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

Course Overview

Expected Implementation in Academic Year (New format)	AY2026-2027
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Asst Prof Tang Bozeng
Course Author Email	bozeng.tang@ntu.edu.sg
Course Title	Plant–Microbe Interactions
Course Code	BS3040
Academic Units	3
Contact Hours	39
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	None
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

This course aims to provide students with a comprehensive understanding of plant–microbe interactions across pathogenic and beneficial systems. Students will examine how fungi, bacteria, oomycetes, viruses, and symbiotic microbes colonize plant tissues; how microbial virulence factors and effectors manipulate host biology; and how plants mount local and systemic immune responses. The course will integrate classical molecular genetics with current concepts in cell biology, bioinformatics, and AI-based methods. Students will also develop scientific skills in literature analysis, data interpretation, and experimental design.

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	Explain the major lifestyles and colonization strategies of plant-associated microbes, including pathogens and beneficial symbionts.
ILO 2	Compare the infection strategies of fungal, bacterial, oomycete, and viral plant pathogens.
ILO 3	Explain how microbial virulence factors, including effectors, toxins, enzymes, and secretion systems, manipulate plant biology.
ILO 4	Describe the major layers of plant immunity, including PTI, ETI, hormone signalling, and systemic acquired resistance.

Course Content

This course explores the molecular, cellular, and spatial basis of plant–microbe interactions, including:

1. **Introduction**
2. **Fungal infection biology**
    - Spores, germination, appressorium formation, penetration, invasive growth
    - Biotrophic, hemibiotrophic, and necrotrophic lifestyles
    - Cell wall-degrading enzymes and host entry strategies
3. **Bacterial pathogenesis**
    - Type III secretion systems and bacterial effectors
    - quorum sensing, toxins, and stomatal entry
4. **Effectors and virulence mechanisms**
    - Effector delivery and host targets
    - Suppression of immunity
    - Effector-triggered susceptibility versus effector-triggered immunity
5. **Plant immune systems**
    - Key molecules act as defense genes
    - plant immune respones
6. **Systemic and spatial immunity**
    - SAR and long-distance signalling
7. **Beneficial interactions and microbiome**
    - How plants accommodate beneficial microbes while restricting pathogens
    - Microbiome assembly and disease suppression
8. **Methods in plant–microbe interaction research**
    - Microscopy and infection assays
    - ROS and callose assays
    - Mutants, transgenics, and effector assays
    - RNA-seq, single-cell, spatial omics, comparative genomics
9. **Applications in agriculture**
    - Disease resistance breeding
    - Effector-informed resistance
    - Durable resistance and sustainable crop protection

Reading and References (if applicable)

The reading and references listed below comprise foundational resources obtained from authoritative websites and online repositories. Where publication dates are not available, the references are cited as “n.d.”. These references are intended primarily as foundational readings to provide core concepts and background knowledge for the subject area.

