Objective

SUMMER INSTITUTES on Scientific Teaching

Multi-day workshops designed to empower university faculty, staff, and future faculty to transform STEM teaching and learning through evidence-based practices

Yale Center for Teaching and Learning

hhmi Howard Hughes Medical Institute

The Leona M. and Harry B. HELMSLEY Charitable Trust

SUMMER INSTITUTES on Scientific Teaching

- Founded in 2004 by Jo Hendelsman & Bill Wood, University of Wisconsin
- Currently based at the Center for Teaching and Learning at Yale University
- Funded by:
    - The Howard Hughes Medical Institute (HHMI)
    - The National Science Foundations (NSF)
    - The National Academies of Science (NAS)
    - Yale University

SUMMER INSTITUTES on Scientific Teaching

Summer 2016

- **HHMI – sponsor of research-intensive institutions (2)**
  - University of Chicago (August 9-13)
  - Evergreen State College (June 13-17)
- **The Helmsley Charitable Trust – sponsor of teaching institutions (3)**
  - University of Minnesota (June 6-8)
  - University of Connecticut (June 12-16)
  - Louisiana State University (July 18-22)
- **Mobile Summer Institutes (6)**
  - Ohio State University, Utah State University, the Claremont Colleges, University of California, Riverside, University of Illinois, Urbana-Champaign, the University of Oregon

Organization of Midwest SI in 2016

- **3 directors** – administrative support
- **12 facilitators** – past participants of SI; 9 presenters; support of collaborative group work
- **44 participants** - from 22 universities/Institutions

SI Program

9:00AM – 6PM

Lectures:

1. Principles of scientific teaching
2. Science of learning
3. Inclusive classroom
4. Scientific teaching in practice

Discussions

Group work (Tidbits)

Presentations of Tidbits

Panel discussion

Time	Tuesday	Wednesday	Thursday	Friday	Saturday
7:30-8:55 AM		Breakfast Walk to Session	Breakfast Walk to Session	Breakfast Walk to Session	Continental Breakfast Provided (8:00-9:00 AM)
8:55-9:00 AM		Announcements	Announcements	Announcements	Announcements
9:00-10:30 AM		Session 1: Principles of Scientific Teaching	Session 3: Inclusive Classroom	Group Work	Panel Discussion: Summer Institute Leadership
10:30-10:45 AM		Break	Break	Break	Break
10:45-11:15 AM		Metacognitive Discussion	Inclusive Classroom (Cont.)	Group Work	Group Work
11:15 AM-12:00 PM		Group Work	Group Work		
12:00-1:00 PM		Lunch	Lunch	Lunch	Boxed Lunch Available
1:00-2:30 PM		Science of Learning	Scientific Teaching in Practice	Presentations	
2:30-2:45 PM	Check-in to Dorms (Starts at 2:00 PM)	Break	Break	Break (2:30-3:00 PM)	
2:45-3:15 PM		Metacognitive Discussion	Metacognitive Discussion	Presentations	
3:15-4:00 PM		Group Work	Group Work		
4:00 - 5:00 PM	Walk to reception	Flexible Group Work Time	Flexible Group Work Time	Free Time/ Poster Session Prep (4:30-5:30 PM)	
5:00-6:00PM	Opening Night Reception	Group Share Walk to Reception	Group Share	Poster Session with Reception (5:30-7:00 PM)	
6:00-7:30 PM	Dinner	Reception with UChicagoGRAD (6:00-7:00 PM)	Dinner on Your Own/ Group Work if Needed		
7:30 PM	Group Formation	Dinner on Your Own			

Take home message

"Scientific teaching is about putting "little to no" emphasis on teaching and "most to all" emphasis of student learning.

"As you go home, think of small steps. The first thing, I did in my courses, was to write learning objectives for each of my courses."

"Anything that you do to promote active learning, whether it is using iCLickers, small problem solving activities, or reflective essays, will move your teaching in the right direction (evidence-based teaching)."

