

# Research Proposals

## 20.109 Communication Workshop 5

These are so fun!



Dr. Perna Bhargava

Dr. Sean Clarke

Helping you communicate effectively.

[be.mit.edu/communicationlab](https://be.mit.edu/communicationlab)

MIT **BE**  
BIOLOGICAL ENGINEERING

Communication Lab


# We have seen a variety of communication assignments in 109...

Figures

Titles and Abstracts

Manuscripts

Journal Clubs

 We are here.  
Proposals

# All assignments use the same basic communication skills:


Figures

Titles and Abstracts

Manuscripts

Journal Clubs

Proposals

- 
- Know your audience
  - Tell a story
  - Convey clear logic
  - Use clear, precise language and presentation

# Concretely, these skills translate to:

- Clear **visual data** in figures and slides, with strong signal to noise ratio
- Titles as **strong messages** on slides
- Tell **a story** with a clear take-home message, logic, and conclusions
- Use **hourglass structure** to draw the audience in

All these help make a good proposal too!

Let's say you have \$1 million



to give to someone's  
biological engineering project?

What would you want to know  
from the person you're giving it to?

A successful proposal must convince its readers that the proposed work is **significant** and **achievable**.

# Proposals are future papers (with twists)

Both

have structured sections

tell stories

include methods, controls & statistics

argue for excitement and validity



# Proposals are future papers (with twists)

Papers

framed as a **question**

Proposals

framed as a **hypothesis**

# Proposals are future papers (with twists)

## Papers

framed as a **question**  
outcome sounds **un**certain

## Proposals

framed as a **hypothesis**  
outcome sounds certain

# Proposals are future papers (with twists)

## Papers

framed as a **question**  
outcome sounds **un**certain  
the **findings** are exciting

## Proposals

framed as a **hypothesis**  
outcome sounds certain  
the **innovation** is exciting

The 109 proposal is a team presentation

Speaking and slides

**12 minute talk** + lots of Q & A

Comm rule #1 is KNOW YOUR AUDIENCE

BE enthusiasts and experts  
(your peers & teaching staff)



# Tell us the essential **why, what, and how**

Why Identify the **gap/need** or **advance**

What What is the clear idea you propose to try?  
**Impact?**

How Key steps to accomplish goals (“aims”)

We care about the **methods**:  
specify techniques, *in vitro*, *in vivo*, what system

Show us **expected data**

If things don't work, what will you do?

Have **controls and work-arounds**

# Tell us the essential **why**, **what**, and **how**

Why Identify the **gap/need** or **advance**

What What is the clear idea you propose to try?  
**Impact?**

How Key steps to accomplish goals (“aims”)

We care about the **methods**:  
specify techniques, *in vitro*, *in vivo*, what system

Show us **expected data**

If things don't work, what will you do?

Have **controls and work-arounds**

Significant

Achievable

Use both slides & speech to convey these parts:

- a brief project overview
- sufficient background to identify a **clear PROBLEM and approach**
- a **statement of the research problem and goals** (aka "specific aims")
- details and **METHODS** for each goal
- predicted outcomes, alternate approaches, needed resources
- **IMPACT (scientific or societal)** if all goes well



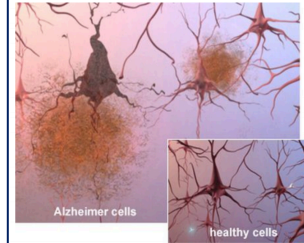
# First, cover the problem you propose to solve (why?) current state of the field (why now?)

## 1 Alzheimer's affects 5.4 million Americans

- Information about disease and progression

Transition statement linking to  $\beta$ -amyloid plaques (written on slide and/or stated verbally)

## 2 $\beta$ -amyloid plaques contribute to degeneration of nerve function



- General information about plaque origin and structure
- Block cell-cell communication
- Induce apoptosis
- Lead to generalized destruction of brain tissue

## 3 Symptoms of Alzheimer's may be alleviated by elimination of plaques

- Information about current field of research
  - Briefly, what has been done

Though some progress has been made in reducing plaques, our aim is to convert them to usable product

## 4 Novel amyloid-to-dark chocolate (ADC) enzyme recently discovered

- Identified in our laboratory using a yeast two-hybrid screen
- Information about ADC enzyme

Then provide a clear statement of your research problem and goals (*what, how?*)