https://pubmed.ncbi.nlm.nih.gov/19219052/

https://www.imrpress.com/journal/FBL/30/1/10.31083/FBL23223

https://pubmed.ncbi.nlm.nih.gov/38857544/

https://academic.oup.com/plcell/article/34/5/1447/6529015

https://pubmed.ncbi.nlm.nih.gov/38670067/

https://nph.onlinelibrary.wiley.com/doi/10.1111/nph.16953

https://www.cell.com/cell-host-microbe/fulltext/S1931-3128(23)00344-X

https://www.nature.com/articles/s41586-024-08383-z

https://academic.oup.com/plcell/article/37/9/koaf214/8248601

https://www.pnas.org/doi/full/10.1073/pnas.2104997118

Planned Schedule

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
1	Introduction to plant–microbe interactions	1	In-person	Lecture + tutorial	
2	Bacterial plant pathogens and colonization strategies	1，2	In-person	Lecture + tutorial	
3	fungal plant pathogens and infection structures	1，2	In-person	Lecture + tutorial	
4	Effectors, secretion systems, and virulence mechanisms	1,2,3	In-person	Lecture + tutorial	
5	Plant immune perception: early signalling	4	In-person	Lecture + tutorial	
6	Effector-triggered Immunity	4	In-person	Lecture + tutorial	
7	Systemic acquired resistance and long-distance signalling	4	In-person	Lecture + tutorial	
8	immune amplification, growth–defence trade-offs	4	In-person	Lecture + tutorial	
9	Beneficial microbes, symbiosis, and microbiome interactions	3,4	In-person	Lecture + tutorial	
10	Methods in plant–microbe interaction research	1,2,3,4	In-person	Lecture + tutorial	

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
11	Wet lab: live-cell imaging to investigate fungal infection	1,2,3,4	In-person	tutorial	
12	Climate change and future crops	1,2,3,4	In-person	Lecture + tutorial	
13	summary	1,2,3,4	In-person	Lecture + tutorial	

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	The lectures are a critical vehicle to communicate the core principles of plant–microbe interactions, including microbial infection strategies, effector biology, and plant immune responses. They provide the intellectual framework for understanding how fungi, bacteria, and other microbes interact with plants across molecular, cellular, and organismal scales. Lectures will integrate classical concepts with recent advances in plant immunity, microbiome research, and spatial organization of defence. This component primarily supports Intended Learning Outcomes ILO1, ILO3, and ILO4.
Tutorials	Tutorials are designed to present authentic scientific problems related to plant–microbe interactions and current research in the field. Students will work in groups to: propose hypotheses and experimental approaches interpret experimental data (e.g. infection assays, ROS assays, transcriptomics) critically evaluate primary literature (e.g. effector studies, host–pathogen interactions) Tutorials emphasize discussion and problem-solving, enabling students to connect theoretical knowledge with experimental evidence. All learning outcomes are addressed in this context, with particular emphasis on ILO2 and ILO4.
Laboratories	The laboratory sessions will provide hands-on experience with experimental approaches used in plant–microbe interaction research, including: Observation and quantification of plant defence responses (e.g. ROS burst assays or pathogen infection assays) Analysis of plant–pathogen interactions using microscopy or phenotypic assays Data analysis workshop using transcriptomic or pathogen-related datasets These activities will allow students to link molecular mechanisms with observable biological outcomes and reinforce experimental design and data interpretation skills.

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): Assignment()	1,2,3,4		5		Individual and Team	Holistic	Multistructural
2	Summative Assessment (EXAM): Final exam()	1,2,3,4		55		Individual	Analytic	Multistructural
3	Continuous Assessment (CA): Presentation()	1,2,3,4		40		Team	Holistic	Multistructural

Description of Assessment Components (if applicable)

Formative Feedback

1.Following the mid-term quiz and questions, the poorly answered points will be identified and discussed. this will be helpful to understand the Learning outcomes.
2.The tutorial format involves groups of about six students working together on field-related questions. these questions, and the students

NTU Graduate Attributes/Competency Mapping

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

Attributes/Competency	Level
Care for Environment	Advanced
Creative Thinking	Intermediate
Curiosity	Intermediate
Information Literacy	Intermediate

Course Policy

Policy (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. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

You are expected to complete all assigned readings, activities, assignments, attend all classes punctually and complete all scheduled assignments by due dates. You are expected to take responsibility to follow up with assignments and course related announcements. You are expected to participate in all project critiques, class discussions and activities.

Policy (Absenteeism)

In-class activities make up a significant portion of your course grade. Absence from class without a valid reason will affect your participation 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 no make-up opportunities for in-class activities.

Policy (Others, if applicable)

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:

If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
If you feel like your performance in the class is being impacted by your experiences outside of class;
If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;
Please speak to your teaching team, our school pastoral officer or a peer or senior (either in-person or via email)

about how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or a faculty member.

Technical Skills To Be Developed

All skills to be developed for this course:

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Last Updated By: Lim Yin Chean