

# Welcome to 20.109!

Fundamentals of Biological Engineering

9/8/16

# Insight from previous 109ers

## Words of wisdom...

Another thing I definitely learned is that if you ever feel unsure about what conclusions can be drawn from any procedures you performed in lab, or if you aren't sure if the information you are about to include in your report is superfluous, never hesitate to **ask the 20.109 faculty for feedback**- these awesome people are actually there to help us!

**Ask questions.**

**Take advantage of office hours.**

**Tip 211: Get a jump start on the next major assignment**

**Makes sure to always check the wiki**

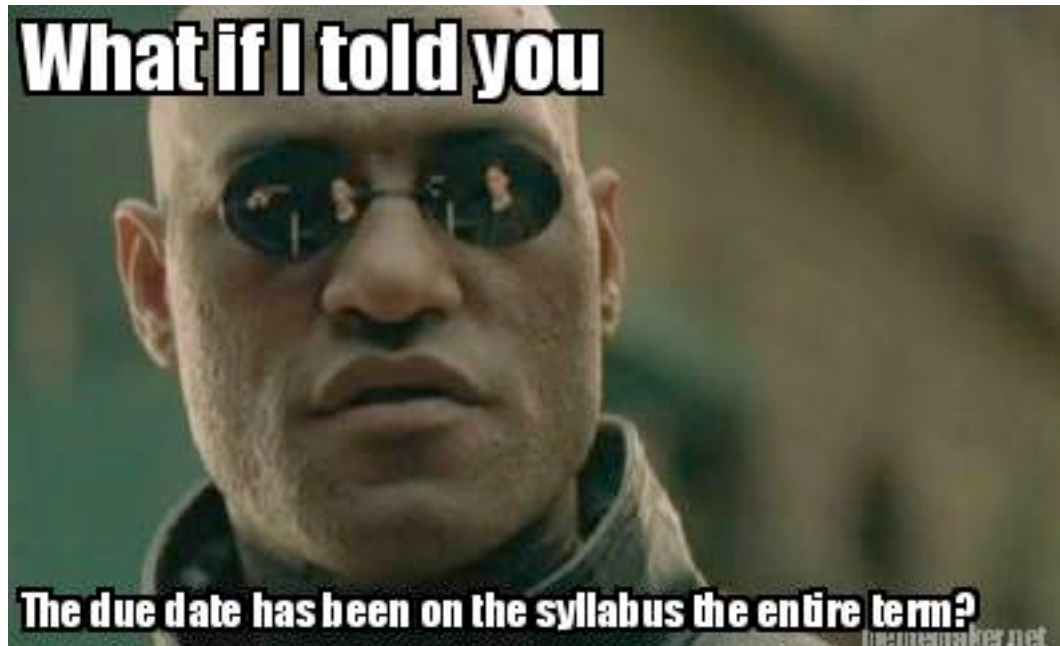
**Don't leave everything to the very last minute.**

**BE Communication Lab Meetings? 10/10 Would Recommend!**

“The wiki contains all of the due dates for assignments, quiz dates, and protocols for every lab day. Make sure you take the time to look over the wiki so you're not caught off guard...”

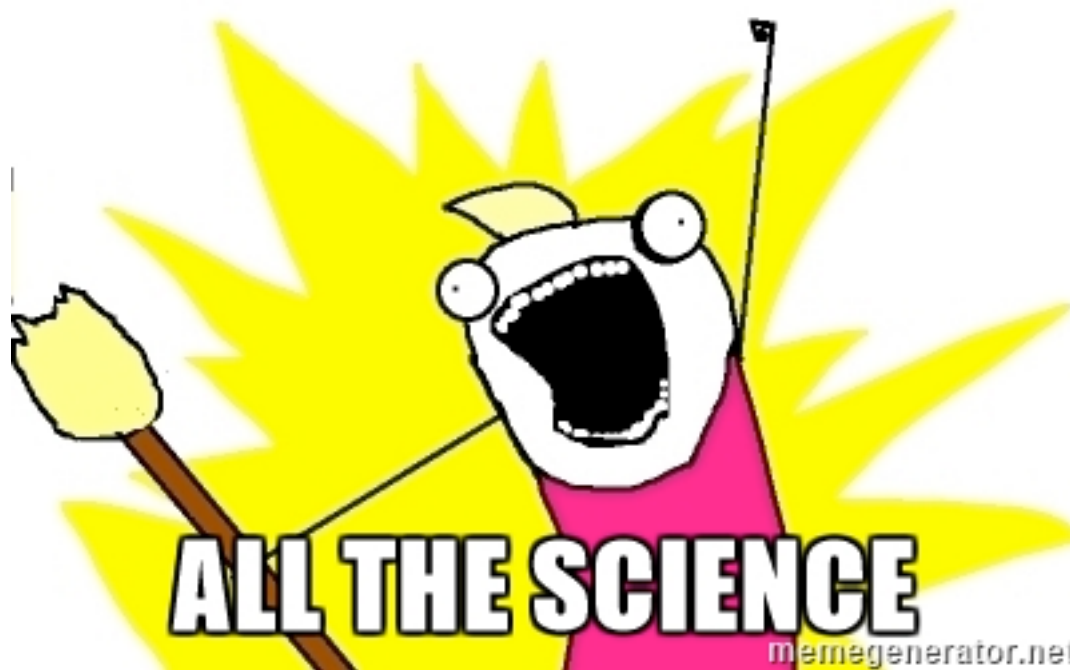


“I’ve also learned to triple check due dates.”



