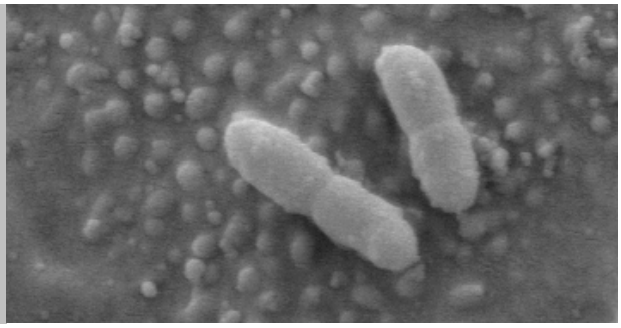
Biology 433/533
Bacterial-Host Interactions

Instructor: Karen Guillemin
Class meeting: Mon, Wed 2:00-3:20 PM
Meetings with include a combination of live Zoom sessions and asynchronous discussions.
Office hours: Friday 11:30 AM -12:30 PM
or by appointment



Course description: This course examines how animals co-exist with microorganisms. We will investigate the molecular mechanisms by which animal cells and associated microorganisms communicate, and how these communications affect the biology of the host and the structure of its associated microbial communities. The course is based on primary research literature, drawing on examples of different bacterial-host interactions in a number of model systems to illustrate basic principles about the molecular and cellular natures of these interactions. The course will emphasize critical reading of the literature and critical thinking. During the course, students will develop original research proposals that address unanswered questions in the field, using experimental approaches covered in the course, which they will present orally and submit as final written research proposals.

Learning Objectives:

- Gain a sophisticated understanding of the emerging field of bacterial-host interactions in biology.
- Gain a working knowledge of modern molecular genetic experimental approaches using model eukaryotes and prokaryotes and gnotobiology.
- Become a critical reader of scientific research articles in the biomedical literature.
- Develop the ability to formulate hypotheses about the mechanistic bases for biological phenomena.
- Learn to provide constructive critiques of your colleagues' scientific writing and presentations.
- Become proficient at designing experimental strategies to test hypotheses about the mechanistic bases for biological phenomena.
- Learn to give a concise and compelling oral presentation that identifies a scientific question, proposes a hypothetical answer to this question, and lays out a novel strategy to test this hypothesis.
- Learn to write a compelling research proposal that identifies a scientific question, proposes a hypothetical answer to this question, and lays out a novel strategy to test this hypothesis.

Course topics: The course is structured into three units. In the first unit, we will explore how the resident microbes of animals impact animal biology in diverse ways. We will read papers that present four of the most widely-used animal model systems for study host-microbe interactions, which will provide students with inspiration for designing their own research proposals. In the second unit, we will learn about the methodologies used to characterize complex host-associated microbial systems and we will explore the major factors thought to shape the composition of these communities. In the third unit, we will examine the application of these animal model systems and microbiome analysis approaches to tackle major human health challenges. The final four class sessions will be devoted to student presentations of their original research proposals.

Course format: This class will be taught remotely, which is an experiment for all of us. My plan is to hold classes in real time via Zoom in sessions that will be recorded and subsequently posted on Canvas. I will also experiment with using discussion boards for additional class exchanges to engage students who have difficulty connecting to the live classroom sessions.

Zoom session participation: For the best experience with Zoom, please plan to enter the session a few minutes early. Please keep your microphone on mute. If you have connection problems, you can try turning off your video as well. We will experiment with using the chat function or taking turns unmuting for class discussions. I will value your feedback on what remote classroom practices work best to enhance your learning.

Assignments and grading

***Assigned reading*:** For each topic covered, the assigned reading will consist of a combination of current review articles by leaders in the field and impactful original research articles. These will be posted, organized by week, in Canvas.

***Reading responses*:** During the course of the class, you will be asked to complete 12 reading response questionnaires to help you engage with the assigned reading. These will not be graded, but you will receive credit for submitting them on time on Canvas by 1:45 PM before class. Students are encouraged to discuss the reading material with each other and their answers to the reading preparation assignments, but they must submit their own original work. I strongly encourage you to revisit your reading response questionnaires after class to solidify your learning and develop study materials for the reading quizzes. **Each reading response will comprise 1% of your final grade (12% in all).**

Reading quizzes: A reading quiz will be given at the end of each of the three class units. These quizzes will be made available to students for 48 hours. These quizzes will test student understanding of the assigned reading. Students can refer to their reading, class notes and any other sources to complete the quizzes, but they are expected to complete this work independently without collaborating with their classmates. **Each reading quiz will comprise 6% of the final grade (18% in all).**

