

Discovery-Based Laboratory Courses and Teaching Assistant Training

Mary Ellen Wiltrout
Molecular and Cellular Biology Preceptor
Harvard University

My Path to Teaching and Discovery-Based Labs



Beth Jones
CMU
HHMI Professor



Graham Walker
MIT
HHMI Professor



Rich Losick
Harvard
HHMI Professor

Briana Burton



Tom Torello

The Harvard Glossary

Preceptor - similar to an instructor at MIT

- Expert in content - write problem sets and exams and some lecturing
- Responsible for laboratory experiment development and execution
- Manager of the teaching staff
- General problem-solver

Teaching fellows (TFs) = teaching assistants (TAs)

Discussion section = MIT recitation

Concentration = major

MCB 52: Molecular Biology

Who are my students?

~150 students

5% freshman, 58% sophomores, 32% juniors, 5% seniors

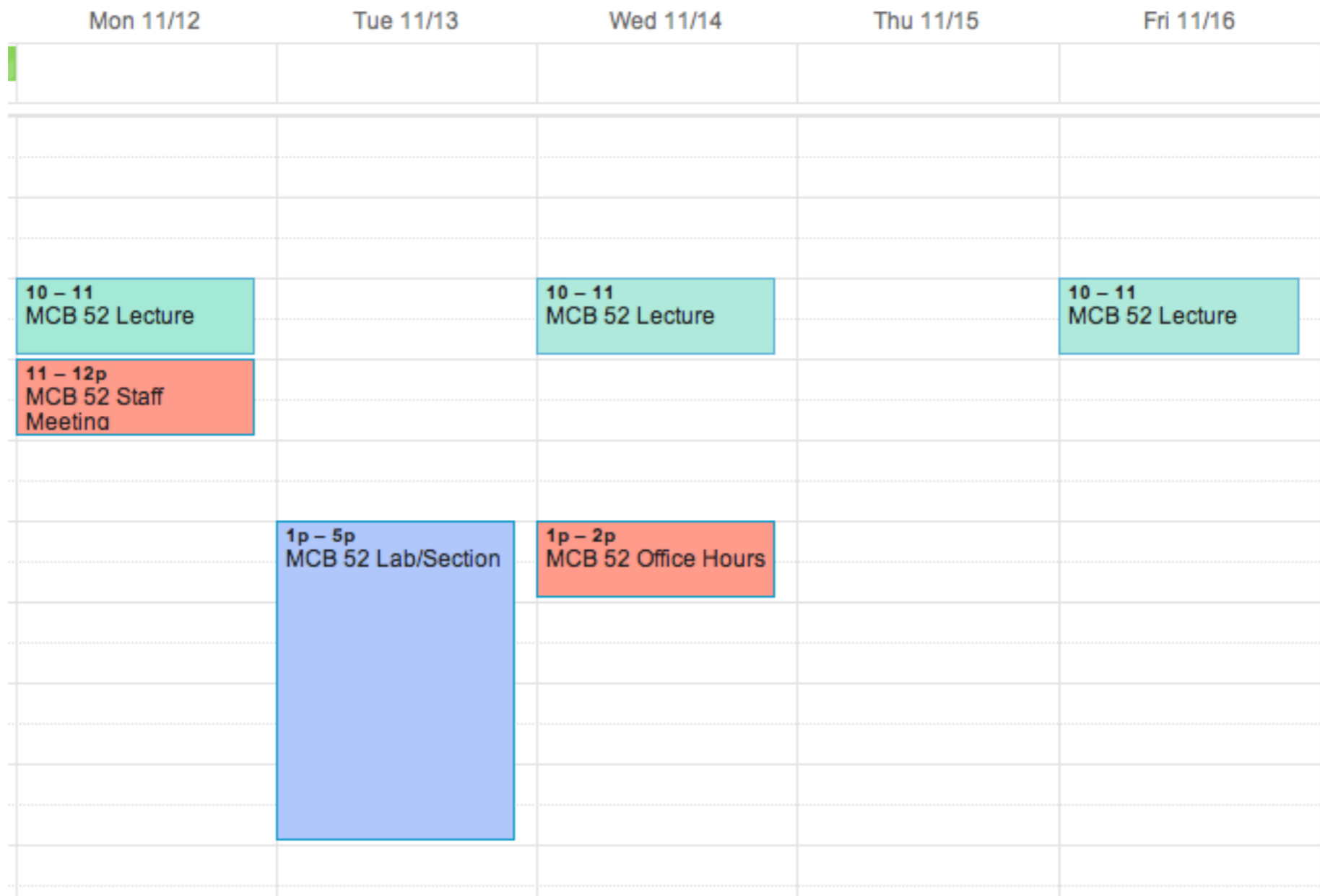
Reason for enrolling:

