Course Specification
(Bachelor)

Course Title:	Environmental Microbiology
Course Code:	EVS 1242
Program:	Bachelor of Science in Environmental Science
Department:	Biology
College:	Science
Institution:	Imam Mohammed Ibn Saud Islamic University
Version:	1
Last Revision Date:	-

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A. General information about the course:

1. Course Identification

1. Credit hours: 3 (2 Lecture + 2 Lab)					
2. Course type					
A.	☐University	☐College	☒ Department	☐Track	Others
B.	☒ Required		☐Elective		
3. Level/year at which this course is offered: (Level 4/ 2nd Year)					
4. Course general Description:					
This course will introduce students to the field of environmental microbiology, which is the study of microbes in natural environments such as soil, water and air. Environmental Microbiology introduces students to the fascinating world of microorganisms, highlighting their evolution, importance, and functionality in the most varied environments. In this course, students learn of the vital role of microbes in marine and terrestrial ecosystems by exploring the dynamic interactions that take place between microbial communities, the surroundings, and higher organisms. Students will learn about microbial abundance and diversity in common habitats and in peculiar niches under extreme environmental conditions. During the course, we will explore the importance of microorganisms in soil formation and quality, in food production and plant health, in nutrient cycling and biodegradation of varied substrates and pollutants, in medicine and industry, in space exploration, and in bioremediation of contaminated soils. In this course, students will also learn how microorganisms can communicate with each other using signaling molecules, and how their genetic potential can be used for the advance of biotechnological processes. Furthermore, students will learn how to perform scientific experiments for monitoring, quantification, and qualification of microorganisms associated with plants, soil, and water, and how to use DNA sequences for identifying species and their function. This course will provide students with the ability to demonstrate their knowledge of prokaryotic biodiversity and function, and to apply this understanding to solve problems and find solutions related to current environmental issues that threaten planetary and human health (i.e.: antibiotic resistance, pollution, greenhouse gas emission, and global warming).					
5. Pre-requirements for this course (if any)**:**					
EVS 1111					
6. Co-requisites for this course (if any)**:**					

None

7. Course Main Objective(s):

The objective of this course is to provide a basic understanding of environmental microbiology including; the functional diversity of microorganisms in the environment in relation to human welfare and ecosystem health, microbial interactions with pollutants in the environment and the fate of microbial pathogens in the environment. Special emphasis will be placed on how the activities and interactions of microorganisms influence biological systems ranging from humans to the planet as a whole. The course covers key themes in contemporary environmental microbiology including microbial diversity and function, adaptation to extreme environments, and biogeochemical cycling. Students will gain theoretical and practical experience in the latest cutting-edge techniques used to study microbial ecosystem function. Laboratory sessions allow students to gain experience in experimental design and practical research skills in the context of mini-research projects involving environmental issues. This course emphasizes how the principles and techniques of environmental microbiology can be applied to a range of environmental problems, and lead to the development of sustainable resources and commercial applications.

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	√	100%
2	E-learning	-	-
3	Hybrid • Traditional classroom • E-learning	-	-
4	Distance learning	-	-

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	30
2.	**Laboratory/Studio**	30
3.	**Field**	0
4.	**Tutorial**	0
5.	**Others (specify)**	0
Total		60

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Method

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	State the fundamental concepts and methodology of environmental microbiology.	K1	Lecture and take-home research assignment	Quizzes, midterm exam and final exam
1.2	Outline the diversity and distribution of microbes in several different environments, including water, sediments, soil and air.	K2	Lecture and take-home research assignment	Quizzes, midterm exam and final exam
1.3	Tell how plants, soil, and human microbiomes are interconnected and how they can influence each other.	K3	Lecture and take-home research assignment	Quizzes, midterm exam and final exam
1.4	Recognize the importance of microbial communities to the functioning of diverse ecosystems.	K3	Lecture and take-home research assignment	Quizzes, midterm exam and final exam
1.5	Describe microbial metabolism, genetics, growth and function in an environmental context.	K4	Lecture and take-home research assignment	Quizzes, midterm exam and final exam
2.0	**Skills**			

