

MICROBIOLOGY 408
Microbial Pathogenesis
Course Outline: Spring 2023

Classroom: Engineering Computer Science Bldg 116

Time: Monday and Thursday (8:30am – 9:50am)

Textbook: There is no text book for this course

Course Coordinator / Instructor: Dr. Aditya Mojumdar (he/him), Petch 270

Office hours: By appointment

email: amojumdar@uvic.ca

We acknowledge and respect the lək'wəŋən peoples on whose traditional territory the university stands and the Songhees, Esquimalt and W̱SÁNEĆ peoples whose historical relationships with the land continue to this day.

The classroom will be a place where everyone will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expression, national origins, religious affiliations, sexual orientations, ability-and other visible and non-visible differences. All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment for every other member of the class.

Software and communication platforms: The primary website for the course will be on Brightspace. Lectures will be available on Brightspace. Groups will meet with me in class to work on group projects during scheduled times. Any online communication outside of Brightspace will utilize Zoom, with details to accessing this platform to be available within the Brightspace site. Additional notifications will be made through Brightspace as necessary.

First Scheduled Lecture of course: This will be in Engineering Computer Science Bldg 116, and at that time we will discuss the structure of the class.

Course Organization and Marking:

The course is organized as a hybrid of traditional and 'flipped' lesson. Some of the concepts will be included in the traditional lecture/seminar given by me and other concepts will be presented by the student groups. The lecture/seminar topics are listed below and are divided into sections.

You will be divided into groups and each group will present twice during the course as specified in the class schedule. The two presentations include –

1. A seminar topic (25 min for each group presentation).
2. A journal club, present in detail a research article (20 min for each group presentation).

The seminar topics and research articles will be assigned to you. The presenter is indicated in front of the lecture topics, for eg. (AM) means I will present those topics and (G1-G10) means those topics will be presented by Groups 1 to 10; and same stands for the research articles (**see below the article list**).

Everyone is required to read all the research articles as it will enable a discussion of the paper following the respective presentation.

The PowerPoint slides need to be submitted on Brightspace by the respective **due date** (see the due dates).

All lectures are available as **PDFs only (No recordings)** at the MICR 408 Brightspace site. You are expected to view the PDF lectures on your own.

See course calendar for your group’s formal meeting dates. I will attend all the formal meeting dates and note students’ attendance and participation. **Attendance and Participation in class is mandatory and contributes to your group presentation mark.**

Your group might want to meet outside of these times, as possible for your collective schedules. You can meet up in person or you may set up your own online conferencing sessions for these meetings that I will not attend.

Due dates and weighted values of exams, assignments and presentations –

Assessment type	Weight
Group Presentation 1 – Seminar Topic	30%
In-class Assessment 1	20%
In-class Assessment 1	20%
Group Presentation 2 – Research article	30%

Assessment type	Due date
In-class Assessment 1	Monday, February 06, 2023

In-class Assessment 2	Thursday, March 09, 2023
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PPT slides submission of Group Presentation 1 (Seminar Topic)	All groups - 9.00pm Wednesday, January 25, 2023
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PPT slides submission of Group Presentation 2 (Research article)	All groups - 9.00pm Wednesday, March 15, 2023
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Completion of all components (in-class assessments, group presentations and final assignment) are required to complete the course and receive a passing grade.

Class #	Date	Topic	Presenter
1	Jan 09 (Mon)	Introduction to course	A.M.
2	Jan 12 (Thurs)	Topic I - Introduction	A.M.
3	Jan 16 (Mon)	Groups 1 to 3 meeting	
4	Jan 19 (Thurs)	Groups 4 to 6 meeting	
5	Jan 23 (Mon)	Groups 7 to 10 meeting	
6	Jan 26 (Thurs)	Topic II – Host pathogen interactions	AM. And Group 1
7	Jan 30 (Mon)	Topic II – Host pathogen interactions	Group 2 and 3
8	Feb 02 (Thurs)	Topic II – Host pathogen interactions	Group 4 and 5
9	Feb 06 (Mon)	In-class Assessment 1	
10	Feb 09 (Thurs)	Topic III – Microbiome	Group 6
11	Feb 13 (Mon)	Topic IV – Mechanisms of bacterial pathogenesis	Group 7 and 8
12	Feb 16 (Thurs)	Topic IV and V – Infectious disease treatment strategies	Group 9 and 10