88% concentration requirement; 43% pre-med requirement

What is the structure of the course?

Hourly lectures on Monday, Wednesday, Friday

A four hour lab section that is fully integrated with problem-solving discussion section



Our Vision for the Course

Learning goals

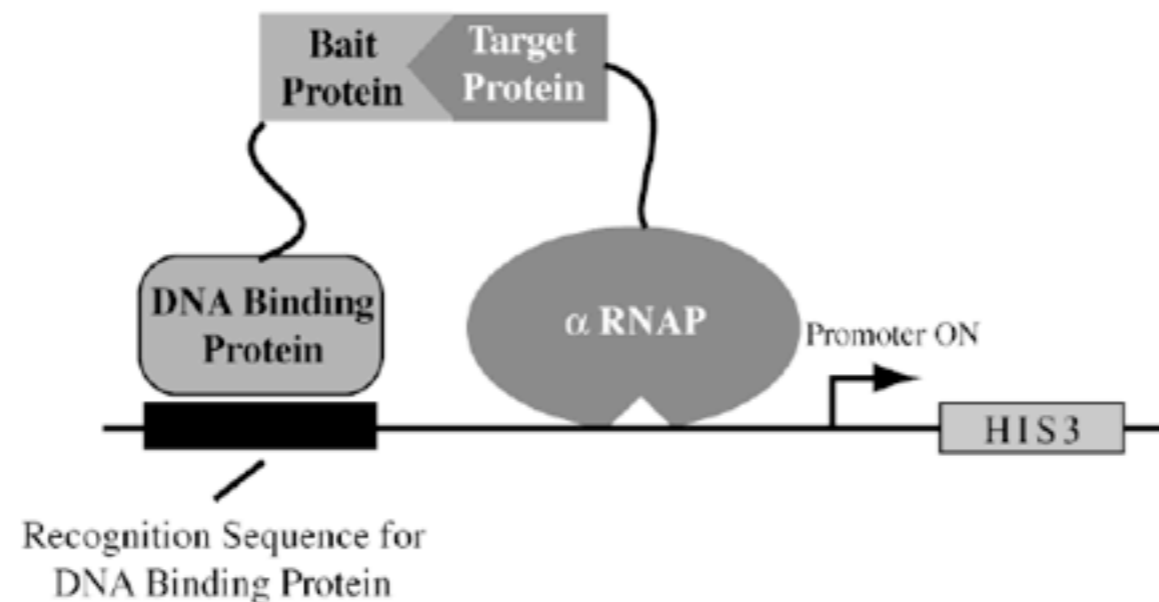
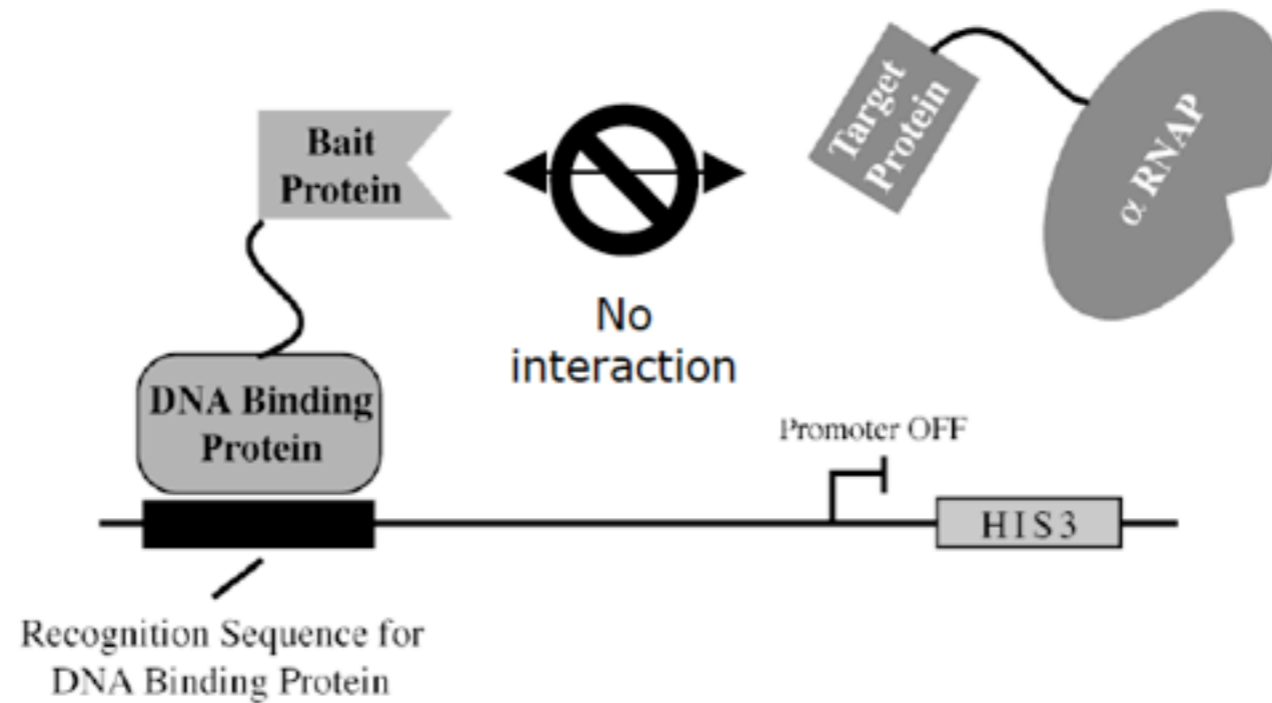
Content: You will learn about the basis of life.

