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Course No: FRSEM-UA 502  
Time: Tuesdays, 3:30 PM – 6:00 PM  
Location: Room LC7, Tisch Hall (40 W 4th St.)  

Description: Biology has become an incredibly interdisciplinary science. Major breakthroughs often result from collaborations between scientists inventing new technologies and biologists studying the fundamental questions of life. This seminar focuses on the latest discoveries in biology and the technological innovations that enable them. Through a combination of readings, lectures, and discussions, the seminar leapfrogs classical textbook biology to present science at the forefront of biological research. Student-led discussions develop in-depth knowledge of each topic. A collaborative seminar blog, updated by seminar participants, documents and disseminates the discussion. Emphasis is placed on understanding how the scientific research process works in today’s world. The course is geared towards highly motivated individuals, with a strong high-school background in science and/or a deep passion for scientific inquiry. This year’s three major topics are Metagenomics, Synthetic Biology, and Quantitative Immunology. Two additional one-week feature topics are chosen each year.

Grading:  
50% Discussions (in class, student-led)  
20% Midterm report / proposal  
30% Final presentation and paper  

Prerequisites:  
- Honors-level Biology (AP strongly recommended), and  
- At least one Advanced Placement course in Biology, Environmental Science, Chemistry, Physics, or Mathematics.
Seminar Format:

Weekly Reading: Each week, we will typically discuss one research paper. While these papers are short, they will be quite challenging. Students are expected to read the papers very carefully – a scientific paper of 5 pages can often be as challenging and content-rich as readings of 100 pages in other disciplines. To fully comprehend the weekly paper, additional independent research will be necessary. For example, specialized terminology will need clarification, either using online information or from reference texts. Understanding experimental procedures will often require additional investigation. I expect each participant to work independently on the weekly reading for about 5 hours. After that, you will meet once a week in small discussion groups (see below).

Discussion Groups: The seminar will be divided into discussion groups, with 3 students each. Each week, sometime before Tuesday, the discussion groups will meet independently, on their own schedule, for about 1 – 1.5 hours to discuss the paper. During this time, the goal is to begin clarifying the difficult points – among the three members of a group, lots of questions can be resolved. Any remaining perplexing issues can be brought up in the main seminar discussion on Tuesday.

Weekly Seminar Leaders: Each week, a different group will be assigned to lead the seminar discussion. The leader group will be responsible for three major tasks:

(A) giving a 10-minute PowerPoint or Keynote presentation
(B) leading the seminar discussion
(C) writing the weekly blog entry

To accomplish this, the leader group should meet twice before the seminar. The first time, discuss the paper and plan out how to present it to the class. Also, split up the three major tasks among yourselves: decide which slides need to be made, how you will lead the discussion, what should go into the blog entry – and who will be responsible for doing each part. The second time, meet to go over the final presentation slides, read over your blog entry, make any changes, and post it online for the rest of the seminar.

Weekly Seminar: Each week, the seminar will consist of a discussion (~ 1.5 hours) followed by a lecture. The discussions will focus on a specific reading, usually a research paper. The weekly leader group will open the seminar with their introductory presentation (~ 10 minutes) using a small number of well-chosen slides; identifying a stimulating set of discussion questions; and guiding the conversation to stay on-topic. All other participants
will be responsible for thoughtfully answering questions, pointing out connections between papers we have read, and otherwise meaningfully contributing without dominating the conversation. Towards the end of the discussion, we will discuss the draft blog entry, and all participants can make suggestions for improvement. The leader group will incorporate these changes for the following week’s class, at which point the seminar will approve a final version for publication.

**Weekly Blog Entry:** The collaborative seminar blog appears at [www.frontiersofbiology.org](http://www.frontiersofbiology.org). Each week, the seminar will publish an entry summarizing the weekly research paper. The intended audience should be scientists and science enthusiasts – but not specialists. Key to a successful entry is the ability to convey the main scientific ideas clearly, and to make the basic technical aspects of the research accessible to a non-specialist. The big picture – i.e. the main message of the paper, a discovery or a major result – as well as any important implications – e.g. further research enabled by the work – should be highlighted. Including some visuals within the blog entry is highly recommended.

**Piazza:** Our on-line forum for the seminar ([www.piazza.com](http://www.piazza.com)) – this will be the fastest way to get answers to any of your questions as you are doing weekly readings and working with your discussion groups. You can post questions and also answer your classmates’ posts. Prof. Kussell will be checking the Piazza site daily to provide additional feedback – instead of e-mail, please post all seminar-related questions directly to Piazza.

**Grading and Assignments:**

**Final grade components:**

- 50% Discussions (30% participating, 20% leading)
- 20% Midterm Report
- 30% Final Paper and Presentation

**Discussions:** The discussion grade (50%) is composed of 20% based on how well a student contributed to leading discussions as part of their discussion group (each group will lead twice during the semester); and 30% for participating productively in all other discussions.