Main Idea of SI is to promote a pedagogical framework called Scientific Teaching

"The way science is taught should reflect the way science is practiced." (AAAS, 1990)

Our approach to apply the principles of Scientific Teaching

Project:

Research experience in a large-enrollment introductory class

Z. Swigonova & K. Curto

Project rationale

- Increase student's awareness of the exciting research conducted in our institution/department
- Increase student's sense of belonging to the institution by learning about people of the institution/department
- Reinforce the value of material covered in courses by showing their application in current research projects of our faculty
- Practice scientific approaches utilized by scientists of our institution/department in their research

Broad Learning Goals

- Students will gain insight into the research done by the PI faculty at our department/institution (research topics carefully selected to be in alignment with the introductory biology curriculum (BIOSC 0150&0160)
- Students will read and analyze primary literature
- Student will learn scientific vocabulary in the context of current research
- Students will apply the scientific method to analyze and interpret scientific data

Apply Principles of Scientific teaching

- **Inclusivity** (minimize potential biases and promote success of all students)
- **Backward design** (design educational experience around specific student learning outcomes)
- **Assessment** (formative & summative) proving feedback on student progress; aligned with learning objectives
- **Active learning** (students learn by doing: writing, discussing, solving, reflecting)

Modified from Handelsman et al., 2004 *Science* 304:521-522.

Inclusive learning environment

- A few students have opportunity to conduct scientific research in a PI's research lab
- Some students take inquiry-based laboratory classes
- Some students receive summer research fellowships

- **Include research experience in large-enrolment introductory classes (involve all students)**

Backward Design

Identify PI faculty whose research is in alignment with material covered in Foundations of Biology courses

↓

Formulate specific learning objectives

↓

Design formative and summative assessments

↓

Develop activities to support learning

↓

Evaluate effectiveness of the education experience

Active learning module

- **Pre-recitation activity:**
  - Watch video of a PI faculty
    - From a student to a scientist
    - The PI's current research
    - Message to a young scientist

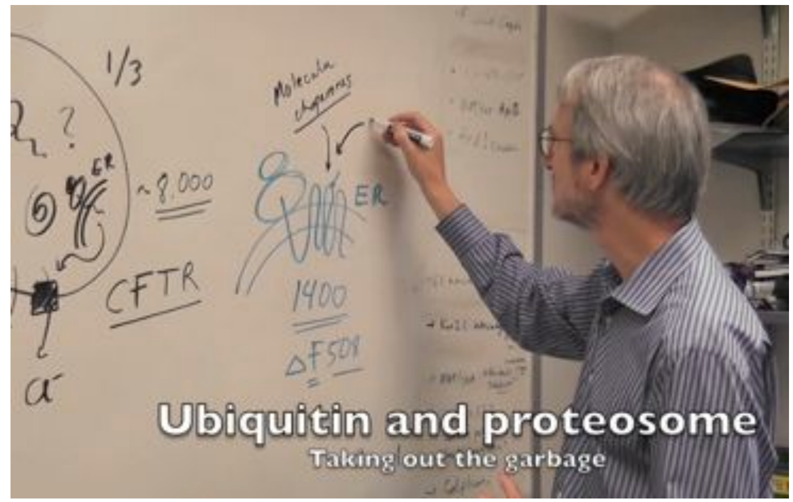
- **In-class (recitation) activity (based on the PI's research/data):**
  - Practice with scientific method
    - Make hypotheses and predictions
    - Analyze scientific data
    - Interpret research data (graphs, gel images, etc.)
    - Utilize public databases (to study structures/compare sequences, etc.)
  - Build scientific vocabulary in the context of the research activity
  - Learn about basic experiments used in biological research

- **Post-recitation activity:**
  - Apply the approaches from in-class activity to a new problem

Identify PI faculty whose research is in alignment with material covered in Foundations of Biology courses

