

Course Syllabus

Classroom & Contact Information

10am-11am: Lecture (room TBA, but first day lecture is in the lab room)
11am-12pm: Life Skills (room 1-150)
12pm-1pm: Lunch (room 3-270)
1pm-3pm: Lab (room 31-068)

Finding your way around: see <http://whereis.mit.edu> for a map.

Email: seed-synthbio@mit.edu (All Instructors and T.A.s)

Course website: <http://openwetware.org/wiki/SEED/2012>

Jacob Rubens (Instructor)

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Tyler Wagner (T.A.)

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Hannah Johnsen (T.A.)

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Office Hours

Office hours, tutoring, and homework help will be held on a weekly basis. Time and location of office hours will be announced at the beginning of the semester.

Description / Goal / Objective

Synthetic Biology is an exciting emerging field which seeks to develop and facilitate the engineering of biology as an intentional, rational, standardized, and reproducible discipline. Synthetic Biology takes a ground up approach to the creation of living machines for achieving a wide variety of engineering objectives in fields ranging from medicine to environment and energy to computation. The goal of this class is to gain practical, hands-on experience in molecular biology techniques relevant to the field of Biological Engineering while learning the design concepts, methods, and rationale behind Synthetic Biology.

During the course, we will learn the process of cloning a gene from start to finish including using PCR to amplify a gene of interest, BioBrick assembly of DNA fragments, transformation of DNA into a host bacteria strain, and controlled expression through a variety of expression systems. Finally, we characterize the systems we have created so that they may be understood and used in a quantitative fashion.

Course Website

Course materials will be posted online at the course website (wiki format). Students are expected to be familiar with using the website for access to reading material, assignments, discussion, and project submission. The course website can be found at:

<http://openwetware.org/wiki/SEED/2012>

Grading

Assignments (30%)

Assignments are an essential component of the class. We rely on homework to extend learning objectives, assess progress, and reinforce key concepts. We encourage students to work together and discuss the class material, but all work is expected to reflect the student's individual work. Homework will be assigned for each class session and will include: readings on course material, written summaries and critical evaluations, various problems and calculations, and final project design and development.

A "Pre-Lab" will be assigned as a supplement to each homework. The purpose of these assignments (often consisting of general questions that require brief responses or short calculations) is to facilitate the mastery of new material and laboratory techniques. Pre-Lab assignments may require looking up terms and concepts and thus need to be completed *before arriving at SEED*.

Final Project (20%)

The project for the course will be a design project in which the students are expected to propose a design and construction method for the production of a synthetic biological system. The final project will be presented in poster format at the final ceremony.

Quizzes & Exam (20%)

To measure student progress and emphasize critical concepts, several brief in-class quizzes will be given during the semester. Quizzes will cover topics discussed in class as well as those covered in homework. One comprehensive exam will be given at the end of the semester to assess success in achieving course objectives. The exam will be short and will encompass all of the topics covered in lecture, laboratory, and homework.

Labwork & Safety (10%)

Students are expected to work diligently to complete each experiment. Because this is a laboratory class, completion of assigned lab work and strict adherence to the safety policy are of the utmost importance. There will be no tolerance for breaking safety rules. In addition, *lab cleanliness is essential*; students are expected to ensure that their lab space is tidy before leaving for the day. *Proper labeling of all samples and solutions is required*.

One critical component of any experimenter's work is accurate record-keeping. Students will be provided a lab notebook in which they will describe procedures, record data and observations, and make any further relevant notes. Students will be allowed to take these notebooks outside the laboratory (for review, to complete assignments, etc.). *It is crucial that students bring their lab notebooks to each and every class period. Lab notebooks must be kept in pen (no pencil)*.

Attendance & Participation (20%)

Participation in class discussions is critical for comprehension of course material. Students are expected to actively join in on class discussions and ask questions to clarify confusing points that may come up.

Attendance / Schedule / Punctuality

Since a large portion of the course material includes lab work, attendance is required at all class sessions. Some information provided in lecture will not be available online. If an absence from class is necessary, the student is expected to complete all relevant assignments and to attend office hours/tutor session to review the material missed.

Class will be held during the first half of the morning session (10:00 am – 11:00 am) and all of the afternoon session (1:00 pm - 3:00 pm). Biological experiments take significant time to set up and run, and are very sensitive to timing. Students are expected to arrive promptly at the beginning of class sessions ready to begin.

Lab Safety & Clean-up

Our first priority is to create a safe environment for learning and discovery. Since this class will be taught in a laboratory setting, there are special considerations for classroom safety. The first day of class will include a biosafety training session; students are required to attend this session and follow all practices describe during the presentation. Some key points of laboratory safety:

- ⤴ NO eating or drinking in Lab
- ⤴ NO open-toed shoes / sandals
- ⤴ NO shorts (long pants or long skirts only)
- ⤴ Safety glasses & laboratory coat **MUST** be worn at ALL times
- ⤴ Gloves required when performing experiments
- ⤴ Do not touch equipment or chemicals we are not using
- ⤴ Put away lab materials as instructed at the end of each session; keep the lab neat
- ⤴ Bring a pen (not a pencil), course manual, and lab notebook to class with you

Finally, one component of lab safety that deserves special note is **clean-up**. Messy workspaces not only hinder productivity, but more importantly, increase the likelihood of potentially dangerous accidents. Students will be expected to clean their assigned workspaces at the end of each day and keep them neat during the lab session.

Prerequisites

Synthetic Biology builds upon the science disciplines of biology (and in turn chemistry), and incorporates engineering principles as well. In order for us to cover the synthetic biology material over the term, all students must be familiar with the basic background material of molecular and cellular biology as well as simple chemistry. You need to understand the following concepts in order to do well in the class. We will review many of them on the first day.

If you are unfamiliar with any of this material or need extra review, please check the appendices at the end of the lab manual and/or seek extra assistance outside class hours.

Basic Chemistry

- ⤴ The Metric System
 - ⤴ Base Units
 - ⤴ Prefix System (especially milli, micro, and nano)
- ⤴ Relationship and inter-conversion between:
 - ⤴ Mass
 - ⤴ Moles
 - ⤴ Molecular Weight
- ⤴ Units of Concentration and their Inter-conversion
 - ⤴ Mass Concentration (%)
 - ⤴ Molar Concentration (molarity)
 - ⤴ Concentration Factors
- ⤴ Inter-conversion between:
 - ⤴ Concentration
 - ⤴ Volume
 - ⤴ Quantity of Material (mass, moles)

Basic Biology

- ⤴ Basic Prokaryotic Cellular Structure & Organization
 - ⤴ Compartmentalization & Cell Membranes
 - ⤴ Difference between Prokaryotes & Eukaryotes
 - ⤴ Cell Division
 - ⤴ The Role of DNA
 - ⤴ The Composition and Role of Proteins
- ⤴ DNA Composition & Structure
 - ⤴ The Nitrogenous Bases
 - ⤴ Anti-Parallel Strands & Base Pairing
- ⤴ The Central Dogma of Biology
 - ⤴ Transcription of DNA to mRNA
 - ⤴ Translation of mRNA into protein