**Midterm Report / Proposal (5 pages)** – Due on Friday, Nov. 8 at 5 PM

This short report will provide an outline for the final paper (see below). It will identify and describe the topic of focus, the major references (at least 10, with 1 or more focal references from the last 5 years), and the scientist(s) that will be interviewed. Students must reach out by e-mail to the scientists they would like to interview (an example e-mail will be provided in class). Students must confirm via e-mail that the scientist is willing to be interviewed by phone, e-mail, Skype, or in person. The response e-mail must be attached to the report. Family members, or extended family members, who are working scientists cannot be
interviewed. Scientists working at any NYU affiliated school cannot be interviewed, except if needed to supplement the major interviewee(s) in some way. The goal is to reach out beyond your immediate community, to find out how scientists go about their research in diverse settings.

**Final Presentation & Paper (20 pages) – Due on Wednesday, Dec. 18 at 5 PM**

The paper will discuss a biological research topic in which major new developments have taken place over the last 5 years, involving discoveries and/or new methodologies or approaches. The presentation of the paper will be 5 minutes in length, plus 2 minutes for questions, and should have no more than 5 slides. The paper should be constructed in two parts:

Part I (The Science ~ 12 pages): Describe the biological question at hand, explain what was already known, and show how the new research revolutionized our understanding of the topic.

Part II (The Process ~ 8 pages): Interview one or more of the key scientists involved in the research. Report on this interview, explaining how the basic discovery was made, what enabled it, what were the major challenges. Find out how the researcher felt during different phases of this process. Would they have done anything differently? Can they trace how their thinking changed over time during this research, or more broadly? What do they see as the future challenge(s) or next big steps in their field?

Part III (Blog Entry): Post your interview as a blog entry, including a brief introduction to the science (1 - 2 paragraphs), followed by the interview, and any concluding remarks you wish to make.

Papers and presentations will be evaluated based on:

1. Clarity of writing – the ability to explain the major concepts clearly and correctly, yet without over-simplifying.

2. Making connections – the ability to identify connections between the specific work described, and the broader field; e.g. by showing how it relates to papers we have read, pointing out its implications for future research, etc.

3. Clarity of presentation – the ability to convey the major points to the audience in a short amount of time; to answer questions as they come up; and to craft visually elegant slides.
Syllabus

Papers for discussion are listed below for each date, and will be available on Piazza. Background readings provide context for the weekly research paper. Lectures will introduce material related to the following week’s discussion topic.

Introduction

Sep 3  Lecture & Discussion:
        Introduction to the three major topics. Course overview.

Sep 10 Discussion (led by Prof. Kussell):
        (2) Research question on the logic of DNA replication.

Lecture: Introduction to Metagenomics

Metagenomics

Sep 17 Background reading:

Discussion (led by Group 1):

Lecture: Bacterial Species and Horizontal Transfer
Sep 24  

Background reading:
- “Genomes of Other Organisms: DNA Barcoding and Metagenomics” by Kira Zhaurova, in Scitable

Discussion (led by Group 2):

Lecture: Bacterial Communities and Host-Microbe Interactions

Oct 1  

Background reading:
- “Hybrid Incompatibility and Speciation” by Norman Johnson, in Scitable

Discussion (led by Group 3):

Lecture: Introduction to Synthetic Biology

Oct 8  

**Feature Topic 1: Special Lecture & Discussion**
Marcelo Magnasco (The Rockefeller University)

Discussion (led by Group 4):

Lecture: Information Processing in Slime Molds
Synthetic Biology

Oct 15       NO CLASS – Fall Recess

Oct 22       Background Reading: Chapters 1-2 in *Regenesis*.

Discussion (led by Group 5):

Lecture: Synthetic Circuits

Oct 29       Background Reading: Chapter 8 in *Regenesis*.

Discussion (led by Group 6):

Lecture: Biosensors

Nov 5        (Midterm Paper due Thursday, Nov. 7 by midnight)

Discussion (led by Group 1):

Lecture: Synthetic Ecology
Nov 12  Discussion (led by Group 2):
  Hekstra DR & Leibler S. Contingency and Statistical Laws in Replicate Microbial Closed Ecosystems, Cell 149:1164 (2012).

  Lecture: Introduction to Quantitative Immunology

Quantitative Immunology

Nov 19  Discussion (led by Group 3):
  – Chapter 5 in Regenesis

  Lecture: Single-cell genomics

Nov 26  **Feature Topic II : Special Lecture & Discussion
Laura Landweber (Princeton University)

  Discussion (led by Group 4):

  Lecture: Scrambled Genomes

Dec 3  Background Reading:

  Discussion (led by Group 5):

  Lecture: Helper T Cells and B Cell Activation
Dec 10 Discussion (led by Group 6):

Lecture: The Next Frontier...

Dec 17 Final Presentations in Class

Dec 18 Final Paper due by 5 PM
Required Reading:


Written by one of the pioneers of synthetic biology, this book covers a wide range of topics, from biofuels to extinct genomes, to the iGEM (genetically engineered machine) undergraduate competition. As a side note, the text and images of this book have been encoded and synthesized into DNA in a readable format in George Church’s lab at Harvard.

Useful Books (on Reserve at Bobst Library)


Other Resources

5. *Scitable* by Nature Education (free and on-line). This website contains over 500 expert-authored, peer-reviewed educational materials on many current topics in biology.