“And it was quite an interesting experience. We had many issues with our experiments...not working/giving us results we wanted/expected. Thus, we would often be sitting there very stumped.”

**WE'RE GONNA DO**



**ALL THE SCIENCE**

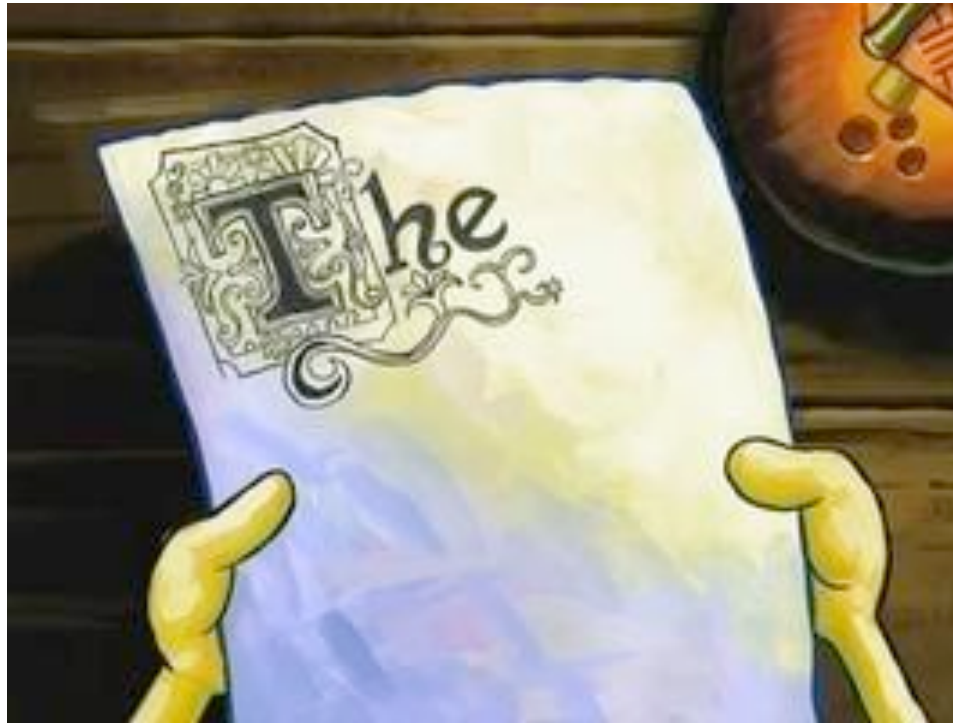
“...one of the aspects of 20.109 that I truly appreciated the most. It was extremely useful to be able to learn new protocols while gaining an understanding of what you were actually doing along the way. Even when you may have thought that you knew a protocol...”



“It's exciting, and a bit scary, because I had never thought of this aspect of becoming a scientist.  
"Communicating your science"- that's the whole point, right? If communicating your science means learning a new language, then so be it.”



“Writing can sometimes be a challenge. Going into my mod 2 report, I felt a lot like Spongebob writing his essay for boating school - I really didn't know where to start.”





“Thanks to the super useful feedback that I constantly received from my professors...I was able to learn how I could organize myself in order to start writing those components, and learned what I needed to look out for while revising my writing. I now feel confident tackling...research papers that lie ahead in my future.”



