Development of Dry Lab Curriculum for High Enrollment Introductory Biology Courses

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Session Outline

• Introduction
  • Introduction to UCI and the goal/task
  • Lesson design strategy
  • Focus on case study example
  • Dry lab resources

• Lesson Activity Breakout & Brainstorming

• Diversity, Equity, and Inclusion (DEI) Resources
  • Why integrate DEI?
  • DEI in our case study
  • Resources for adding DEI components

• DEI Integration Breakout & Brainstorming
Our student population

- University of California, Irvine
  - Public research (R1) university
  - ~30,000 undergraduate students
  - Minority Serving Institution
    - Hispanic-Serving Institution (HSI)
    - Asian American and Native American Pacific Islander-Serving Institution (AANAPISI)
  - ~60% first generation students
- School of Biological Sciences
  - 4000+ undergraduate students
  - 300+ graduate students
Goals

• California Learning Lab grant to redevelop biology courses
  • Design material without serving as course instructors
  • Focus on active learning, DEI (diversity, equity, inclusion)

• Create active learning dry lab experiences for introductory biology students
  • BIO SCI 93: DNA to Organisms
  • BIO SCI 94: Organisms to Ecosystems

• ~1500 students (mostly first year) across 4 sections
  • 300-450 students per lecture
  • Weekly discussion sections run by a graduate TA with 30 students
  • Discussion activities vary section to section
What is a “dry lab” to us?

A survey of biology faculty asking for a definition of authentic research experiences.

Common themes:
1. novel questions
2. student generated questions
3. hypothesis formation
4. experimental design
5. data collection
6. data analysis
7. presentation or publication
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Our goal: discussion “dry lab” activities should involve one or more of these themes
What is a “dry lab” to us?

Redefining Authentic Research Experiences in Introductory Biology Laboratories and Barriers to Their Implementation

Rachelle M. Spell, Judith A. Guinan, Kristen R. Miller, and Christopher W. Beck
Nancy Pelaez, Monitoring Editor
Published Online: 13 Oct 2017 | https://doi.org/10.1187/cbe.13-08-0169

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Extra benefit: dry labs are a natural way to integrate active learning into discussion sections
Why active learning and dry labs?

• Exposure to active learning and authentic scientific inquiry early in college improves student persistence (Hurtado et al., 2009; Schultz et al., 2011; Rodenbusch et al., 2016)

• Active learning disproportionately benefits minoritized populations (PNAS Vol 117 No. 2, 2020)
Lesson design

• Backwards design
• Considerations
  • Instructor input
  • Areas of student difficulty
  • Remote or in-person instruction
  • Pre-health student interests
  • DEI component
• Limitations
  • Moderately high student:TA ratio (30:1)
  • 50-minute time limit
Learning objectives

CA Learning Lab LOs

After completing the courses (or modules) developed through this collaboration, students should be able to…

1. engage with the tenets of the scientific method.
2. communicate effectively, both orally and written, according to the standards of the scientific community.
3. work effectively in a team of their peers.
4. recognize the diversity of participants within the scientific community.
5. effectively utilize quantitative skills to address scientific questions.
Learning objectives

**Activity LOs**

After completing this case study, students should be able to…

1. identify chemical differences between folate and MTX.
2. describe how a substrate analog would act as an inhibitor.
3. identify a reason why cancer cells can metastasize to other sites.
4. predict when cell cycle arrest would occur with drug treatment.
5. interpret cell cycle data from a graph or image to determine when cell cycle arrest occurs.
6. appreciate the role of URM scientists in biomedical research.

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Intro Bio Activities Implemented

• Cell Cycle and Cancer
  • Case study with data interpretation

• Properties of Water and Osmosis
  • Perform simple experiments that can be conducted at home
  • Provide data

• Ecosystems
  • Data Nuggets
    • Limit By Limit: Nutrients control algal growth in Arctic streams
    • Activity adapted and new material added

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Why use case studies?

• Common teaching tool in business, law, medicine, and other disciplines

• Gained popularity in science as an active learning tool

• Case studies are particularly well suited to...
  • encourage teamwork
  • strengthening communication skills
  • ensure critical thinking:
    • adapting knowledge to new situations and
    • applying knowledge to real life problems
  • increase student interest

Intro Bio Scores

[Graph showing Intro Bio Scores with white = control and black = case study, asterisks indicating significance]
National Science Teaching Association Case Study Database

• AKA “Buffalo Case Studies”
• Recognized and/or funded by NSF, AAAS, NAS
• 20+ years
• >800 cases and growing
• Educational, non-profit use
• Accessible (machine-readable, alternative text for images)
• Anyone can access the case study activity
• Paid membership ($25/year) required for full access to instructional materials (teaching notes, answer keys)
Maria, Metastasis, and Methotrexate

• Maria is a fictional woman recently diagnosed with metastatic cancer.
• Follow her as she works with her care team to determine how to treat it.
• Help her be an informed patient by researching the history and function of the drug she receives.
Breakout

Use the worksheet provided to...

1. identify a topic from your course
2. list learning objectives
3. choose an activity
   - case study
   - home lab or lab with data analysis
   - Data Nuggets
   - other?