Clear, concise research statement

3-4 goals to prove your hypothesis

Research aim: use ADC to convert  $\beta$ -amyloid plaques to dark chocolate

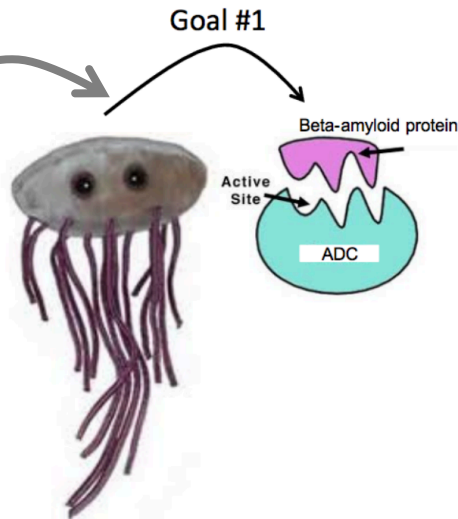
- **Goal 1:** Optimize the production of genetically engineered ADC using non-toxic *E. coli* strain
- **Goal 2:** Determine enzymatic efficiency of engineered ADC *in vitro* using harvested  $\beta$ -amyloid plaques
- **Goal 3:** Measure efficacy of engineered ADC *in vivo* using a mouse model of Alzheimer's disease

# Each goal should have a slide for what you'll do

Title of your goal

## Optimize production of ADC in *E. coli*

Schematic of goal/ method/ expected results



- Engineer BL21(DE3) to express ADC
  - Clone ADC into pXYZ
  - Test protein expression
  - Additional steps...
- Potential setback
  - Possible solution

Key methods

Potential limitations and alternative approaches

# Remember:

You want to highlight that you are solving an important (and real) problem with an innovative solution.

And this should be clear to your audience.

Include a slide that highlights the **impact** this work would have on society and science

Why is this work important?

Why should someone give you money to do this work?

# Remember all the tips for good slide design

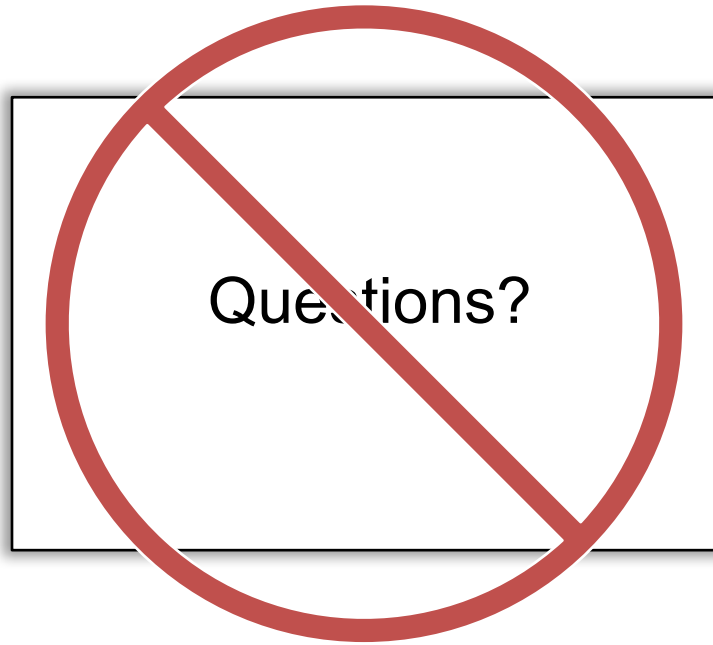
- One message per slide
- Titles as messages
- Use visuals/schematics when you can
- Just relevant text
- Maximize signal to noise

# New! Adapt to presenting as a team

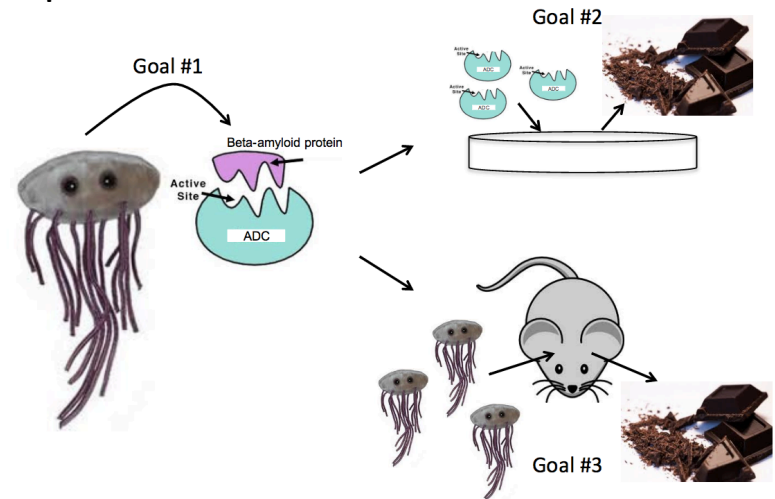
- Decide who will say what
- Maybe announce organization/transitions
  - “I’ll introduce our Question and Aims, and Prerna will talk about the Methods we’ll use...”
- Stay visually quiet when you’re not speaking
- Don’t read from slides, just use transitions and bits of text to guide
- Q&A: Share answers
- Leave a helpful slide up, flip around as needed