Discovery: You will think like a scientist through discovery-based experiments accompanied with critical reading of research articles.

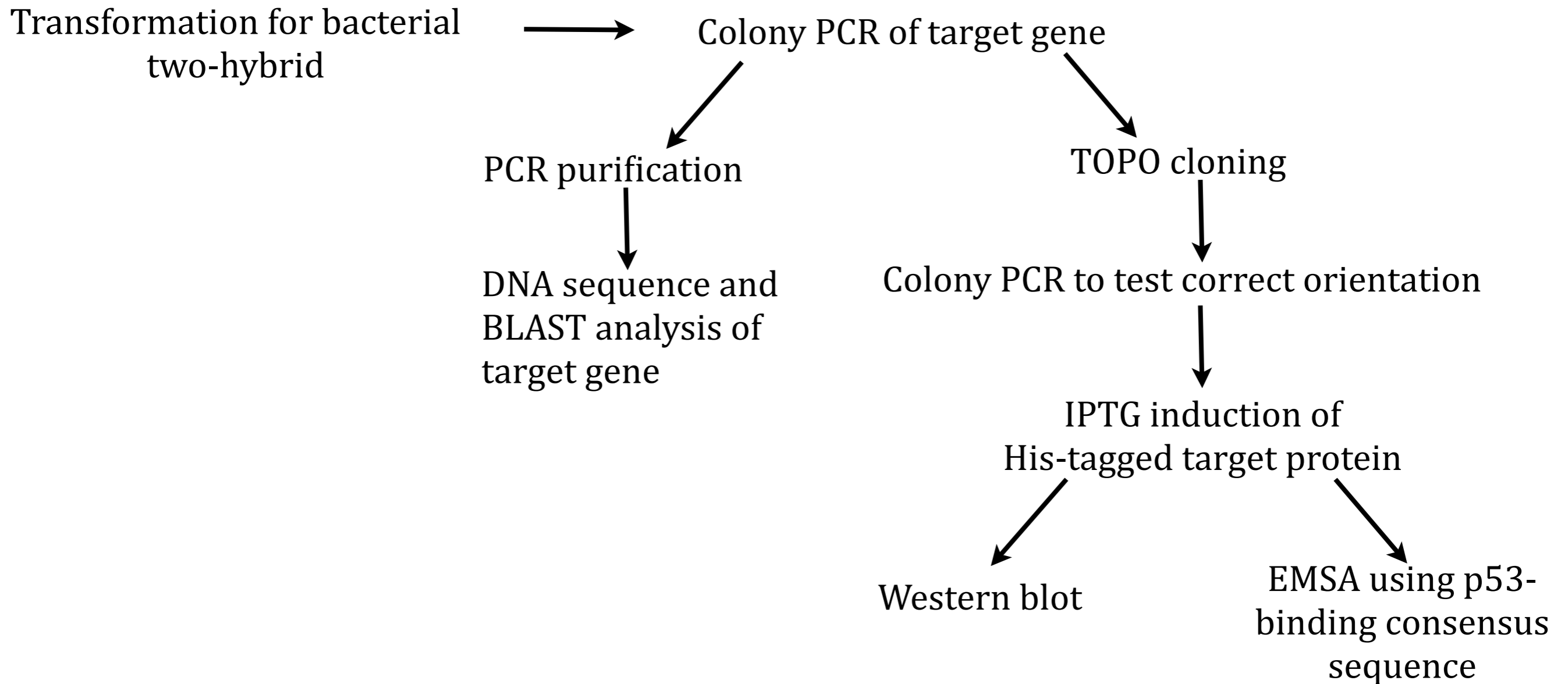
Pedagogy: You will develop effective strategies for learning.

1. You will be able to list, explain, and employ the tools molecular biologists use to study DNA, RNA, and proteins and the interactions between these molecules.
2. You will be able to interpret data from molecular biology experiments.
3. You will be able to perform molecular biology experiments and analyze the data that you produce.
4. You will be able to read, examine, and evaluate primary literature and will be able to apply the methods and concepts of molecular biology to discover new knowledge.