Lesson Planning Worksheet  Dry Lab Resource Toolkit
Activity Lesson Plan (Example)

ABLE Mini-workshop: Development of Dry Lab Curriculum for High Enrollment Introductory Biology Courses

The purpose of this assignment is to create or revise an assignment or activity that uses elements of dry lab work and introduces students to diversity, equity, and inclusion (DEI) ideas. The following questions will guide the creation of a lesson plan that outlines the activity, its intended outcomes, and provides resources for activity development. Please answer these questions in detail and share them with your group members.

1. Who is the audience? (for example, undergraduate students, graduate students, majors, non-majors)
   - Introductory biology students
   - Mostly first year students
   - Mostly Bio Sci or other STEM major
   - Mostly pre-health

2. What do you want the student to know or do? How does this relate to laboratory or data analysis skills?
   - Identify chemical differences between folate and methotrexate.
   - Describe how a substrate analog would act as an inhibitor.
   - Identify a reason why cancer cells can metastasize to other sites.
   - Predict when cell cycle arrest would occur with drug treatment.
   - Interpret cell cycle data from a graph or image to determine when cell cycle arrest occurs.
   - Appreciate the role of underrepresented minority scientists in biomedical research.

3. Which one of the presented dry lab activities are you interested in experimenting with?
   - Case study with a fictional narrative and real data

4. What does the activity have them doing (i.e. conduct an experiment, solve a problem, analyze data, etc.)?
   - Explain a treatment plan
   - Analyze data
   - Discuss with peers

5. Which of the DEI resources would you like to pair with your dry lab activity?
   - Video biography of methotrexate researchers who are women of color

6. If this is a new assignment/activity, what are you hoping it will add to your class? If this is a revised assignment/activity, what are you hoping these revisions will improve or change?

This is a new activity. We were hoping that it would allow students to combine their theoretical knowledge with a more concrete, “real life” story as well as get a sense of the real people behind important biomedical innovations.
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Activity LOs
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6. appreciate the role of URM scientists in biomedical research.
Diversity, Equity and Inclusion

• A more diverse team of problem solvers outperforms a less diverse team (Hong and Page, PNAS 101 No. 46, 2004)

• At UCI, underrepresented students who begin in STEM programs are nearly 50% more likely to change majors than other students

• Active learning disproportionately benefits minoritized populations (PNAS Vol 117 No. 2, 2020)

• How can we incorporate DEI components?
  • spotlight the role of scientists from underrepresented groups
The Science Behind Methotrexate

- Cancer chemotherapy (also immune suppressant)
- One of the first chemotherapeutics
- First drug to successfully treat metastatic cancer
- Folate analog

MTX

[folate and MTX diagrams]

https://www.ebi.ac.uk/wikipedia/commons/
The Women Behind Methotrexate

Jewel Plummer Cobb
MTX in treatment of childhood cancers

Jane Cooke Wright
MTX in treatment of solid tumors

Wright (with Cobb and others) developed and championed tissue culture systems for studying cancer
Centering the role of scientists from underrepresented groups
Highlights - DEI Resources

• Scientist spotlights
  • easy search tool to identify a scientist spotlight for your class

• I am a scientist
  • personal narratives and classroom resources

• The secret life of scientists and engineers
  • video resources on a wide variety of scientists
Highlights - DEI Resources

• Dialog on Disparities
  • maintained by NCI
  • cancer disparities
  • includes short, non-technical spotlights on cancer researchers

• HHS Health Disparities
  • links to many different health disparities resources
    • educational programs
    • information for at-risk populations
Breakout

Use the worksheet provided to...

1. browse different DEI resources
2. determine how you will incorporate DEI into the lesson plan

Lesson Planning Worksheet
DEI Resources Toolkit
Additional Resources

• Resource list includes link to Google Drive with lesson materials on
  • Cell Cycle and Cancer
  • Ecosystems and Nutrient Limitations
  • Properties of Water
Acknowledgements

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UCI Co-PI: Brian Sato
Instructor materials

Part 1: The diagnosis.

Maria visited the doctor after feeling a lump in her breast for a few weeks. She was referred to a mammogram, which showed a suspicious mass. The biopsy confirmed it was breast cancer.

Dr. Lee asked Maria about her family history of cancer and other risk factors. Maria shared that her mother was diagnosed with breast cancer at a young age.

Dr. Lee explained the importance of early detection and encouraged Maria to undergo further testing.

Part 2: Treatment.

Several weeks later, Maria underwent a lumpectomy and radiation therapy. The treatment was successful, and Maria was able to resume her normal activities.

Maria thanked Dr. Lee and the hospital staff for their support and care.

Media

Full activity & key

Instructor Guide
How did MM&M do in our first ever remote Bio93 class?

**Positives**
- Worked with experienced TA/instructors to find gap in activities and understanding
- Instructor buy in
  - Sent helpful feedback
  - Provided access to TAs
- Facilitated interaction in Zoom
- Students enjoyed the activity
  - “can we have exams like this?”

**Points to consider**
- Designers/instructors experience and predictions
- Quieter students still were quiet
- Even when planning for it, the 50-min time scale is still a challenge
- *Trigger warning due to personal nature?*
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Why use case studies?

Course: introductory biology

Case studies increase assessment scores, perhaps due to student perception as “helpful”
Overall learning objectives

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