

# to 20.109!

### Fundamentals of Biological Engineering 9/6/18

# Insight from previous 109ers

Words of wisdom...

Lesson learned: Label Your Tubes

Don't be afraid to ask your professors and TA's questions:

Failure is Beautiful Too

GO TO OFFICE HOURS! You will get useful tips and comments for your presentation.

BE Communications Lab is a great resource!



"After sitting through the introduction on day one, my first thought was "FINALLY!" This class sounded like it was going to be the most applicable class to real life that I had ever taken. I feel that up until this point, I've been learning subjects that all build on each other in interesting ways...Here was finally a class that would combine both theory and actual application to complete meaningful projects."



"I have real life course 20 skills and actual methods I can talk about in an interview (either with my parents when they ask what course 20 is or with employers). 20.109 combines all these really unique teaching techniques to become a really weird, cool class. It's not like any other class I've taken at MIT. 20.109 is a recombinant class that is teaching me what it really means to be course 20."

"Over the past year or so I have been learning how to read...scientific papers. Honestly, this is a skill I will be developing for a long time. I feel like scientific paper reading is something you can never be too good at. Yes, I am reading the words on the page, but what do these words mean?? What do the figures tell? Are the authors discussing anything in their discussion?"





"Reading, or rather decoding, this paper was probably one of the most difficult parts of the process for me. As interesting as the subject matter was, there was a lot of terminology and methods that were used that I was unfamiliar with, and the paper was quite long." "Mod2 report was certainly a tough one."





"One of the hardest parts of writing this paper was that the results were not very clear-cut and often contradictory with what was expected... That's exactly like real life though. In my UROP we often get contradictory or unsatisfactory results as well."



"I regret not starting earlier on this assignment. I think I should have started at least a week earlier so I could feel less pressed for time at the end. Also, I feel like I was relatively inefficient when working. In the beginning I felt less pressured so I got things done really slowly."



"Coming up with a research proposal was probably my favorite part of 20.109. I don't think I am asked to produce 100% original ideas very often here, but I think this project allowed me to do that. I think that is probably one of my favorite parts of biology and I am glad that I could do it again. So, yeah what a way to end 20.109, it was a great time and I think I learned a lot!!!!" "Though the class could be stressful and was a lot of work at times, it has probably been my favorite class here at MIT so far...

Thank you so much to all the instructors who invested so much time and energy into making this a great experience for all of us taking the class. I'm sure I speak for all of us when I say that we all appreciate the support and encouragement."





"But most importantly, I think I've become much better at scientific communication. Before, I could identify whether a paper was good or bad, but I guess I never really thought about what really made it good or bad. Furthermore, the thought of writing a paper seemed like an insurmountable task to me, and I definitely had no idea how to even begin doing such a thing."



"In then end, I ended up with a super cool battery and a mind full of knowledge. I feel more like the quintessential scientist than ever before. I have held a beaker, cooked a battery, and put on a lab coat. And I feel more secure in my choice to be course 20 than before." "Leaving 109, I definitely feel like an engineer. 109 opened the door to all the things a BE student can do..."



Friendships can end. Girlfriends/boyfriends can end. Only lab partner has no end.



"Thanks to all my fellow 109ers for making this class such a fun experience (: I do wish I took this class earlier, but I'm glad that I got to meet y'all by taking it this semester... I enjoyed working with you and getting to know you, and I'm really happy with what we've accomplished this semester (: " "And the good news? I do get another shot at this! 20.380...you're going down."



# An introduction to 20.109

- Meet the team
- Core mission
  - Building a better bioengineer
- Modular structure



- Module 1: Measuring genome instability
- Module 2: Manipulating metabolism
- Module 3: Engineering biomaterials
- Logistics

# Meet the 20.109 teaching team

- Lecture / Laboratory
  - Prof. Bevin Engelward (M1)
  - Dr. Noreen Lyell (M2)
  - Prof. Angela Belcher (M3)
  - Dr. Josephine Bagnall (T/R)
  - Dr. Leslie McClain (W/F)
- Communication
  - Dr. Sean Clarke
  - Dr. Prerna Bhargava



- Teaching assistants
  - Corban Swain (T/R)
  - Jai Padmakumar (W/F)
- Research assistant
  - Dr. Jifa Qi

# Core mission of 20.109

 To prepare students to be the future of Biological Engineering

 To teach cutting edge research skill and technology through an authentic research experience

• To inspire rigorous data analysis and its thoughtful communication

# Modular structure of 20.109

20.109(F18): Laboratory Fundamentals of Biological Engineering



Fall 2018 schedule FYI 1. Measuring genomic instability Assignments

Homework 2. Modulating metabolism

Class data Communication 3. Engineering biomaterials

Module 1: Measuring genomic instability (Prof. Engelward) Module 2: Manipulating metabolism (Dr. Lyell) Module 3: Engineering biomaterials (Prof. Belcher)

# Module 1: Measuring genomic instability



• Fundamental Biological Concepts in molecular pathway analysis, genomic stability, and inter-individual variation in susceptibility to cancer.

• Fundamental Engineering Concepts in translating a low throughput assay into a high throughput assay. Includes learning about the process from going from an idea to a product.

