	-	3
Pre-requisites	Basic knowledge of microbes as food acquired during the HSE programme.				
Course Summary	This course provides a comprehensive understanding of the principles and applications of microbiology in the food industry. It covers various aspects of food microbiology, fermentation processes, dairy products, food spoilage, preservation techniques, foodborne diseases and sanitation practices in food production.				

Detailed Syllabus:Total hours 45

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**45 Hrs**
I	**Module 1 : Fermented Foods**		**9**
	1	Microbiology of fermented foods – Wine, beer, vinegar, idly, bread, Sauerkraut	
	2	Nutritional value of fermented foods	
	3	Microorganisms as food: single cell protein, edible mushrooms	
	4	Probiotics: definition and uses	

II	**Module 2 : Dairy Products**		**9**
	1	Composition and properties of milk	
	2	Type of milk and milk products: whole milk, low fat milk, toned milk, skim milk, vitamin D milk, low sodium milk, homogenized milk, concentrated milk, sweetened condensed milk evaporated milk, dry milk, low lactose milk.	
	3	Fermented Dairy Products- Yoghurt, Dahi, Cultured buttermilk, Bulgarian milk, Acidophilus milk, Kefir, Koumiss, Butter, Ghee and Cheese (Brief account only)	
III	**Module 3 :Food Spoilage**		**9**
	1	Important microbes involved in spoilage of food - meat, poultry, vegetables and dairy products	
	2	Factors affecting food spoilage	
	3	Different types of spoilage	
IV	**Module 4 :Food Preservation**		**9**
	1	Principles of preservation	
	2	Asepsis, removal of microorganism, maintenance of anaerobic conditions.	
	3	Preservation by the use of high temperature, low temperature, drying, food additives and irradiation – Brief Account	
V	**Module 5 : Food Borne Diseases and Food Sanitation**		**9**
	1	Milk borne diseases (Brief account only)	
	2	Common food borne pathogens	
	3	Diseases caused by them and their symptoms,	
	4	Food sanitation- good manufacturing practices, Hazard Analysis Critical Control Points (HACCP)	
	5	Dairy Plant Visit	

References

1.Frazier WC and West off DC. (1988) Food microbiology, TATA McGraw Hill Publishing Company Ltd. New Delhi.

2.Adams MR and Moss MO. (1995). Food Microbiology, The Royal Society of Chemistry, Cambridge

3.Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India

4.Elmer H. Marth ,Marth H. Marth, Elmer H. Marth -Applied Dairy Microbiology, Second Edition.

5.James M. Jay , Modern food microbiology, 4th ed.

6.Marwaha S.S. and Arora, J.K. (2000), Food Processing: Biotechnological

Applications, Asia tech Publishers Inc., New Delhi.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the types of different fermented food products and analyse the values of probiotics, SCP and Edible mushrooms.	U	PSO1
CO-2	Summarize the basic properties. Nutritional importance of Dairy products. Emphasize the role of dairy starter cultures in the manufacture of fermented dairy products.	R, U	PSO1
CO-3	Create information on microbial food spoilage.	U,C	PSO1
CO-4	Describe the principles and methods of food preservation	U	PSO1
CO-5	Understand and remember the microbes causing food intoxications and food infections and food sanitation methods	U and R	PSO1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand the types of different fermented food products and analyse the values of probiotics, SCP and Edible mushrooms.	PO1/ PSO1	U	F	L	
2	Summarize the basic properties. Nutritional importance of Dairy products. Emphasize the role of dairy starter cultures in the manufacture of fermented dairy products.	PO1/ PSO1	R, U	F	L	
3	Create information on microbial food spoilage.	PO1/ PSO1	U,C	F,C	L	
4	Describe the principles and methods of food preservation	PO1/ PSO1	U	F	L	
5	Understand and remember the microbes causing food intoxications and food infections and food sanitation methods	PO1, 2/ PSO1 ,2	U and R	F,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-	1	-	-	-	-	-
CO 2	1			-	-	-	1	-	-	-	-	-

CO 3	2	-	-	-	-	-	1	-	-	-	-	-
CO 4	1	-	-		-	-	1	-	-	-	-	-
CO 5	2	1	-	-	-	-	2	1	-	-	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK2MDCMBY102				
Course Title	**Entrepreneurial Microbiology**				
Type of Course	**MDC**				
Semester	II				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	3	3 hours	-	-	3
Pre-requisites	Basic knowledge in microbiology and managerial economics				
Course Summary	This course provides a comprehensive overview of entrepreneurship within the field of microbiology, guiding individuals through the entire process from idea generation to commercialization. It aims to equip participants with the necessary knowledge and skills to establish and manage successful microbiology-based businesses including product development, quality control, and funding acquisition.				

Detailed Syllabus: Total hours -45

Course Type:		**Theory, Total credits: 3, Contact hours/week: 3**	
Module	**Unit**	**Content**	**Hrs 45**
I		**Module 1: General Entrepreneurship**	**9**
	1	Entrepreneurship and microbial entrepreneurship - Introduction and scope	
	2	Business development, product marketing, HRD	
	3	Bio-safety and Bioethics, IPR and patenting (Brief account)	