Meet Dr. Jeff Brodsky

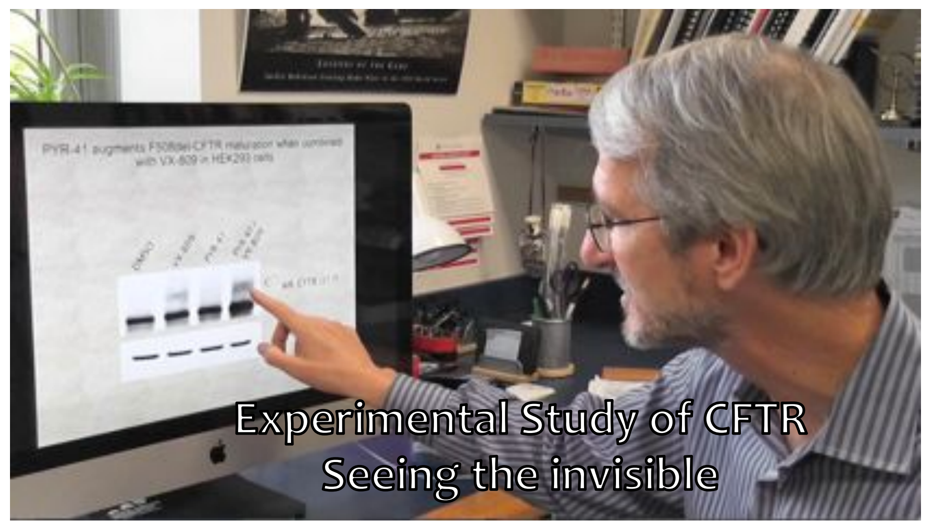
The CFTR protein



Pre-recitation activity:

Watch video of a PI faculty

- From a student to a scientist
- The PI's current research
- Message to a young scientist



Alignment between learning outcome, assessment, and pre-recitation activity

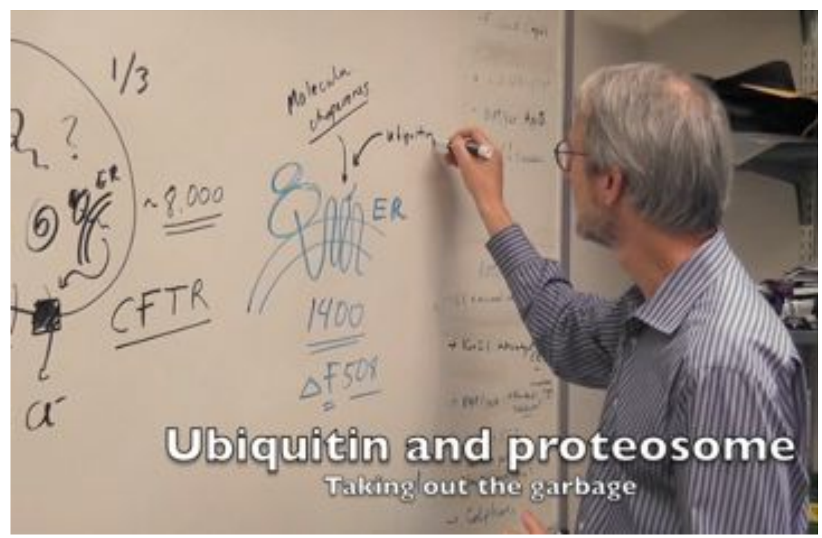
Learning goal	Intended learning Outcome	Evidence of achievements (Summative assessment)	Learning activity that promotes achievement (Formative assessment)
Students will understand the mechanism of protein production and processing in a cell.	Students will be able to predict how mutation in a DNA may result in human disease.	Students will be able to explain the role of ER, molecular chaperones, ubiquitin, and proteosome in cellular protein processing.	Students will watch video of selected PI faculty and identify information presented. Students will answers questions about the role of ER in protein processing, the purpose of ubiquitination, the outcome of ΔF508 mutation in CFTR, and ligand correction of of mutated protein.

Examples of Formative assessment

Cellular production of proteins

- How many proteins are made in a human cell?
- How many proteins are processed in ER?
- What is the function of molecular chaperones?
- What is the function of CFTR?
- What happens to a CFTR ΔF508?

