Programme	B.Sc. (Hons) Agriculture (Major: Soil Science)	Course Code	SS-309	Credit Hours	3(2-1)
Course Title	**SOIL MICROBIOLOGY**				

Course Introduction

Kinds and significance of microorganisms present in soil and their role in crop productivity and environmental quality are discussed. The students should be able to recognize different microbes, their functions in nutrient transformations under different conditions and their relationships with crops and environment.

Learning Outcomes

- Comprehend the diversity and classification of soil microorganisms, including bacteria, archaea, fungi, algae, and soil fauna.
- Recognize the ecological roles and interactions of these microorganisms within soil ecosystems.
- Understand the growth phases of soil microorganisms and the environmental factors influencing their activity.
- Learn about the various factors such as temperature, pH, moisture, and nutrient availability that affect microbial growth in soil.
- Integrate knowledge of soil microbiology with broader environmental and agricultural sciences.
- Apply concepts learned to real-world scenarios and current issues in soil health and sustainability.

	Course Content (Theory)	Assignments/Readings
Week 1	**Unit 1** 1.1. Introduction and historical prospective of Soil Microbiology 1.2. Overview of Soil Microbiology 1.3. Historical Development of Soil Microbiology	Read the first two chapters of "Soil Microbiology, Ecology, and Biochemistry" by Eldor A. Paul. Focus on the historical development of soil microbiology
Week 2	**Unit 2** 2.1. Distribution, functions and classification of bacteria, archaea, actinomycetes, fungi, algae and fauna	

	2.1.1. Distribution of Soil Microorganisms 2.1.2. Bacteria, Archaea and Actinomycetes 2.1.3. Habitat and Abundance	
Week 3	2.1.4. Fungi, Algae, and Fauna 2.1.5. Habitat and Abundance	
Week 4	2.1.6. Functions of Soil Microorganisms 2.1.7. Role in Soil Fertility and Plant Growth 2.1.8. Ecological Significance	Write a summary of the different habitats where soil microorganisms can be found and their relative abundances. Include at least three specific examples
Week 5	2.1.9. Classification of Soil Microorganisms 2.1.10. Taxonomy and Nomenclature 2.1.11. Major Groups and Their Characteristics	
Week 6	**Unit 3** 3.1. Growth phases and environmental factors affecting soil microflora 3.1.1. Lag Phase, Log Phase, Stationary Phase, Death Phase 3.1.2. Factors Influencing Growth	
Week 7	3.1.3. Environmental Factors Affecting Soil Microflora 3.1.4. Temperature, pH, Moisture, Nutrients 3.1.5. Influence of Soil Type and Texture	Write a step-by-step guide for preparing a specific culture medium used in soil microbiology. Include the rationale for each step and the purpose of key ingredients.
Week 8	**Unit 4**	

	4.1. Microbial ecology: soil organisms and their interactions 4.1.1. Symbiotic and Non-Symbiotic Relationships 4.1.2. Competition, Predation, and Parasitism	
Week 9	**Unit 5** Soil organic matter decomposition; immobilization and mineralization of carbon; microbial fixation and release of CO2 Process and Stages of Decomposition Role of Microorganisms in Decomposition	
Week 10	Immobilization and Mineralization of Carbon Mechanisms and Pathways Factors Influencing Immobilization and Mineralization	
Week 11	Microbial Fixation and Release of CO2 Carbon Cycling in Soil Role of Microorganisms in CO2 Dynamics	Read the chapter on microbial interactions in "Soil Microbiology and Sustainable Crop Production" by Geoffrey Gadd.
Week 12	**Unit 6** 6.1. Microbial transformations of nutrients under aerobic and anaerobic soil conditions. 6.1.1. Nitrogen, Phosphorus, Sulfur, and Other Nutrients 6.1.2. Mechanisms and Pathways	
Week 13	6.1.3. Microbial Transformations of Nutrients under Anaerobic Soil Conditions 6.1.4. Differences from Aerobic Conditions	Quiz