	4	Barriers to entrepreneurship- Managerial Vs. Entrepreneurial approach- Innovation and Entrepreneurship.	
II	**Module 2:Institutions Supporting Entrepreneurship**		**9**
	1	A brief overview of financial institutions in India- Central level institutions- SIDBI- NABARD- IDBI-	
	2	A brief overview of financial institutions in India- State level institutions- SIDCO, DIC, KIED	
	3	Latest Industrial Policy of Government of India.	
III	**Module 3: Product Development**		**9**
	1	Dairy products- Production of yoghurt	
	2	Alcoholic products and Beverages- Production of wine	
	3	SCP– Production of Mushroom	
	4	Biofertilizers and Biopesticides production and applications (Brief account)	
IV	**Module 4: Healthcare Entrepreneurship**		**9**
	1	Production and applications of Sanitizers, Antiseptic solutions	
	2	Polyphenols (Flavonoids), Alkaloids, Cosmetics (Brief account)	
	3	Bio-pigments and Bioplastics (Brief account)	
	4	Vaccines, Diagnostic tools and kits (Brief account)	
V		**Module 5: Women and Rural Entrepreneurship**	**9**
	1	Women Entrepreneurship- Scope and Growth of Women Entrepreneurship, Problems faced by Women Entrepreneurs	
	2	Special Scheme for Women Entrepreneurs, Role of SHG IN Women Entrepreneurship Development	
	3	Rural Entrepreneurship- Meaning, Need, Scope, Problems faced by Rural Entrepreneurs, Special Schemes for Rural Entrepreneurs	

References

1. Entrepreneurial Development - S.S. Khanka
2. Entrepreneurial Development - Satish Taneja & Dr.S.L. Gupta
3. Entrepreneurial Development - P.C. Shejwalkar

4. Dynamics of Entrepreneurial Development - Vasant Desai.
5. Fundamental of Entrepreneurship – Dr. A.K. Gavai
6. Srilakshmi B, (2007), Dietetics. New Age International publishers. New Delhi
7. Srilakshmi B, (2002), Nutrition Science. New Age International publishers. New Delhi
8. Swaminathan M. (2002), Advanced text book on food and Nutrition. Volume I. Bappco
9. Gopalan.C., RamaSastry B.V., and S.C.Balasubramanian (2009), Nutritive value of Indian
10. Foods. NIN.ICMR.Hyderabad.
11. Mudambi S R and Rajagopal M V, (2008), Fundamentals of Foods, Nutrition & diet therapy by New Age International Publishers, New Delhi

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the fundamental concepts of entrepreneurship, business development, and innovation within the context of microbiology	U	PSO-2
CO-2	Gaining knowledge about the various institutions and support systems available for successful microbiology-based entrepreneurial ventures	R, U	PSO-1, 2
CO-3	Understand the microbial processes involved, manufacturing, quality control, and commercialization aspects of microbiology-based products, such as dairy products, alcoholic beverages, single-cell protein, biofertilizers, and biopesticides.	U, Ap, C	PSO-2, 3
CO-4	Gain knowledge about entrepreneurial opportunities in the healthcare sector and provide insights into product development, manufacturing, quality control, and commercialization aspects of products derived from microorganisms	U, Ap, C	PSO-2, 3
CO-5	Understand the specific needs, support systems, and government schemes available for women and rural entrepreneurs and the role of Self-Help Groups in empowering women rural entrepreneurship.	R, U	PSO-2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the fundamental concepts of entrepreneurship, business development, and innovation within the context of microbiology	PO-6/ PSO-2	U	F, C	L	
CO-2	Gaining knowledge about the various institutions and support systems available for successful microbiology-based entrepreneurial ventures	PO-6/ PSO-1, 2	R, U	F,C	L	
CO-3	Understand the microbial processes involved, manufacturing, quality control, and commercialization aspects of microbiology-based products, such as dairy products, alcoholic beverages, single-cell protein, biofertilizers, and biopesticides.	PO-3/ PSO-2, 3	U, Ap, C	P	L	

CO-4	Gain knowledge about entrepreneurial opportunities in the healthcare sector and provide insights into product development, manufacturing, quality control, and commercialization aspects of products derived from microorganisms	PO-3/ PSO-2, 3	U, Ap, C	P	L	
CO-5	Understand the specific needs, support systems, and government schemes available for women and rural entrepreneurs and the role of Self-Help Groups in empowering women rural entrepreneurship.	PO-5/ PSO-2	R, U	M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	-	2	-	-	-	-	-	-	-	-	-	1
CO 2	-	2	2	-	-	-	-	-	-	-	-	1
CO 3	-	2	2	-	-	-	-	-	1	-	-	-

CO 4	-	2	2	-	-	-	-	-	1	-	-	-
CO 5	-	2	-	-	-	-	-	-	-	-	1	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓			✓
CO 5	✓			✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK3VACMBY201				
Course Title	**Microbial Waste Management**				
Type of Course	**VAC**				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	3	3 hours	-		3
Pre-requisites	Basic Understanding of waste and its adverse effect				
Course Summary	This course covers a comprehensive range of topics related to waste management and environmental remediation, providing students with a thorough understanding of principles, techniques, and applications in the field.				

Detailed Syllabus: Total hours- 45

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
I	**Module 1: Introduction to Waste Management**		**9**
	1	Types of waste- solid waste and liquid waste	
	2	Sources and types of solid waste	
	3	Sources and types of liquid waste	
	4	Microbiology of municipal waste	
II	**Module 2: Solid Waste Management**		**9**

	5	Treatment of solid waste- static pile, aerated pile, feed reactor, landfilling and incineration	
	6	Composting- Windrow, Aerated static pile, vermicomposting	
	7	Role of microorganisms in composting	
III	**Module 3: Sewage Management**		**9**
	8	Primary treatment- screening, sedimentation, floatation, coagulation and flocculation	
	9	Secondary treatment - trickling filter, Activated sludge, oxidation pond and	
	10	Tertiary treatments - methods of chlorination- Breakpoint chlorination, super chlorination, chloramines, and chlorine dioxide and Ozone treatment.	
	11	Anaerobic sludge digestion process- anaerobic digester	
	12	Household sewage treatment- septic tank, imhoff tank, cesspool	
IV	**Module 4: Environmental Cleaning**		**9**
	13	Bioremediation- xenobiotic compounds,	
	14	Biodegradation- Pesticides, detergents, petroleum and hydrocarbon compounds.	
	15	Biosorption, Bioaugmentation and Biostimulation (brief account)	
V	**Module 5: Microbiology of Water Pollution**		**9**
	16	Microbial indicators of water pollution, BOD, COD, Eutrophication.	
	17	Aspects of water pollution- biofilm, biocorrosion	
	18	Bacteriological techniques for the examination of water – total count, most probable number, membrane filter technique.	