Proposal workshop preparation and participation: We will hold two proposal writing workshops during the term. In the first workshop you will develop the abstract and specific aims for your proposal. In the second workshop, you will hone your specific aims and develop your experimental design. For each of these workshops, you will be asked to complete a preparatory questionnaire. These will not be graded, but you will receive credit for submitting them on time on Canvas by 1:45 PM before class. **Each proposal workshop preparation will comprise 2% of the final grade (4% in all).** You will also be asked to complete a rubric of feedback on your group members' proposals. These will not be graded, but you will receive credit for submitting them at the end of the workshop. **Each proposal workshop feedback rubric will comprise 2% of the final grade (4% in all).**

***Oral presentation feedback*:** Each student will be assigned to a proposal group. You will work with your group members during the proposal workshops and you will be asked to provide constructive feedback on your group members' oral presentations of their proposals at each of the four proposal presentation sessions. **Your feedback for each of the four sessions will be graded and will comprise 2% of the final grade (8% in all).**

***Additional class participation*:** In addition to the assigned participation exercise for the assigned reading and proposal development, students will receive a grade for their overall class participation, comprising **4% of the final grade**.

***Original research proposal*:** Over the course each student will develop an original research proposal on a topic of their choice related to the course. At the end of the term each student will give a short oral presentation of their proposal and submit a final written proposal. The graded components of the research proposal will be:

Abstract and specific aims (8% final grade)
Oral presentation (18% final grade)
Written proposal (24% final grade)

Grading for undergraduates versus graduate students: Undergraduate and graduate students will be graded separately, based on different expectations of their background knowledge in scientific approaches. The expectations for the research proposal and scope of the project will be different for the undergraduate and graduate students. The expectation for the undergraduate research proposal

will be that the student describes a single experimental strategy to address an unanswered question. The graduate students will be required to write a proposal that employ several independent approaches to address a well-defined research question, similar in scope to a professional predoctoral research fellowship proposal. The graduate students will be expected to lead group discussions in their assigned proposal writing groups and to provide more extensive feedback on the oral presentations of their group members.

Office hours and communications: I will hold drop in zoom meeting on Fridays from 11:30-12:30. If you are not free at this time, you may schedule an appointment to meet with me at another time or send me messages via **Canvas**.

Students with disabilities: The University of Oregon is working to create inclusive learning environments. Please notify me if there are aspects of the instruction or design of this course that result in disability-related barriers to your participation. You are also encouraged to contact the Accessible Education Center in 164 Oregon Hall at 541-346-1155 or uoaec@uoregon.edu.

Academic integrity: All students will be expected to adhere to the University's guidelines on academic integrity as outlined in the Student Conduct Code:
http://studentlife.uoregon.edu/programs/student_judi_affairs/conduct-code.htm
Students are encouraged to discuss class material and exercises with one another, with the exception of the reading quizzes. All submitted written work must be the original work of each student. Proper citation of sources is required in all written work and oral presentations.