5. You will be able to clearly communicate in written and oral formats the process and results of experimental research from your own lab work and that found in the literature.

The Discovery-Based Lab: A p53 Bacterial Two Hybrid



Outline of the Lab Experiments



This lab series can be completed in 7 four hour lab sections.

TFs can complete the lab in 5 consecutive days.

Before I arrived, Tom Torello and Mandy Simons developed this lab. I optimized and added a western blot.

Requirements for Success

Ownership and discovery

The staff must do the identical lab in the same teaching lab space.

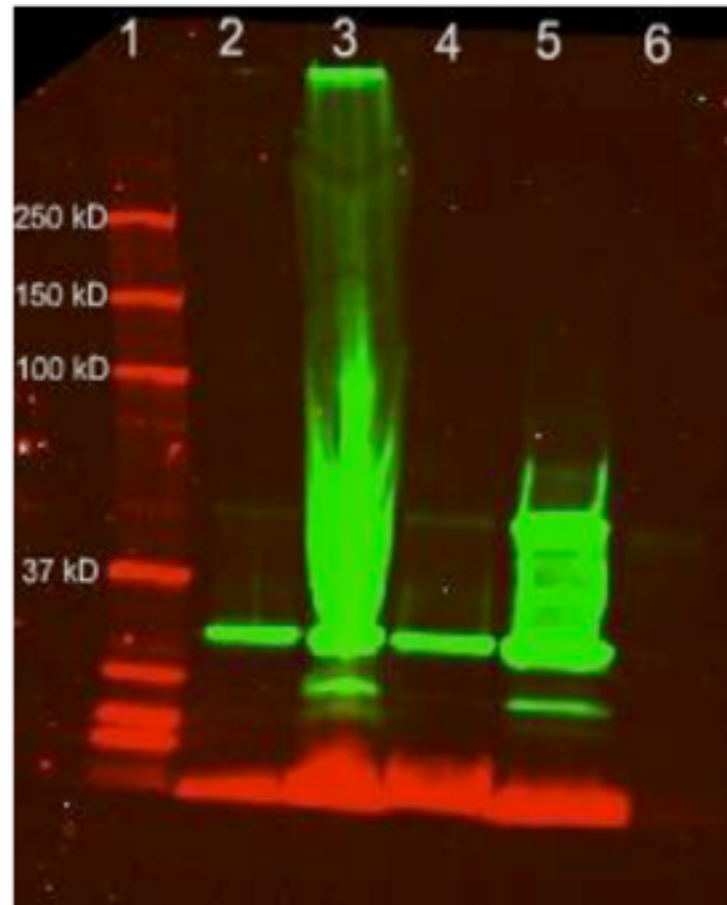
Pre-run all materials year-to-year.