References

Microbial Ecology Fundamentals and applications – Atlas and Bartha (ISBN 981-405-344-9)

Environmental Microbiology- K.Vijaya Ramesh (ISBN 81-8094-003-9)

Odum, E. P. and Barrett, G. W. 2005. Fundamentals of Ecology. 5th Edition. Thomson Brooks/Cole, Belmont, CA.

J. C. Daniel, 1999. Environment Aspects of Microbiology. 1st Edition, Bright Sun Publications, Chennai.

Rajendran, P. and Gunasekaran, P. 2006. Microbial Bioremediation. MJP Publishers, Chennai.

Varnam, A. H. and Evans, M. G. 2000. Environmental Microbiology. Manson Publishing Ltd.

Hurst, C. J., Crawford, R. L., Garland, J. L., Lipson, D. A. and Mills, A. L. 2007. Manual of Environmental Microbiology. ASM Press.

Grant, W. D. and Long, P. E. 1981. Environmental Microbiology. Kluwer Academic Publishers

E-RESOURCES:

https://www.soinc.org/sites/default/files/uploaded_files/417_MICROBES_AND_ECOLOGY.pdf

https://www.thebalancesmb.com/waste-treatment-and-disposal-methods-2878113

https://www.intechopen.com/books/biodegradation-life-of-science/pesticide-

biodegradation-mechanisms-genetics-and-strategies-to-enhance-the-process

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the concept of solid waste and liquid waste management	R, U	PSO-1, 3
CO-2	Identify and analyze different methods of treatment of solid waste.	R, U, An	PSO-2
CO-3	Apply various techniques for the treatment of sewage.	U, Ap	PSO-3
CO-4	Study the Significance of bioremediation, bioaugmentation, biosorption and biostimulation	U, Ap	PSO-3
CO-5	Gaining knowledge on indicators of water pollution	Ap, An, E	PSO-2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the concept of solid waste and liquid waste management	PO 1, 6 / PSO-1, 3	R, U	F, C	L	
CO-2	Identify and analyze different methods of treatment of solid waste.	PO1,6 / PSO-2	R, U, An	P	L	
CO-3	Apply various techniques for the treatment of sewage.	PO 2,6 / PSO-3	U, Ap	P	L	
CO-4	Study the Significance of bioremediation, bioaugmentation, biosorption and biostimulation	PO 6 / PSO-3	U, Ap	C	L	
CO-5	Gaining knowledge on indicators of water pollution	PO 2, 3 / PSO-2	Ap, An, E	P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8

CO 1	2	-	2	-	-	-	1	-	-		-	1	-	-
CO 2		3	-	-	-	-	1	-	-	-	-	1	-	-
CO 3	-	-	2	-	-	-	-	1	-	-	-	1	-	-
CO 4	-	-	2	-	-	-	-	-	-	-	-	2	-	-
CO 5	-	2	-	-	-	-	-	2	-	-	-	2	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations

CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK4VACMBY201				
Course Title	**Microbes in Sustainable Agriculture and Development**				
Type of Course	**VAC**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	3	3 hours	-		3
Pre-requisites	Basic understanding of general microbiology acquired in previous semesters				
Course Summary	This course provides an overview of the applications of microorganisms and biotechnology in sustainable agriculture practices. It covers both the use of beneficial microbes as biofertilizers as well as bioengineered crops.				

Detailed Syllabus: Total hours- 45

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
I		**Module 1: Introduction to Agriculture and Sustainable Farming Practices**	**9**
	1	An overview of agriculture and its significance in food production, The Importance of microorganisms for sustainable agriculture	
	2	Biofertilizers: types used in agriculture and organic farming system	
	3	Classification of biofertilizers, microorganisms used in biofertilizers production (General account)	

II	**Module 2: Symbiotic N2 Fixing Biofertilizers**		**9**
	1	*Bradyrhizobium*: Isolation, identification, field application and crop response	
	2	*Rhizobium*: Isolation, identification, field application and crop response	
	3	*Frankia*: Isolation, identification, field application and crop response	
III	**Module 3: Non-symbiotic N2 fixing biofertilizers**		**9**
	1	*Azospirillum*: Isolation, identification, field application and crop response	
	2	*Azotobacter*: Isolation, identification, field application and crop response	
IV	**Module 4: Phosphate solubilizing and Mycorrhizal biofertilizers**		**9**
	1	Phosphate solubilizing biofertilizers: Microbial isolation, characterization, production, field application and crop response	
	2	Mycorrhizal biofertilizers: Classification	
	3	Importance of mycorrhizal association Ectomycorzhiza – Endomycorrhiza	
	4	Isolation of VA mycorrhiza, Quantification and assessment of VAM in roots, Mass inoculum production of VAM, field applications of Ectomycorrhiza and VAM PGPRs	
V	**Module 5: GM crops**		**9**
	1	Application of engineered microbial inoculants in soil and concerns	
	2	GM crops: Pest and disease resistance, Safety, Benefits	
	3	Examples-GM crops: golden rice, rainbow papaya, Bt Brinjal	;

References

1.Agrios GN. (2006). Plant Pathology.5th edition. Academic press, San Diego

2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.

