Breaking down the complexity of primary literature with participation from *all* students

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BREW 2023 virtual workshop

Molecular Biology class with lab

Class size: 10-36 students
Class years: Juniors and Seniors, and sometimes….Sophomores

Brief overview of class structure

- Replication, DNA damage repair, chromosome structure, transcriptional regulation
- Post-transcriptional regulation
- Translation and post-translational regulation
- Molecular biology techniques to study the topics introduced

			Ch.13: p.450-454, 472-478
	F	02/24	**Paper Presentation 1 (NER paper)**/Catch up
5	M	02/27	~~Application of Knowledge 2~~/Review
	W	03/01	**Exam 1**
	F	03/03	Studying Genes: Cloning and PCR p.220-223, 232-235
6	M	03/06	Studying Genes: Altering Genetic Sequences and Sequencing Ch.7: 226-232, 235-238, 245-247, reading on Moodle
	W	03/08	Application of Knowledge 3/Prep. For Paper 2
	F	03/10	**Paper Presentation 2 (PCR paper)**/Catch up
How is gene expression regulated?			
7	M	03/13	Chromosome structure and function/Prep. For Paper 3 Ch.10: p.332-341
	W	03/15	**Paper Presentation 3 (CRISPR paper)**/Catch up
	F	03/17	~~Chromosome structure and function~~ Ch.10: p.343-349, 351-356
8	**03/20-03/24**		**Spring break**
9	M	03/27	Regulation of Transcription in Eukaryotes Ch.21: p.728-739, Ch. 19: p.675-680
	W	03/29	Regulation of Transcription in Eukaryotes Ch. 19: p.675-680

Motivation

2018 Course evaluations:

30% of comments → primary literature is the least helpful

26% of comments → primary literature is the most helpful

What do I hope to achieve through primary literature?

- Ability to analyze evidence and draw conclusions
- Ability to break down complexity
- Ability to apply molecular biology concepts
- Ability to propose an experiment to test a hypothesis

- How do I increase students' buys-ins?
- How do I scaffold concepts and skills?
- How do I leverage peer-to-peer teaching?

Contextualizing

Why primary research literature?

- **Core Competencies and Disciplinary Practice** (Vision and Change, 2011, American Association for Advancement of Science and National Science Foundation)

1. ABILITY TO APPLY THE PROCESS OF SCIENCE:

Biology is evidence based and grounded in the formal practices of observation, experimentation, and hypothesis testing. All students need to understand the process of science and how biologists construct new knowledge by formulating hypotheses and then testing them against experimental and observational data about the living world. *Studying biology means practicing the skills of posing problems, generating hypotheses, designing experiments, observing nature, testing hypotheses, interpreting and evaluating data, and determining how to follow up on the findings*.

- Reinforce concepts from lecture

- Application of what you learn in lecture. Meet these learning outcomes.
    1. Students ***employ*** molecular biology concepts to ***explain*** relevant research approaches, to ***assess*** hypothetical or real data or to ***formulate*** new research questions
    2. Students ***make use of*** scientific evidence to ***assess*** molecular biology problems applicable to society

- Some are seminal papers that contribute to the knowledge in the textbook!