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
2.1	Summarize methods commonly used in environmental microbiology and explain their limitations.	S1	Laboratory and take-home research assignment	Lab reports and Lab exam
2.2	Demonstrate how microbial diversity is assessed in diverse ecosystems.	S2	Laboratory and take-home research assignment	Lab reports and Lab exam
2.3	Compare and evaluate microbial communities by employing a variety of laboratory techniques, including isolation, enumeration, basic genome analysis and functional assays.	S3	Laboratory and take-home research assignment	Lab reports and Lab exam
2.4	Predict changes in microbial community structure according changes in biotic and abiotic factors.	S3	Laboratory and take-home research assignment	Lab reports and Lab exam
2.5	Use knowledge in environmental microbiology and ecosystems management to find out solutions for environmental issues.	S4	Laboratory and take-home research assignment	Lab reports and Lab exam

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
3.0	**Values, autonomy, and responsibility**			
3.1	Analyze and criticize primary literature articles in the field of environmental microbiology, extract essential information, interpret figures, and summarize key points, to improve critical thinking and evaluation skills.	V1	Lecture, laboratory and take-home research assignment	Quizzes, midterm exam, Lab reports, project presentations, Lab exam and final exam
3.2	Communicate environmental microbiology-related information to various audiences in an accurate, compelling, and logically supported manner, via writing, talks and posters.	V2	Lecture, laboratory and take-home research assignment	Quizzes, midterm exam, Lab reports, project presentations, Lab exam and final exam
3.3	Discuss specific problems using scientific evidence to support their position to an audience of peers.	V3	Lecture, laboratory and take-home research assignment	Quizzes, midterm exam, Lab reports, project presentations, Lab exam and final exam

C. Course Content

No	List of Topics (Lectures)	Contact Hours
1.	Introduction to Environmental Microbiology A. Environmental Microbiology as a Discipline. B. Microbial Influences on our Daily Lives.	4
2.	Microorganisms Found in the Environment A. Classification of Organisms. B. Prokaryotes. C. Eukaryotes. D. Viruses. E. Other Biological Entities.	4
3.	Earth Environments A. Earth's Living Skin. B. Physiochemical Characteristics of the Earth Environment. C. Soil as a Microbial Environment. D. Microorganisms in Surface Soils. E. Distribution of Microorganisms in Soil. F. Microorganisms in Subsurface Environments.	4
4.	Aeromicrobiology A. Aerosols. B. Nature of Bioaerosols. C. Aeromicrobiology Pathway. D. Microbial Survival in the Air. E. Extramural Aeromicrobiology. F. Intramural Microbiology.	2
5.	Aquatic Environments A. Microbial Habitats in the Aquatic Environment. B. Microbial Lifestyles in Aquatic Environments. C. Marine Environments. D. Freshwater Environments. E. Other Notable Aquatic Environments.	2
6.	Extreme Environments A. Low Temperature Environments. B. High Temperature Environments. C. Desiccation and UV Stress. D. Aphotic Environments Based on Chemolithoautotrophy.	2

7.	Environmental Sample Collection and Processing A. Soils and Sediments. B. Water. C. Air. D. Detection of Microorganisms on Fomites.	**2**
8.	Cultural Methods A. Extraction and Isolation Techniques. B. Plating Methods. C. Culture Media for Bacteria. D. Culture Methods for Algae and Cyanobacteria. E. Cell Culture-Based Methods for Viruses. Physiological Methods A. Measuring Microbial Activity in Pure Culture. B. Choosing the Appropriate Activity Measurement for Environmental Samples. C. Carbon Respiration. D. Incorporation of Radiolabeled Tracers into Cellular Macromolecules. E. Adenylate Energy Charge. F. Enzyme Assays. Immunological Methods A. What is an Antibody? B. Immunoassays. C. Immunosensors. Nucleic Acid-Based Methods A. Structure and Complementarity of Nucleic Acids. B. Obtaining Microbial Nucleic Acids from the Environment. C. Hybridization-Based Assays. D. Amplification-Based Assays. E. DNA Fingerprinting. F. Recombinant DNA Techniques. G. Sequence Analysis.	**2**
9.	Biogeochemical Cycling A. Carbon Cycle. B. Nitrogen Cycle. C. Sulfur Cycle. D. Iron Cycle.	**2**
10.	Microorganisms and Organic Pollutants A. The Overall Process of Biodegradation. B. Contaminant Structure, Toxicity, and Biodegradability.	**2**