3.Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press

4.Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

5.Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4 th edition. Benjamin/Cummings Science Publishing, USA

6.Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA

7.Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel Decker Inc

8.Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York

9.Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the concept of Agriculture and Sustainable Farming	U	PSO- 1,3
CO-2	Create information and understand about symbiotic association as biofertilizers	C ,U	PSO- 1,3
C0-3	Understand and about non-symbiotic association as biofertilizers	U	PSO- 1,3
C0-4	Understand and anlyse the use of different phosphate solubilizing and mycorrhizal biofertilizers	U , An	PSO-1,3
C0-5	Understand the improvement of crop quality through genetic engineering	U,An, E	PSO-1,3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the concept of Agriculture and Sustainable Farming	PO3,6/ PSO- 1,3	U	F,C	T	

CO-2	Create information and understand about symbiotic association as biofertilizers	PO3,6/ PSO- 1,3	C ,U	F,C	T	
C0-3	Understand and about non-symbiotic association as biofertilizers	PO3,6/ PSO- 1,3	U	F,C	T	
C0-4	Understand and anlyse the use of different phosphate solubilizing and mycorrhizal biofertilizers	PO3,6/ PSO-1,3	U , An	F,C	T	
C0-5	Understand the improvement of crop quality through genetic engineering	PO 1,7PSO-1, 3,5	U,An, E	F,C,P	T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO 7**
CO 1	1	-	1	-	-	-	-	-	1	-	-	2	-
CO 2	1	-	1	-	-	-	-	-	1	–		2	-
CO 3	1	-	1	-	-	-	–		1	–	-	2	-
CO 4	1	-	1	-	-	-	-	-	1	-	-	2	-
CO 5	1	-	2	-	2	-	2	-	-	-	–	-	2

Correlation Levels:

Level	**Correlation**
-	Nil

1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK4VACMBY202				
Course Title	**One Health Approach for Emerging Pathogens**				
Type of Course	**VAC**				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	3	3 hours	-	-	3 hours
Pre-requisites	Undergraduate students of any discipline with a general awareness of health and hygiene.				
Course Summary	This course provides a comprehensive understanding of the One Health concept, which emphasizes the interconnectedness of human, animal, and environmental health. It covers various aspects related to the surveillance, prevention, and management of infectious diseases from a unified One Health perspective.				

Detailed Syllabus: Total hours -45

		Course Type: Theory, Total credits: 3, Contact hours/week: 3	
Module	**Unit**	**Content**	**Hrs 45**
I		**Module 1:Introduction to One Health**	**9**
	1	Introduction to the One Health One Medicine Concept, Integrated human and animal disease/Pathogen surveillance systems.	
	2	Significance and applications of One Health approach to control emerging infectious diseases.	

	3	The Importance of Understanding the Human–Animal Interface	
	4	Infectious disease overview: The causative agent, source or reservoir of the pathogen, modes of transmission, portals of entry, infectious dose, adherence and portals of exit.	
II	**Module 2:Comprehending Viral Pathogen**		**10**
	1	General awareness of Viral Pathogens- mode Transmission -control measures	
	2	Viral Pathogens, transmission and the symptoms of : Dengue, Chikungunya, Monkey Pox, Swine flu, Bird flu, AIDS, Rabies, Nipah, COVID-19	
	3	Antibiotic resistance as a global threat	
III	**Module 3: Acquaintance with Bacterial Fungal ,Protozoan Infection**		**9**
	1	Bacterial Pathogens, transmission and the symptoms of: TB, Brucellosis, Plague, Leptospirosis, Typhoid, Anthrax, Tetanus	
	2	Bacterial Pathogens, transmission and the symptoms of: - Cryptococcosis, Ringworm	
	3	Protozoan pathogen transmission and the symptoms of: Malaria, Amoebic dysentery	
IV	**Module 4: Public Awareness Management Initiatives**		**8**
	1	Application of One Health in the control of endemic and pandemics in communities- Rapid Response system, Disaster Management and Outbreak Investigation	
	2	Pharmacotherapeutics in Infectious Diseases (Brief account only)	
	3	Immunisation: Immunisation schedule.	
	4	Exotic infections (Bief account)	
	Module 5: One Health Policies		**9**
	1	Introduction to health policy	

V	2	Challenges in implementing One Health, the Importance of a unified policy to address the shared health threats of humans and animals	
	3	Risk Communication and Pandemic Preparedness	

Reference

1.Mackenzie JS, Jeggo M, Daszak P, Richt JA, editors. One Health: The Human-Animal-Environmental Interfaces in Emerging Infectious Diseases: The Concept and Examples of a One Health Approach (Current Topics in Microbiology and Immunology). Springer; 2013

2. One Health the Theory and Practice of Integrated Health Approaches 2020 Edition by Jakob Zinsstag, Esther Schelling, CABI Publishing

3. One Health from AIDS to Zika by Richard Riegelman and Brenda Kirkwood

4. One Health: People, Animals, and the Environment (ASM Books) by Ronald M. Atlas and Stanley Maloy.

5. Bhattacharya D, Kshatri JS, Choudhary HR, Parai D, Shandilya J, Mansingh A, et al. (2021) One Health approach for elimination of human anthrax in a tribal district of Odisha: Study protocol. PLoS ONE 16(5): e0251041. https://doi.org/10.1371/journal.pone.0251041

6. Kock R, Haider N, Mboera LE, Zumla A. A One-Health lens for anthrax. The Lancet. Planetary Health. 2019 Jul;3(7):e285.

7. Mansingh A, Choudhary HR, Shandilya J, Bhattacharya D, Kshatri JS, Parai D, Pattanaik M, Padhi AK, Jain HK, Mohanty P, Kanungo S. A qualitative exploratory study using One Health approach for developing an intervention package for elimination of human anthrax in an endemic district of Odisha, India. The Indian journal of medical research. 2021 Mar;153(3):394.

8. Mazet JA, Clifford DL, Coppolillo PB, Deolalikar AB, Erickson JD, Kazwala RR. A “one health” approach to address emerging zoonoses: the HALI project in Tanzania. PLoS medicine. 2009 Dec 15;6(12):e1000190.