Be ready for anything to go wrong.

Have back-up products ready for certain steps.

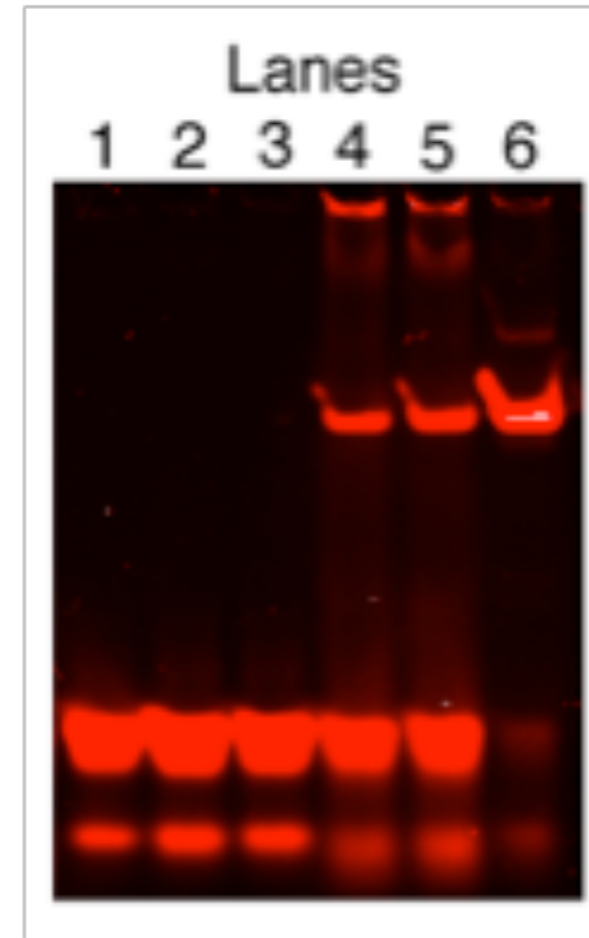
Sample Student Data

western blot



- Lane 1 - Molecular weight marker
- Lane 2 - uninduced whole cell
- Lane 3 - induced whole cell
- Lane 4- uninduced lysate
- Lane 5 - induced lysate
- Lane 6 - Positive control (did not work here)

EMSA



- dsDNA probe bound to p53 in wells
- possible supershift
- dsDNA probe bound to p53
- dsDNA probe
- ssDNA probe

How do we assess student learning for the lab?

