BIOLOGY 4803/8803: Microbial Symbiosis as Biological Innovation

Lectures: MWF 2:00-3:00 pm

Course Description: Microbial symbioses affect almost all life on this planet. 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 critical roles in ecosystem productivity, the evolution of new species, and human health and agriculture. This course explores core topics in the study of bacteria-eukaryote symbioses, including partner recognition and communication, molecular adaptations to intracellular lifestyles, symbiont-symbiont interactions and metabolic synergism, and the role of symbiosis in bacterial genome evolution. Course lectures and discussions will draw heavily from the primary literature, focusing on the most recent discoveries in the field, key methodological advancements, and on diverse associations ranging from hydrothermal vent symbioses to the human microbiome.

Instructor:
Dr. Frank Stewart, School of Biology
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Prerequisites:
BIOL 3880 - Introductory Microbiology (requires a minimum grade of "D")

Text:
Douglas AE. 2010. The Symbiotic Habit. Princeton University Press.
(*Available at the bookstore*)

Text readings:

For exam 1 (Feb 5): *Preface*, Chapters 1 and 2
For exam 2 (March 12): Chapters 3 and 4
For exam 3 (April 18): Chapters 5 and 6, and *Perspectives*

Course organization: Course meetings will involve a combination of lectures (1/4), group discussions (1/2), and student presentations (1/4) 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 in-class exams will cover material presented in lecture and paper discussions. All exams will be closed book and will consist primarily of multiple-choice and short answer questions. A review session will be held prior to each exam to identify key focal topics. Attendance in class is mandatory. 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.

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. 21) and an intermediate draft (Due March 28) prior to the final submission. Final submissions (Due April 25) 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:

Undergrad
Research paper discussion questions, and additional assignments** – 40%
Three in-class exams (15% each) – 45%
Paper presentation – 15%

Grad
Research paper discussion questions, and additional assignments** – 40%
Three in-class 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	Overview and definition of “Symbiosis”
Jan. 17	**Student presentations start**
2	Endosymbiosis and the origin of the eukaryotic cell
3	Molecular methods in symbiosis research
4	Physical structuring of symbiotic associations
Feb. 5	**EXAM 1 – in class**
5	The role of metabolic synergism
6	Costs and benefits of symbiosis
Feb. 21	**Proposal outline due (grad only)**
7	Symbiont function: mutualist vs. pathogen
8	Symbiont-host specificity
9	Symbiont recognition and acquisition
Mar. 12	**EXAM 2 – in class**
10	Transmission mode and population structure
11	Symbiont-environment interactions
12	Gene flow and symbiont diversification
Mar. 28	**Proposal draft due (grad only)**
13	Molecular adaptations to intracellularity
14	Symbiont genome structure and evolution
April 18	**EXAM 3 – in class**
15	Symbiotic consortia: the human microbiome – overview and methods
16	Symbiotic consortia: the human microbiome – function and stability
April 25	**Proposal FINAL due (grad only)**