9. Prescott’s Microbiology (9th Edition) Authors: Christopher J.Woolverton, Joanne Willey, and Linda Sherwood.

10. Jawetz Melnick & Adelbergs Medical Microbiology, 27th Edition

11. Ananthanarayan and Paniker's Textbook of Microbiology Tenth edition.

E-Resources

https://www.onehealthcommission.org/en/resources__services/oh_resources_for_public_health_educators/

https://www.cdc.gov/onehealth/basics/index.html

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	P S O addressed
CO-1	Understand the concept of One Health and its significance in	U,R	/PSO1,5
CO-2	Apply one health approaches and create awareness about various viral pathogen and emergence of drug resistance	U,R,C,Ap	PSO1,5
CO-3	Gain some insights on various bacterial, fungal, and protozoan, pathogens and their infections and emergence of drug resistance	U,R,C	/PSO1,5
CO4	Knowledge and application of immunisation and understand its significance.	Ap,C	PSO 5
CO5	Gain insight on one health policies	U,C	/PSO 5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO1	Understand the concept of One Health and its significance in	PO4,8/ PSO1,5	U,R	C	L	
CO2	Apply one health approaches and create awareness about various viral pathogen and emergence of drug resistance	PO6,8/ PSO1,5	U,R,C,Ap	F	L	

CO3	Gain some insights on various bacterial, fungal and protozoan, pathogens and emergence of drug resistance	PO6,8/ PSO1,5	U,R,C	F,C	L	
CO4	Knowledge and application of immunisation and understand its significance.	PO2,8/ PSO 5	Ap,C	F,C		P
CO5	Gain insight on one health policies	PO1,4,/ PSO 5	U,C	C,P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PS O2**	**PS O3**	**PS O4**	**PSO 5**	**PSO 6**	**P O1**	**P O2**	**P O 3**	**PO 4**	**P O5**	**PO 6**	**PO 7**	**PO8**
CO 1	2	-	-	--	2	-	-	-	-	2	-	-	-	2
CO 2	2	-	--	-	1	-	-	-	--	-	-	2	-	2
CO 3	2	-	-	-	1	-	-	-	-	-	-	2	-	2
CO 4	-	-	-	-	2	-	-	2	-	-	-	-	-	2
CO 5	-	-	-	-	2	-	3	-	-	2	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓			✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK4SECMBY201				
Course Title	**Food Quality Assurance**				
Type of Course	**SEC**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	3	3 hours	-	-	3
Pre-requisites	Basic knowledge of microorganisms gained during HSE and first and second year of UG programme				
Course Summary	The course covers good practices, regulatory requirements, major food safety hazards and analytical techniques to ensure production of safe, unadulterated and high-quality food products.				

Detailed Syllabus: Total hours -45

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hr 45**
I	**Module 1: Basic concepts of food quality assurance**		**9**
	1	Current Good Manufacturing Practices (GMP)	
	2	Standard Sanitary Operation Procedures	
	3	Good Laboratory Practices (GLP)	
	4	ISO 22000 FSMS	
	Module 2: Food laws and standards		**9**

II	1	HACCP – definition, principles, steps involved	
	2	Food standards - Voluntary and mandatory food laws	
	3	Food Safety and Standards Act of India, 2006	
III		**Module 3: Physical and Chemical Hazards**	**9**
	1	Hazards – Definition and Types	
	2	Physical hazards: Glass, Wood, Stones, Metal Fragments, Insulation Materials, Plastic and Bones	
	3	Chemical hazards: Naturally occurring chemical hazards – Naturally occurring toxicants in foods and antinutritional factors in foods(Brief account)	
	4	Unintentional Chemicals: Pesticides, Fertilizers, Pollutants, Toxic metals - Lead, Cadmium, Mercury, Aluminium and Arsenic(Brief account)	
	5	Intentional Chemicals: Food preservatives and food additives(Brief account)	
IV		**Module 4: Biological Hazards**	**9**
	1	Introduction to biological hazards, Types of biological hazards	
	2	Food infections and intoxications: ● Bacterial: *Salmonella typhi, Clostridium botulinum, Staphylococcus aureus, Vibrio cholerae, E. coli* - Source and diseases. ● Fungal : *Aspergillus, Penicillium*- Source and diseases. ● Viral: Hepatitis A, Rotavirus- Source and diseases.	
V		**Module 5: Techniques For Quality Assessment**	**9**
	1	Rapid tests for food adulterants ● Milk– Detection of water, Detection of detergents ● Oil– Detection of other oils in coconut oil ● Honey– Detection of sugar ● Sugar– Detection of chalk powder ● Chilli powder & Turmeric powder– Detection of synthetic colours	
	2	Microbiological Tests - Direct microscopic count, Total Plate Count	
	3	Rapid Detection Methods – PCR (Brief account)	

REFERENCES:

1. Bhatia,R. and Ichhpujan,R.L. Quality assurance in Microbiology. CBS Publishers and Distributors, New Delhi. 2004.
2. Kher, C.P. Quality control for the food industry. ITC Publishers, Geneva. 2000.
3. Philip,A.C. Reconceptualizing quality. New Age International Publishers, Bangalore.2001
4. Devendra, K. B. and Priyanka, T. 2006. An Introduction to Food Science and technology and Quality Management. Kalyani Publishers 81-272-2521-5.
5. Fundamentals of Quality Control for the Food Industry. Vol 1. 1970. Kramer, A. & Twigg, B.A. AVI. Westport, Conn.
6. Total Quality Assurance for the Food Industries. 1988. Gould, W.A. & Gould, R.W. CTI Publications.
7. https://www.fssai.gov.in
8. https://vikaspedia.in/health/health-campaigns/beware-of-adulteration/quick-tests-for-some-adulterants-in-foods

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand food quality management systems	R,U	PSO1,2
CO-2	Learn laws and regulations for food quality assurance	R, U	PSO1,4
CO-3	Gain knowledge on HACCP in food processing	U,Ap	PSO1,5
CO-4	Distinguish physical and chemical hazards in food	An,E	PSO2,5
CO-5	Understand biological hazards in food	An,E	PSO3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture: Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)

