



to 20.109!

Laboratory Fundamentals of Biological Engineering

9/9/21

# Insight from previous 109ers

Words of wisdom...

Lesson learned: Label Your Tubes

BE Communications Lab is a great resource!

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

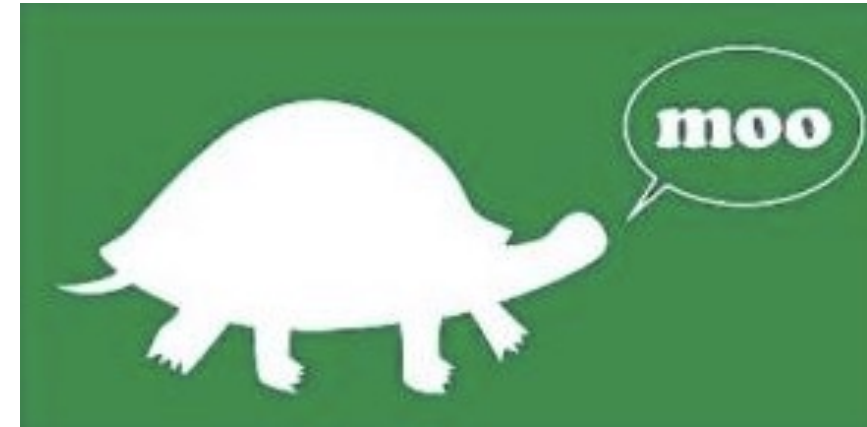
Failure is Beautiful Too

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

## Best Preparation for Graduate School EVER

# A brief introduction to 20.109

- Core mission
  - Building a better bioengineer
- Meet the Fa21 team
- Experimental overviews
  - Module 1: Genomic instability
  - Module 2: Drug discovery
- Logistics



# Our core mission is building bioengineers

- 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**

# Meet the 20.109 Fa21 teaching team

- Lecture / Laboratory Instructors

- Prof. Bevin Engelward (M1)
- Prof. Jacquin Niles (M2)
- Dr. Noreen Lyell
- Dr. Becky Meyer
- Dr. Leslie McClain
- Amanda Facklam

- Communication Instructors

- Dr. Prerna Bhargava

- Teaching assistants

- Ben Allsup (T/R)
- Thomas Costa (W/F)



# Mod1: Genomic Instability

“Engineers turn dreams into reality.”

Hayao Miyazaki



The Wind Rises

# Mod1: Genomic Instability

- Research results are nothing if not shared.
- The same data can have either a high or a low impact depending on communication skills.



## **Sensitive CometChip assay for screening potentially carcinogenic DNA adducts by trapping DNA repair intermediates**

Le P. Ngo<sup>1</sup>, Norah A. Owiti<sup>1</sup>, Carol Swartz<sup>2</sup>, John Winters<sup>2</sup>, Yang Su<sup>3</sup>, Jing Ge<sup>1</sup>,  
Aoli Xiong<sup>4</sup>, Jongyoon Han<sup>1,4,5</sup>, Leslie Recio<sup>2</sup>, Leona D. Samson<sup>1,3</sup> and  
Bevin P. Engelward<sup>1,\*</sup>

<sup>1</sup>Department of Biological Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139, USA,  
<sup>2</sup>Toxicology Program, Integrated Laboratory Systems, Inc., Research Triangle Park, NC 27560, USA, <sup>3</sup>Department of  
Biology, Massachusetts Institute of Technology, Cambridge, MA 02139, USA, <sup>4</sup>BioSystems and Micromechanics  
(BioSyM) IRG, Singapore-MIT Alliance for Research and Technology, 138602 Singapore and <sup>5</sup>Department of  
Electrical Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139, USA



- The only way to get support for your research is to get the reader excited about your ideas.





