

Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

Expected Implementation in Academic Year (New format)	
Semester/Trimester/Others (specify approx. Start/End date)	
Course Author * Faculty proposing/revising the course	Adriana Lopes dos Santos (Asst Prof);#991
Course Author Email	adriana.lopes@ntu.edu.sg
Course Title	Microbes on natural ecosystems
Course Code	ES2304
Academic Units	3
Contact Hours	39
Research Experience Components	

Course Requisites (if applicable)

Pre-requisites	BS1001
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

Microbial communities are the life support system of our biosphere. Microorganisms date back to the origin of life on Earth and they will likely exist well beyond any future extinction events. They can be found in every environment on Earth that is occupied by macroscopic organisms and are the unique life forms in 'extreme' environments (e.g. deep sea vents, earth interior). This is an introductory course that will explore how microbes play key roles in and support the complex ecosystems we find in our biosphere. Through the lectures and lab tutorials, Microbes on natural ecosystems will provide you with background knowledge on fundamentals of microbiology, origin and diversity of microbial world, common methods to study microbes in their environment, how microorganisms control the chemistry of Earth, how microorganisms affect and will be affected by global climate change and how conservation biologists and microbial scientists can work together to preserve our biosphere. By the end of this course, you will appreciate and understand the importance of microbial processes to maintain a healthy global ecosystem. This course will be also open to graduate students who wish to improve and/or overview their knowledge on microbiology and microbial ecology.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Apply basic microbial knowledge to address ecological and biological issues in a global context
ILO 2	Describe the diversity of microbial world, including both functional and metabolic aspects
ILO 3	Describe and explain how the microbial processes mediate and affect the earth chemistry
ILO 4	Evaluate and choose which current method can give information about the microbial abundance, diversity and processes in a given environment
ILO 5	Formulate scientific questions and develop hypotheses through laboratory practical classes
ILO 6	Engage critically with different disciplinary and theoretical perspectives on microbial research
ILO 7	Use logical and critical thinking in order to make informed assessments of current environmental issues and the link with microbial research
ILO 8	Demonstrate competence in scientific ethics and the ability to work independently and as part of a team
ILO 9	Debate or lead a discussion on a current issue, in a measured and concise manner

Course Content

Introductory concepts in microbiology within a historical narrative (Microscopy and the origins of microbiology, three domains of life and microbial cell structure) Metabolic and Functional diversity of microorganism Diversity of Bacteria and Archaea Origin and diversity of microeukaryotes Methods to access microbial diversity: Culture dependent methods. Methods to access microbial diversity: Culture independent methods Measuring Microbial activity in the lab and nature Microbial Ecosystems Nutrient Cycle and how microbes control earth chemistry: Part I Nutrient Cycle and how microbes control earth chemistry: Part II Interactions in the microbial world Microorganisms and climate change in marine and terrestrial biomes Conservation biologists and microbiologist: how to integrate microbes in conservation debates and management

Reading and References (if applicable)

This course will be based on original research and review articles, mixing classical papers with the latest research and newly emerging topics. Papers will vary from year to year as new research is published. In addition, as a standard basic book, "Brock – Biology of Microorganisms" will be adopted. 1) Brock Biology of Microorganisms, 15th Edition. Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl

Planned Schedule

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
1	Introductory concepts in microbiology within a historical narrative (Microscopy and the origins of microbiology, three domains of life and microbial cell structure) Using the microscope to observe different microbes in live and preserved samples	1,2,5,6,	In-person		Note: A key element of this course is to train you to make effective use of the primary scientific literature. The lectures will be built on scientific literature and hence, the course literature will consist of original research and review papers that will be provided in each class.
2	Metabolic and Functional diversity of microorganism Creating an entire ecosystem with Winogradsky columns	1,2,3,5,6 7,8,9	In-person		Note: A key element of this course is to train you to make effective use of the primary scientific literature. The lectures will be built on scientific literature and hence, the course literature will consist of original research and review papers that will be provided in each class.
3	Diversity of Bacteria and Archaea [Quiz to review the concepts learned in weeks 1 and 2]	1,2,3,5,6 7	In-person		Note: A key element of this course is to train you to make effective use of the primary scientific literature. The lectures will be built on scientific literature and hence, the course literature will consist of original research and review papers that will be provided in each class.

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
4	Origin and diversity of microeukaryotes [Quiz to review the concepts learned in week 3]	1,2,3,5,6 7	In-person		Note: A key element of this course is to train you to make effective use of the primary scientific literature. The lectures will be built on scientific literature and hence, the course literature will consist of original research and review papers that will be provided in each class.
5	Methods to access microbial diversity: Culture dependent methods. Isolation of bacteria and microeukaryotes	1,2,3,4,5,6 7,8,9	In-person		Note: A key element of this course is to train you to make effective use of the primary scientific literature. The lectures will be built on scientific literature and hence, the course literature will consist of original research and review papers that will be provided in each class.
6	Methods to access microbial diversity: Culture independent methods [Quiz to review the concepts learned in week 5]	1,2,3,4,5,6 7	In-person		Note: A key element of this course is to train you to make effective use of the primary scientific literature. The lectures will be built on scientific literature and hence, the course literature will consist of original research and review papers that will be provided in each class.
7	Measuring Microbial activity in the lab and nature Investigating Photosynthesis with Algal Balls and observation of isolation experiments	1,2,3,4,5,6 7,8,9	In-person		Note: A key element of this course is to train you to make effective use of the primary scientific literature. The lectures will be built on scientific literature and hence, the course literature will consist of original research and review papers that will be provided in each class.

