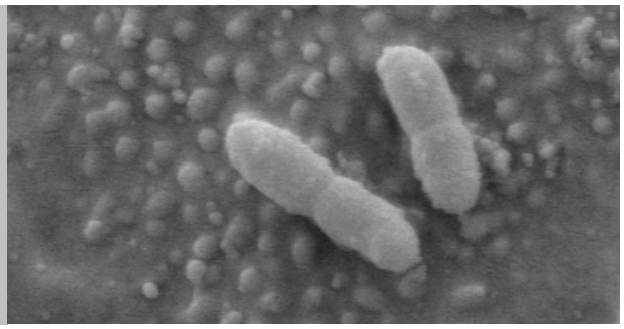
Biology 433/533
Bacterial-Host Interactions

Instructor: Karen Guillemin
Class meeting time: Tue, Thu 2:15-3:45 PM
Class meeting location: via Zoom
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 via Zoom. Class sessions will be recorded and subsequently posted on Canvas, but the discussions that happen in breakout rooms will not be captured on the recording. I will also experiment with using shared documents and discussion boards for additional class exchanges. I will value your feedback on what remote classroom practices work best to enhance your learning.

Zoom session participation: Please log into Zoom using your uoregon account, which will allow me to pre-assign breakout rooms. Please keep your microphone on mute and if at all possible, your video on. We will experiment with using the raise hand function and chat box for for class discussions.

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 13 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 2 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 (13% 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 8% of the final grade (24% in all).**

Proposal workshop participation and feedback: 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 rubric of feedback on your group members' proposals. These will not be graded, but you will receive credit for submitting them at prior to the workshop. **Each proposal workshop feedback 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 comprise 2% of the final grade (8% in all).**

***Additional class participation*:** Students will be graded for class participation -- absent/uninvolved (0), minimal involvement (1), engaged (2), major contributions (3) -- comprising **3% 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 revision (8% final grade)
Oral presentation (16% 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 a d Zoom office hour 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 2021

1	January 5	Motivations for studying bacterial-host interaction: understanding basic biology and combatting human disease	1. Review article: Beutler and Rietschel, 2003 2. Review article: McFall-Ngai, et al., 2013 3. Review article: Blaser and Falkow, 2009 **Introductory questionnaire due 5 PM**
1	January 7	Bacterial modulation of animal morphogenesis (squid model)	4. Review article: Nyholm and McFall-Ngai, 2004 5. Research article: Koropatnick, et al., 2004 **Reading response 1 due 2 PM**
2	January 12	Bacterial modulation of animal metabolism (mouse model) **View seminar by Dr. Johnson January 12 @ 11 am or recorded seminar**	6. Review article: Leulier, et al., 2017 7. Research article: Johnson, et al., 2020 **Reading response 2 due 2 PM**
2	January 14	Bacterial modulation of animal metabolism (fruit fly model)	8. Research article: Consuegra, et al., 2020 **Reading/viewing response 3 due 2 PM**
3	January 19	Bacterial modulation of neuronal function (mouse model)	9. Review article: Pronovost and Hsiao, 2019 10. Research article: Hsiao, et al., 2013 **Reading response 4 due 2 PM**
3	January 21	Bacterial modulation of neuronal function (zebrafish model)	11. Research article: Ye, et al., 2020 **Reading response 5 due 2 PM**
3	January 23	**Reading quiz 1 due Saturday January 23 at 5 PM**	
4	January 25	**Proposal abstract and specific aims draft due Monday January 25 at 9 AM**	
4	January 26	Methodologies for analyzing microbial communities	12. Review article: Lozupone, et al., 2012 13. Review article: Abreu and Taga, 2016 **Reading response 6 due 2 PM**
4	January 28	**Proposal writing workshop: hypothesis and specific aims**	**Proposal group feedback due at 9 AM**
5	February 2	Dietary determinants of microbiomes	14. Review article: Gentile and Weir, 2018 15. Research article: Johnson, et al., 2019 **Reading response 7 due 2 PM**
5	February 4	Host genetic determinants of microbiomes	16. Review article: Suzuki and Ley, 2020 17. Research article: Goodrich, et al., 2014 **Reading response 8 due 2 PM**
6	February 8	**Proposal abstract and specific aims revision and experimental design outline due Monday February 8 at 9 AM**	
6	February 9	Bacterial determinants of microbiomes	18. Review article: Dantas, et al., 2013 19. Research article: Goodman, et al., 2009 **Reading response 9 due 2 PM**
6	February 11	**Proposal writing workshop: refining specific aims and experimental design**	**Proposal group feedback 2 due at 9 AM**
6	February 13	**Reading quiz 2 due Saturday February 13 at 5 PM**	
7	February 16	Pathologic shifts in microbial communities: invasion by pathogens	20. Review article: Tsolis and Baumler, 2020 21. Research article: Winter, et al., 2010 **Reading response 10 due 2 PM**
7	February 18	Microbiome-mediated therapies against bacterial infections	22. Review article: Lewis and Pamer, 2017 23. Research article: Buffie, et al., 2015 **Reading response 11 due 2 PM**
8	February 23	Microbiota modulation of viral infections	24. Review article: Li, et al., 2019 25. Research article: Erickson, et al., 2018 **Reading response 12 due 2 PM**
8	February 25	The future of probiotics and personalized medicine	26. Review article: Suez, et al., 2019 27. Research article: Di Luccia, et al., 2020 **Reading response 13 due 2 PM**
8	February 27	**Reading quiz 3 due Saturday February 27 at 5 PM**	
9	March 2	**Proposal oral presentations session 1**	**Proposal group feedback due March 3 at 9 AM**
9	March 4	**Proposal oral presentations session 2**	**Proposal group feedback due March 5 at 9 AM**
10	March 9	**Proposal oral presentations session 3**	**Proposal group feedback due March 10 at 9 AM**
10	March 11	**Proposal oral presentations session 4**	**Proposal group feedback due March 12 at 9 AM**
11	March 18	**Written research proposals due Thursday March 18 at 9 AM**	