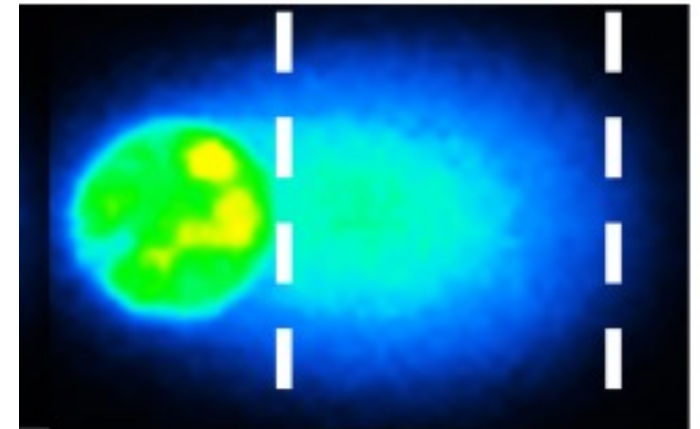
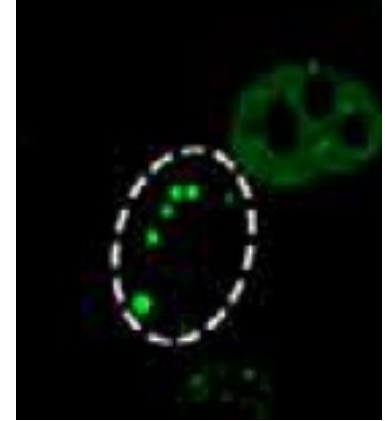
# Mod1: Genomic Instability

## Knowledge and Conceptual Goals:

- Importance of genomic stability in preventing diseases
- How small structural changes have large consequences
- Biochemistry of a multistep DNA repair pathway
- Cost/benefit of DNA repair
- Importance of pathway balance
- Public health importance of studying combined exposures
- Importance of interdisciplinary research for public health
- Responsibility to community stakeholders
- Responsibility as research advocates

## General Research Knowledge:

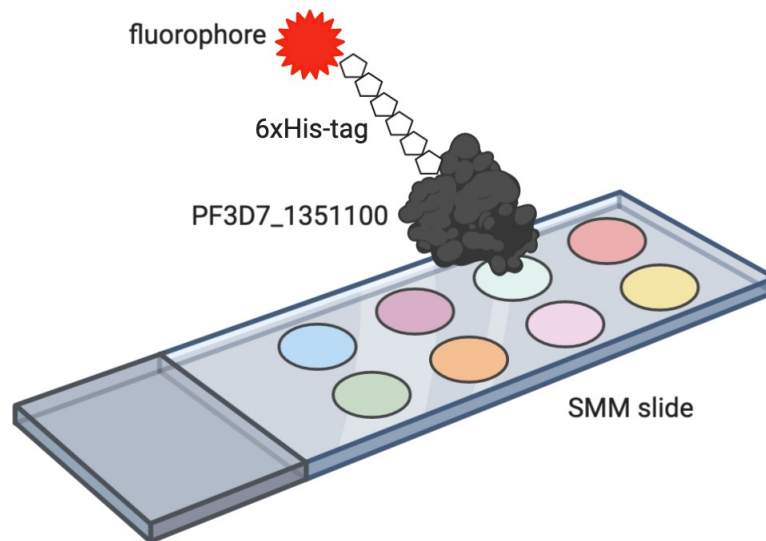
- Mammalian cell culture
- Immunofluorescence
- Quantitative image analysis
- High-throughput assay development and application
- Data presentation and conservative interpretation



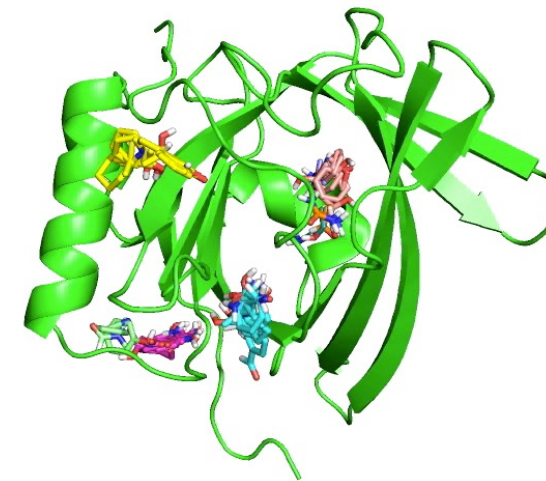
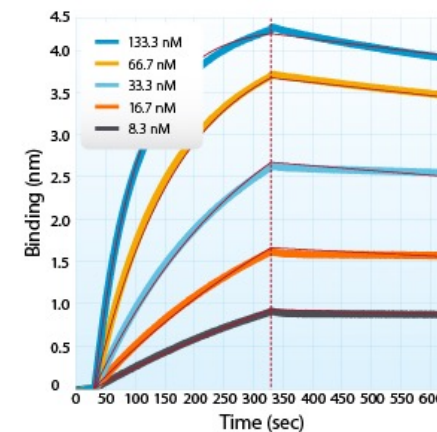
# Mod2: small molecule drug discovery

