BIOLOGY 4803/8803: Microbial Symbiosis as Biological Innovation

Lectures: MWF 2:00-3:00 pm

Course Description: Microbial symbioses affect all life on this planet. The human body can be thought of as a symbiosis between our cells and organs, and the trillions of microorganisms (the microbiome) that live throughout the body, notably in the gut. A recent surge of research has identified the critical role of these microbial symbionts in maintaining host health and well-being, for example by mediating the breakdown of food for host nutrition, priming the immune system and directly fighting off pathogenic bacteria, and triggering key physiological outcomes associated with behavior and development. Microbial symbionts can also be sources of biological innovation. For example, key eukaryotic organelles, including the mitochondrion and chloroplast, evolved from bacteria living inside ancient host cells. Today, similar associations between microbes and plants and animals occur in every major biome, playing essential roles in ecosystem processes, the evolution of new species, and human health and agriculture. This course explores core topics in the study of microbial symbioses, including partner recognition and communication, adaptations to host association, the role of symbiosis in genome evolution and ecology, and the effects of microbial symbiosis on host health. Course lectures and discussions will draw heavily from the primary literature in the field of microbiome/symbiosis research, focusing on the most recent discoveries, key methodological advancements, and on diverse associations ranging from marine symbioses to the human microbiome.

Instructor:
Dr. Frank Stewart, School of Biology
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Prerequisites:
BIOL1510 (Minimum Grade of D) BIOL 1511 (Minimum Grade of D)

Texts (*Available at the bookstore*)**:**
Douglas AE. 2010. The Symbiotic Habit. Princeton University Press.
Leach, Jeff. 2012. Honor thy symbionts. CreateSpace Independent Publishing Platform.

Text readings *(Douglas text):*

For exam 1 (Feb 12): *Preface*, Chapters 1 and 2
For exam 2 (March 16): Chapters 3 and 4
For exam 3 (April 25): Chapters 5 and 6, and *Perspectives*

Course organization: Course meetings will involve a combination of lectures (1/3), group discussions (1/3), and student presentations (1/3) focused on the primary literature. Course material will be based on weekly readings of recent research articles from the primary literature, review articles, and the Douglas (2010) text. Primary literature readings and review papers will be made available as pdfs and posted on TSquare.

Research articles will be chosen by Dr. Stewart to complement the lecture schedule and to reflect the most recent substantive advancements in the field. These articles will be presented to the class through **graded** student presentations (15 min; 1-2 presentations

per student depending on enrollment), followed by student-led group discussions (25 min). The format for the presentations is flexible, but should be designed to both summarize the content of the paper and also present ideas for discussion. Use of Powerpoint is highly recommended. Dr. Stewart will provide guidelines for what to include in the presentation, and will give an example presentation in week 1.

Students are required to read each research paper carefully (prior to class) and to answer a set of questions relating to the content of each study. These questions are designed to encourage reflection and to prepare students to discuss the goals, methods, and outcomes of the research, and also to become critical reviewers of scientific research articles. Answers (~1-2 pages) to paper questions will be handed in (hard copy) by the end of class on the day the paper is discussed. These answers **will be graded**. Late assignments will **NOT** be accepted.

Three take-home exams, consisting primarily of short answer or essay questions, will cover material presented in lecture and paper discussions, or will be based on additional reading material. Exams will be distributed 1 week prior to the scheduled due date (see schedule below). Exams can only be missed if proper documentation is presented. Make-up exams will be different from the original exams. There is **NOT** a comprehensive final exam. Attendance in class is mandatory.

Graduate students will be required to submit a term paper (due at the end of the semester) in the form of an NSF research proposal. These proposals should be focused on an understudied or novel question in microbial symbiosis. This project is designed to foster critical thinking in the field of symbiosis and also to develop important skills in experimental design, hypothesis testing, and proposal writing. Proposal writing will follow a format defined by Dr. Stewart and will involve the submission of an outline (Due Feb. 29) and an intermediate draft (Due April 4) prior to the final submission. Final submissions (Due April 20) should be 10-12 double-spaced pages in length (Times, 12 Point font), not including Figures/Tables and References.

Conduct in the course should conform to the Student Honor Code (http://www.honor.gatech.edu/). Students failing to follow the Honor Code will be reported to the Institute for disciplinary action.

Grading:

<u>Undergrad</u>
Research paper discussion questions, and additional assignments** – 40%
Three take-home exams (15% each) – 45%
Paper presentation – 15%

<u>Grad</u>
Research paper discussion questions, and additional assignments** – 40%
Three take-home exams (10% each) – 30%
Research proposal – 20%
Paper presentation – 10%

**A small number of additional assignments may be added periodically during the semester at the discretion of Dr. Stewart. A 1-2 week period will be provided for completion of each assignment.

Class Schedule *(Topics and dates **may be modified** based on the interests of the class or in response to time constraints)*:

Week	
1	Defining “Symbiosis”
Jan. 22	**Student presentations start**
2	Molecular methods in symbiosis and microbiome research
3	Physical structuring of microbe-host associations
4	Microbe-microbe symbioses, synergisms, and microbiomes
Feb. 12	**EXAM 1 due**
5	Endosymbiosis, organelles, and the origin of the eukaryotic cell
6	Symbiont-host specificity
Feb. 29	**Proposal outline due (grad only)**
7	Symbiont recognition and acquisition
8	Transmission mode and population structure
9	Symbiont genome structure and evolution
Mar. 16	**EXAM 2 due**
10	Symbiont functional diversity
11	Symbiont-pathogen parallels
12	Symbiont-environment interactions
April. 4	**Proposal draft due (grad only)**
13	Microbiomes and host immunity
14	Microbiomes and host nutrition
15	Microbiomes and host development
16	Microbiomes and host behavior
April 20	**Proposal FINAL due (grad only)**
April 25	**EXAM 3 due**