8:40



In-class activity:

- Based on the PI's research/data
  - The CFTR protein, cellular manufacture and processing
- Align activity with material covered in lecture
  - The Central Dogma
  - Protein structure and function
  - Protein cellular processing
- Practice with scientific method
  - Analyze scientific data (sequence comparison to learn about structure of mRNA)
  - Interpret research data & experimental approaches (using western analysis to evaluate drug effect on CFTR processing)
  - Utilize public databases (BLAST, NCBI)
- Build scientific vocabulary in the context of the research activity (exons, introns, ORF, ubiquitination, proteosome, etc.)

Alignment between learning outcome, assessment, and in-class activity

Learning goal	Intended learning Outcome	Evidence of achievements (Summative assessment)	Learning activity that promotes achievement (Formative assessment)
Students will understand the process of information flow from gene to protein (The Central Dogma).	Students will be able to describe how genetic information is processed during transcription and translation.	Draw a figure representing sequence comparison between DNA and mRNA. Students will analyze the structure of the mRNA (UTRs, ORF, exons, introns).	Students are given accession numbers for the CFTR gene, mRNA and protein. Using public databases, students work in groups to characterize molecular processing during transcription and translation. Students draw annotated figures to represent relation between CFTR coding gene, its mRNA and mature CFTR.

Example of Formative assessment

Information for a protein is encoded in the cell's genome. Compare and contrast the gene and the mRNA:

The DNA region of the gene is 257,188 bp long, while the mRNA sequence consists of 6,132 nts. What percentage of the gene is represented in the mRNA sequence?

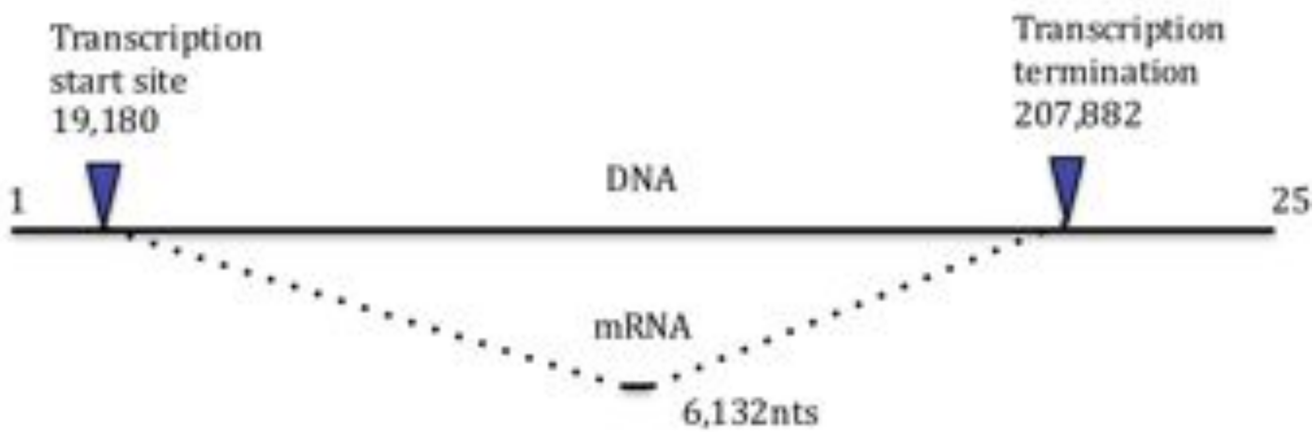
Example of Formative assessment

The mRNA sequence consists of three major parts, the 5' and 3' untranslated regions and the coding region (ORF). Predict the ORF of the CFTR by launching "ORF Finder" at the NCBI. Submit the mRNA accession number NM_000492, click on the longest ORF, accept and save as a fasta nucleotide ORF sequence.

Based on the Dot Matrix Plot, the 5' UTR is _______ nucleotides long and the 3' UTR is ______ nucleotides long. What proportion of the mRNA sequence is translated into the protein?