**PRACTICE PRACTICE PRACTICE**

# Make good use of your last slide



## Conversion of $\beta$ -amyloid plaques to usable product in treatment of Alzheimer's





# Proposals are challenging!

1. How do I develop a goal that is feasible *and* significant?
2. What might the steps be to reach it?

You can consider two strategies for innovation

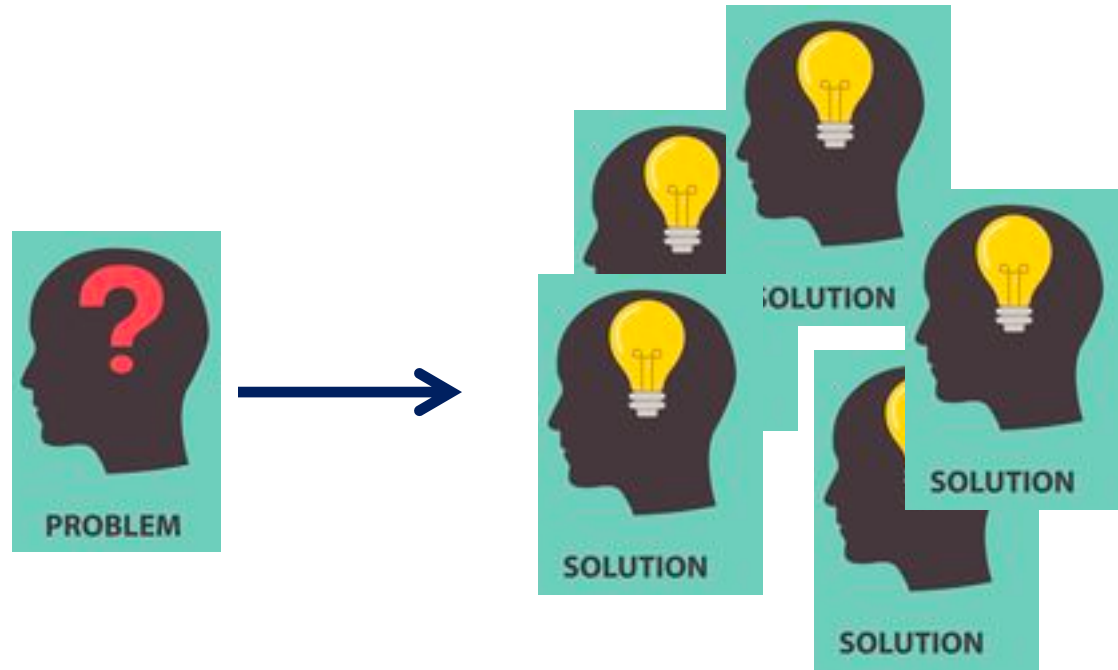
“market pull”



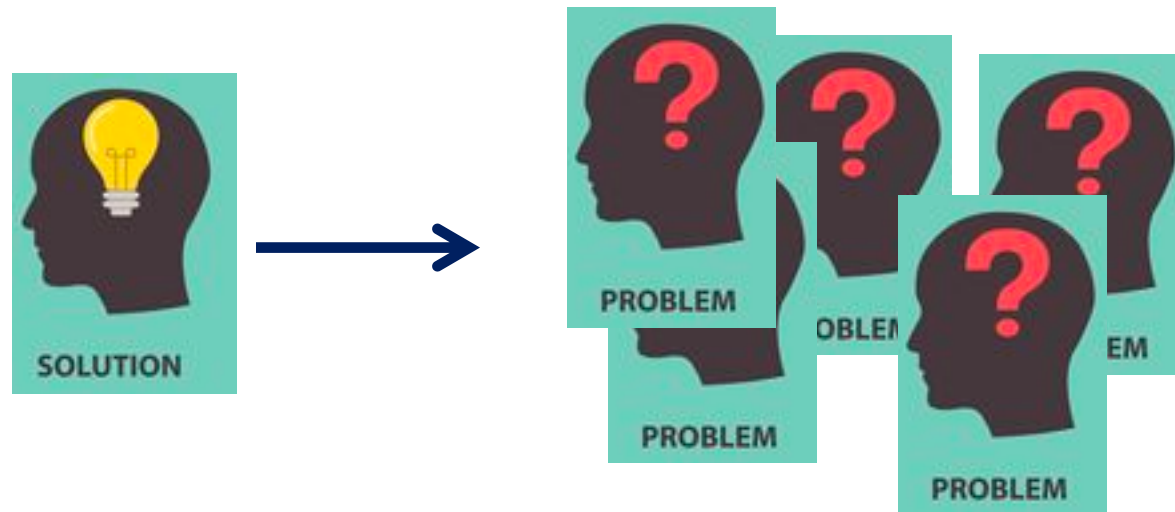
“tech push”

