

10.521: DESIGN PRINCIPLES IN MAMMALIAN SYSTEMS & SYNTHETIC BIOLOGY

Fall 2021

Instructor:	Katie Galloway	Time:	TR 13:00 – 14:30
Email:	katiegal@mit.edu	Place:	66-154.

Course Description: This course focuses on the layers of design, from molecular parts to large transcriptional networks in mammalian biology. The course formally introduces concepts in the emerging fields of mammalian systems and synthetic biology, including engineering principles in neurobiology and stem cell biology. One aim is to expose students from quantitative backgrounds to problem-solving opportunities at the interface of molecular biology and engineering.

Course Pages:

1. [Canvas](#)

Office Hours: After class, or by appointment.

Main References:

- Uri Alon, *An Introduction to Systems Biology - Second Edition*, CRC Press, 2019.

Objectives: This course is primarily designed for graduate students and advanced undergraduates looking to dive into topics in mammalian synthetic and systems biology.

Prerequisites: An undergraduate-level understanding of molecular cell biology, kinetics, thermodynamics, and ordinary differential equations is assumed.

Tentative Course Outline:

- Week 1: Introduction to Course and Policies
- Week 2: Intro to Synthetic Biology: Tools, Parts, & Systems
- Week 3: Introduction to Principles in Molecular Systems Biology
- Week 4: Now Make it Mammalian
- Week 5: Challenges in Mammalian Systems
- Week 6: Novel Tools in Mammalian Systems
- Week 7: Engineering Cell Fate: Stem Cells and Reprogramming
- Week 8: Systems-level Principles of Cell-fate Transitions
- Week 9: MAPK Pathways in Cell-fate Decision-Making
- Week 10: AIChE; No Class
- Week 11: Engineering Chromatin and Nuclear Architecture
- Week 12: Thanksgiving; No Class
- Week 13: Modeling Neurological Disease with Engineered Cells
- Week 14: Group Project Presentations

Grading Policy:

Journal club presentation	40%
Written topic summaries	20%
Modeling project	20%
Group project	20%

Important Dates:

Lecture	Tuesdays
Journal club presentations	Thursdays
Modeling project	November 16, 2021
Group project	December 7-9, 2021

Class Policy:

- Regular attendance is essential and expected.

Journal Club: For each weekly topic, 5 papers will be posted that are relevant for that week's topic. You will sign-up for one to provide the class with a quick summary. You will also select a paper not on the list to compare with the pre-selected paper. Each paper should be summarized in a single slide and no more than 5 minutes. Over the course of the semester you should present approximately 5 times on a total of 10 papers. This may vary by class size.

Topic Summary: Based on the lecture and journal club for the weekly topic, a summary of the content and synthesis of the ideas will be prepared. A questionnaire will be provided to guide the narrative response. Two topic summaries of the 10 topics should be completed over the course of class.

Modeling Project: Each student will select a model from a system developed in bacteria and adapt that model to the parameters of a mammalian system. Each student will summarize how changes in parameters affected the desired properties of the system and what mitigating strategies could be employed to restore or enhance functionality.

Group Project: A project of with teams of 2-3 people. Format of deliverables and other details TBD.