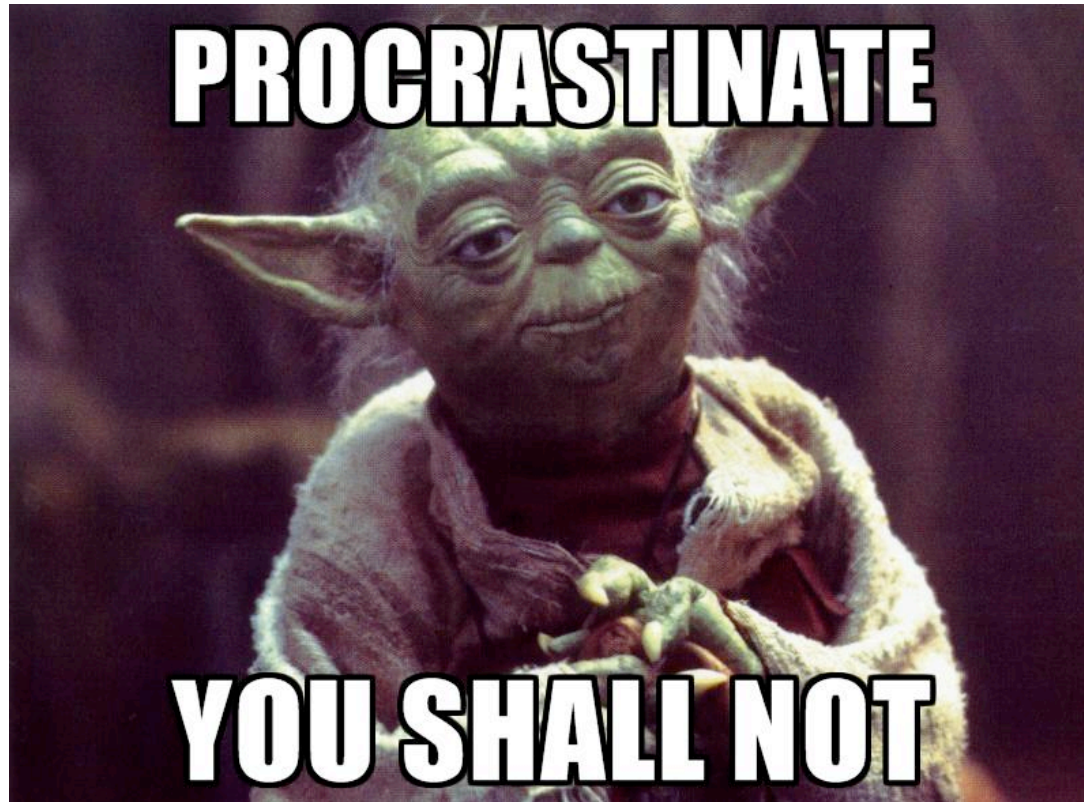
“I really appreciate the feeling of camaraderie that you all had with the students as well – it always felt like we were on the same side, whether it be about deadlines, grades, or even experiments.”



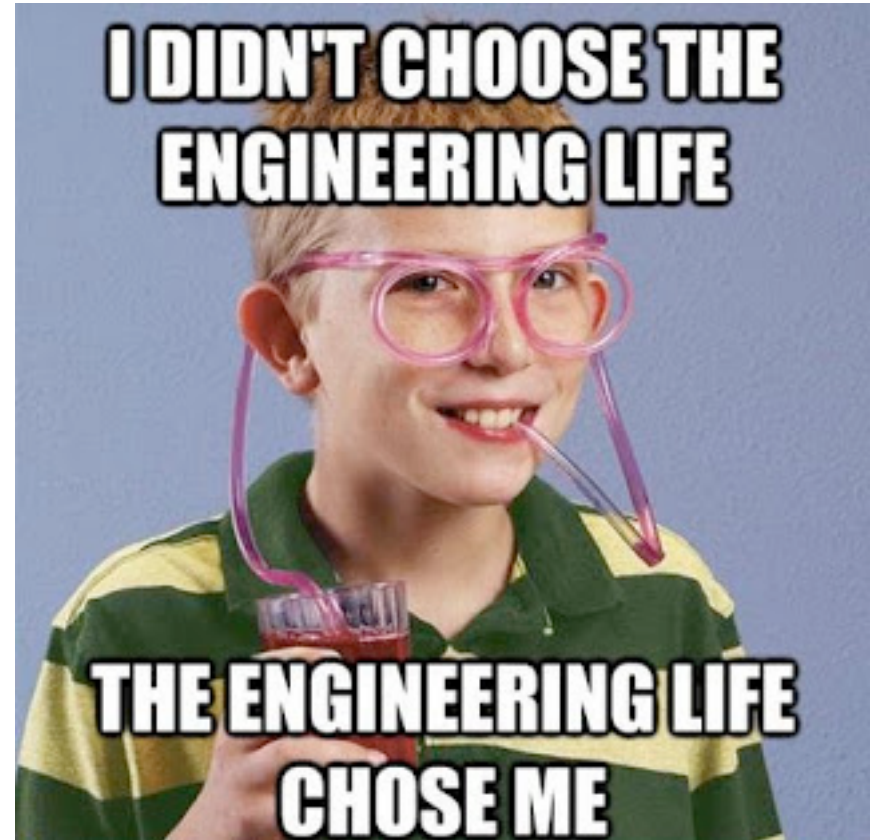
“Overall, I am much more confident in my ability to read and write about science.”