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
8	Microbial Ecosystems Discussion on the results of Algal ball experiment	1,2,3,4,5,6 7,8,9	In-person		Note: A key element of this course is to train you to make effective use of the primary scientific literature. The lectures will be built on scientific literature and hence, the course literature will consist of original research and review papers that will be provided in each class.
9	Nutrient Cycle and how microbes control earth chemistry: Part I [Quiz to review the concepts learned in week 6,7 and 8]	1,2,3,4,5,6,7	In-person		Note: A key element of this course is to train you to make effective use of the primary scientific literature. The lectures will be built on scientific literature and hence, the course literature will consist of original research and review papers that will be provided in each class.
10	Nutrient Cycle and how microbes control earth chemistry: Part II Observation of Winogradsky columns and discussion	1,2,3,4,5,6,7,8,9	In-person		Note: A key element of this course is to train you to make effective use of the primary scientific literature. The lectures will be built on scientific literature and hence, the course literature will consist of original research and review papers that will be provided in each class.
11	Interactions in the microbial world [Quiz to review the concepts learned in week 9 and 10]	1,2,3,4,5,6,7	In-person		Note: A key element of this course is to train you to make effective use of the primary scientific literature. The lectures will be built on scientific literature and hence, the course literature will consist of original research and review papers that will be provided in each class.

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
12	Microorganisms and climate change in marine and terrestrial biomes Discussion on the topics to be address at the final presentation	1,2,3,4,5,6 7,8,9	In-person		Note: A key element of this course is to train you to make effective use of the primary scientific literature. The lectures will be built on scientific literature and hence, the course literature will consist of original research and review papers that will be provided in each class.
13	Conservation biologists and microbiologist: how to integrate microbes in conservation debates and management	1,2,3,4,5,6 7,8,9	In-person		Note: A key element of this course is to train you to make effective use of the primary scientific literature. The lectures will be built on scientific literature and hence, the course literature will consist of original research and review papers that will be provided in each class.

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lecture	Lectures will be used to outline context, background, historical overview theories and basic concepts you are expected to be familiar with.
Interactive based activities	Group discussion groups, debate and presentation will help you analyze, formulate and communicate a deep understanding of topics covered during course
Independent learning	You are required to show self motivation and initiative in your learning process, such as preparation for the week quizzes and team work opportunities

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Others([class participation] Participation in lecture and practical class discussion)	1,5,6,7,8,9	1,3,4	10		Individual		
2	Continuous Assessment (CA): Others([quiz/test] Continuous Assessment through quizzes at weeks: 3, 4, 6, 9, 11 - Undergraduate only)	1,2,3,4	1,3	70		Individual		
3	Continuous Assessment (CA): Others([quiz/test] Continuous Assessment through quizzes at weeks: 3, 4, 6, 9, 11 - PhD students only)	1,2,3,4	1,3	50		Individual		
4	Continuous Assessment (CA): Others([presentations] Presentation of case study)	1,8,9	2,4,6	20		Team		
5	Continuous Assessment (CA): Others(Case study comment or perspective manuscript - PhD students only)	1,2,3,4,5,6,7,8,9	1,2,3,5	40		Individual		

Description of Assessment Components (if applicable)

Formative Feedback

You will receive informal feedback continuously throughout the course where appropriate, and formal feedback following every quiz.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
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Course Policy

Policy (Academic Integrity)

Policy (General)

(1) General

Students are expected to complete all assigned class readings and activities, attend all classes punctually, be attentive and engaged during the classes, spend an adequate amount of time on the assignments and seek for help when appropriate. As student, you can expect from me to start and end class on time, to reply e-mails, be available when office hours meetings are requested and the time determined, assign readings and activities that adequately covers the learning objectives of the course.

Policy (Absenteeism)

(2) Absenteeism

Weekly quizzes and discussions on lab tutorial activities or landmark papers are a crucial part of the course and a significant part of the assessment. Absence from any part of the course without a valid reason will affect your overall course grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies. There will be limited make-up opportunities. If you miss a lecture or discussion group exercise you must inform me via email (adriana.lopes@ntu.edu.sg) prior to the start of the class.

Policy (Others, if applicable)

(3) Online Compulsory Assignments

You are required to submit compulsory assignments on due dates, unless a valid reason is provided. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies.

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Last Updated By: Nani Harniwati