- Research goal: Identify & characterize small molecule binders to a protein drug target
- Laboratory skills
  - Recombinant protein expression and purification
  - High-throughput screening assays to identify small molecule hits
  - *In silico* analysis of hits
  - Validating binding interactions

## Discovery

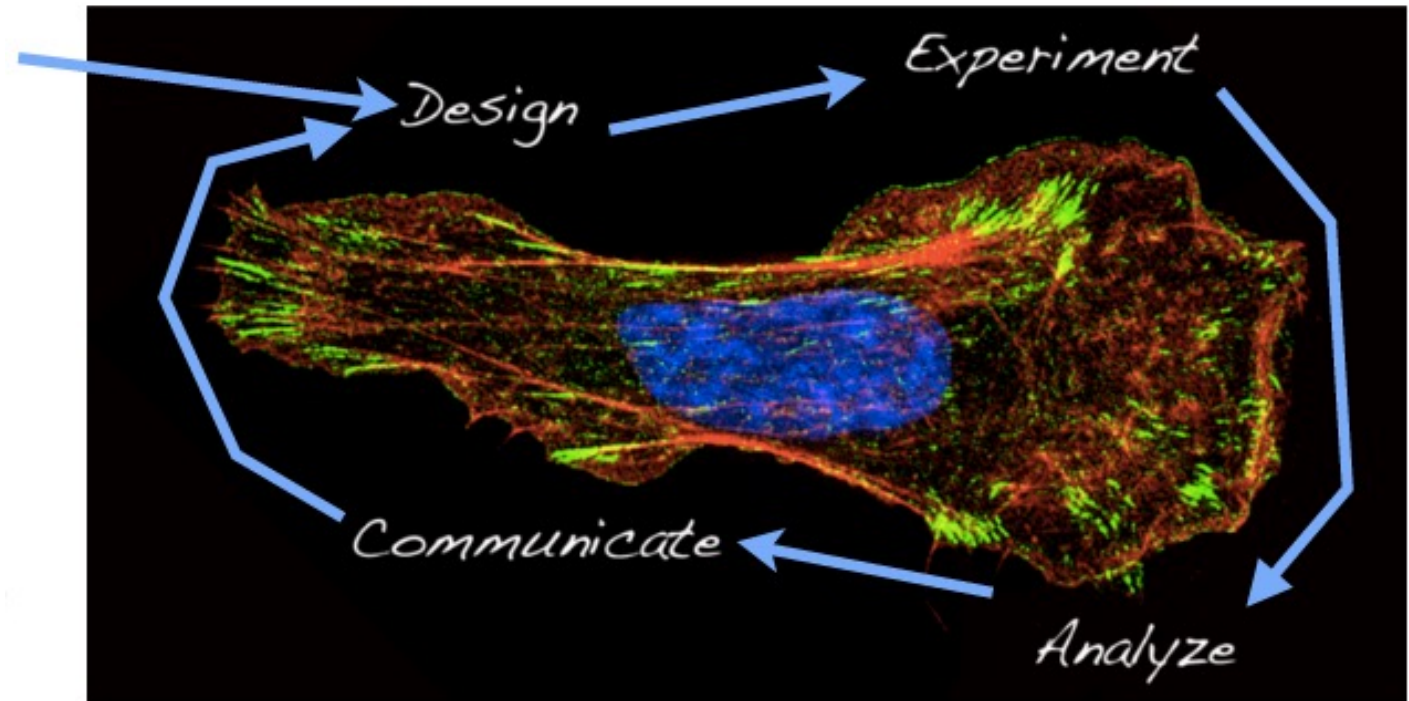


## Validation/ Analysis



# Workflow in 20.109

We start here...