# You can consider two strategies for innovation

“market pull”



“tech push”



# Where do you get ideas?



# Ideas come from many sources

- Recent papers (discussion sections!)
- Popular news articles
- Seminars or conferences
- Your own “bug list”
- Talking to people, especially experts
  
- Idea trees
- 5 Whys method



# Spend time brainstorming on your own and as a team

Go for **quantity**--having **a lot of ideas** raises your probability of coming up with a good idea

**Defer judgment**

**Build on** the ideas of others

Encourage **wild ideas**, be bold and creative

Rules from design firm **IDEO**

# Language matters in brainstorming

Supportive language

And...

What if...?

Also...

Get visual!

Unhelpful language

No...

But...

That won't work...

That doesn't make sense...

Great.

*Activity:*

*Let's try brainstorming for 10 min. in teams*

- Take the **most interesting research finding** you identified and talk about why you think it is an **important problem to solve** or an **intriguing technology**
- Ideate **potential ways to solve** your identified problem or apply the technology
- This is NOT binding, so be creative!



# Some pitfalls to avoid are:

## Incremental improvements

- A lab built a battery with zinc, so let's build a battery with nickel.

## Idea/buzzword stacking

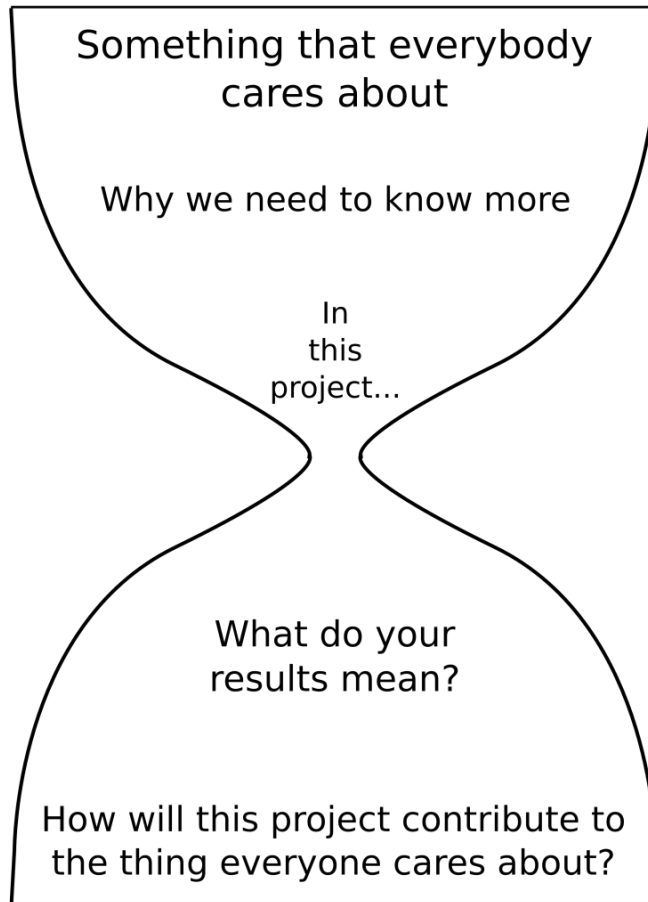
- Let's use CRISPRi & optogenetics on the gut microbiome

## Scope that is too big/too small

- Let's build a rocket ship out of bacteria
- Let's build a genetic circuit in *E. coli* that only requires cloning one gene

# Remember your hourglass!

Your proposal should match your identified problem



**Knowledge gap, Unknown**

**HERE WE PROPOSE...**

Once you have a topic or idea,  
you'll need goals/aims to get there.