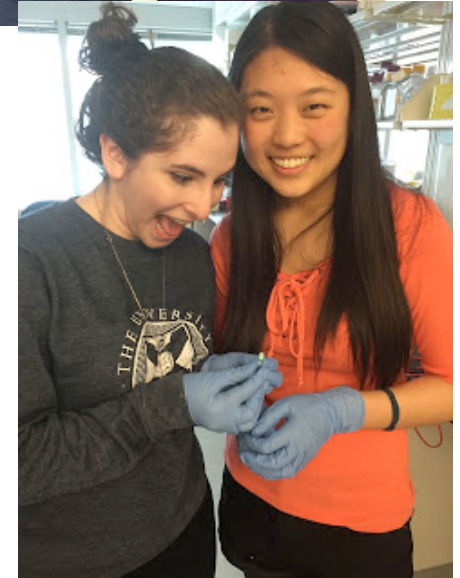
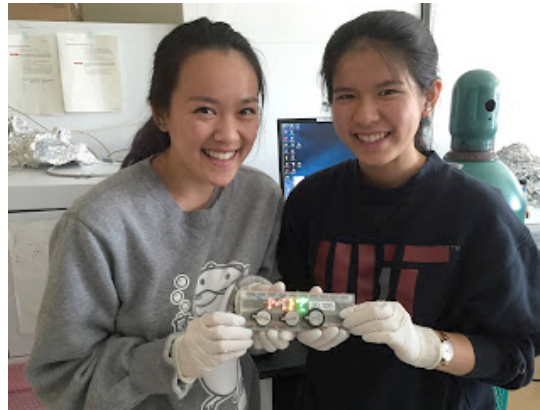
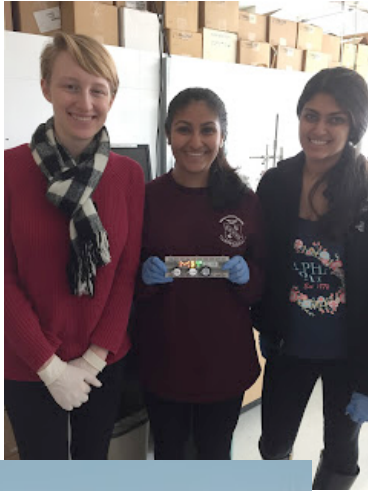
“In an attempt to save others from following the same tracks I did, I will continue to emphasize to start assignments and seek help EARLY!”



“20.109 definitely taught me more about the real world than any other class I have taken ever. Not only was it the most useful and practical class I have taken, it was one that made me finally understand what biological engineering really is.”



“Don't make the mistake of getting through the whole course and not knowing anyone other than your lab partner. Great friendships are waiting to be made!”



“Even though the class was a ton of work, it didn't feel like it some days because I really liked what I was doing and I definitely got a lot out of the class! I'm definitely sad that it's over, but happy I learned so so much!”



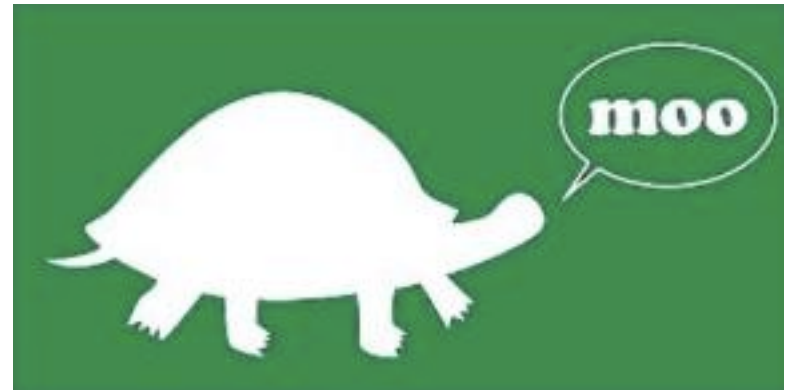
“Although we don't receive diplomas or get to dress up in fancy caps and gowns, there exists the same sense of achievement in finishing something that compelled its students to learn and do so much.”





# An introduction to 20.109

- Meet the team
- Core mission
  - Building a better bioengineer
- Modular structure
  - Module 1: Measuring genomic instability
  - Module 2: Manipulating metabolism
  - Module 3: Engineering biomaterials
- Logistics