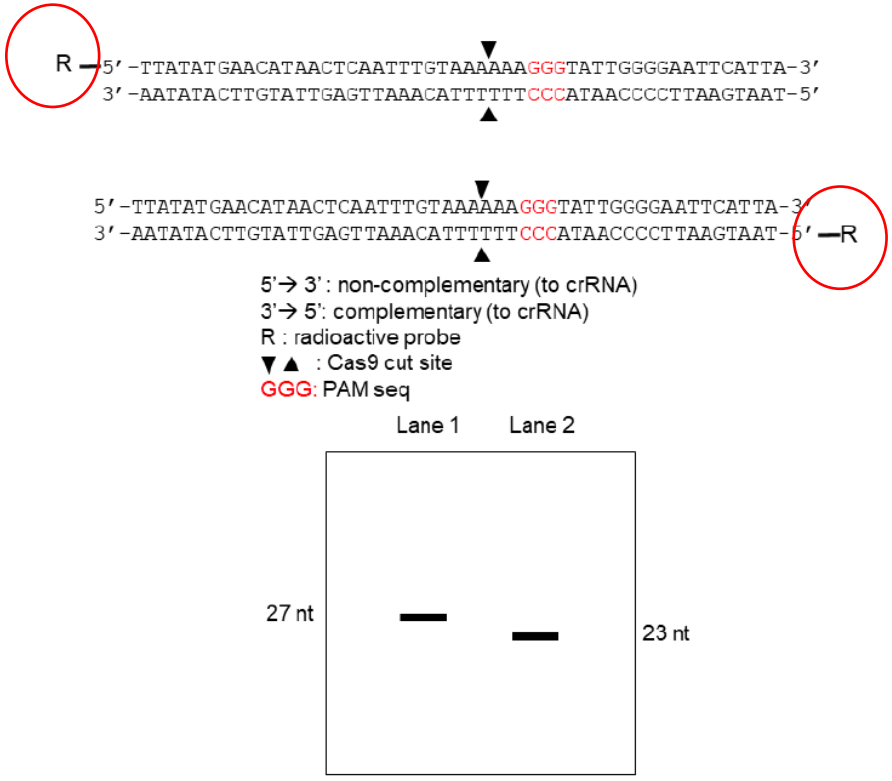
AAAS

https://visionandchange.org/

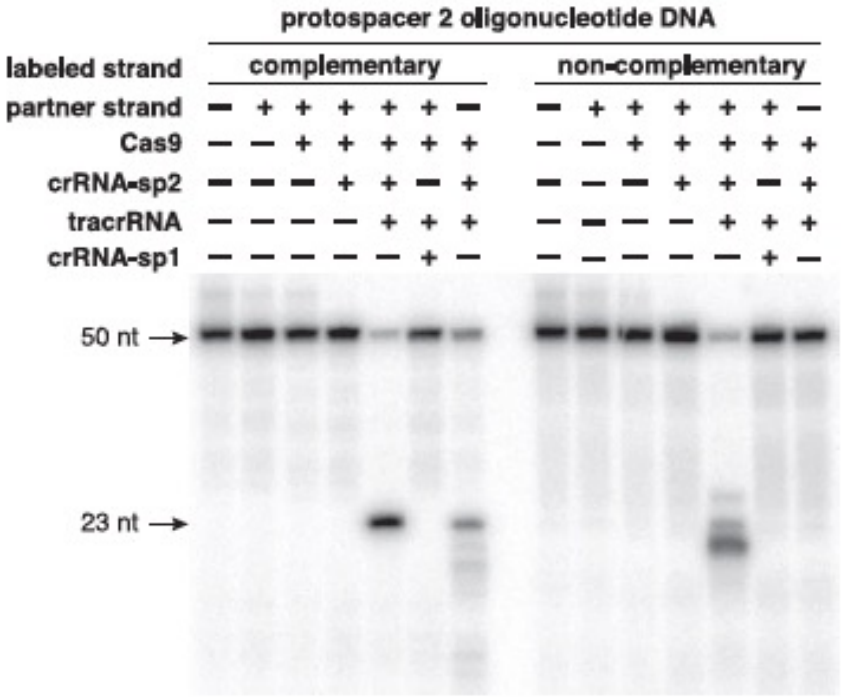
Preparation

One class period before discussion: in-class activity on hypothetical data

Example



- Separating and visualizing DNA
- Mechanisms and components of CRISPR
- CRISPR relation to the DNA molecule

