

A Primer on Molecular Biology, Fall 2018

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Prerequisites

- Interest in biology and science
- Ability to meet at the regularly scheduled time, **5-6:30 pm in 102 Wheeler**
- Must have taken: Chem 1A or 4A

Course Motivation

Laboratories are innovative factories that provide some of the greatest breakthroughs of the century; every ounce of medicinal advancements are entirely based on research that is conducted every day (usually at large institutions like UC Berkeley). However, to actually make these changes, a particular toolkit needs to be employed; this class will give you the basis of this toolkit.

Course Description

This course is intended to provide an introduction to laboratory-based molecular biology. UC Berkeley is one of the finest research institutions in the world - especially in the realm of biology; therefore, science majors here have the ability to partake in ground-breaking research with world-renowned faculty. However, if accepted, there is a certain amount of information you're expected to have learned; this information is not explicitly taught in any lower division course, and synthesizing it on your own can be daunting and difficult.

This course is intended to bridge this gap; we will be providing an insight into the basic techniques that will be utilized in any molecular biology lab. Of course, going over every possible laboratory mechanism is impossible; for this reason, we'll be discussing techniques that are the most common and often assigned to undergraduates when they first join laboratory. This will facilitate your transition into the laboratory and also help you make the most of your research experience, whether you currently are working in one or intend to in the future. The instruction will be done through a mixture of lecturing and group activities during class time.

Course Benefits

This course will provide an introduction to the concepts and skills professors expect undergraduate researchers to pick up; often times, the students who make the most of research (get publications, awards, patents, and additional research-based stipends) are the ones who have a strong foundation and understanding of molecular biology. This course is aimed as being the first step in developing that foundation. Furthermore, taking this course will also give you a kit of resources that you can then use in your future studies at Berkeley. Most importantly, you will develop a passion for molecular biology and come to understand how the field is revolutionizing our world today.

Key Learning Outcomes

At the end of this decal course, the students will be able to:

- Understand the basic notions of research and what it has the potential to accomplish.
- Understand the fundamental tools utilized in a basic biological research laboratory and their theoretical underpinnings.
- Understand the WHY behind several key lab techniques (knowing how to interrelate the classroom environment to the laboratory environment).
- Know how to apply to and attain a great research position within the UC Berkeley community (usually in a URAP-independent process)
- Be able to readily read and analyze different biological publications.
- Learn techniques that can facilitate a student's transition into a laboratory or research environment. These techniques include, but are not limited to:
 - Proper note taking
 - Proper pipetting
 - Proper data-analysis
 - Proper equipment/reagent care
- Approach future science courses from an experimental mindset.

Course Grading

The course is graded on a P/NP basis. Regular attendance, participation and completion of assignments is required for a Pass grade. In the case of habitual problems in any of these areas we may ask students to drop the course, or in the worst-case scenario, grant a NP grade. A rough weighting of grade breakdown is as follows, with a minimum of 70% being required to pass unconditionally.

Attendance 20%

Attendance will be taken every class. Two unexcused absences are allowed, after which the students risks being dropped from the course. Absences for midterms with prior notice (at least 48 hours in advance) or emergencies are acceptable.

Participation 10%

In addition to attending class, students are expected to actively participate during class. There will be group activities and plenty of space during presentations for questions and contributions from the students as well as event nights.

Homework 40%

There will be homework most weeks: this will usually be composed of a reading or video accompanied by a homework set. The set of questions will likely be based on the assigned reading/video and will provide additional insight into the concepts that we have discussed in class.

You will be expected to turn in homework for that week regardless of your attendance that week. If you are absent, turn it in to primeratcal@gmail.com. A hard deadline will be set for all homework assignments; one excused homework is allowed. Late submissions are permitted only due to extenuating circumstances.]

Final Project 30%

In groups, students will be expected to decompose a research publication revolving around relevant molecular biology techniques and discoveries in the field. Students will then be asked to report on these findings to the rest of the class during a short presentation.

As part of this final assignment, students will be expected to independently write a 2-3 page paper on the approved research publication as demonstration of understanding of the material. Grading will be based on clarity of information conveyed and extraction of relevant information from the publication.

Assignments

Students are expected to do the assigned reading/viewing every week and complete the assigned homework. The homework will be collected every week, graded both on accuracy of answers and the basis of completion.

Course Schedule (*subject to change)

9/6	Introduction, Course Overview, and General Laboratory Tips <ul style="list-style-type: none"> • Research Background and Instructor Introductions • Icebreaker • Overview of Material, Grading, Policies and Course Expectations • General Laboratory Tips
9/13	Introduction to Molecular Biology <ul style="list-style-type: none"> • Cell Theory and General Biology Review • Central Dogma of Molecular Biology: Processes and Key Players: Processes of Replication, Transcription, and Translation • Macromolecular Structure, Function, and Detection <p><u>Homework due today:</u> none <u>Homework this week:</u> Complete Homework #1</p> <p>Readings:</p> <ul style="list-style-type: none"> • Molecular Composition of Cells • Structure and Function of Genes • Optional Reading: Introduction to Molecular Biology Slideshow <p>Videos:</p> <ul style="list-style-type: none"> • A Beginner's Guide to Molecular Biology • Central Dogma

