

## Course Syllabus

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**Professor:** Dr. Joshua Weitz

**Contact information:**

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**Lectures:** Monday, Wednesday, Friday, 3:05-3:55 PM in Cherry Emerson 320

**Textbooks:**

**Required:**

Uri Alon (abbreviated A), An Introduction to Systems Biology: Design Principles of Biological Circuits. Chapman & Hall/CRC, 2007.

**Suggested reading:**

Mark Ptashne and Alexander Gann (abbreviated P). Genes and Signals. Cold Spring Harbor Laboratory Press, 2002.

Steven Strogatz (abbreviated S). Introduction to Nonlinear Dynamics. Addison-Wesley, 1994.

Special readings to be posted on <http://tsquare.gatech.edu>

**Course Topics:** Mathematics of gene regulation; transcriptional network dynamics; structure of transcription networks; network motifs; robustness; applications including chemotaxis, development, kinetic proofreading and optimal circuit design.

**Prerequisites:** The equivalent of BIOL 2400 or (BIOL 1510 AND MATH 2403). Students should be comfortable with basic mathematical concepts of simple probability, statistics, and integration/differentiation & basic biological concepts of how a cell works. Introductory material on the biology and mathematics of systems biology will be introduced as needed.

## Overview

Advanced introduction to systems biology and the quantitative analysis of how cells work: from gene regulation to complex networks to examples of chemotaxis, kinetic proofreading, and collective behaviors. The textbook, An Introduction to Systems Biology, is accessible to math, science, and engineering, majors. The aim will be to develop quantitative toolkits to analyze the complex mechanisms behind the regulation, design, and operation of biological circuits. Computer programming will be done in Matlab, though no prior experience with Matlab is necessary for the course.

## Course format

Three hours each week are scheduled for the class. Class time will be divided among traditional lectures and group problem-solving exercises or discussions. A component of the course will involve students formulating and solving problems in small cooperative groups of three to four members.

Some class days will be devoted to in-class modeling exercises. These days will be announced at least one day prior to class. You are encouraged to bring laptop computers to class to work on these problems.

The reading listed for each week should be done *prior* to the first lecture of the week. The course is tightly tied to Alon's book, and you will get more out of and contribute more to in-class discussions if you are up to date with the reading.

**Software:** Implementation of homework requires use of (i) mathematic analysis; and (ii) Matlab.

### Grading Scheme:

- 45% homework
- 15% midterm
- 15% final presentation
- 15% final paper
- 10% class participation

**Final project:** Final projects will be developed over the course of the semester. Final presentations are *tentatively*, scheduled for the week of April 25-29. Final papers will be due on April 29<sup>th</sup>. More information will be available later in the term.

**Homework:** All homework should be done individually. Setting up study groups to discuss problems is okay, however, each student is responsible for solving and writing up their own solutions and explanations.

**Midterm:** In-class exam to last 50 minutes, tentative date is March 11<sup>th</sup>.

**Attendance:** Regular attendance in lectures is expected – most lectures will include some component of group work and problem solving. Exceptions will be accepted for valid, documented reasons only, including: (1) official representation of the Institute; and (2) medical emergencies.

**Academic Integrity:** Students are reminded of the obligations and expectations

associated with the Georgia Tech Academic Honor Code and Student Code of Conduct, available online at:

[http://www.deanofstudents.gatech.edu/integrity/policies/honor\\_code.php](http://www.deanofstudents.gatech.edu/integrity/policies/honor_code.php)

<http://www.deanofstudents.gatech.edu/codeofconduct>.

Any violations must be reported to directly to the Dean of Students.

**Additional Resources:**

- Tsquare — <http://tsquare.gatech.edu>
- Tech Tutoring — <http://www.undergradstudies.gatech.edu/supportTutoring.htm>

**Updates:** This syllabus is subject to modification. Any changes will be announced in class and posted on the course website.

**Lecture Schedule:**

Note that special lectures and events, including exams & break, are noted in **bold**.

*I. Introduction to Systems Biology - Overview*

Readings: Matlab handout, Molecular biology cheat sheet, S.1 & S.2

January 14, 19 & 21

**January 14: Course logistics; course overview**

**January 17: MLK holiday**

**January 19: Molecular biology fundamentals**

**January 21: Introduction to Matlab**

*II. Basic concepts of transcription networks*

Readings: A.2 & P.1

January 24, 26 & 28 (HW1 out)

*III. Autoregulation: a network motif*

Readings: A.3

January 31, Feb 2 & 4 (HW1 due; HW 2 out)

*IV. The feed forward loop network motif*

Readings: A.4

February 7, 9 & 11 (HW2 due; HW3 out)

*V. Global structure of transcription networks*

Readings: A.5

February 14, 16 & 18 (HW 3 due; HW 4 out)

*VI. Biological chemotaxis*

Readings: A.7 & handouts

February 21, 23 & 25 (HW4 due; HW 5 out)

*VII. Kinetic proofreading (JSW away – guest lecturer)*

Readings, A.9

February 28, March 2 & 4 (HW 5 due)

*VIII. Evaluation & final project development*

Readings: Handouts

March 7, 9 & 11

**Final project in-class exercise, March 7**  
**Final project idea critique, March 9**  
**Midterm, March 11**

IX. Resources in the analysis of biological circuits (experimental techniques, data manipulation methods, and dynamical inference)

Readings: Handouts TBA

March 14, 16, 18 (Abstract of project proposal due; Midterm returned)

**Spring break, March 21-25**

*X. Identifying interactions from gene expression data*

Readings: Handouts TBA

March 28, 30, & April 1 (Abstracts returned)

**April 1 – Project lab day**

*XI. Noise in biological networks*

Readings: Handouts TBA

April 4, 6 & 8

**April 8 – Project lab day**

*XII. Quantitative features of complex gene regulation*

Readings Handouts TBA

April 11, 13 & 15

**April 15 – Project lab day**

*XIII. Final project preparation week*

April 18, 20 & 22

*XIV. Final project presentations*

Readings: A.12

**April 25: No-class (JSW traveling – will reschedule extra presentation class)**

**April 27: Presentations**

**April 29: Presentations**