BIMM 194 – Synthetic Biology
Winter 2024

Professor: Nan Hao, E-mail: nhao@ucsd.edu

Lecture: Friday, 2:00 – 3:20 PM, YORK 3010

COURSE SUMMARY
Synthetic biology is an interdisciplinary field that merges biology, engineering, and computational sciences to design and construct novel biological systems or redesign existing ones. By leveraging the principles of standardization, modularity, and abstraction, it aims to engineer biological components to create solutions for diverse applications, from healthcare and biotechnology to environmental sustainability. This course serves as a dynamic platform for exploring cutting-edge research, discussing seminal papers, and dissecting the fundamental principles that underpin the rapidly evolving field of synthetic biology. By critically analyzing and discussing landmark papers, students gain invaluable insights into the latest methodologies, tools, and breakthroughs driving advancements in synthetic biology. With a focus on fostering critical thinking, debate, and a deeper understanding of synthetic biology and its applications, this course empowers students to become adept in navigating the complex landscape of this revolutionary scientific discipline.

COURSE FORMAT
We will have weekly seminar-style presentations in person at YORK 3010. You will be a member of a team of 3-4 students. Each group will be assigned with one primary research paper to present a 60 minutes' seminar, including approximately 45 minutes for the presentation and 15 minutes for questions and discussions. Please do not run over time!

The team members should collaborate to synthesize a cohesive presentation, and each student should present some portion of the presentation. EACH presenter must be able to clearly explain ANY part of the assigned paper.

All the students (no matter as presenters or audience) are required to read the assigned paper carefully before each class.

PRESENTATION CONTENT
Presentations should be thoroughly prepared and clearly delivered. There should be several components of your presentation:

I. **Background & Introduction:** You should begin with an introduction that provides the context of the work. Make sure to provide adequate background, so that the class can understand the rationale behind the study. For example, what is the biological significance of the signaling pathway or receptor that authors study? What is the question they were trying to address? Why was it an important question? It is likely that you will need to read additional articles, such as some of the citations in the article's introduction section, or a review article. Oftentimes, it is helpful to show a figure or two from review articles to describe the bigger context of the research or the molecules of interest.

II. **Figures & Tables:** You should describe main figures and tables in the article, explaining the techniques they used and the results they obtained. It is important to highlight controls that are key for the data interpretation. You may also cover some supplemental material if they can help you convey the points. Inclusion of movies is usually a great way to engage the audience. For complex experiments, you are also encouraged to generate customized animations or cartoons to help your explanation.

III. **Conclusion & Implications**: You should close the presentation with a discussion of the major conclusion of the paper. Showing a model to summarize the key findings is also helpful. Discuss the overall contribution to the field, the limitation of the work, and possible future studies that can build on this work.

There are four major questions should be addressed during the presentation:
1. What is the most important conclusion and take-home message?
2. What is the most critical experiment that supports their main conclusion?
3. Are there major caveats in the study?
4. What are the most important follow up questions that should be addressed?

Please email your finalized PPT to Dr. Hao before the class and bring it on a memory stick to the class. This way, in case your laptop fails to communicate with the projector, you will be able to use Dr. Hao's laptop for the presentation.

Presenters should arrive 15 min before the class start time to set your presentation up.

GRADING:
There will be NO final exam. Your performance in the course will be evaluated based on three aspects:
1. Oral presentation of the assigned paper
2. In-class iClicker questions
3. Submission of audience peer evaluations

Total: 100 pts

1. **Oral presentation of the assigned paper (45 pts):** Your peers in the audience will submit a Peer Audience Evaluation Form with via canvas to evaluate your presentation. The form asks you to evaluate nine aspects of the presentation on a scale 1 to 5. Every member of the team will share the same score.

2. **Submission of audience peer evaluation (12 pts):** for each seminar that you are not presenting, you are asked to submit a Peer Audience Evaluation Form to rate/comment on the quality of the presentation. There will be a total of 6 evaluation forms to submit for the course, and each submission will earn you 2 points.

3. **In-class questions (32 pts).** In addition to providing feedbacks about your learning, these iClicker questions are primarily used to record your lecture attendance. Your points will be based entirely on clicker <u>use</u>, not on whether you get the iClicker questions right. There will be a total 16 iClicker questions for the entire course, two per lecture (except the first week). The first question will be given before the presentation to check your understanding of the paper. The second question will be given after the presentation to check the improvement of your understanding.

4. **Professor evaluation (11 pts).** At the conclusion of the course the Professor will assign up to 18 points based on your performance as a presenter (5 pts) and your participation in Q/A when you are not a presenter (6 pts).

Class Schedule

Jan 12 – Class Overview

Jan 19 - Demo Presentation
A programmable fate decision landscape underlies single-cell aging in yeast.
Li Y, Jiang Y, Paxman J, O'Laughlin R, Klepin S, Zhu Y, Pillus L, Tsimring LS, Hasty J, Hao N.
Science. 2020 Jul 17;369(6501):325-329. doi: 10.1126/science.aax9552.
PMID: 32675375

Jan 26
Construction of a genetic toggle switch in Escherichia coli.
Gardner TS, Cantor CR, Collins JJ.
Nature. 2000 Jan 20;403(6767):339-42. doi: 10.1038/35002131.
PMID: 10659857

Feb 2
A synthetic oscillatory network of transcriptional regulators.
Elowitz MB, Leibler S.
Nature. 2000 Jan 20;403(6767):335-8. doi: 10.1038/35002125.
PMID: 10659856

Feb 9
Network motifs: simple building blocks of complex networks.
Milo R, Shen-Orr S, Itzkovitz S, Kashtan N, Chklovskii D, Alon U.
Science. 2002 Oct 25;298(5594):824-7. doi: 10.1126/science.298.5594.824.
PMID: 12399590

Feb 16
Rewiring MAP kinase pathways using alternative scaffold assembly mechanisms.
Park SH, Zarrinpar A, Lim WA.
Science. 2003 Feb 14;299(5609):1061-4. doi: 10.1126/science.1076979.
PMID: 12511654

Mar 1
A synchronized quorum of genetic clocks.
Danino T, Mondragón-Palomino O, Tsimring L, Hasty J.
Nature. 2010 Jan 21;463(7279):326-30. doi: 10.1038/nature08753.
PMID: 20090747

Mar 8
Creation of a bacterial cell controlled by a chemically synthesized genome.
Gibson DG, Glass JI, Lartigue C, Noskov VN, Chuang RY, Algire MA, Benders GA, Montague MG, Ma L, Moodie MM, Merryman C, Vashee S, Krishnakumar R, Assad-Garcia N, Andrews-Pfannkoch C, Denisova EA, Young L, Qi ZQ, Segall-Shapiro TH, Calvey CH, Parmar PP, Hutchison CA 3rd, Smith HO, Venter JC.
Science. 2010 Jul 2;329(5987):52-6. doi: 10.1126/science.1190719.
PMID: 20488990

Mar 15
Engineering longevity-design of a synthetic gene oscillator to slow cellular aging.

Zhou Z, Liu Y, Feng Y, Klepin S, Tsimring LS, Pillus L, Hasty J, Hao N.
Science. 2023 Apr 28;380(6643):376-381. doi: 10.1126/science.add7631.
PMID: 37104589