A Primer on Molecular Biology, Spring 2018

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Prerequisites
- Interest in biology and science
- Ability to meet at the regularly scheduled time, Thursdays 5-6:30 PM in 102 Wheeler
- Must have taken: Chem 1A or 4A; AP Bio or Bio 1A/1AL

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 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.

[Note: 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 accompanied worksheet. This worksheet will be collected every week, graded both on accuracy of answers and the basis of completion.

Course Schedule (*subject to change)

<table>
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<tr>
<th>Day</th>
<th>Course Content</th>
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<tr>
<td>2/8</td>
<td><strong>Introduction, Course Overview, and General Laboratory Tips</strong></td>
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<td>• Icebreakers</td>
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<td>• Research Background and Instructor Introductions</td>
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<td>• Overview of Material, Grading, Policies and Course Expectations</td>
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<td>• General Laboratory Tips</td>
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### 2/15

**Introduction to Molecular Biology**
- 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
- General Classes of Enzymes

**Homework Due Today:** none  
**Homework this week:** Complete Homework #1

**Readings:**
- Molecular Composition of Cells  
- Structure and Function of Genes

**Videos:**
- [A Beginner's Guide to Molecular Biology](#)  
- [Central Dogma](#)  
- [Using a Micropipette](#)

### 2/22

**Introduction to Experimental Principles and Design**
- Experimental Set-up (Variables, Controls, Optimization)  
- Experiment Troubleshooting  
- Lab notebooks, pipetting, basic protocols  
- Sterile Technique

**Homework Due Today:** Homework #1  
**Homework this week:** Complete Homework #2

**Readings:** None

**Videos:**
- [Experimental Design](#)  
- [Hypothesis, Variables, and Controls](#)  
- [Aseptic Technique](#)

### 3/1

**Cloning Part I: Cloning Basics**
- PCR basics  
- Types of PCR  
- Restriction Enzymes  
- Gel Electrophoresis  
- Plasmid design
Homework Due Today: Homework #2
Homework this week: Complete Homework #3

Readings:
• The Polymerase Chain Reaction

Videos:
• Polymerase Chain Reaction (PCR)
• PCR Education by ThermoFisher
• Agarose gel electrophoresis
• DNA Cloning

3/8
Cloning Part II: From Ligations to Screening
• Ligations
• Bacterial Transformation
• Plating, Colony Picking (Digest or Colony PCR), and Liquid Culture
• Plasmid Extraction (Mini/Midi/Maxi-preps)
• Restriction Enzyme “Test Digest”
• Blue White Screening

Homework Due Today: Homework #3
Homework this week: Complete Homework #4

Readings:
• Bacterial Transformation
• Miniprep Guide and Protocol
• Restriction Enzyme Diagnostic Digests

Videos:
• Plasmid Miniprep Kit Protocol
• How to Purify Molecular Grade Plasmid DNA
• The Mechanism of Transformation with Competent Cells
• Competent Cell Transformation
• How to Perform Colony PCR
• Blue White Screening of DNA clones

3/15
Cloning Part III: Sequencing, Stocking, & CRISPR Overview
• Interpreting DNA Sequencing Data
• Stocking Overview
• CRISPR

Homework Due Today: Homework #4
Homework this week: Complete Homework #5

Readings:
• Analyzing DNA Sequencing Data
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<tr>
<td>3/22</td>
<td>Research Panel (tentative)</td>
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<td>3/29</td>
<td>Spring Break (No Class)</td>
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<td>4/5</td>
<td><strong>Cell Culture and Transfections</strong></td>
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<td>• Cell Types and Maintenance</td>
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<td>• Transfection: Theory and Practice</td>
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<td>Homework this week: Homework #6</td>
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<td>• Cell Culture Basics Handbook</td>
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<td>• Lentiviral Plasmids Guide</td>
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<td>• Cell Culture Training Video</td>
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<td>• Thawing, Passage, and Freezing Cells</td>
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<td><strong>Immunofluorescence</strong></td>
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<td>• Immunofluorescence: A General Overview</td>
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<td>• Immunohistochemistry/Immunolabeling</td>
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<td>• IHC Troubleshooting</td>
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<td>• Flow Cytometry</td>
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| 4/19 | **Blots and Assays**  
- BCA and Bradford-Lowry Assays  
- Western Blot + Visualization: SDS-PAGE and Transfer  
- Southern Blot  
- Antibody-Probing  
- ELISA  
**Homework Due Today:** Homework #7  
**Homework this week:** Work on final presentations  
**Readings:**  
- Western Blotting: Principles and Methods  
**Videos:**  
- [Western Blotting](#)  
- [How to Run an SDS-PAGE Gel](#)  
- [SDS-PAGE Gel Electrophoresis](#)  
- [ELISA](#) |

| 4/26 | **Final Presentations**  
No Homework Due Today; Final Presentations and Final Papers Due Today |