CO-1	Understand food quality management systems	PO1/ PSO1,2	R,U	F, C	L	
CO-2	Learn laws and regulations for food quality assurance	PO1/ PSO1,4	R, U	M	L	
CO-3	Gain knowledge on HACCP in food processing	PO2/ PSO1,5	U,Ap	F,C	L	
CO-4	Distinguish physical and chemical hazards in food	PO2/ PSO2,5	An,E	F,C	L	
CO-5	Understand biological hazards in food	PO3/ PSO3,5	An,E	P,M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	1	-	-	-	-	1	-	-	-	-	-
CO 2	2	-	-	2	-	-	1	-	-	-	-	-
CO 3	2	-	-	-	2	-	-	2	-	-	-	-
CO 4	-	2	-	-	2	-	-	2	-	-	-	-
CO 5	-	-	2	-	2	-	-	-	2	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK4SECMBY202				
Course Title	**Food Quality Control**				
Type of Course	**SEC-P**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	3	2 hours	-	2	4
Pre-requisites	Basic knowledge of microorganisms gained during HSE and first and second year of UG programme				
Course Summary	This course provides a comprehensive overview of food quality assurance and hazard analysis in the food industry, covering essential concepts, legal frameworks, types of hazards, and quality assessment techniques.				

Detailed Syllabus: Total hours -45

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hr 30**
I		**Module 1: Basic concepts of food quality assurance**	**4**
	1	Current Good Manufacturing Practices (GMP)	
	2	Standard Sanitary Operation Procedures	
	3	Good Laboratory Practices (GLP)	
	4	ISO 22000 FSMS	

II	**Module 2: Food laws and standards**		**5**
	1	HACCP – definition, principles, steps involved	
	2	Food standards - Voluntary and mandatory food laws	
	3	Food Safety and Standards Act of India, 2006	
III	**Module 3: Physical and Chemical Hazards**		**7**
	1	Hazards – Definition and Types	
	2	Physical hazards: Glass, Wood, Stones, Metal Fragments, Insulation Materials, Plastic and Bones	
	3	Chemical hazards: Naturally occurring chemical hazards – Naturally occurring toxicants in foods and antinutritional factors in foods(Brief account)	
	4	Unintentional Chemicals: Pesticides, Fertilizers, Pollutants, Toxic metals - Lead, Cadmium, Mercury, Aluminium and Arsenic(Brief account)	
	5	Intentional Chemicals: Food preservatives and food additives(Brief account)	
IV	**Module 4: Biological Hazards**		**8**
	1	Introduction to biological hazards, Types of biological hazards	
	2	Food infections and intoxications: ● Bacterial: *Salmonella typhi, Clostridium botulinum, Staphylococcus aureus, Vibrio cholerae, E. coli* - Source and diseases. ● Fungal : *Aspergillus, Penicillium*- Source and diseases. ● Viral: Hepatitis A, Rotavirus- Source and diseases.	
V	**Module 5: Techniques For Quality Assessment**		**6**
	1	Rapid tests for food adulterants ● Milk– Detection of water, Detection of detergents ● Oil– Detection of other oils in coconut oil ● Honey– Detection of sugar ● Sugar– Detection of chalk powder ● Chilli powder & Turmeric powder– Detection of synthetic colours	
	2	Microbiological Tests - Direct microscopic count, Total Plate Count	
	3	Rapid Detection Methods – PCR (Brief account)	

		Practicals	Hrs 15
Course Type: Practical, Total Credits: 1 Contact hours/week: 2			
VI	1	Detection of water and detergents in milk	
	2	Detection of other oils in coconut oil	
	3	Detection of chalk powder in sugar	
	4	Detection of synthetic colours in chilli powder and turmeric powder	
	5	Perform total plate count of the given sample	
	6	Determination of quality of a milk sample by MBRT	

REFERENCES:

1. Bhatia,R. and Ichhpujan,R.L. Quality assurance in Microbiology. CBS Publishers and Distributors, New Delhi. 2004.
2. Kher, C.P. Quality control for the food industry. ITC Publishers, Geneva. 2000.
3. Philip,A.C. Reconceptualizing quality. New Age International Publishers, Bangalore.2001
4. Devendra, K. B. and Priyanka, T. 2006. An Introduction to Food Science and technology and Quality Management. Kalyani Publishers 81-272-2521-5.
5. Fundamentals of Quality Control for the Food Industry. Vol 1. 1970. Kramer, A. & Twigg, B.A. AVI. Westport, Conn.
6. Total Quality Assurance for the Food Industries. 1988. Gould, W.A. & Gould, R.W. CTI Publications.
7. https://www.fssai.gov.in/upload/uploadfiles/files/Manual_Methods_Testing_Adulterants_18_10_2019.pdf
8. https://foodsafety.kerala.gov.in/wp-content/uploads/2019/06/DART-1.pdf
9. https://www.fssai.gov.in
10. https://vikaspedia.in/health/health-campaigns/beware-of-adulteration/quick-tests-for-some-adulterants-in-foods

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand food quality management systems	R,U	PSO1,2
CO-2	Learn laws and regulations for food quality assurance	R, U	PSO1,4
CO-3	Gain knowledge on HACCP in food processing	U,Ap	PSO1,5
CO-4	Distinguish physical, chemical and biological hazards in food	An,E	PSO2,5
CO-5	Learn methods to detect adulterants and microorganisms in food	An,E	PSO3,5
CO-6	Practice detection of chemical and biological hazards in laboratory	An,E	PSO3,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture: Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand food quality management systems	PO1 / PSO 1,2	R,U	F, C	L	
CO-2	Learn laws and regulations for food quality assurance	PO1 / PSO 1,4	R, U	M	L	
CO-3	Gain knowledge on HACCP in food processing	PO2 / PSO 1,5	U,Ap	F,C	L	
CO-4	Distinguish physical, chemical and biological hazards in food	PO2 / PSO 2,5	An,E	F,C	L	
CO-5	Learn methods to detect adulterants and microorganisms in food	PO3 / PSO 3,5	An,E	P,M	L	
CO-6	Practice detection of chemical and biological hazards in laboratory	PO2 / PSO 3,5	An,E	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	1	-	-	-	-	1	-	-	-	-	-
CO 2	2	-	-	2	-	-	1	-	-	-	-	-
CO 3	2	-	-	-	2	-	-	2	-	-	-	-
CO 4	-	2	-	-	2	-	-	2	-	-	-	-
CO 5	-	-	2	-	2	-	-	-	2	-	-	-
CO 6	-	-	2	-	2	-	-	2	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓	✓		