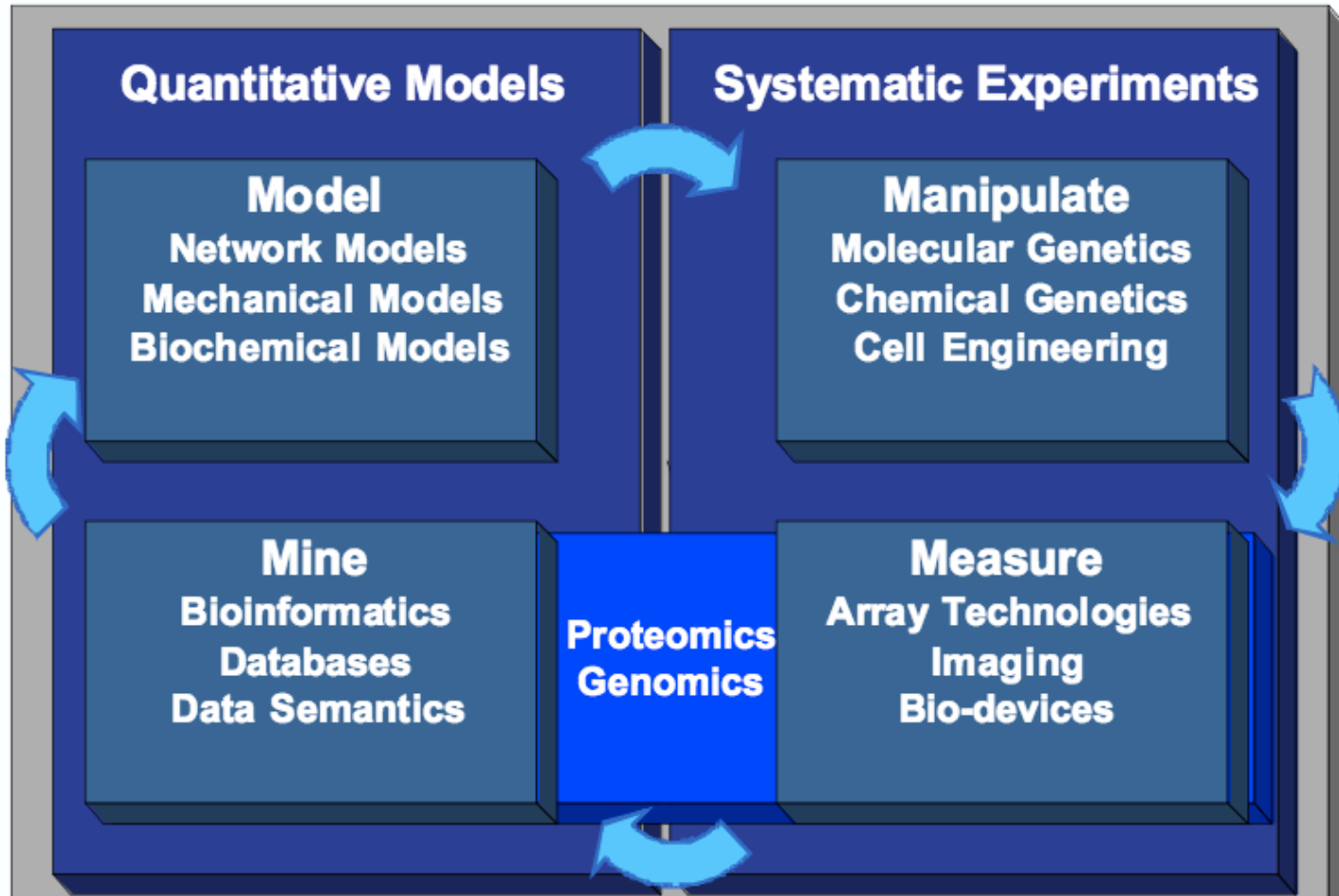
# Meet the 20.109 teaching team

- Lecture / laboratory
  - Prof. Bevin Engelward (M1)
  - Dr. Noreen Lyell (M2)
  - Prof. Angela Belcher (M3)
  - Dr. Leslie McClain (T/R)
  - Dr. Maxine Jonas (W/F)
- Communications
  - Dr. Diana Chien
  - Dr. Sean Clarke



- Teaching assistant
  - Emily Clark
- Research assistant
  - Dr. Jifa Qi

# Core mission of BE department



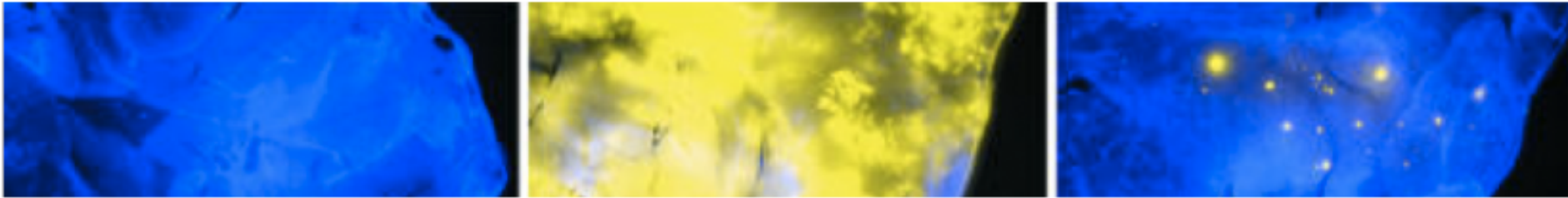
Definition of BE from Prof. Doug Lauffenburger

# 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(F16): Laboratory Fundamentals of Biological Engineering



Schedule Fall 2016    Announcements    Assignments    Homework    Communication  
1. Measuring Genomic Instability    2. Manipulating Metabolism    3. Engineering Biomaterials