	<ul style="list-style-type: none"> • Using a Micropipette
9/20	<p>Introduction to Experimental Principles and Design & Cloning Part I: PCR and Gel Electrophoresis</p> <ul style="list-style-type: none"> • Experimental Set-up (Variables, Controls, Optimization) • Experiment Troubleshooting • Lab notebooks, pipetting, basic protocols • Sterile Technique • PCR basics • Types of PCR • Gel Electrophoresis <p><u>Homework due today:</u> Homework #1 <u>Homework this week:</u> Complete Homework #2</p> <p>Readings:</p> <ul style="list-style-type: none"> • The Polymerase Chain Reaction • Khan Academy PCR Guide • Khan Academy Gel Electrophoresis <p>Videos:</p> <ul style="list-style-type: none"> • Experimental Design • Hypothesis, Variables, and Controls • Aseptic Technique • Polymerase Chain Reaction (PCR) • PCR Education by ThermoFisher • Agarose gel electrophoresis
9/27	<p>Cloning Part II: Restriction Enzyme Digest and Ligations</p> <ul style="list-style-type: none"> • Restriction Enzymes/Restriction Enzyme "Test Digest" • Plasmid design • Ligations • Gibson Assembly <p><u>Homework due today:</u> Homework #2 <u>Homework this week:</u> Complete Homework #3</p> <p>Readings:</p> <ul style="list-style-type: none"> • Restriction Enzyme Diagnostic Digests • DNA Ligation • Gibson Assembly <p>Videos:</p> <ul style="list-style-type: none"> • DNA Cloning • Restriction Digest Analysis • Gibson Assembly
10/4	<p>Cloning Part III: From Transformations to Screening</p> <ul style="list-style-type: none"> • Bacterial Transformation • Plating, Colony Picking (Digest or Colony PCR), and Liquid Culture

	<ul style="list-style-type: none"> • Plasmid Extraction (Mini/Midi/Maxi-preps) • Blue White Screening • Interpreting DNA Sequencing Data • Stocking Overview <p><u>Homework due today:</u> Homework #3 <u>Homework this week:</u> Complete Homework #4</p> <p>Readings:</p> <ul style="list-style-type: none"> • Bacterial Transformation • Miniprep Guide and Protocol • Analyzing DNA Sequencing Data <p>Videos:</p> <ul style="list-style-type: none"> • The Mechanism of Transformation with Competent Cells • Competent Cell Transformation • How to Perform Colony PCR • Blue White Screening of DNA clones • Monarch Plasmid Miniprep Kit Protocol • Preparation of a Bacterial Stock Plate from a Frozen Stock • Creating Glycerol Stocks
10/11	<p>CRISPR Overview</p> <p><u>Homework due today:</u> Homework #4 <u>Homework this week:</u> Complete Homework #5</p> <p>Readings:</p> <ul style="list-style-type: none"> • CRISPR Vox article • CRISPR/Cas9 & Targeted Genome Editing: New Era in Molecular Biology • Addgene CRISPR Guide <p>Videos:</p> <ul style="list-style-type: none"> • Genetic Engineering will change everything forever – CRISPR • Mechanism of CRISPR Cas9
10/18	<p>Cell Culture and Transfections</p> <ul style="list-style-type: none"> • Cell Types and Maintenance • Transfection: Theory and Practice <p><u>Homework due today:</u> Homework #5 <u>Homework this week:</u> Complete Homework #6</p> <p>Readings:</p> <ul style="list-style-type: none"> • Cell Culture Basics Handbook <p>Videos:</p> <ul style="list-style-type: none"> • Cell Culture Training Video • Thawing, Passaging, and Freezing Cells • Mammalian Cell Culture Transfection

	<ul style="list-style-type: none"> • Plasmid DNA Transfection
10/25	<p>How to Get Research Night</p> <ul style="list-style-type: none"> • TA experiences • Tips for applying • Interviewing for lab positions <p><u>Homework due today:</u> Homework #6</p>
11/1	<p>Immunofluorescence, Blots, and Assays</p> <ul style="list-style-type: none"> • Antibody-Staining • Visualization • Flow Cytometry • BCA and Bradford-Lowry Assays • Western Blot + Visualization: SDS-PAGE and Transfer • Southern Blot • Antibody-Probing • ELISA <p><u>Homework due today:</u> None</p> <p><u>Homework this week:</u> Complete Homework #7</p> <p>Readings:</p> <ul style="list-style-type: none"> • Immunofluorescence: A General Overview • Western Blotting: Principles and Methods <p>Videos:</p> <ul style="list-style-type: none"> • Immunohistochemistry/Immunolabeling • IHC Troubleshooting • Flow Cytometry • Western Blotting • How to Run an SDS-PAGE Gel • SDS-PAGE Gel Electrophoresis • ELISA • Immunohistochemistry 101
11/8	<p>Research Panel Night</p>
11/15	<p>Bioinformatics</p> <ul style="list-style-type: none"> • Introduction to Bioinformatics • Shotgun Sequencing • Genotyping By Sequencing • QTL and GWAS • Bioinformatics Tools <p><u>Homework due today:</u> Homework #7</p> <p><u>Homework this week:</u> Work on final presentations and final papers</p>

	Readings: <ul style="list-style-type: none"> Bioinformatics: An Overview and its Applications Videos: <ul style="list-style-type: none"> What is Bioinformatics?
11/22	Thanksgiving Break (no class)
11/29	Final Presentations Group final presentations and individual written assignments due today