	C. Environmental Factors Affecting Biodegradation. D. Biodegradation of Organic Pollutants. E. Bioremediation. Microorganisms and Metal Pollutants A. Metals in the Environment. B. Metal Solubility, Bioavailability, and Speciation. C. Metal Effects on the Microbial Cell. D. Mechanisms of Microbial Metal Resistance and Detoxification. E. Microbial Metal Transformations. F. Microbial Approaches in the Remediation of Metal-Contaminated Environments.	
11.	Microbial Diversity and Interactions in Natural Ecosystems A. Microbial Diversity in Natural Systems. B. Microbial Interactions. C. Microbial Diversity and Natural Products.	2
12.	Indicator Microorganisms A. Total Coliforms. B. Fecal Coliforms and Escherichia coli. C. Fecal Enterococci. D. Clostridium perfringes. E. Bacteroides and Bifidobacterium. F. Heterotrophic Plate Count. G. Bacteriophages.	2
Total		**30**

No	List of Topics (Lab)	Contact Hours
1.	Laboratory operations, safety, and reporting techniques	4
2.	Aseptic techniques	4
3.	Soil Microbiology	4
4.	Aeromicrobiology	2
5.	Aquatic microbiology	2
6.	Isolation of environmental microbes from soil, water and air (sampling, collecting, culturing)	2
7.	Enumeration of environmental microbes from soil, water and air (microscopy: (light, fluorescence, transmission electron, scanning electron)	2
8.	Identification of environmental microbes from soil, water and air: A. Physiological methods (measuring microbial activity, carbon respiration, radiolabeled tracers, enzyme assays, stable isotopes)	2

9.	Identification of environmental microbes from soil, water and air: B. Immunological methods (fluorescent immunolabeling, enzyme-linked immunosorbent assay, western immunoblotting)	**2**
10.	Identification of environmental microbes from soil, water and air: C. Nucleic acid-based methods (obtaining nucleic acids, hybridization, amplification, fingerprinting, recombinant DNA and sequence analysis)	**2**
11.	Determination of environmental microbial function (analysis of carbon metabolism, enzyme assays)	**2**
12.	Biodegradation and Bioremediation	**2**
Total		**30**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Midterm exam 1	Around 4th - 5th week	15%
2.	Midterm exam 2	Around 7th - 8th week	15%
3.	Quizzes, Participation, and Attendance	During the semester	10%
4.	Lab reports	During the semester	5%
5.	Lab Exam	15th week	15%
6.	Final Exam	16th week	40%
Total			**100%**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	Jean-Claude Bertrand, Pierre Caumette, Philippe Lebaron, Robert Matheron, Philippe Normand, Télesphore Sime-Ngando. (2015) Environmental Microbiology: Fundamentals and Applications, 1st Edition, Springer Nature Ralph Mitchell, Ji-Dong Gu. (2010) Environmental Microbiology, 2nd edition, Wiley Raina M. Maier, Ian L. Pepper and Charles P. Gerba. (2009) Environmental Microbiology, 2nd edition, Elsevier

Supportive References	Marylynn V. Yates, Cindy H. Nakatsu, Robert V. Miller, Suresh D. Pillai. (2016) Manual of Environmental Microbiology, 4th Edition, Wiley
Electronic Materials	None
Other Learning Materials	None

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Classrooms and Laboratories
Technology equipment (projector, smart board, software)	Projector and Smart board
Other equipment (depending on the nature of the specialty)	Environmental Microbiology-related instruments

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students	Direct
Effectiveness of Students assessment	Program Leader	Direct
Quality of learning resources	Peer Reviewer	Indirect
The extent to which CLOs have been achieved	Program Leader	Direct
Other	-	-

Assessors (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	**Head of Biology Department**
REFERENCE NO.	
DATE	