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. **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.
3. **Blaser, M. J., and S. Falkow.** 2009. What are the consequences of the disappearing human microbiota? Nat Rev Microbiol **7:**887-94.
4. **Nyholm, S. V., and M. J. McFall-Ngai.** 2004. The winnowing: establishing the squid-vibrio symbiosis. Nat Rev Microbiol **2:**632-42.
5. **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.
6. **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.
7. **Johnson, E. L., S. L. Heaver, J. L. Waters, B. I. Kim, A. Bretin, A. L. Goodman, A. T. Gewirtz, T. S. Worgall, and R. E. Ley.** 2020. Sphingolipids produced by gut bacteria enter host metabolic pathways impacting ceramide levels. Nat Commun **11:**2471.
8. **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.
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. **Ye, L., M. Bae, C. D. Cassilly, S. V. Jabba, D. W. Thorpe, A. M. Martin, H. Y. Lu, J. Wang, J. D. Thompson, C. R. Lickwar, K. D. Poss, D. J. Keating, S. E. Jordt, J. Clardy, R. A. Liddle, and J. F. Rawls.** 2020. Enteroendocrine cells sense bacterial tryptophan catabolites to activate enteric and vagal neuronal pathways. Cell Host Microbe.
12. **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.
13. **Abreu, N. A., and M. E. Taga.** 2016. Decoding molecular interactions in microbial communities. FEMS Microbiol Rev **40:**648-63.
14. **Gentile, C. L., and T. L. Weir.** 2018. The gut microbiota at the intersection of diet and human health. Science **362:**776-780.
15. **Johnson, A. J., P. Vangay, G. A. Al-Ghalith, B. M. Hillmann, T. L. Ward, R. R. Shields-Cutler, A. D. Kim, A. K. Shmagel, A. N. Syed, S. Personalized Microbiome Class, J. Walter, R. Menon, K. Koecher, and D. Knights.** 2019. Daily Sampling Reveals Personalized Diet-Microbiome Associations in Humans. Cell Host Microbe **25:**789-802 e5.
16. **Suzuki, T. A., and R. E. Ley.** 2020. The role of the microbiota in human genetic adaptation. Science **370**.
17. **Goodrich, J. K., J. L. Waters, A. C. Poole, J. L. Sutter, O. Koren, R. Blekhman, M. Beaumont, W. Van Treuren, R. Knight, J. T. Bell, T. D. Spector, A. G. Clark, and R. E. Ley.** 2014. Human genetics shape the gut microbiome. Cell **159:**789-99.
18. **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.
19. **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.
20. **Tsolis, R. M., and A. J. Baumler.** 2020. Gastrointestinal host-pathogen interaction in the age of microbiome research. Curr Opin Microbiol **53:**78-89.
21. **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.
22. **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.

23. **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.
24. **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.
25. **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.
26. **Suez, J., N. Zmora, E. Segal, and E. Elinav.** 2019. The pros, cons, and many unknowns of probiotics. Nat Med **25:**716-729.
27. **Di Luccia, B., P. P. Ahern, N. W. Griffin, J. Cheng, J. L. Guruge, A. E. Byrne, D. A. Rodionov, S. A. Leyn, A. L. Osterman, T. Ahmed, M. Colonna, M. J. Barratt, N. F. Delahaye, and J. I. Gordon.** 2020. Combined Prebiotic and Microbial Intervention Improves Oral Cholera Vaccination Responses in a Mouse Model of Childhood Undernutrition. Cell Host Microbe **27:**899-908 e5.