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK5SECMBY301				
Course Title	**Mushroom Cultivation**				
Type of Course	**SEC**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	3	3	-	-	3
Pre-requisites	Basic knowledge of microorganisms gained during HSE and first and second year of UG programme				
Course Summary	Mushroom cultivation course enable the students to identify edible and poisonous mushrooms and provide exposure to the experiences of experts and functioning mushroom farms. This course helps the students to learn a means of self employment and income generation.				

Detailed Syllabus:Total hours -45

		Course Type: Theory, Total credits: 3, Contact hours/week: 3	**45 Hrs**
Module	**Unit**	**Content**	
I	**Module 1: Introduction to Mushrooms**		**9**
	1	History and Scope of mushroom cultivation.	
	2	Vegetative characters of edible and poisonous mushrooms.	
II	**Module 2: Common Edible mushrooms**		**9**

	1	Button mushroom (*Agaricus bisporus*), Milky mushroom (*Calocybe indica*), Oyster mushroom (*Pleurotus sajorcaju*) and paddy straw mushroom (*Volvariella volvcea*).	
III	**Module 3 : Principles of mushroom cultivation**		**9**
	1	Structure and construction of mushroom house.	
	2	Sterilization of substrates.	
	3	Spawn production - culture media preparation- production of pure culture, mother spawn, and multiplication of spawn.	
	4	Composting technology, mushroom bed preparation. Spawning, spawn running, harvesting.	
	5	Cultivation of oyster and paddy straw mushroom. Problems in cultivation - diseases, pests and nematodes, weed moulds and their management strategies.	
IV	**Module 4: Post-Harvest Technology**		**9**
	1	Preservation of mushrooms - freezing, dry freezing, drying and canning.	
	2	Quality assurance and entrepreneurship.	
	3	Value added products of mushrooms.	
	4	Health benefits of mushrooms - Nutritional and medicinal values of mushrooms. Therapeutic aspects- antitumor effect.	
V	**Module 5 : Training/ Workshop/ Field visit**		**9**
	1	Sterilization and sanitation of mushroom houses.	
	2	Preparation of mother culture	
	3	Media preparation, inoculation, incubation and spawn	
	4	Cultivation of oyster mushroom using paddy straw/agricultural wastes	
	5	Hands on training for the preparation of bed for mushroom cultivation and spawn production	
	6	Field visit	

References

1. Marimuthu, T. et al. (1991). Oyster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.

2. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi

3. Pandey R.K, S. K Ghosh, 1996. A Hand Book on Mushroom Cultivation. Emkey Publications.

4. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.

5.Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.

6. Tripathi, D.P. (2005) Mushroom Cultivation, Oxford & IBH Publishing Co. PVT.LTD, New Delhi.

7. V.N. Pathak, Nagendra Yadav and Maneesha Gaur, Mushroom Production and Processing Technology/ Vedams Ebooks Pvt Ltd., New Delhi (2000)

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the basics of mushroom and develop interest in mushroom cultivation	R,U	PSO 1
CO-2	Gain the knowledge of cultivation of different types of edible mushrooms and spawn production	U	PSO 1,2
CO -3	Provide knowledge for the preparation of bed for mushroom cultivation and spawn production	U,Ap	PSO 2,3
CO – 4	Learn about nutritional and medicinal values of mushrooms	U	PSO1
CO - 5	Learn self-employment and income generation. Design and develop mushroom production growing structure / unit	Ap,An,C	PSO 2,6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1		PO1/ PSO 1	R,U	F	L	
2		PO1/ PSO 1,2	U	F,C	L	
3		PO2/ PSO 2,3	U,Ap	P	L	
4		PO1/ PSO1	U	F	L	
5		PO2/ PSO 2,6	Ap,An,C	P,M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	1	-	-	-	-	1	-	-	-	-	-
CO 3	-	2	1	-	-	-	-	1	-	-	-	-
CO 4	2	-	-	-	-	-	-	1	-	-	-	-
CO 5	-	2	-	-	-	1	-	2	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil

1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓			✓

University of Kerala

Discipline	MICROBIOLOGY				
Course Code	UK6SECMBY301				
Course Title	**Scientific Writing and Presentation**				
Type of Course	**SEC**				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	3	3 hours	-	- hours	3
Pre-requisites	Basic understanding of scientific concepts, research methods, writing skills, english proficiency and computer literacy				
Course Summary	This course provides a comprehensive understanding of communication, writing, presentation and personal development skills, with a particular emphasis on scientific writing and presentation, equipping students with the necessary knowledge and skills for academic and professional success.				

Detailed Syllabus: Scientific Writing and Presentation **Total hours- 45**

Course Type: Theory, Total credits: 3, Contact hours/week: 3			
Module	**Unit**	**Content**	**Hrs 45**
I		**Communication Skills**	**9**
	1	Language – A means of communication, Principles of Communication, Types of Communication, Principles of effective Communication	
	2	Communication barriers and overcoming the barriers, developing effective messages.	