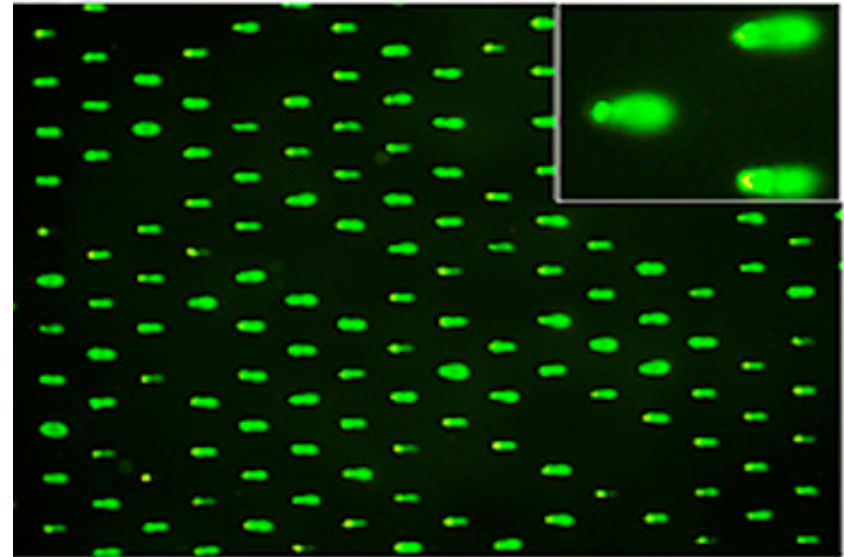
Module 1: Measuring genomic instability (Prof. Engelward)

Module 2: Manipulating metabolism (Dr. Lyell)

Module 3: Engineering biomaterials (Prof. Belcher)

# Module 1: Measuring genomic instability

- Fundamental Concepts in High Throughput Quantitative Single Cell Analysis, Binding Affinity, Pathway Intermediates, Immunohistochemistry
- Key Concepts: Genome Structure/Function, Origins of Inter-Individual Differences in Disease Susceptibility, Cancer Etiology, Molecular Responses to CRISPR Products



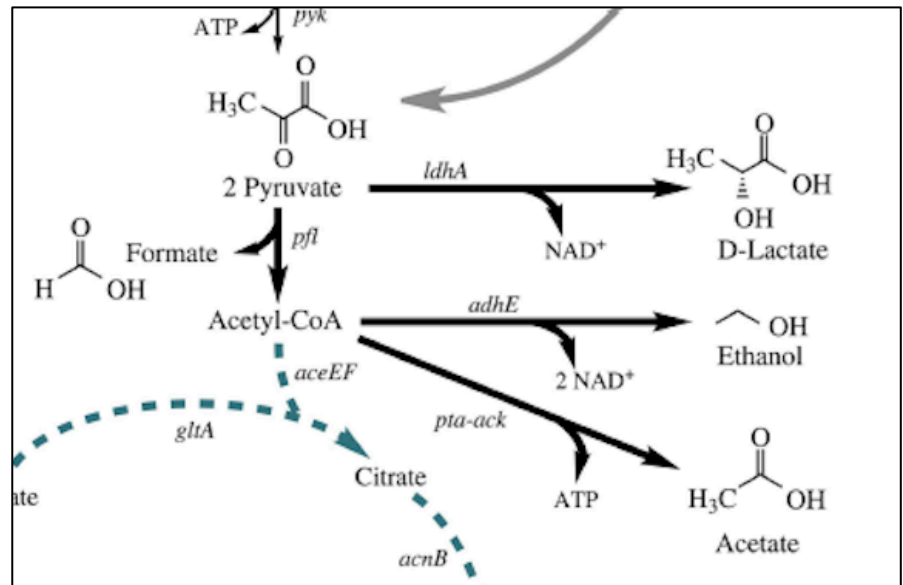
# Module 2: Manipulating metabolism

- Experiments

- Alter genetic circuitry using CRISPRi system to increase fermentation products
- Colorimetric biochemical assay

