BE 159: Signal Transduction and Biomechanics in Eukaryotic Cell Morphogenesis

Caltech, Spring 2014

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Course description and objectives

The cell is a fundamental unit of biology. In higher organisms, almost all cells have exactly the same genome, yet there are a wide variety of cell types and function in a single organism. A cursory glance at our own body reveals the incredible range and splendor of this cellular diversity. How to cells take on such different forms and function in a developing organism? And how do cells communicate with each other? These questions are largely unanswered, but we have come a long way in the last several decades. This class will explore the physical principles behind morphogenesis in development by investigating current and classic literature on the subject. The class will feature plenty of in-class discussion and student presentations. We will also attempt some calculations of our own on morphogenic processes in homework assignments.

Course content

The course consists almost entirely of reading of current literature. The schedule for the readings, as well as all documents, are found on the syllabus on the class website. You can also find pertinent handouts on the handouts page of the class website.

Grading

Your grade will be assessed as follows.

- Homework: 45%

- Class participation: 25%

- Final project: 30%

Homework

There will be four homework assignments related to lecture and reading material. The homeworks will not always have "right answers," but are always aimed at making you think about the central concepts of the course. We will not have any exams. Homework assignments are posted on the website. The due date, usually two weeks after posting, is indicated on the website and on the homework PDF. Following are homework policies.

- Homeworks must be handed in as a hard copy unless prior arrangements have been made with the instructor or TAs.

- No late homeworks will be accepted after the due date and time unless you have a note from someone like a doctor or dean. There are no exceptions to this rule.

- All homeworks must either be typed or written in legible handwriting. You will lose points for illegible homework. Mathematical expressions must be clearly presented with all variables defined.

- You must include and code you use to get results in your homework.

- You are encouraged to discuss the homework with your classmates, but your explanations and derivations must be your own.

- You may not refer to homework problems from previous editions of this course. You also may not refer to solutions manuals, etc., for problems assigned from textbooks.

- The logic and *significance* of the results in your homeworks must be discussed in clear English.

- Graded homeworks are returned within two week after they are submitted.

Prerequisites and assumed background

Mathematics. Courses in ODEs and PDEs are a prerequisite for the course, as we will be analyzing some differential equations. We will also be applying concepts from probability and statistics. That said, if you feel like your mathematical background is shaky, do not worry. Mathematical rigor is not the central thrust of this course, and the TAs and I will assist you with mathematical difficulties.

Programming. Some of the problem sets will ask you to write short programs to do simulation or analysis. The calculations will not be computationally intensive, and may be written in a high-level language. You can use tools such as Python, Matlab, Mathematica for this purpose. As these skills are needed, we will provide tutorials and handouts to help you along.

Lecture policies

Lecture attendance is mandatory. We will have in-class discussions about the literature, and participation essential. It is also imperative that you are present for the background lectures because we all need to be on the same page for the discussions.

Lectures are a very important time for me to interface with you. As we have discussions in lecture, we both learn, and I get a good idea of how you are doing with the material. I therefore often find it distracting when students use laptops in lecture. Nonetheless, I do not what to take away your preferred method of note-taking, if that is the case, so laptops are allowed in lecture. **I do ask that you use laptops and tablets strictly for note-taking purposes.** Cell phones must be completely silenced and put away.

Lectures may not be recorded without my permission. If you miss a lecture, I invite you to discuss what you have missed with a classmate, your TAs, or with me.