Lab-based exam questions - increase in student motivation

Weekly submissions of post-labs (3% of total course grade)

- Figure and figure legend
- Answers to short questions

Lab report

- Includes abstract, introduction, materials and methods, results, discussion, and figures
- Part I submission for TF feedback (3% of total course grade)
- Final report submission (9% of total course grade)

Harvard Extension School

BIOS E-176: Experimental Molecular and Cellular Biology co-taught
with Cheryl Vaughn

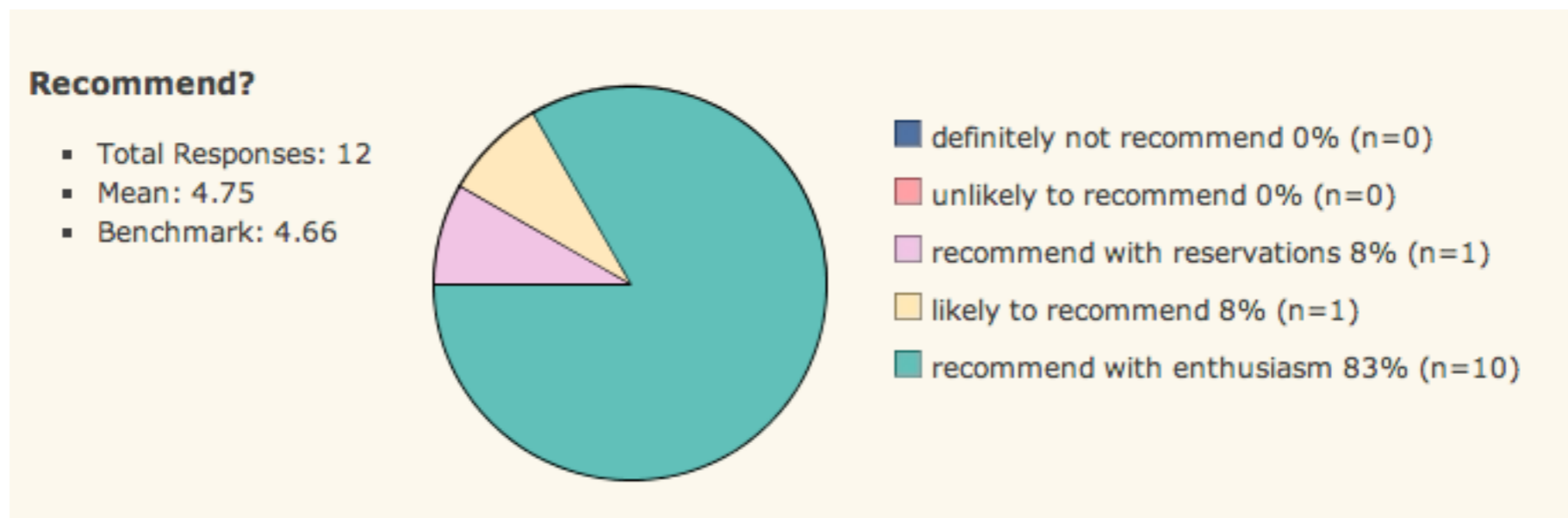
Adult students love the lab!

Students complete the entire two-hybrid lab and some cell biology
experiments in three weeks in January.

Rate this course overall (1 unsatisfactory to 5 excellent)

Average: 4.75

Response rate: 13/14 students



Harvard Extension School

BIOS E-176: Experimental Molecular and Cellular Biology co-taught
with Cheryl Vaughn

Rate the sections or lab meetings.