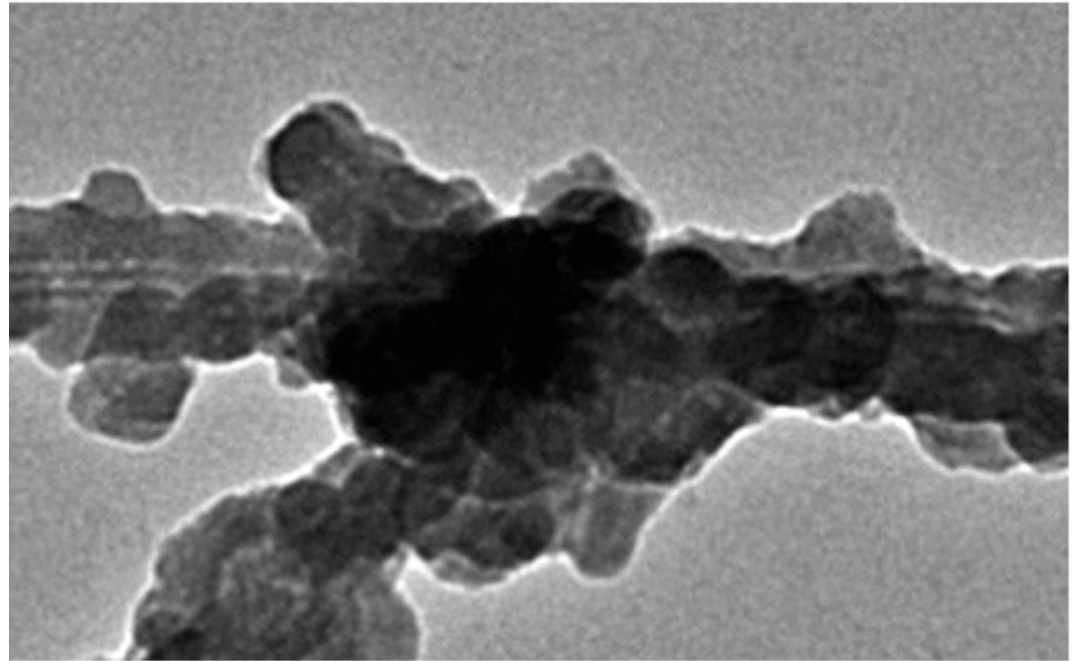
- Lab skills

- Bacterial culturing
- Molecular biology techniques



# Module 3: Engineering biomaterials

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

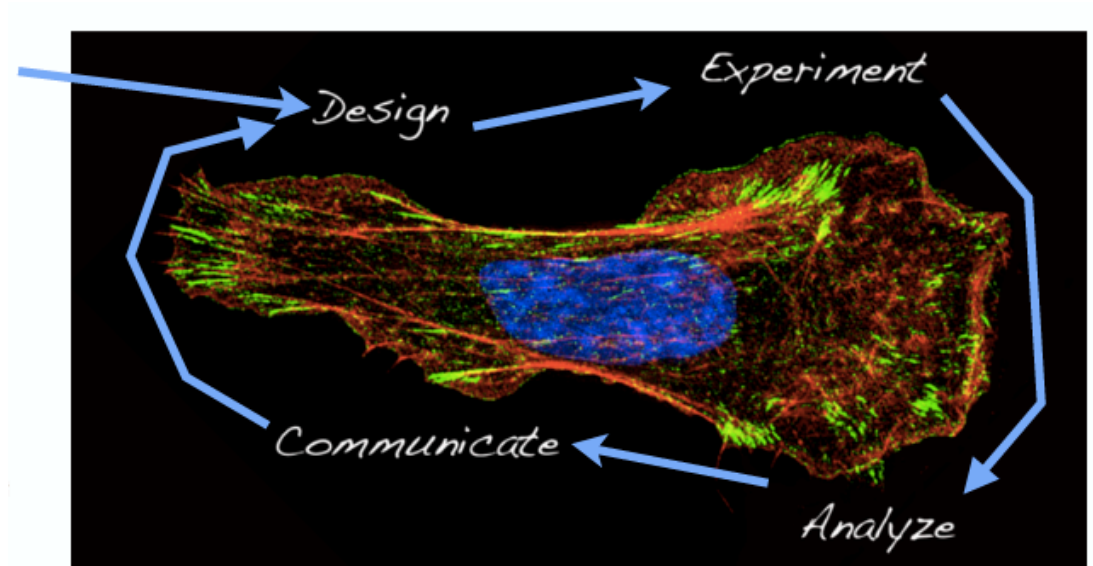


- Lab skills
  - Bacteriophage M13 material production
  - Fabrication of bio-based devices