BI433/533 Class Schedule 2018

1	March 30	Human co-existence with microbes: a history of infectious disease and the disappearing microbiota hypothesis	Review article: Beutler and Rietschel, 2003 Review article: Blaser and Falkow, 2009 **Reading response 1 due 1:45 PM**
1	April 1	Bacterial modulation of animal morphogenesis (squid model)	Review article: McFall-Ngai, et al., 2013 Research article: Koropatnick, et al., 2004 **Reading response 2 due 1:45 PM**
2	April 6	Bacterial modulation of animal metabolism (fly model)	Review article: Leulier, et al., 2017 Research article: Consuegra, et al., 2020 **Reading response 3 due 1:45 PM**
2	April 8	Bacterial modulation of animal immunity (zebrafish model)	Review article: Murdoch and Rawls, 2019 Research article: Murdoch, et al., 2019 **Reading response 4 due 1:45 PM**
3	April 13	Bacterial modulation of neurodevelopment (mouse model)	Review article: Pronovost and Hsiao, 2019 Research article: Hsiao, et al., 2013 **Reading response 5 due 1:45 PM**
3	April 15	**Proposal writing workshop: overview and brainstorming specific aims**	**Reading quiz 1: submit answers by 1:45 PM**
4	April 20	Methodologies for analyzing microbial communities	Review article: Lozupone, et al., 2012 **Proposal abstract and specific aims draft due 1:45 PM**
4	April 22	Dietary determinants of microbiota assembly	Review article: Turnbaugh, 2017 Research article: Turnbaugh, et al., 2008 **Reading response 6 due 1:45 PM**
5	April 27	Host genetic determinants of microbial community assembly	Review article: Goodrich, et al., 2017 Research article: Goodrich, et al., 2016 **Reading response 7 due 1:45 PM**
5	April 29	Bacterial determinants of microbial community assembly	Review article: Dantas, et al., 2013 Research article: Goodman, et al., 2009 **Reading response 8 due 1:45 PM**
6	May 4	**Proposal writing workshop: refining specific aims and brainstorming experimental design**	**Reading quiz 2: submit answers by 1:45 PM**
6	May 6	Pathologic shifts in microbial communities: invasion by pathogens	Review article: Stecher and Hardt, 2011 Research article: Winter, et al., 2010 **Reading response 9 due 1:45 PM**
7	May 11	Microbiome-mediated therapies against bacterial infections	Review article: Lewis and Pamer, 2017 Research article: Buffie, et al., 2015 **Reading response 10 due 1:45 PM**
7	May 13	Microbiota modulation of viral infections	Review article: Li, et al., 2019 Research article: Erickson, et al., 2018 **Reading response 11 due 1:45 PM**
8	May 18	The future of probiotics and personalized medicine	Review article: Thaiss and Elinav, 2017 Review article: Bashiardes, et al., 2018 **Reading response 12 due 1:45 PM**
8	May 20	**Research proposal oral presentations: 533 students**	**Reading quiz 3: submit answers by 1:45 PM**
9	May 25	**Memorial Day. No class**	
9	May 27	**Research proposal oral presentations: 433 students group 1**	**Proposal group feedback 1 due by 1:45 PM**
10	June 1	**Research proposal oral presentations: 433 students group 2**	**Proposal group feedback 2 due by 1:45 PM**
10	June 3	**Research proposal oral presentations: 433 students group 3**	**Proposal group feedback 3 due by 1:45 PM**
10	June 5		**Proposal group feedback 4 due by 1:45 PM**
11	June 10	**Written research proposals due at 5 PM Wednesday June 10**	

Assigned reading (available on Canvas)