Example of summative assessment

Based on the information you discovered in the previous part (of the in-class activity), draw a simple figure comparing the size difference of the CFTR DNA gene and the mRNA. Mark transcription start site and transcription termination (provide the nucleotide position). Explain why is there such a disproportion in size between the DNA and mRNA.

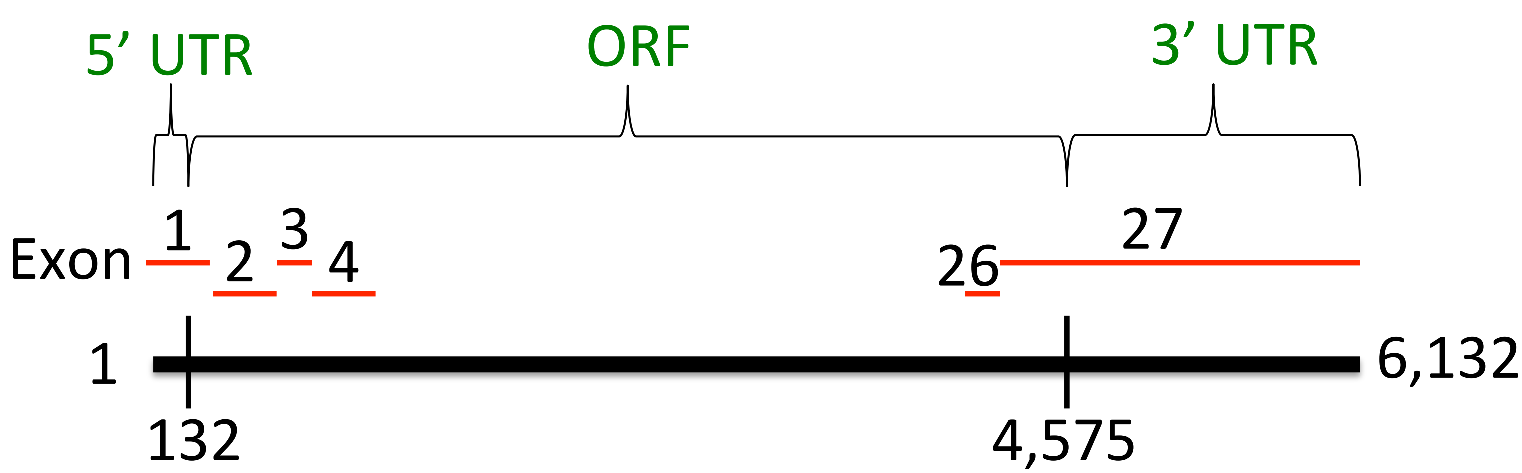


RNA processing removes 96.8% of the nucleotides from the pre-mRNA. Those regions represent regulatory regions and introns.

Example of summative assessment

Based on the information you discovered in the previous part (of the in-class activity), draw a picture of the CFTR mRNA and note the following features:

5' UTR, 3' UTR, ORF, exon 1-4, exon 26 & 27.



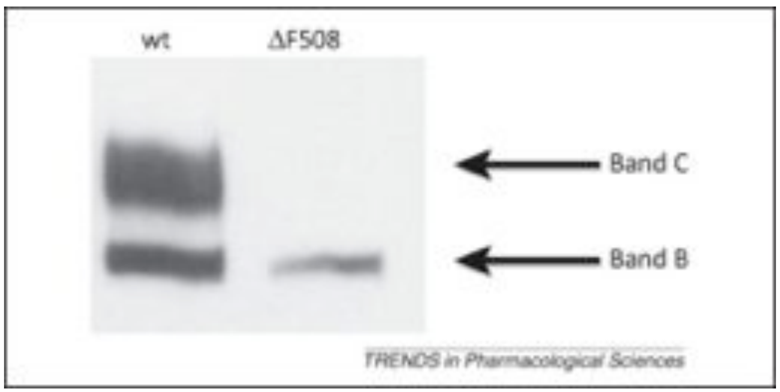
Alignment between learning outcome, assessment, and in-class activity

Learning goal	Intended learning Outcome	Evidence of achievements (Summative assessment)	Learning activity that promotes achievement (Formative assessment)
Students will understand the dynamics of protein processing in a cell (especially cellular degradation of mutated proteins).	Students will be able to analyze scientific data and interpret what happens to proteins during cellular processing.	When given western blot data (gel images), students will evaluate the effect of tested drugs on the cellular processing of mutant proteins.	Students will analyze research data from western analysis to explain differences in cellular processing of a wild type CFTR and a mutated protein (ΔF508).