•Laboratory skills: Many fundamental laboratory skills are covered in this module. These include electrophoresis, mammalian cell culture, assay optimization, basic statistical tests, image analysis, immunohistochemistry, epigenetic analysis and much more!

# Module 2: Manipulating metabolism

- Experiments
  - Alter genetic circuitry using CRISPRi system to increase valuable fermentation products
  - Colorimetric
    biochemical assay
- Lab skills
  - Bacterial culturing
  - Molecular biology techniques



# Module 3: Engineering biomaterials

- Experiments
  - Mineralize phage surface with nanoparticles
  - Use TEM to
    visualize
    structure
  - Assemble and test batteries
- Lab skills



- Bacteriophage M13 material production
- Fabrication of bio-based devices

# Workflow in 20.109

- We start here...
- But, you can't design an experiment without analyzing some data!



# Workflow in 20.109

### Research

- We start here...
- But, you can't design an experiment without analyzing some data!



# Experiments in 20.109

We aim to prevent 'just follow the protocol' syndrome



### Experiments in 20.109

#### We do relevant and cutting edge science...



#### and we do it safely!!

### We analyze real and novel data in 20.109



Figure 5 (A) Ca<sup>2+</sup> binding titration assay curves for WT IPC, IPC D55A, and IPC D21A. Purified IPC proteins were titrated against varying [Ca<sup>2+</sup>], and fraction of protein bound to Ca<sup>2+</sup> was measured and plotted in MATLAB. (B) Kinetic parameters (K<sub>d</sub> and n) for Ca<sup>2+</sup> binding to WT IPC and IPC D55A, extrapolated from the titration assay. Binding affinity constant, K<sub>d</sub>, is a measure of the Ca<sup>2+</sup> binding affinity. Hill coefficient, n, is a measure of the Ca<sup>2+</sup> binding cooperativity.

# Written and oral communication

MODULE	TOPIC	ASSIGNMENT	WEIGHT
1	Measuring genomic instability	Data summary	15%
		Mini-presentation	5%
2	Manipulating metabolism	Research article	20%
		Journal club presentation	15%
3	Engineering biomaterials	<b>Research proposal presentation</b>	20%
		Mini-report	5%

- Written communication assignments = 40%
- Oral communication assignments = 40%
- Daily work and participation = 20%

# Why communicate your science?



COPress is a website highlighting the science and scientists of the Natural Resource Ecology Laboratory at Colorado State University

#### why scientists should tell more stories

RECENT PUBLICATIONS ARTICLES INTERVIEWS OPINIONS EDUCATION THIS IS HOW I DID IT... FROM THE FIELD ECOPICS EVENTS NREL NEWS LINKS CITATION SUBMISSION PODCAST



http://nrelscience.org/2013/09/26/why-scientists-should-tell-more-stories/

### Why scientists should tell more stories

"Story is the number one way we learn from past experiences, to be better people, and share in experiences. Yet as scientists we feel the need to separate ourselves from this proven method of communication...

...encourage the use of narrative in science, but with caution. I would argue that narrative is imperative for science communication. Data already incorporates a narrative; we just need to find ways to bring it to light."

# We are here to help!

• 20.109 Teaching faculty

- BE Communications Lab
  - Instructors
    - Dr. Sean Clarke
    - Dr. Prerna Bhargava
  - Writing fellows



# **BE Communication Lab**

#### **BE Communication Lab**



#### Helping you communicate effectively.

Staffed by the BE Communication Fellows, the BE Communication Lab offers writing and speaking support for scientists by scientists.

Course 20 undergraduate students, graduate students and post-docs are invited to bring in any communication-related pieces they are working on – from coursework and posters to resumes and publications.

We encourage students to **book an appointment** at any stage in the writing process – the sooner the better. In addition to offering coaching, the BE Communication Lab runs **workshops** and is building an online tool box to help you find tips and resources quickly to help you communicate more effectively.

#### mitcommlab.mit.edu/be

# **Course logistics**

- Lectures
  - Tuesday and Thursday 11-12p in 16-220
  - − Prof. Engelward → Dr. Lyell → Prof. Belcher
- Laboratory sections
  - Tuesday and Thursday 1-5p in 56-322
  - Wednesday and Friday 1-5p in 56-322
- Details
  - You will work in pairs throughout the semester
  - Collaboration with integrity is key

# Expectations

- Your expectations of us...
  - We will come to class and laboratory prepared
  - We will be clear and reasonable in all assignments
  - We will treat every 109er with respect
  - We will give everyone equal chance at success

# Expectations

- Our expectations of you...
  - You will come to class
  - You will be prepared for lecture and laboratory
  - You will not interfere with each other's learning
  - You will invest the very best of yourself
  - You will be honest with your peers and the teaching faculty

# Our goals for you

- Organize a constructive laboratory notebook
- Implement laboratory protocols and troubleshoot
- Interpret and analyze data
- Recognize the utility of models and assays
- Critically examine scientific literature
- Communicate your science
- Work as a team
- Provide constructive and helpful feedback

# Final notes

- Please arrive to laboratory today / tomorrow on time
  - Will begin with EHS 109-specific training
  - See Noreen if you received an email concerning General Biosafety Training, but have not completed the course with EHS
- Please wear / bring pants and closed toed shoes
  - We will be working in the lab