1. **Beutler, B., and E. T. Rietschel.** 2003. Innate immune sensing and its roots: the story of endotoxin. Nat Rev Immunol **3:**169-76.
2. **Blaser, M. J., and S. Falkow.** 2009. What are the consequences of the disappearing human microbiota? Nat Rev Microbiol **7:**887-94.
3. **McFall-Ngai, M., M. G. Hadfield, T. C. Bosch, H. V. Carey, T. Domazet-Loso, A. E. Douglas, N. Dubilier, G. Eberl, T. Fukami, S. F. Gilbert, U. Hentschel, N. King, S. Kjelleberg, A. H. Knoll, N. Kremer, S. K. Mazmanian, J. L. Metcalf, K. Nealson, N. E. Pierce, J. F. Rawls, A. Reid, E. G. Ruby, M. Rumpho, J. G. Sanders, D. Tautz, and J. J. Wernegreen.** 2013. Animals in a bacterial world, a new imperative for the life sciences. Proc Natl Acad Sci U S A **110:**3229-36.
4. **Koropatnick, T. A., J. T. Engle, M. A. Apicella, E. V. Stabb, W. E. Goldman, and M. J. McFall-Ngai.** 2004. Microbial factor-mediated development in a host-bacterial mutualism. Science **306:**1186-8.
5. **Leulier, F., L. T. MacNeil, W. J. Lee, J. F. Rawls, P. D. Cani, M. Schwarzer, L. Zhao, and S. J. Simpson.** 2017. Integrative Physiology: At the Crossroads of Nutrition, Microbiota, Animal Physiology, and Human Health. Cell Metab **25:**522-534.
6. **Consuegra, J., T. Grenier, P. Baa-Puyoulet, I. Rahioui, H. Akherraz, H. Gervais, N. Parisot, P. da Silva, H. Charles, F. Calevro, and F. Leulier.** 2020. Drosophila-associated bacteria differentially shape the nutritional requirements of their host during juvenile growth. PLoS Biol **18:**e3000681.
7. **Murdoch, C. C., and J. F. Rawls.** 2019. Commensal Microbiota Regulate Vertebrate Innate Immunity-Insights From the Zebrafish. Front Immunol **10:**2100.
8. **Murdoch, C. C., S. T. Espenschied, M. A. Matty, O. Mueller, D. M. Tobin, and J. F. Rawls.** 2019. Intestinal Serum amyloid A suppresses systemic neutrophil activation and bactericidal activity in response to microbiota colonization. PLoS Pathog **15:**e1007381.
9. **Pronovost, G. N., and E. Y. Hsiao.** 2019. Perinatal Interactions between the Microbiome, Immunity, and Neurodevelopment. Immunity **50:**18-36.
10. **Hsiao, E. Y., S. W. McBride, S. Hsien, G. Sharon, E. R. Hyde, T. McCue, J. A. Codelli, J. Chow, S. E. Reisman, J. F. Petrosino, P. H. Patterson, and S. K. Mazmanian.** 2013. Microbiota modulate behavioral and physiological abnormalities associated with neurodevelopmental disorders. Cell **155:**1451-63.
11. **Lozupone, C. A., J. I. Stombaugh, J. I. Gordon, J. K. Jansson, and R. Knight.** 2012. Diversity, stability and resilience of the human gut microbiota. Nature **489:**220-30.
12. **Turnbaugh, P. J.** 2017. Microbes and Diet-Induced Obesity: Fast, Cheap, and Out of Control. Cell Host Microbe **21:**278-281.
13. **Turnbaugh, P. J., F. Backhed, L. Fulton, and J. I. Gordon.** 2008. Diet-induced obesity is linked to marked but reversible alterations in the mouse distal gut microbiome. Cell Host Microbe **3:**213-23.
14. **Goodrich, J. K., E. R. Davenport, A. G. Clark, and R. E. Ley.** 2017. The Relationship Between the Human Genome and Microbiome Comes into View. Annu Rev Genet.
15. **Goodrich, J. K., E. R. Davenport, M. Beaumont, M. A. Jackson, R. Knight, C. Ober, T. D. Spector, J. T. Bell, A. G. Clark, and R. E. Ley.** 2016. Genetic Determinants of the Gut Microbiome in UK Twins. Cell Host Microbe **19:**731-43.
16. **Dantas, G., M. O. Sommer, P. H. Degnan, and A. L. Goodman.** 2013. Experimental approaches for defining functional roles of microbes in the human gut. Annu Rev Microbiol **67:**459-75.
17. **Goodman, A. L., N. P. McNulty, Y. Zhao, D. Leip, R. D. Mitra, C. A. Lozupone, R. Knight, and J. I. Gordon.** 2009. Identifying genetic determinants needed to establish a human gut symbiont in its habitat. Cell Host Microbe **6:**279-89.
18. **Stecher, B., and W. D. Hardt.** 2011. Mechanisms controlling pathogen colonization of the gut. Curr Opin Microbiol **14:**82-91.
19. **Winter, S. E., P. Thiennimitr, M. G. Winter, B. P. Butler, D. L. Huseby, R. W. Crawford, J. M. Russell, C. L. Bevins, L. G. Adams, R. M. Tsolis, J. R. Roth, and A. J. Baumler.** 2010. Gut inflammation provides a respiratory electron acceptor for Salmonella. Nature **467:**426-9.
20. **Lewis, B. B., and E. G. Pamer.** 2017. Microbiota-Based Therapies for Clostridium difficile and Antibiotic-Resistant Enteric Infections. Annu Rev Microbiol **71:**157-178.
21. **Buffie, C. G., V. Bucci, R. R. Stein, P. T. McKenney, L. Ling, A. Gobourne, D. No, H. Liu, M. Kinnebrew, A. Viale, E. Littmann, M. R. van den Brink, R. R. Jenq, Y. Taur, C. Sander, J. R. Cross, N. C. Toussaint, J. B. Xavier, and E. G. Pamer.** 2015. Precision microbiome reconstitution restores bile acid mediated resistance to Clostridium difficile. Nature **517:**205-8.
22. **Li, N., W. T. Ma, M. Pang, Q. L. Fan, and J. L. Hua.** 2019. The Commensal Microbiota and Viral Infection: A Comprehensive Review. Front Immunol **10:**1551.
23. **Erickson, A. K., P. R. Jesudhasan, M. J. Mayer, A. Narbad, S. E. Winter, and J. K. Pfeiffer.** 2018. Bacteria Facilitate Enteric Virus Co-infection of Mammalian Cells and Promote Genetic Recombination. Cell Host Microbe **23:**77-88 e5.

24. **Thaiss, C. A., and E. Elinav.** 2017. The remedy within: will the microbiome fulfill its therapeutic promise? J Mol Med (Berl).
25. **Bashiardes, S., A. Godneva, E. Elinav, and E. Segal.** 2018. Towards utilization of the human genome and microbiome for personalized nutrition. Curr Opin Biotechnol **51:**57-63.