E&EB175L, Spring 2018: Virus Discovery and Evolution

(Formatted for an interactive syllabus the Canvas Learning Management System)

Instructor: Dr. Alita Burmeister, Ph.D. | **Office hours:** Fridays 10-11 am in SCL 146; by appointment in Osborne Memorial Labs Room 220; by appointment on Zoom; rotating residential dining hall lunches 11:30-12:30 throughout the semester | **Email:** alita.burmeister@yale.edu | **Twitter:** @AlitaBurmeister, #VirusDiscovery2018

Teaching Fellow: Mike Blazanin | **Office hours:** Tuesdays 4-5 pm in SCL 146; by appointment via email in SCL 146 (when the room is available) or OML 226 | **Email:** mike.blazanin@yale.edu

Course Location and Time: E&EB175L meets Thursdays 1:10-5:00 pm in SCL 146.

Course Overview: This research-based lab course will provide you with an introduction to empirical research in microbiology. I will use a hybrid approach involving lab exercises and mentored research. A general goal of this course is for you to decide whether you want to continue with undergraduate research in a research lab on campus.

The course is roughly organized into a progression of three parts:

- Part 1: "Basics" Learning Objectives focus on technician-level skills essential to working in a research laboratory.
- Part 2: "Inquiry" Learning Objectives focus on scientist-level skills essential to conducting scientific research.
- Part 3: "Professional Development" Learning Objectives focus on communicating as part of a scientific community.

Learning Objectives: Your learning objectives and assessments will focus on the activities scientists do everyday, from keeping a professional lab notebook to designing experimental controls and presenting research. You will practice these skills with independent projects to discover and characterize novel bacteriophage, which are viruses that infect bacteria. The LOs follow the general organization of the course and focus on what you should be able to do by the end of the semester:

Laboratory Basics

Basics LO-1: Demonstrate proper sterile technique without consulting a reference.

Basics LO-2: Demonstrate basic microbiological lab safety.

Basics LO-3: Keep a functional lab notebook in accordance with the responsible conduct of research, scientific reproducibility, and intellectual property.

Basics LO-4: Employ "Basics" LOs 1-3 to isolate, grow, and characterize a new virus from the environment.

Scientific inquiry and reasoning

Inquiry LO-1: Apply quantities and units that are essential to virus discovery and research.

Inquiry LO-2: Make scientific predictions about your experiments using your current knowledge.

Inquiry LO-3: Generate hypotheses and **design** experiments, including the design of appropriate controls.

Inquiry LO-4: Conduct a scientific experiment to test a prediction, including data collection and analysis.

Inquiry LO-5: Apply hypothesis generation and experimental design in an evolutionary context.

Inquiry LO-6: Apply knowledge about the diversity of the viral world in terms of nucleic acid content and replication style.

Professional development and scientific communication

Pro LO-1: Use evidence to make a scientific argument.

Pro LO-2: Present, defend, and modify knowledge as part of a scientific community.

Pro LO-3: Evaluate peer's scientific experiments, recognizing excellence and contributing constructive feedback on how to strengthen ongoing studies.

Schedule: We will meet in person once per week for four hours (Thursdays 1:10-5:00pm, SCL 146). Out of class work will vary by the week, but I will typically aim for that to take 45-60 minutes of videos, short readings, quizzes, sample collection, and final project preparation.

Participation: Positive, activive participation is essential for this course and makes up a large percentage of the grade, and familiarity with my <u>participation rubric</u> will help you do well.

Grading: Grading on the activities involved in conducting research, with frequent homework designed to develop scientific research experience and to provide early feedback on your projects. Grades will be based on <u>active participation in E&EB175L</u> (~30%), homework (~30%), and a cumulative final project (~23%), and miscellaneous other lab essentials. Many of the assignments serve as rough-drafts for components of your final project, so focusing attention on participation and homework will directly help your final project grade as well.