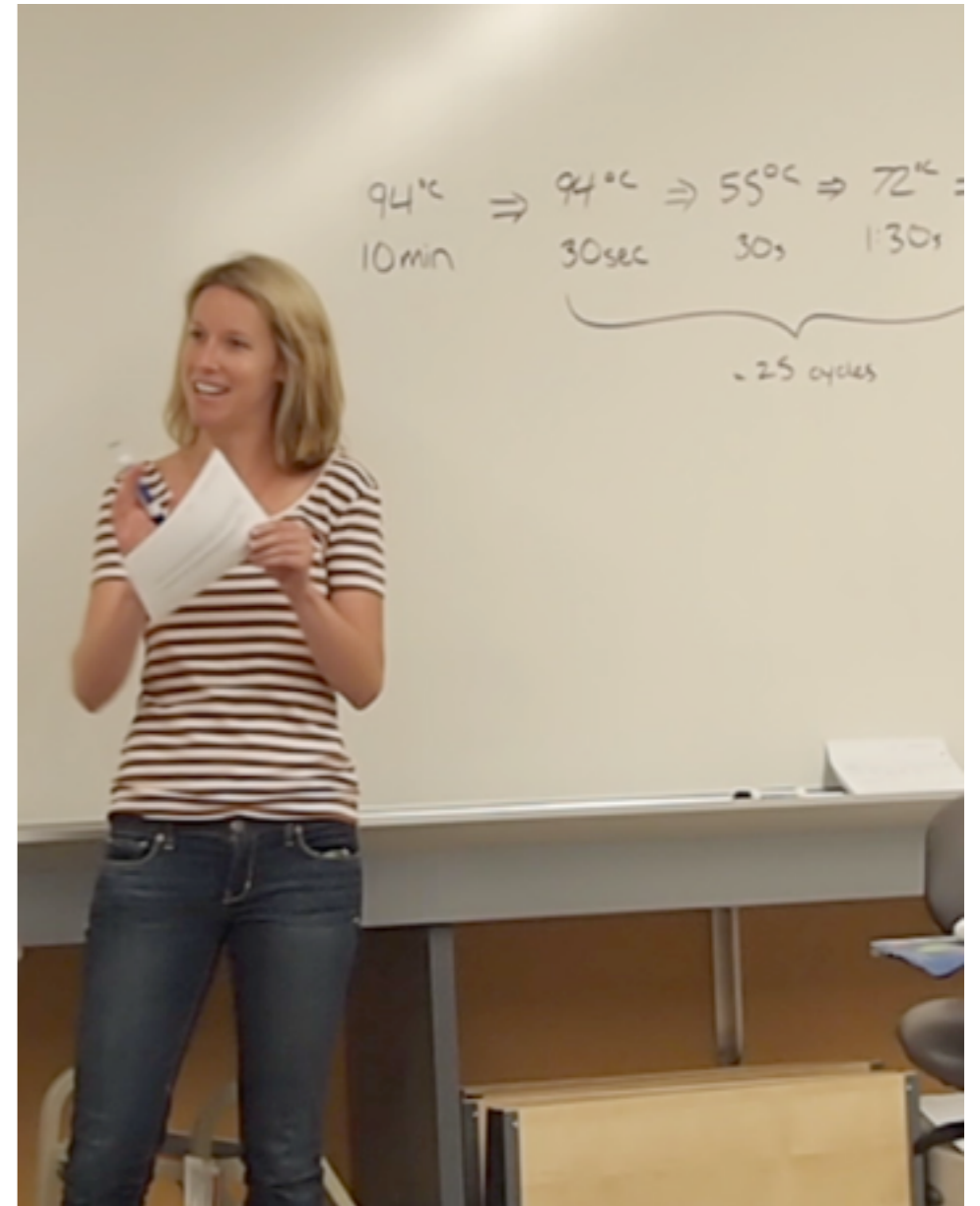
“Lab was the whole course. Excellent!”

“Loved every minute!”

“The whole course was a lab!”

“The labs were smoothly run and they were very instructive in key techniques that are important to molecular and cellular biology.”

Training in Teaching



Training in Teaching

Pre-2009

- Individual course-based training in a few large courses
- Derek Bok Center for Teaching and Learning
 - Teaching Conference at the beginning of each semester (voluntary for MCB students)
 - Videotaping of teaching if the course asks for it
- Graduate students could complete teaching requirements with no training

Departmental Two-Day Workshop

Two-day workshop modeled after HHMI Summer Institute

- Mandatory attendance for all first-year MCB graduate students
- Before first teaching experience
- Three themes: Active learning, Assessment, and Diversity
- Group project with peer review

Northeast Summer Institute: Stony Brook University August 4th-9th
<http://www.academiessummerinstitute.org/>



Two-Day Workshop Evaluation

Graduate students self-report gains in pedagogical knowledge.

Rate your knowledge on a scale of 1 to 5.