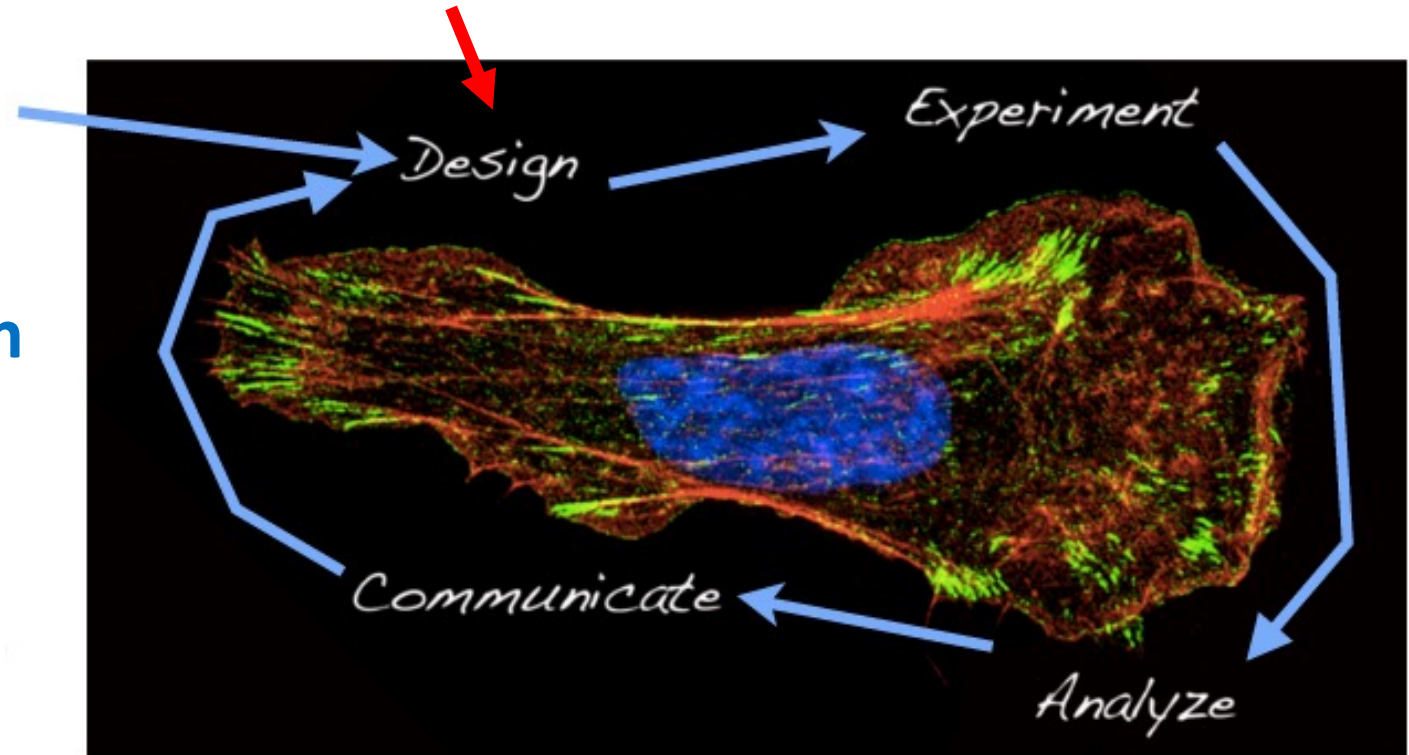


# Workflow in 20.109

Research!

We start here...

**But you can't design  
an experiment  
without reviewing  
the literature!**



# We do real science

We aim to prevent 'just follow the protocol' benchwork

Will discuss not only how experiments are completed, but what each step actually does