- Weekly homework sets (10 points each): 130 points, 30%
- Quizzes (10 points each): 30 points, 7%
- Lab Notebook Checks (10 points each): 40 points, 9%
- Participation (10 points per week): 130 points, 30%
- Final Project (rubric provided during the semester): 100 points, 23%
- Office hour visits: 1 point, .2%

Academic and research Integrity: As in all courses, we'll hold a rigorous standard for academic honesty. This course in particular has the potential to generate new scientific knowledge, including publishable material and intellectual property, and we'll discuss these aspects of research throughout the semester. Homework assignments will include a mix of individual work and work for which group collaboration is allowed, to be announced per assignment. All protocols, handouts, and presentations will include unpublished data and methods from ongoing research, so sharing them outside of class (on websites, by email, other file sharing methods, to peers, etc.) is strictly not allowed without preapproval from Dr. Burmeister.

Syllabus flexibility: The general activities planned throughout the semester will remain the same, although expect the order and timing of some of the activities to vary. This is a typical amount of flexibility involved in any original research project -- unexpected results, mistakes, etc. cause setbacks for all scientists, so flexibility is key to learning new things about the world.

Week		Learning objectives	Activities	Points
WEEK 1	Jan. 18	 Basics LO-3: Keep a functional lab notebook in accordance with the responsible conduct of research, scientific reproducibility, and intellectual property. Inquiry LO-1: Apply quantities and units that are essential to virus discovery and research. Inquiry LO-2: Make scientific predictions about your experiments using your current knowledge. Inquiry LO-3: Generate hypotheses and design experiments, including the design of appropriate controls. 	Introductions and Semester Overview <u>Pre-course Survey</u> Laboratory Basics: • Lab tour, safety overview • Notebook tutorial and practice Week 1 Lab: Working with the Invisible • Work with viruses: Cross-streak setup	Participation: 10 <u>Syllabus quiz: 10</u> <u>HW-1: 10</u>
Week 1 out of class work	Jan 18- 22	These out-of-class activities will get you thinking about what you'll be doing this semester, and they will get everyone up to speed on the basics of virus study. The activities provide foundational knowledge for: Inquiry LO-3: Generate hypotheses and design experiments, including the design of appropriate controls. Inquiry LO-6: Apply knowledge about the diversity of the viral world in terms of nucleic acid content and replication style.	HW-1: Notes on Virus video at the Khan Academy	If not finished in class: <u>HW-1: 10</u> <u>Syllabus Quiz: 10</u> Read protocol for Week 2

WEEK 2	Jan. 25	Inquiry LO-1: Apply quantities and units that are essential to virus discovery and research.	Results: Week 1 phage cross-streaks Discussion: HW-1, lab notebooks, fire safety, and sterile technique New technique: Spot plating	Participation: 10
Week 2 out of class work	Jan. 25- 30	 Inquiry LO-2: Make scientific predictions about your experiments using your current knowledge. Inquiry LO-4: Conduct a scientific experiment to test a prediction, including data collection and analysis. Pro LO-1: Use evidence to make a scientific argument. Inquiry LO-3: Generate hypotheses and design experiments, including the design of appropriate controls. 	Collect environmental samples HW-2: Article on phage therapy and evolution Read Week 3 'Quick Protocols'	HW 2: 10 Read protocol for Week 3
WEEK 3	Feb. 1	 Inquiry LO-4: Conduct a scientific experiment to test a prediction, including data collection and analysis. Basics LO-3: Keep a functional lab notebook in accordance with the responsible conduct of research, scientific reproducibility, and intellectual property. Basics LO-5: Employ "Basics" LOs 1-4 to isolate, grow, and characterize a new virus from the environment. 	Results: Week 2 spot tests *** Continue Week 2 Spot Tests Environmental sample preparation *** Begin Lab Practical Quiz	Participation: 10 Practical quiz: 10 (can redo, must score 10 to pass class). Part 1: Pipetting. Part 2: Sterile technique.
Week 3 out of class work	Feb. 1-6	Inquiry LO-3: Generate hypotheses and design experiments, including the design of appropriate controls.	HW-3: Evolution and Nucleic Acid Replication Video Notes Read protocol for Week 4	HW-3: 10