	Feb 20 (Mon)	Family Day	
	Feb 23 (Thurs)	Reading Break	
13	Feb 27 (Mon)	Groups 1 to 3 meeting	
14	Mar 02 (Thurs)	Groups 4 to 6 meeting	
15	Mar 06 (Mon)	Groups 7 to 10 meeting	
16	Mar 09 (Thurs)	In-class Assessment 2	
17	Mar 13 (Mon)	In-formal Group meeting day – No class	
18	Mar 16 (Thurs)	Group presentation 2	Groups 10 and 9
19	Mar 20 (Mon)	In-formal Group meeting day – No class	
20	Mar 23 (Thurs)	In-formal Group meeting day – No class	
21	Mar 27 (Mon)	Group presentation 2	Groups 8 and 7
22	Mar 30 (Thurs)	Group presentation 2	Groups 6 and 5
23	Apr 03 (Mon)	Group presentation 2	Groups 4 and 3
24	Apr 06 (Thurs)	Group presentation 2	Groups 2 and 1

Lecture topics –

Topic I – Introduction (AM)

- A. History and Impact of infectious diseases
 - Definitions and Examples of infectious diseases
 - Effect on communities
 - Global burden of infectious diseases
 - Antimicrobial resistance
- B. Introduction to Microbial pathogenesis
 - Emerging and Re-emerging diseases
 - Two main pathogenic strategies
 - Frontal assault – Acute
 - Stealth assault – Chronic

Topic II - Host-pathogen interactions

- A. Host defense mechanisms and Bacterial evasion strategies
 - General overview of immune system (AM)
 - Lines of defense against infection
 - Non-specific defense
 - Innate immunity
 - Adaptive immunity
 - Complement cascade and bacterial evasion (G1)
 - Complement cascade activation pathways – Classical, Lectin and Alternative
 - Mimic host complement membrane regulators, eg. *Borrelia burgdorferi*
 - Secrete Proteases, eg. *Pseudomonas aeruginosa*
 - Secrete evasion molecules, eg. *Staphylococcus aureus*
 - Binding host complement regulatory proteins, eg. *Streptococcus pneumoniae*
 - Phagocytosis, Opsonization and bacterial evasion (G2)
 - Phagocytosis
 - Autophagy
 - Xenophagy

Opsonization

Examples of bacterial evasion strategies

Listeria monocytogenes

Mycobacterium tuberculosis

Staphylococcus aureus

PAMPs, PRR's and bacterial evasion **(G3)**

PAMPs: Pathogen-Associated Molecular Patterns

DAMPs: Damage-Associated molecular Patterns

PRRs: Pattern Recognition Receptors

Soluble PRR

Membrane bound PRR

TLR: Toll-like receptors: signalling pathways

B. Microbial colonization and adherence strategies **(G4)**

Microbial content within host

Surfaces for adhesion – Teeth, Skin, Mucosae (small intestine)

Steps in colonization

Non-specific interaction

Initial anchoring

Tight adhesion

Bacterial adherence components

Capsule, S-layers, Pili, Flagella, Adhesins – Features, Classes, Mechanisms

C. Microbial invasion strategies **(G5)**

Classification of invasive pathogens – Obligate intracellular, Facultative intracellular, Extracellular bacteria

Overview of Host tissue organization

Cell junctions – Occluding/Tight junctions and Anchoring junctions

Function, Composition and types

Invasive intracellular pathogen mechanisms – Zipper and Trigger mechanisms eg. *Yersenia sp*, *Listeria sp*

