

<b>Academic Year</b>	2020/2021	<b>Semester</b>	1
<b>Course Coordinator</b>	Adriana Lopes dos Santos		
<b>Course Code</b>	ES2304		
<b>Course Title</b>	Microbes on Natural Ecosystems		
<b>Pre-requisites</b>	BS1001		
<b>No of AUs</b>	3		
<b>Contact Hours</b>	2h Lecture and 1h tutorial/lab (3h total)		
<b>Proposal Date</b>	24-Feb-21		

### **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.

### **Intended Learning Outcomes (ILO)**

By the end of this course, you (as a student) would be able to:

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

**Course Content**

Details on schedule below

**Assessment (includes both continuous and summative assessment)**

Component	Course LO Tested	Related Programme LO or Graduate Attributes (Appendix 1)	Weighting	Team/ Individual	Assessment Rubrics
Participation in lecture and practical class discussion	1,5,6,7,8,9	1,3,4	10%	Individual	Appendix 2
Continuous Assessment through quizzes at weeks: 3, 4, 6, 9, 11	1,2,3,4	1,3	70% (undergraduate) 50% (PhD students)	Individual	Appendix 3
Presentation of case study (only undergraduate)	1,8,9	2,4,6	20%	Team	Appendix 4
Case study comment or perspective manuscript (only PhD students)	1,2,3,4,5,6,7,8,9	1,2,3,5	40%	Individual (depending of number of PhD students)	Appendix 5
Total			100%		

**Formative feedback**

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

**Learning and Teaching approach**

Approach	How does this approach support students 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

## Reading and References

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; ISBN-13: 978-0134261928

## Course Policies and Student Responsibilities

### (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 during office hours, assign readings and activities that adequately covers the learning objectives of the course.

### (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.

### (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.

## Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the [academic integrity website](#) for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

## Course Instructors

Instructor	Office Location	Phone	Email
Adriana Lopes dos Santos	N2-01C-70	69047585	adriana.lopes@ntu.edu.sg

## Planned Weekly Schedule

Week	Topic		Course LO	Readings/ Activities
1	Lecture	Introductory concepts in microbiology within a historical narrative (Microscopy and the origins of microbiology, three domains of life and microbial cell structure)	1,2,5,6,	See note below
	Lab tutorial	<i>Using the microscope to observe different microbes in live and preserved samples</i>		
2	Lecture	Metabolic and Functional diversity of microorganism	1,2,3,5,6 7,8,9	See note below
	Lab tutorial	<i>Creating an entire ecosystem with Winogradsky columns</i>		
3	Lecture	Diversity of Bacteria and Archaea	1,2,3,5,6 7	See note below
	<b>Quiz</b>	<b>[Quiz to review the concepts learned in weeks 1 and 2]</b>		
4	Lecture	Origin and diversity of microeukaryotes	1,2,3,5,6 7	See note below
	<b>Quiz</b>	<b>[Quiz to review the concepts learned in week 3]</b>		
5	Lecture	Methods to access microbial diversity: Culture dependent methods.	1,2,3,4,5,6 7,8,9	See note below
	Lab tutorial	<i>Isolation of bacteria and microeukaryotes</i>		
6	Lecture	Methods to access microbial diversity: Culture independent methods	1,2,3,4,5,6 7	See note below
	<b>Quiz</b>	<b>[Quiz to review the concepts learned in week 5]</b>		
7	Lecture	Measuring Microbial activity in the lab and nature	1,2,3,4,5,6 7,8,9	See note below
	Lab tutorial	<i>Investigating Photosynthesis with Algal Balls and observation of isolation experiments</i>		
8	Lecture	Microbial Ecosystems	1,2,3,4,5,6 7,8,9	See note below
	Lab tutorial	<i>Discussion on the results of Algal ball experiment</i>		
9	Lecture	Nutrient Cycle and how microbes control earth chemistry: Part I	1,2,3,4,5,6 ,7	See note below
	<b>Quiz</b>	<b>[Quiz to review the concepts learned in week 6,7 and 8]</b>		
10	Lecture	Nutrient Cycle and how microbes control earth chemistry: Part II	1,2,3,4,5,6 ,7,8,9	See note below
	Lab tutorial	<i>Observation of Winogradsky columns and discussion</i>		
11	Lecture	Interactions in the microbial world	1,2,3,4,5,6 ,7	See note below
	<b>Quiz</b>	<b>[Quiz to review the concepts learned in week 9 and 10]</b>		
12	Lecture	Microorganisms and climate change in marine and terrestrial biomes	1,2,3,4,5,6 7,8,9	See note below
	Lab tutorial	<i>Discussion on the topics to be address at the final presentation</i>		
13	Final presentations and discussions	Conservation biologists and microbiologist: how to integrate microbes in conservation debates and management	1,2,3,4,5,6 7,8,9	See note below

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.