	Average	Standard Deviation	Net Change Average	Standard Deviation
Active Learning - Pre-workshop	2.57	0.98	+1.76	+1.00
Active Learning - Post-workshop	4.33	0.58		
Assessment- Pre-workshop	2.90	0.89	+1.10	+0.89
Assessment- Post-workshop	4.00	0.71		
Diversity - Pre-workshop	3.52	1.12	+0.71	+0.75
Diversity - Post-workshop	4.24	0.70		

Two-Day Workshop Evaluation

Graduate students want to be trained!

Workshop overall (1-5)

Average: 3.81

Standard Deviation: 0.98

I would recommend this workshop to other graduate students who plan to teach. (1 for unlikely to 5 for definitely)

Average: 4.14

Standard Deviation: 0.79

Having completed this workshop, I feel better prepared to teach next year. (1 for not true to 5 for very true)

Average: 4.05

Standard Deviation: 0.97

Rate how much you learned in this workshop overall. (1 for none to 5 for a great deal)

Average: 4.00

Standard Deviation: 0.89

Some Quotes from the Evaluations

What was the most important piece of knowledge or skill that you gained during the workshop?

“Preparation takes time.”

“I learned that I have at my disposal a variety of great tools for teaching and that I don’t have to freak out about TFing.”

“The experience of section designing tells that thinking is always easier than doing.”

“That it's possible to come up with interactive activities with relative ease! But also that even topics I thought I knew I don't know enough to teach... lots of reading of MBOC to come!”

My teaching staff

10 graduate students

A system of student choice,
interviewing, and selecting

One lab section per TF

Teaching Fellows



Alicia DeFrancesco



Erin May



Jamie Dempsey



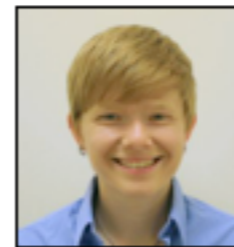
Joseph Piechura



Sarah Douglas



Ryan Richardson



Hannah Foster



Jonathan Russell



Kristin Little



Clarissa Scholes

Training for my staff

May	Two-day workshop
	Staff hiring
July	Nanoteaching* - practice giving 3 minute introduction
	Microteaching* - videotaped 5 minutes of teaching including active learning
August	Week-long training - run through all experiments and more -scenario training* -practice grading and grading rubrics with real answers -design active learning activities based on misconceptions

*Support from Bok Center consultants

Qualitative Results from Training

Building a sense of community and team

What TF training session or activity did you find to be most valuable?

TF: 1. Nanoteaching 2. Physically running through labs on our own

TF: Going through all the labs

TF: Definitely the nanoteaching and microteaching, hearing the input on areas where I can improve was so valuable

TF: Working through all the labs

TF: Scenario, nano, and microteaching were super useful as well as making up an activity to deal with a misconception - even more would be great

Qualitative Results from Training

Is there any TF training session or activity that you feel was not useful and should be removed?

TF: Nope

TF: no

TF: I thought it was all useful.

TF: No - I felt we maximized the time.

TF: Nothing should be removed. If anything we could benefit from a little more teaching/grading practice.

Qualitative Results from Training

**Do you think TF training helped you prepare for teaching this fall?
You can state very helpful, helpful, somewhat helpful, only slightly helpful, or not helpful at all.**

TF: Very helpful! A touch more teaching practice could have been helpful, but I feel prepared.

TF: Yes-It was very helpful.

TF: Very helpful!! I plan on using what I learned in other teaching situations.

TF: Yes, I thought it was helpful.

TF: Yes, definitely, it was extremely useful.

My Advice for Successful TF Training and Mentoring

Take on a role as mentor/advisor for teaching.

Be extremely organized.

Structure activities like teaching a course.

Model active learning and using course goals and objectives.

Don't waste their time.

Use real examples and have them practice topics from the actual course.

Set high expectations and communicate those expectations.

Be encouraging.

Make it fun.

Show your appreciation.

Additional Opportunities from Training

Bok Center teaching certificate

- Two-courses: MCB 52 training counts as a course.
- Writing component
- Video evaluation of teaching students

- ~50% of 2012 TFs plan on completing the requirements

Thank you!