# Workflow in 20.109

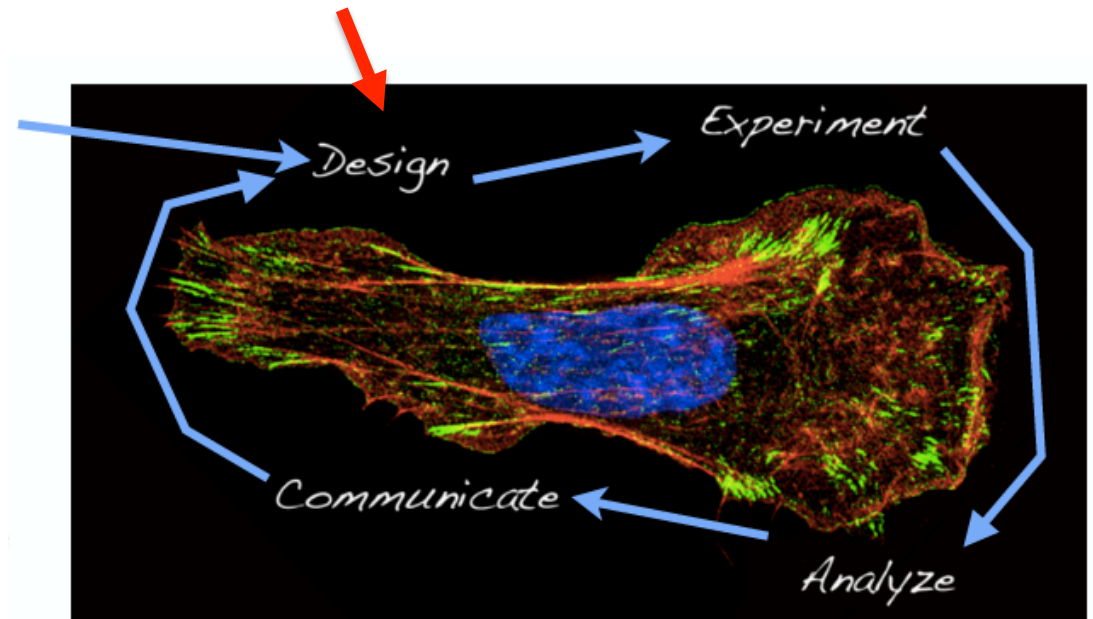
- We start here...
- But, you can't design an experiment without analyzing some data!



# 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



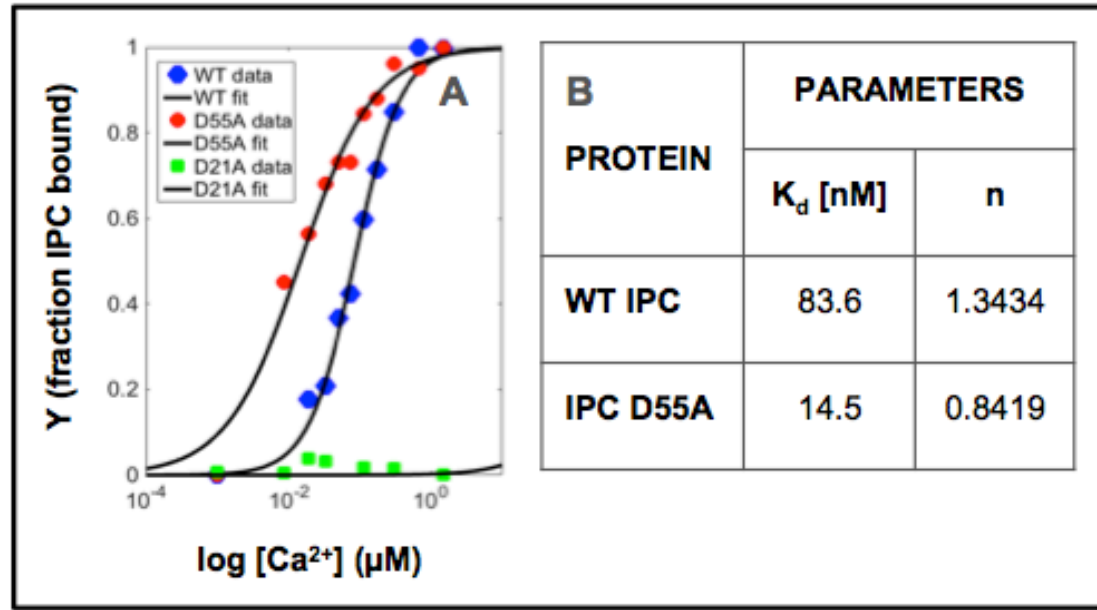
# Experiments in 20.109

We do relevant and cutting edge science...



**and we do it safely!!**

# We analyze real and novel data in 20.109



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

# Written and oral communication

MODULE	TOPIC	ASSIGNMENT	WEIGHT
1	Measuring genomic instability	Data summary	15%
		Mini-presentation	10%
2	Manipulating metabolism	Research article	20%
		Journal club presentation	10%
3	Engineering biomaterials	Research proposal presentation	20%
		Mini-report	5%

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

# Why communicate your science?



EcoPress 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



Credit: jvoves (via Flickr, <http://bit.ly/190MCCw>)

<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

- BE Communications Lab
  - Instructors
    - Dr. Diana Chien
    - Dr. Sean Clarke
  - Writing fellows
- 20.109 Teaching faculty



# 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.

### NEW!

Check out our blog, created by the BE Communication Fellows: <http://thebench.scripts.mit.edu/home/>.

<https://be.mit.edu/communicationlab>

# 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 and tomorrow on time
  - Representatives from EHS will be delivering a safety training presentation
- Be sure to wear/bring pants and closed toed shoes
  - We will be working in the laboratory