# We follow best practices

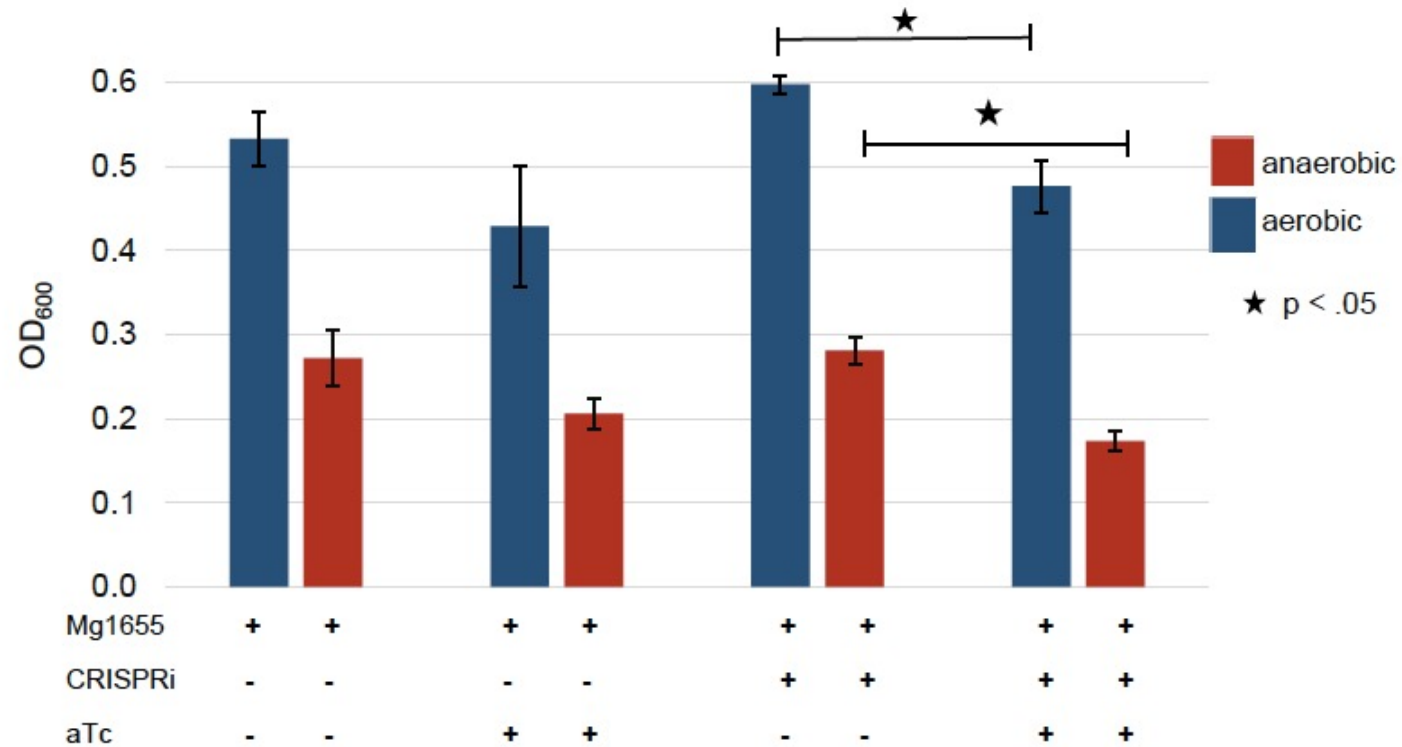
We do relevant and cutting edge research

Will discuss best practices for data collection and personal / environmental safety





# We analyze and report data



**Figure 4. O<sub>2</sub> affects E.coli growth significantly and activated CRISPRi decreases overall cell growth.** Conditions similar for CRISPRi and aTc presence were compared in aerobic and anaerobic conditions to check for side-effects on growth rate. Across all four conditions there was a significant difference between aerobic and anaerobic conditions. In addition there was a significant difference between aerobic CRISPRi+O<sub>2</sub>+aTc and inactivated CRISPRi+O<sub>2</sub>-aTc. Also, there was a significant difference between anaerobic CRISPRi-O<sub>2</sub>+aTc and CRISPRi-O<sub>2</sub>-aTc. ★ = p<.05

# We develop written and verbal communication skills

MODULE	TOPIC	ASSIGNMENT	WEIGHT
1	Genomic instability	Data summary	15%
		Research talk	5%
2	Drug discovery	Research article	20%
		Journal club presentation	15%

Research proposal presentation 20%

- Written communication assignments = 35%
- Verbal communication assignments = 40%
- Daily work and participation = 25%

# We are here to help!

- 20.109 Teaching Team
  - Faculty
  - Instructors
  - Teaching assistants
- BE Communication Lab
  - Instructors
  - Writing fellows



# 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/>

# 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.”

# Our goals for you this semester

- 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



# Expectations in 20.109...

## 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

## 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

# Schedule and structure logistics

- Lectures meet Tuesday and Thursday 11-12p
  - Prof. Engelward → Prof. Niles
- Class divided into two laboratory sections
  - Tuesday and Thursday 1-4p
  - Wednesday and Friday 1-4p
- Details
  - You will work in pairs throughout the semester
  - Collaboration with integrity is key!

# Final administrative notes

- Attendance is expected, in both lecture and laboratory
- Participation is required
  - Laboratory exercises are completed with your partner
  - Some homeworks and assignments are completed with your partner
- **We know this will be a new and interesting experience for everyone, please always feel free to reach out with questions / comments / concerns as we move through the semester!**