Invasive extracellular pathogen mechanisms

Disruption of Tight junctions and Paracytosis

Exploitation of Adherens junctions and Transcytosis

Topic III – Microbiome (G6)

A. Introduction to Microbiome

Diversity

Function

B. Protection from pathogens – mechanisms

Competition for nutrients

Production of short-chain fatty acids

Bacteriocins

C. Microbiome and Immune response

D. Pathogen Strategies to Overcome Commensal-mediated Resistance

Exploitation of the gut microbiome

Express adhesins for attachment to epithelial cells

Metabolize unique nutrients

Pathogen-induced gut inflammation

Utilization of different siderophores for iron uptake

Topic IV – Mechanisms of bacterial pathogenesis

A. Bacterial secretion systems – Overview, Components and Mechanisms (G7)

Sec Pathway – SecB and SRP pathway

Tat Pathway

Secretion system types in Gram negative bacteria

Type I Secretion System T1SS eg. *E. coli* for haemolysin (Hly) toxin

Type II Secretion System T2SS eg. *V. cholerae* Cholera toxin

Type III Secretion System T3SS eg. *Yersinia sp.*

Type VI Secretion System T6SS

Secretion system types in Gram positive bacteria

Sec and Tat Pathway

Type VII Secretion System T7SS

B. Toxins – Overview, Types and Mechanisms (G8)

Endotoxins

Exotoxins – Types I, II and III – General features, Mechanism of action, Regulation and examples

C. Biofilms (G9)

Overview,

Functions,

Formation and Composition

Stages – Reversible adhesion, Semi-irreversible attachment to irreversible, Maturation, Dispersal

Extracellular Polymeric Substances (EPS) – Overview, Composition and Functions

Regulation

c-di-GMP – Overview

Quorum Sensing – Overview, Types – LuxI/LuxR, Oligopeptide-two-component, LuxS-encoded Autoinducer 2 (AI-2)

Topic V – Infectious disease treatment strategies (G10)

A. Antibiotics – Classes and Mechanism of action

β -lactams – Penicillin, Cephalosporins, Carbapenems,

B. Resistance – Acquisition, Mechanisms

C. Other treatments – AMPs (anti-microbial peptides) and Bacteriocins

Research Articles to be presented by students as Journal Club –

G10

Walter, L., Sürth, V., Röttgerding, F., Zipfel, P. F., Fritz-Wolf, K., & Kraiczy, P. (2019). Elucidating the Immune Evasion Mechanisms of *Borrelia mayonii*, the Causative Agent of Lyme Disease. *Frontiers in immunology*, 10, 2722. <https://doi.org/10.3389/fimmu.2019.02722>

G9

Brannon, J. R., Dunigan, T. L., Beebout, C. J., Ross, T., Wiebe, M. A., Reynolds, W. S., & Hadjifrangiskou, M. (2020). Invasion of vaginal epithelial cells by uropathogenic *Escherichia coli*. *Nature communications*, 11(1), 2803. <https://doi.org/10.1038/s41467-020-16627-5>

G8

Hart, T., Nguyen, N. T. T., Nowak, N. A., Zhang, F., Linhardt, R. J., Diuk-Wasser, M., Ram, S., Kraiczy, P., & Lin, Y. P. (2018). Polymorphic factor H-binding activity of CspA protects *Lyme borreliae* from the host complement in

feeding ticks to facilitate tick-to-host transmission. PLoS pathogens, 14(5), e1007106.