	6.1.5. Key Microbial Processes	
Week 14	**Unit 7** 7.1. Microbial Inoculants for Nitrogen Fixation 7.1.1. Types of Nitrogen-Fixing Microorganisms 7.1.2. Benefits and Application	Collect data regarding available microbial inoculants in market
Week 15	7.1.3. Microbial Inoculants for Phosphorus Solubilization 7.1.4. Types of Phosphorus-Solubilizing Microorganisms 7.1.5. Benefits and Application	Quiz
Week 16	Review and Integration of Course Topics • Recap of Key Concepts • Integration of Microbial Roles in Soil Health	
Course Content (Practical)		**Assignments/Readings**
Week 1	**Unit 1** 1.1. Introduction to laboratory equipment 1.1.1. Overview of Soil Microbiology 1.1.2. Historical Development of Soil Microbiology	
Week 2	1.1.3. Overview of Essential Lab Equipment for Soil Microbiology 1.1.4. Safety and Proper Usage	Practical notebook completion
Week 3	1.1.5. Distribution of Soil Microorganisms 1.1.6. Bacteria, Archaea, Actinomycetes, Fungi, Algae, and Fauna	
Week 4	**Unit 2** 2.1. Media Preparation 2.1.1. Types of Media for Culturing Soil Microorganisms 2.1.2. Sterilization Techniques	Practical notebook completion

Week 5	2.1.3. Growth Phases of Soil Microflora 2.1.4. Lag Phase, Log Phase, Stationary Phase, Death Phase 2.1.5. Factors Influencing Growth	
Week 6	2.1.6. Isolation of microbes from soil sample-Lecture (Dilution plate technique)	Practical notebook completion
Week 7	2.1.7. Isolation of microbes from soil sample-Practical	
Week 8	**Unit 3** 3.1. Measurement of microbial population and activity in soil 3.1.1. Methods and Techniques (e.g., Plate Counts, MPN, ATP Assays) 3.1.2. Interpretation of Results	Practical notebook completion
Week 9	3.1.3. Microbial Ecology: Soil Organisms and Their Interactions 3.1.4. Symbiotic and Non-Symbiotic Relationships 3.1.5. Competition, Predation, and Parasitism	
Week 10	3.1.6. Soil Organic Matter Decomposition 3.1.7. Process and Stages of Decomposition 3.1.8. Role of Microorganisms in Decomposition	Practical notebook completion
Week 11	3.1.9. Immobilization and Mineralization of Carbon 3.1.10. Factors Influencing Immobilization and Mineralization	
Week 12	3.1.11. Measurement of microbial population and activity in soil-Practical	Practical notebook completion
Week 13	**Unit 4** 4.1. Algal culturing and their microscopy	

	4.1.1. Techniques for Culturing Soil Algae 4.1.2. Microscopy Methods for Observation	
Week 14	**Unit 5** 5.1. Study of Mineralization, Nitrification, and Denitrification 5.1.1. Processes and Microbial Involvement 5.1.2. Factors Affecting These Transformations	Practical notebook completion
Week 15	5.1.3. Microbial Inoculants for Nitrogen Fixation 5.1.4. Types of Nitrogen-Fixing Microorganisms 5.1.5. Benefits and Application	
Week 16	5.1.6. Microbial Inoculants for Phosphorus Solubilization 5.1.7. Types of Phosphorus-Solubilizing Microorganisms 5.1.8. Benefits and Application	Practical notebook completion

Textbooks and Reading Material

1. Barton, L.L. and D.E. Northup. 2011. Microbial Ecology. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
2. González, M.B.R. and J. González-López. 2014. Beneficial Plant-microbial Interactions- Ecology and Applications. CRC Press, Taylor & Francis, Boca Ratoon, FL.
3. Paul, E.A. (ed.). 2007. Soil Microbiology, Ecology and Biochemistry. 3rd Ed. Elsevier, Oxford, UK.
4. Pommerville, J.C. 2014. Fundamentals of Microbiology. 10th Ed. Jones & Bartlett learning, Burlington, MA, Page 59 of 65 USA.
5. Sylvia, D.M., J.J. Fuhrmann, P.G. Hartel and D.V. Zuberer. 2005. Principles and Applications of Soil Microbiology. Prentice Hall International, NJ, USA.

Teaching Learning Strategies

1. Multimedia
2. White Board
3. Group discussion
4. Quiz/Assignments
5. Demonstration/Activity

Assignments: Types and Number with Calendar

1. Read the first two chapters of "Soil Microbiology, Ecology, and Biochemistry" by Eldor A. Paul. Focus on the historical development of soil microbiology
2. Write a summary of the different habitats where soil microorganisms can be found and their relative abundances. Include at least three specific examples
3. Write a step-by-step guide for preparing a specific culture medium used in soil microbiology. Include the rationale for each step and the purpose of key ingredients.
4. Read the chapter on microbial interactions in "Soil Microbiology and Sustainable Crop Production" by Geoffrey Gadd.
5. Collect data regarding available microbial inoculants in market
6. Practical notebook completion

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.