## **Appendix 1: OBTL Approved ASE learning outcomes**

At the completion of your course of study in ASE, you will be able to:

- 1) Demonstrate intellectual flexibility and critical thinking in order to apply environmental knowledge in the real world
- 2) Communicate environmental concepts with enthusiasm to varied audiences both orally and in writing
- 3) Formulate scientific questions, and be able to access and analyse quantitative and qualitative information to address them
- 4) Exhibit the motivation, curiosity and skills for lifelong learning
- 5) Demonstrate ethical values and responsibility
- 6) Collaborate and lead by influence

**Appendix 2: Assessment Criteria for Participation in Class Discussion**

Criteria	Standard				
	A+ (Exceptional) A (Excellent)	A- (Very good) B+ (Good)	B (Average) B- (Satisfactory) C+ (Marginally satisfactory)	C (Bordering unsatisfactory) C- (Unsatisfactory)	D, F* (Deeply unsatisfactory)
Contribution to class discussion	Important; Meaningful	Meaningful	Some	Minimal	Very minimal to none
Capacity to articulate and present points of view	Very clear	Clear	Some	Limited	None
Respectful discussion where all students contribute and no-one dominates the conversation	Achieved	Achieved	Not consistently	Limited	No
Arguments and debates about the topic, based on the literature and student's own insights and knowledge	Well-reasoned	Some evidence of reasoning	Some evidence of having considered the discussion topic	Little serious thought about the discussion topic	Unexplained or unjustified absences from discussions

**Appendix 3: Assessment criteria of the week quiz**

Week quizzes are small tests designed to offer you the opportunity to revised and practice the topics learned in class. The quiz will contain 5 to 10 punctual questions covering the key concepts discussed previously.

#### Appendix 4: Assessment Criteria for Preparation and Presentation of Case study (undergraduates only)

Please Note: In principle, students in the same group share the same group marks. However, there can be some individual variation within a group, depending on the evaluation of the tutor and the feedback from the peers. You may be awarded more marks for showing exemplary contribution to other team members' learning that goes beyond what is required. You may also receive lower marks than the rest of the team members if you have not contributed sufficiently.

Criteria	Standard				
	A+ (Exceptional) A (Excellent)	A- (Very good) B+ (Good)	B (Average) B- (Satisfactory) C+ (Marginally satisfactory)	C (Bordering unsatisfactory) C- (Unsatisfactory)	D, F (Deeply unsatisfactory)
Visuals (e.g. slides)	Outstanding; Well-structured, focused and effective	Very good; Reasonable structure and focus	Adequate; some capacity and focus	Inadequate; limited capacity and focus	Poor quality, difficult to follow; Not addressing the topic
Oral presentation	Exceptionally well prepared and structured	Reasonably clear and well-structured	Satisfactory	Lackluster; Poorly organized	Inadequate; Badly structured
Evidence of preparation and rehearsal	Content reflects the important aspects of the reading, highlighting key points and issues exceptionally well; Introduces additional knowledge through secondary readings	Content is well structured and presented in a clear and engaging way; Content reflects the important aspects of the reading, highlighting key points and issues well	Content reflects some important aspects of the reading	Content has little structure and the presentation is difficult to follow; Marginal; Poor timing	Limited to none; Very poor timing
Questions for others	Thought-provoking questions; Showing understanding and engagement	Asked; Showing understanding and engagement	Some; Some understanding and engagement	None	None; Obvious lack of engagement
Answering of questions	Correct with critical insight	Correctly	Correctly	Mostly correctly	Not able

**Appendix 5: Assessment Criteria for perspective/comment manuscript (PhD students only)**

The manuscript will follow the format of academic journals in the field of Microbiology with 2000 – 4000 words, include a maximum of 20 references and one figure, table or diagram.

Criteria	Standard				
	A+ (Exceptional) A (Excellent)	A- (Very good) B+ (Good)	B (Average) B- (Satisfactory) C+ (Marginally satisfactory)	C (Bordering unsatisfactory) C- (Unsatisfactory)	D, F* (Deeply unsatisfactory)
Visuals (e.g. Figures)	Outstanding; Well-structured, focused and effective	Very good; Reasonable structure and focus	Adequate; some capacity and focus	Inadequate; limited capacity and focus	Poor quality, difficult to follow; Not addressing the topic
Evidence of preparation	Content reflects the important aspects of the reading, highlighting key points and issues exceptionally well; Introduces additional knowledge through secondary readings	Content is well structured and presented in a clear and engaging way; Content reflects the important aspects of the reading, highlighting key points and issues well	Content reflects some important aspects of the reading	Content has little structure and the presentation is difficult to follow; Marginal; Poor timing	Limited to none; Very poor timing
Answering of questions	Correct with critical insight	Correctly	Correctly	Mostly correctly	Not able
Topic selected	Thought-provoking questions; Showing understanding and engagement	Asked; Showing understanding and engagement	Some; Some understanding and engagement	None	None; Obvious lack of engagement
Ability to place the findings in context of what was discussed in class	Excellent ability	Very good ability	Satisfactory	Limited	Not able