	3	Formal written skills: Office drafting job applications, Report writing, Academic correspondence, Leave applications	
	4	Communication skills – Interview skills	
	5	Technology and Communication- E-mail- Principle, Netiquettes and Etiquettes	
II	**Scientific writing and presentation**		**9**
	5	Good English and grammar in scientific writing: Use and misuse of words, Jargon and Avoiding Jargon,	
	6	Abbreviations –Guidelines for use of abbreviations, accepted abbreviations and symbols. Common errors in style and in spelling	
	7	Programme of writing: Selection of topic and outline, Thinking and planning, Information collection, Paragraph writing: Order of paragraph, writing and revising of paragraph.	
	8	Main requirements of a scientific document: Accuracy, Appropriateness, Clarity, Simplicity, Brevity, Precision, Balance, consistency, Impartiality, Sincerity, Objectivity, Control of interest and in Scientific Writing Page	
III	**Scientific paper**		**9**
	9	Scientific paper – Definitions and Organization of a scientific paper, History, IMRAD system.	
	10	Writing a scientific paper: Title, Listing the authors and addresses, Abstract, Introduction, Materials and Methods, Results and Discussion, Summary and Conclusions, stating the acknowledgements and citing the references.	
	11	Keyboarding the manuscript, submission of the manuscript, The Review process, The publishing process.	
	12	Designing of effective table, graphs, diagrams and illustrations	
	13	Legal aspects of scientific authorship: Copyright considerations, Plagiarism	
	14	Presentation of scientific paper: Oral presentation, Preparation and presentation of a poster.	
	15	Writing review papers, Conference reports, Book reviews, Project and Project reports, and a Thesis.	
IV	**Planning and Goal setting**		
	18	Five skills needed to achieve career goals: Human perceptions, understanding people types of soft skills.	

	19	Types of soft skills Need for achievement and Spiritual Intelligence, Developing potential and self-actualization	
V	**Conflict and Stress**		**9**
	23	Types of conflicts, conflict resolution skills	
	24	Types of stress, causes of stress, effects of stress and regulating the stress	
	25	Habits – Good and Bad habits, Forming Habits of success, Breaking bad habits.	

References

Guffey, M. E., & Loewy, D. (2015). Business communication: Process and product (9th ed.). Cengage Learning.

Bovee, C. L., & Thill, J. V. (2019). Business communication today (14th ed.). Pearson.

Adler, R. B., & Proctor, R. F. (2021). Looking out, looking in (16th ed.). Cengage Learning.

Ober, S. (2017). Contemporary business communication (10th ed.). Pearson.

Hofmann, A. H. (2018). Scientific writing and communication: Papers, proposals, and presentations (3rd ed.). Oxford University Press.

Alley, M. (2013). The craft of scientific presentations: Critical steps to succeed and critical errors to avoid (2nd ed.). Springer.

Williams, J. M., & Bizup, J. (2017). Style: Lessons in clarity and grace (12th ed.). Pearson.

Zeiger, M. (2017). Essentials of writing biomedical research papers (2nd ed.). McGraw-Hill Education.

Heard, S. B. (2016). The scientist's guide to writing: How to write more easily and effectively throughout your scientific career. Princeton University Press.

Coghill, A. M., & Garson, L. R. (Eds.). (2006). The ACS style guide: Effective communication of scientific information (3rd ed.). American Chemical Society.

University of Chicago Press Editorial Staff. (2003). The Chicago guide to communicating science. University of Chicago Press.

Day, R. A., & Gastel, B. (2011). How to write and publish a scientific paper (7th ed.). Cambridge University Press.

Covey, S. R. (2004). The 7 habits of highly effective people: Powerful lessons in personal change. Free Press.

Goleman, D. (2005). Emotional intelligence: Why it can matter more than IQ (10th ed.). Bantam Books.

Bourne, E. J. (2000). The anxiety and phobia workbook (4th ed.). New Harbinger Publications.

Robbins, A. (2017). Unshakeable: Your financial freedom playbook. Simon & Schuster.

E-resources

https://owl.purdue.edu/owl/purdue_owl.html

https://www.ted.com/talks

https://www.coursera.org/

https://www.mendeley.com/

https://researcheracademy.elsevier.com/

https://www.mindtools.com/

https://hbr.org/

https://www.apa.org/topics/stress

https://www.coursera.org/

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	understand the fundamental elements of effective communication and Create proficiency in formal written communication	U, C	PSO-4
CO-2	Gaining knowledge and skills to communicate scientific information effectively through high-quality scientific writings	U, Ap, C	PSO-4
CO-3	Understanding of scientific paper writing, from conceptualization to publication and oral presentation	U, An, C	PSO-4, 5

CO-4	Create necessary soft skills, self-awareness, and goal-setting strategies to navigate their personal and lives successfully	U, C	PSO-4, 5, 6
CO-5	Understand the conflicts, stress, and habits, and provide them with practical strategies for effective conflict resolution, stress management, and habit formation/reformation	U, An	PSO-5, 6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Note: 1 or 2 COs/module

Name of the Course: Scientific Writing and Presentation **Credits: 3:0:0 (Lecture:Tutorial:Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the fundamental elements of effective communication and Create proficiency in formal written communication	PO-4, 5 / PSO-4	U, C	F	L	
CO-2	Gaining knowledge and skills to communicate scientific information effectively through high-quality scientific writings	PO-4, 5 / PSO-4	U, Ap, C	P	L	

CO-3	Understanding of scientific paper writing, from conceptualization to publication and oral presentation	PO-1, 2, 4, / PSO-4, 5	U, An, C	C,P	L	
CO-4	Create necessary soft skills, self-awareness, and goal-setting strategies to navigate their personal and lives successfully	PO-3,5/ PSO-4, 5, 6	U, C	M	L	
CO-5	Understand the conflicts, stress, and habits, and provide them with practical strategies for effective conflict resolution, stress management, and habit formation/ reformation	PO-2, / PSO-5, 6	U, An	M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	-	-	-	2	-	-	-	-	-	2	2	-
CO 2	-	-	-	2	-	-	-	-	-	2	2	-
CO 3	-	-	-	3	3	-	3	2	-	2	-	-
CO 4	-	-	-	3	3	2	-	-	2	-	2	-

CO 5	-	-	-	-	3	3	-	3	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4				✓
CO 5				✓