<https://doi.org/10.1371/journal.ppat.1007106>

G7

Horstmann, J. A., Lunelli, M., Cazzola, H., Heidemann, J., Kühne, C., Steffen, P., Szefs, S., Rossi, C., Lokareddy, R. K., Wang, C., Lemaire, L., Hughes, K. T., Uetrecht, C., Schlüter, H., Grassl, G. A., Stradal, T. E. B., Rossez, Y., Kolbe, M., & Erhardt, M. (2020). Methylation of Salmonella Typhimurium flagella promotes bacterial adhesion and host cell invasion. Nature communications, 11(1), 2013. <https://doi.org/10.1038/s41467-020-15738-3>

G6

Sikorski, P. M., Commodaro, A. G., & Grigg, M. E. (2020). Toxoplasma gondii Recruits Factor H and C4b-Binding Protein to Mediate Resistance to Serum Killing and Promote Parasite Persistence in vivo. Frontiers in immunology, 10, 3105. <https://doi.org/10.3389/fimmu.2019.03105>

G5

Korpela, K., Helve, O., Kolho, K. L., Saisto, T., Skogberg, K., Dikareva, E., Stefanovic, V., Salonen, A., Andersson, S., & de Vos, W. M. (2020). Maternal Fecal Microbiota Transplantation in Cesarean-Born Infants Rapidly Restores Normal Gut Microbial Development: A Proof-of-Concept Study. Cell, 183(2), 324–334.e5.

<https://doi.org/10.1016/j.cell.2020.08.047>

G4

Sequeira, R. P., McDonald, J. A. K., Marchesi, J. R., & Clarke, T. B. (2020). Commensal Bacteroidetes protect against Klebsiella pneumoniae colonization and transmission through IL-36 signalling. Nature microbiology, 5(2), 304–313. <https://doi.org/10.1038/s41564-019-0640-1>

G3

Striednig, B., Lanner, U., Niggli, S., Katic, A., Vormittag, S., Brülisauer, S., Hochstrasser, R., Kaech, A., Welin, A., Flieger, A., Ziegler, U., Schmidt, A., Hilbi, H., & Personnic, N. (2021). Quorum sensing governs a transmissible Legionella subpopulation at the pathogen vacuole periphery. EMBO reports, 22(9), e52972.

<https://doi.org/10.15252/embr.202152972>

G2

Peschek, N., Herzog, R., Singh, P. K., Sprenger, M., Meyer, F., Fröhlich, K. S., Schröger, L., Bramkamp, M., Drescher, K., & Papenfort, K. (2020). RNA-mediated control of cell shape modulates antibiotic resistance in Vibrio cholerae. Nature communications, 11(1), 6067. <https://doi.org/10.1038/s41467-020-19890-8>

G1

Jiang, M., Wang, Z., Xia, F., Wen, Z., Chen, R., Zhu, D., Wang, M., Zhuge, X., & Dai, J. (2022). Reductions in bacterial viability stimulate the production of Extra-intestinal Pathogenic Escherichia coli (ExPEC) cytoplasm-carrying Extracellular Vesicles (EVs). PLoS pathogens, 18(10), e1010908.

<https://doi.org/10.1371/journal.ppat.1010908>

UVic Grading Scheme

A+	90 - 100	B+	77 - 79	C+	65 - 69	F	< 50
A	85 - 89	B	73 - 76	C	60 - 64	N **	< 50
A-	80 - 84	B-	70 - 72	D	50 - 59		

** N grades

Students who have completed the following components will be considered to have completed the course and will be assigned a final grade: **In-class Assessments and Group Presentations.**

Everything counts towards the marks/grades : **Attendance, Participation, Submission of PPTs on time, In-class Assessments, Group Presentations.**

Failure to complete one or more of these elements will result in a grade of "N" regardless of the cumulative percentage on other elements of the course. An N is a failing grade, and it factors into a student's GPA as 0. The maximum percentage that can accompany an N on a student's transcript is 49.