Example of formative assessment

How scientists trace cellular protein production (Western blot analysis):

Below is a western depicting cell extracts from the wild type containing cells and those containing the F508del variant.



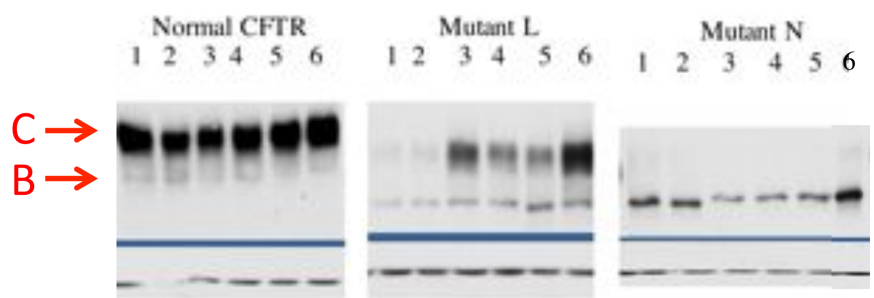
1. What is apparent from the comparison of the wild type (WT) and F508del extracts (ΔF508)?

2. What does the absence of this particular band indicate about F508del??

Example of summative assessment

Using Western analysis of CFTR mutants to evaluate drug effects:

Researchers use western analysis to determine potential drug effects on a variety of CFTR mutants. Below are westerns from normal CFTR and three mutants, including F508del. In each case, the six lanes represent 1 – no treatment, 2 – vehicle control, 3, 4, 5 and 6 are drug treatments.



1. Did the treatments affect the normal CFTR (no effect, detrimental or effective)? Explain your answer.
2. How would you interpret the results for mutant L and N?
3. Lane 6 represents a combination of drug treatments. Do any of these results suggest that this approach might be harmful toward correcting a mutation? Explain you answer.

Backward design

Identify PI faculty whose research is in alignment with material covered in Foundations of Biology courses ✔

⇩

Formulate specific learning objectives ✔

⇩

Design formative and summative assessments ✔

⇩

Develop activities to support learning ✔

⇩

Evaluate effectiveness of the education experience

Evaluate effectiveness of the educational experience

1. Assess learning gains
   - Administer pre- and post-tests
   - Compare content knowledge performance between a recitation section exposed to the module with another that uses regular review session.

2. Survey of student perception of the modules
   - Self-report of perception of specific learning objectives

Survey of student perception

1=strongly disagree; 5=strongly agree

	5	4	3	2	1
The active module clarified material covered in lecture.					
The module prepared me to understand a complex biological issue (protein processing in a cell).					
I valued to learn about how scientists study the invisible (tracing proteins as they are made and processed in a cell)					
I enjoyed to work in groups to figure out the activities in the module.					
The module facilitated a meaningful learning of scientific vocabulary (in the context of research).					
I enjoyed learning about real research examples.					
I learned how scientists approach research question.					
I appreciate learning about the faculty research at Pitt.					
I would like to have more such modules in the recitation.					
Learning about the faculty research and their path to become a scientist will help me to clarify my plans for the future.					

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SUMMER INSTITUTES on Scientific Teaching

Regional Summer Institutes on Scientific Teaching in 2017

http://www.summerinstitutes.org

- **Northstar SI -** University of Minnesota, June 5-10
- **Northeast SI -** University of Connecticut, June 11-15
- **California SI** – University of California, June 19-23
- **Northwest** – University of Oregon, June 20-23
- **Midwest** – University of Chicago, July 24-28
- **Gulf Coast SI** – Louisiana State U., July 17-20