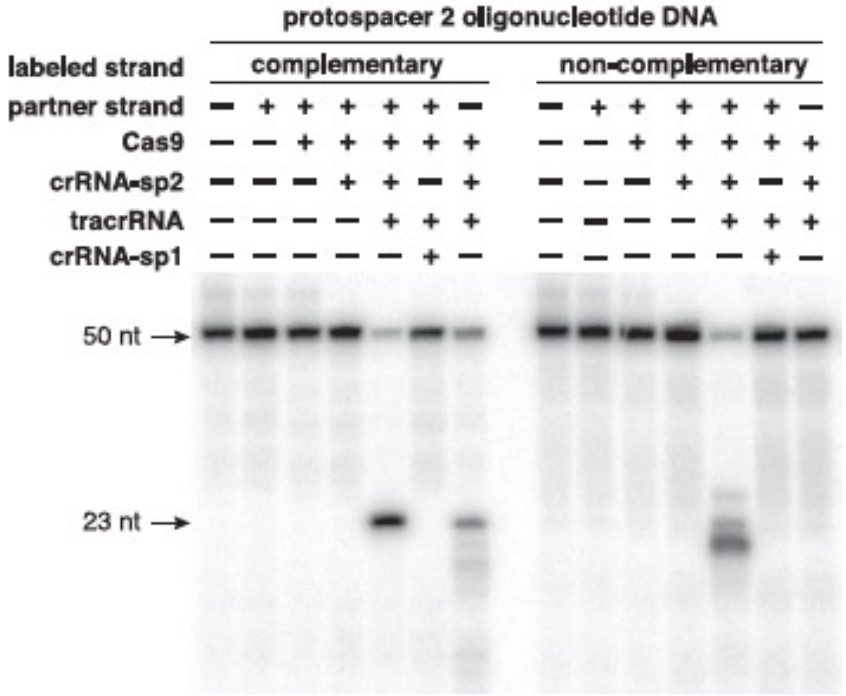


Jinek *et al,* Science, 2012.

Preparation

Approximately a week before the discussion,

- paper to be discussed is posted: only **a few figures** with main messages are to be discussed
- ~10 mins video providing context and highlighting figures
- Guiding questions: turn in as a low-stake assignment



6. What is the goal of this experiment in Figure1B?

7. What is the difference between “labelled strand” and “partner strand”?

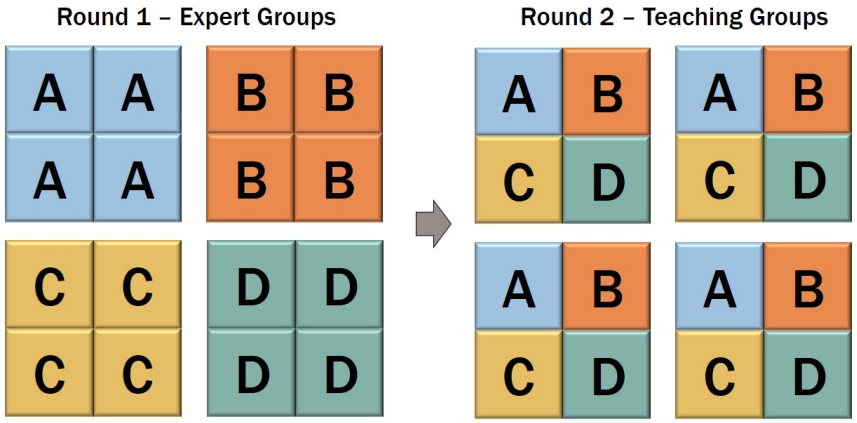
8. In which lane cleavage occurs?

9. Why was there cleavage in the last lane of “complementary” group but not in the last lane of “non-complementary” group?

Jinek *et al,* Science, 2012.

Day of Discussion (~30 mins)

- Students are randomly assigned to a group.
- Each group is responsible for 1-2 figures. ~15mins to discuss the figures in class. Peer-to-peer teaching and teaching individually. (TAs can moderate the discussion.)
- “Jigsaw”: One student from each group is paired with a student from another group. They explain their understanding of figures to their peer.
- Follow-up discussion: Emphasis on some figures, presenting a good question from small group discussion, or posing more challenging questions to the whole class.



https://derekbruff.org/?p=3401

After Discussion

A low-stake assignment testing students’ understanding of main concepts discussed.

Outcomes

More students' buy-ins for primary research paper discussion.

More meaningful participation from students with varying academic preparation.

Reflections

- Choice of paper: a paper that can integrate multiple concepts and stimulate students' interest
- Providing students with multiple opportunities to understand figures and letting them learn from mistakes are crucial.
- Preparation for each activity needs time in the first iteration.
- In a larger class, assigning roles to each member and asking for permission before a member of the group is asked to share are helpful practices to promote participation from all members. TAs can help facilitate small group discussion.
- Expanding the number of figures could be helpful more intense discussion.