WEEK 4	Feb. 8	Inquiry LO-1: Apply quantities and units that are essential to virus discovery and research. Basics LO-4 : Employ "Basics" LOs 1-3 to isolate, grow, and characterize a new virus from the environment.	Results: EOP Worksheet #1: Report cross-streak and spot test results Worksheet #2: Phage quantities *** Learn soft agar overlay method and use it to plate for environmental phages *** In class Lab Notebook Check-in Continue Lab Practical Quizzes	Participation: 10 Notebook check-in #1:10
Week 4 out of class work	Feb 8-13	Inquiry LO-1: Apply quantities and units that are essential to virus discovery and research.	HW-4: TBD (likely phage quantification or evolution-related) Read protocol for Week 5	HW-4: 10
WEEK 5	Feb. 15	Inquiry LO-1: Apply quantities and units that are essential to virus discovery and research. Basics LO-5 : Employ "Basics" LOs 1-4 to isolate, grow, and characterize a new virus from the environment.	Results: Evironmental phage *** Discussions: Experimental evolution and course project ideas *** New method: Picking isolated plaques New approach: Combining the phage serial dilution method with the soft agar overlay method.	Participation: 10
Week 5 out of class work	Feb 15- 20	Inquiry LO-5: Apply hypothesis generation and experimental design in an evolutionary context.	HW-5: Project Ideas Read protocol for Week 6	HW-5: 10

WEEK 6	Feb. 22	 Inquiry LO-1: Apply quantities and units that are essential to virus discovery and research. Inquiry LO-5: Apply hypothesis generation and experimental design in an evolutionary context. Inquiry LO-3: Generate hypotheses and design experiments, including the design of appropriate controls. Basics LO-3: Keep a functional lab notebook in accordance with the responsible conduct of research, scientific reproducibility, and intellectual property. 	Results: Serial dilution soft agar overlays *** Phage harvesting and enumeration *** Lab notebook check-in	Participation: 10 Lab notebook check-in #2: 10
Week 6 out of class work	Feb. 22- 27	Beginning this week, homeowork focuses on the development of your final, independent project. Coming up with three project ideas will especially focus on these three Inquiry LOs: Inquiry LO-5: Apply hypothesis generation and experimental design in an evolutionary context. Inquiry LO-2: Make scientific predictions about your experiments using your current knowledge. Inquiry LO-3: Generate hypotheses and design experiments, including the design of appropriate controls.	HW-6: Refined project ideas Read protocol for Week 7	HW-6: 10
WEEK 7 Week 7 out	Mar. 1	 Inquiry LO-2: Make scientific predictions about your experiments using your current knowledge. Inquiry LO-3: Generate hypotheses and design experiments, including the design of appropriate controls. Inquiry LO-4: Conduct a scientific experiment to test a prediction, including data collection and analysis. Inquiry LO-5: Apply hypothesis generation and experimental design in an evolutionary context. 	Results: Phage enumeration *** Host range experiment: Spot tests on various omp knockouts of the Keio collection (tentative, depends on success of phage growth)	Participation: 10
Week 7 out of class work	Mar. 1 - 6	This week's homeowork continues from last week, improving upon your project	HW-7: Revised project ideas	HW-7: 10

		ideas with feedback us and your classmates:		
		Inquiry LO-2: Make scientific predictions about your experiments using your current knowledge.		
		Inquiry LO-3: Generate hypotheses and design experiments, including the design of appropriate controls.		
		Inquiry LO-5: Apply hypothesis generation and experimental design in an evolutionary context.		
		Pro LO-1: Use evidence to make a scientific argument.		
	Mar. 9	Pro LO-2: Present, defend, and modify knowledge as part of a scientific	Results: Host range	Destisionations 10
WEER 8	Mar. 8	community.	Project planning	Participation: 10
		Inquiry LO-6: Apply knowledge about the diversity of the viral world in terms of nucleic acid content and replication style.	ojoot p	
Week 8 out of class work	Mar. 8- 13	For this week's out-of-class work, you will submit your final project proposal.	HW-8: Selection of final project; final project protocols and materials list due	HW-8:10
WEEK 9	Mar. 15		break	
Week 9 out of class work				
WEEK 10	Mar. 22		break	
Week 10 out of class work				
WEEK 11	Mar. 29	This is the first week of labwork for your independent project, which will constitute most of your grade. Your project will involve every course learning objective. Your project will give you a chance to continue practicing each LO and to master those you haven't yet.	Independent project lab work Day 1	Pre-class work: 10 Participation: 10

