Winter 2021 Bi 23 Section 2 Syllabus

An Exploration of Protein Design and Engineering

DNA mutations and their corresponding changes in amino acids play an essential role in evolution. Recent advancements in biochemistry allow scientists to utilize DNA mutagenesis to create new enzymes, biosensors, antibodies, and even perform gene therapy! In this tutorial, we will learn about basic protein structure (primary, secondary, tertiary, quaternary) and then proceed to examine a range of modern techniques for protein modification, mutation, and evolution. We will study methods such as mutagenic PCR, site-saturated mutagenesis (SSM), display techniques (phage, mRNA), and CRISPR-Cas9. As we learn about each of these topics, we will examine complementary primary literature to see how protein design and engineering contributed to solving a unique scientific question.

Relevant Contact Information

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Office hours: By appointment

I'm excited to go through this course material with all of you. I hope this course will be helpful and instructive! My hope is that by the end of the course you will 1) understand how these techniques work and 2) the types of scientific questions they can be used to answer, so that you can then 3) use these techniques in future work as a scientist.

I'd prefer that you email me rather than call/text me, but if it's urgent, feel free to do so. I'm usually off email by about 6 pm, but I'll do my best to get back to you within 24 hours.

Schedule

Week 1 (1/4-1/8) – Organizational Meeting

Week 2 (1/11-1/15) – Review of protein structure, polymerase chain reaction (PCR),

Week 3 (1/18-1/22) – Introduction to mutagenic PCR

Reading: Engineering green fluorescent protein for improved brightness, longer wavelengths and fluorescence resonance energy transfer PMID: 8673464 DOI: 10.1016/s0960-9822(02)00450-5

Week 4 (1/25-1/29) – Review mutagenic PCR paper, Introduction to site-saturated mutagenesis

Reading: Engineering cytochrome P450s for enantioselective cyclopropenation of internal alkynes PMID: 32223130 DOI: 10.1021/jacs.0c01313

Week 5 (2/1-1/5) – Review SSM, introduction to phage display

Reading: A human SARS-CoV neutralizing antibody against epitope on S2 protein PMID: 15939399 DOI: 10.1016/j.bbrc.2005.05.089

Week 6 (2/8-2/12) – Review phage display paper, introduction to mRNA display

Reading: α1-FANGs: Protein Ligands Selective for the α-Bungarotoxin Site of the α1-Nicotinic Acetylcholine Receptor PMID: 30059207 DOI: 10.1021/acschembio.8b00513

Week 7 (2/15-2/19) – Review mRNA display paper, introduction to CRISPR-Cas9

Reading: Loss of heterozygosity of essential genes represents a widespread class of potential cancer vulnerabilities. PMCID: PMC7239950 DOI: 10.1038/s41467-020-16399-y

Submit your mini proposal topic to me!

Week 8 (2/22-2/26) – Review CRISPR paper, answer questions on mini proposals

Week 9 (3/1-3/5) – Mini Proposal Day!

Class structure

The class will be structured so that we will be splitting half of our time talking about how each protein design and engineering techniques works and the other half will be studying their use in a scientific publication. Once we are into the swing of things, the first half of class will be the discussion of the previous week's technique/publication and the latter half will be an introduction to the upcoming week's technique.

Grading

Given that Bi23 is pass/fail, the grading scheme will be fairly straightforward. Grades will be broken down as follows:

50% participation (Attendance will play a factor in this, but reading the papers and being prepared to talk about them will be the most important!)

50% mini proposal

Mini Proposal Details

Each member of the section will prep a 5 slide deck where they will:

1) Present a scientific problem of interest to them/the scientific community/world.
2) Propose the use of one of the techniques discussed in our class as a means to solve some part of that problem.
3) Explain why this technique is the best one suited for this problem.

Everyone will get ~10 minutes to present (7 mins for presentation, 3 mins for questions).

A grading rubric will be provided ahead of time to help guide your presentation. 😊

Academic Integrity

Caltech's Honor Code:

"No member of the Caltech community shall take unfair advantage of any other member of the Caltech community."

Understanding and Avoiding Plagiarism:

Plagiarism is the appropriation of another person's ideas, processes, results, or words without giving appropriate credit, and it violates the honor code in a fundamental way. You can find more information at: http://writing.caltech.edu/resources/plagiarism.

I believe academic integrity is crucial. Since this should be a class in which each mini proposal is unique, I think we should be able to avoid any problems easily. Feel free to chat with other members of the class about ideas for your mini proposals, but make sure that you land on something unique that you wish to cover. **I have dealt with academic misconduct in the past, so be assured that I will deal with plagiarism/cheating directly and with no hesitation.**

Students with Documented Disabilities

I will do all I can to make the necessary accommodations for any student who needs it. Please reach out to me directly via email and we can discuss your specific need. Additionally, please note that students who may need an academic accommodation based on the impact of a disability must initiate the request with Caltech Accessibility Services for Students (CASS). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty dated in the current quarter in which the request is being made. Students should contact CASS as soon as possible, since timely notice is needed to coordinate accommodations. http://cass.caltech.edu/.

Undergraduate students should contact Dr. Lesley Nye, Associate Dean of Undergraduate Students (administrative contact: Beth Larranaga) and graduate students should contact Dr. Kate McAnulty, Associate Dean of Graduate Studies (administrative contact: Jacob Dalton).