DEPARTMENT INFORMATION AND POLICIES

1. The Department of Biochemistry and Microbiology upholds and enforces the University's policies on academic integrity. These policies are described in the current University Calendar. All students are advised to read this section.
2. Cell phones, computers, and other electronic devices must be turned off at all times during live class sessions unless being used for the purpose of connecting and engaging with the class.
3. No recordings of live lectures are permitted without permission of the instructor. However, many courses will be recorded by the instructor for accessibility for students unable to attend. If you do not wish to be recorded, contact your instructor to determine if alternative arrangements can be made. Attendance and engagement in the classroom is an integral part of the learning process and cannot be substituted with recordings. It is at the instructor's sole discretion whether they provide a recording or give permission to students to record a lecture. There is no obligation to do so nor is there any expectations about the quality of the recordings. Nor should students assume a lecture will be recorded as instructors may withdraw access to recordings or permission to record. It is the responsibility of students who miss lectures to catch up in the material through extra readings, and obtaining notes from fellow students. Students who miss several lectures due to illness should contact their instructors to discuss options.
4. Students and instructors are expected to assess their health daily and avoid campus if they are ill.
5. Course materials, such as notes, problem sheets, quizzes, examinations, example sheets, or review sheets, may not be redistributed without the explicit written permission of the instructor.
6. Students are expected to be available for all exams. Instructors may grant deferrals for midterm examinations for illness, accident, or family affliction. Although students do not require documentation, students must contact their instructor and BCMB office (biocmicr@uvic.ca) with the reason for their absence within 48 hours after the midterm exam. The Department will keep a record of the absences. It is the responsibility of the student to ensure all required components are complete, and to arrange deferred exams/assignments with the instructor, which normally should occur within one week of the original exam date.
7. The Department of Biochemistry and Microbiology considers it a breach of academic integrity for a student taking a deferred examination to discuss the exam with classmates. Similarly, students who reveal the contents of an examination to students taking an examination are considered to be in violation of the University of Victoria policy on academic integrity (see current University Calendar). Students must abide by UVic academic regulations and observe standards of scholarly integrity (no plagiarism or cheating). Online exams must be taken individually and not with a friend, classmate, or group, nor can you access notes, course materials, the internet,

or other resources without the permission of the instructor. You are prohibited from sharing any information about the exam with others. Use of unauthorized electronic devices and accessing the internet and class material during exams is prohibited unless permission is granted by the instructor. Instructors may use Browser Lockdown Software to block access during classes and exams.

8. **Deferral of a final exam** must be requested with an Academic Concession form and submitted directly to Undergraduate Records. Deferred final exams for fall term courses will be arranged by the instructor. Deferred final exams or spring term courses will be arranged through Undergraduate Records and must be written before the end of the summer term as stipulated in the University Calendar.

9. Requests for review/remark of a midterm exam must be made within one week of the exam being returned.

10. The instructor reserves the right to use plagiarism detection software or other platforms to assess the integrity of student work.

11. Supplemental exams or assignments will not be offered to students wishing to upgrade their final mark.

12. Anonymous participation in online classes is not permitted without permission of the instructor.

Important note about COVID-related stress

The current pandemic is placing added stressors- financial, mental, and physical- on everyone. Your wellbeing is of foremost importance. If you are experiencing difficulties coping, the University has resources to help. Please reach out to Counselling Services, the Centre for Academic Communication, or Learning Assistance Program for assistance.

Centre for Accessible Learning

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, approach the Centre for Accessible Learning (CAL) as soon as possible in order to assess your specific needs. <https://www.uvic.ca/services/cal/index.php>

Course Experience Survey (CES)

We value your feedback on this course. Towards the end of term you will have the opportunity to complete a confidential course experience survey (CES) regarding your learning experience. The survey is vital to providing feedback to us regarding the course and our teaching, as well as to help the department improve the overall program for students in the future. When it is time for you to complete the survey, you will receive an email inviting you to do so. If you do not receive an email invitation, you can go directly to your [CES dashboard](#). You will need to use your UVic NetLink ID to access the survey, which can be done on your laptop, tablet or mobile device. We will remind you nearer the time but please be thinking about this important activity.

Code of Conduct

Information about student code of conduct can be found here. <https://www.uvic.ca/services/advising/advice-support/academic-units/student-code-of-conduct/index.php>

BMSS blog

Current announcements, events and award information can be found here. <https://onlineacademiccommunity.uvic.ca/bmss/>