		Basics LO-1, LO-2, LO-3, LO-4		
		<u>Inquiry</u>		
		<u>LO-1, LO-2, LO-3, LO-4, LO-5, LO-6</u>		
		<u>Pro LO-1, LO-2, LO-3</u>		
Week 11 out of class work	Mar. 29 Apr. 3	This week's homeowork focuses on writing up the Background for your final project, most relevant to linking your current knowledge to your project, so this activity will especially bolster Inquiry LO-2: Make scientific predictions about your experiments using your current knowledge.	HW-9: Background section for your final project	HW-9: 10
WEEK 12	Apr. 5	This is the second week of your independent project and is a good time to review how your well you are doing for the courses learning objectives. Is there anything you/your project needs to focus more on? Basics LO-1, LO-2, LO-3, LO-4 Inquiry LO-1, LO-2, LO-3, LO-4, LO-5, LO-6 Pro LO-1, LO-2, LO-3	Independent project lab work Day 2 *** Lab notebook checks	Participation: 10 Lab notebook checks #3: 10
Week 12 out of class work	Apr. 5- 10	This week's homework focuses on articulating your final project's expected results, so this activity is most relevant to LOs: Inquiry LO-2: Make scientific predictions about your experiments using your current knowledge. Inquiry LO-3: Generate hypotheses and design experiments, including the design of appropriate controls.	HW-10: Expected results section for your final project	HW-10: 10
WEEK 13	Apr. 12	This is the third week of your independent project, and you are likely gathering results at this point. Today should still involve most of the course's LO's, but especially the Inquiry LOs: <u>Basics LO-1, LO-2, LO-3, LO-4</u>	Independent project lab work Day 3	Participation: 10

		Inquiry		
		<u>LO-1, LO-2, LO-3, LO-4, LO-5, LO-6</u>		
		<u>Pro LO-1, LO-2, LO-3</u>		
Week 13 out of class work	Apr. 12- 17		HW-11: Misc. sections for your final project	HW-11: 10
WEEK 14	Apr. 19	This is the fourth week of your independent project, and at this point you will be gathering results and beginning to assemble your poster. As with last week, the key LOs this week are the Inquiry LOs , along with the Pro LOs , along with a steady, ongoing demonstration of the Basics LOs: Basics LO-1, LO-2, LO-3, LO-4 Inquiry LO-1, LO-2, LO-3, LO-4, LO-5, LO-6 Pro LO-1, LO-2, LO-3	Independent project lab work Day 4 In class Poster prep	Participation: 10
Week 14 out of class work	Apr. 19- 24	This week's homework will develop the results section of your final project, most relevant to the data collection, analysis, and presentation components of LOs: Inquiry LO-4: Conduct a scientific experiment to test a prediction, including data collection and analysis. Pro LO-2: Present, defend, and modify knowledge as part of a scientific community.	HW-12: Results section for your final project	HW-12: 10
WEEK 15	Apr. 26	This is the final week of your independent project, and time to really focus on the Inquiry and Pro learning objectives. We'll also continue to think about the Basics LO's as usual, with ongoing participation and lab notebook checks: Basics LO-1, LO-2, LO-3, LO-4 Inquiry LO-1, LO-2, LO-3, LO-4, LO-5, LO-6 Pro LO-1, LO-2, LO-3	Independent project lab work Day 5 Future directions discussion In-class poster preparation	Participation: 10 Lab notebook check #4: 10

Week 15 out of class work	Apr. 26- May 1	This week's homework will pull together all of the previous sections of your poster developed in previous homeworks, plus a final section of "Conclusions/Findings." Before the poster session, your poster should be in final form (externally reviewed, edited for grammar, spelling, etc.).	HW-13: Conclusion section for your final project and poster drafts	HW-13: 10
WEEK 16	May 3	This week's poster session is a time to bring your entire project together, present it to your scientific community, consider new ideas, and contribute to your peer's ideas. Pro LO-1: Use evidence to make a scientific argument. Pro LO-2: Present, defend, and modify knowledge as part of a scientific community. Pro LO-3: Evaluate peer's scientific experiments, recognizing excellence and contributing constructive feedback on how to strengthen ongoing studies.	Poster Session	Poster presentation: 50
Week 16 out of class work		This final homework is to submit the final version of your poster, with any corrections noticed during the poster session.	Homework: Poster final draft	Poster final draft: 50