What are critical steps that need to be taken  
in order to answer your question?

best first steps  
logical order  
feasibility

# Your goals should address critical steps to reach your solution



Goal #1

Goal #2

Goal #3



# Your goals should address critical steps that allow you to reach your solution



Alzheimer's is a big problem; B-amyloid plaques contribute

#1 Produce ADC

Proposal is to convert plaques with the novel enzyme ADC

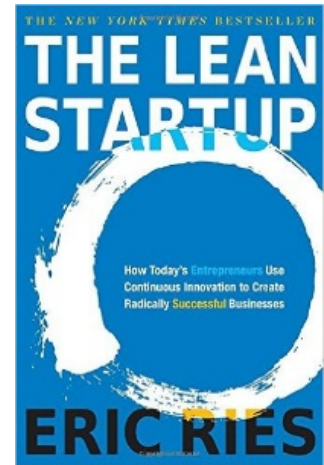
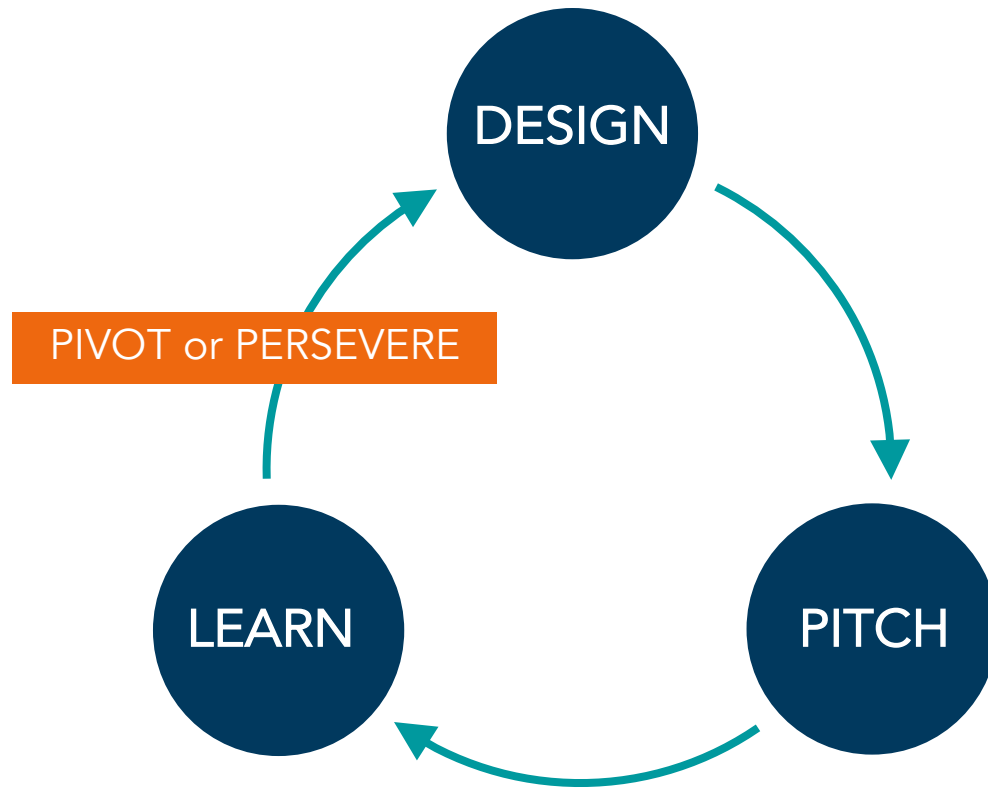
#2 Determine if ADC can get rid of plaque protein

#3 Determine if getting rid of plaques can affect model Alzheimer's



Get rid of plaques to cure Alzheimer's

# Going through feedback loops improves your design



Stay **open to feedback** -- it is how you learn and grow!

Be nimble and **pivot** or build support for your **hunches**

# See the wiki for an example slide deck

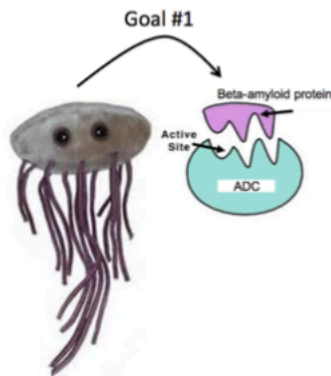
## Engineered bacteria for the conversion of amyloid plaques to dark chocolate

Shannon K. Hughes and Noreen L. Lyell

Research aim: use ADC to convert  $\beta$ -amyloid plaques to dark chocolate

- **Goal 1:** Optimize the production of genetically engineered ADC using non-toxic *E. coli* strain
- **Goal 2:** Determine enzymatic efficiency of engineered ADC *in vitro* using harvested  $\beta$ -amyloid plaques

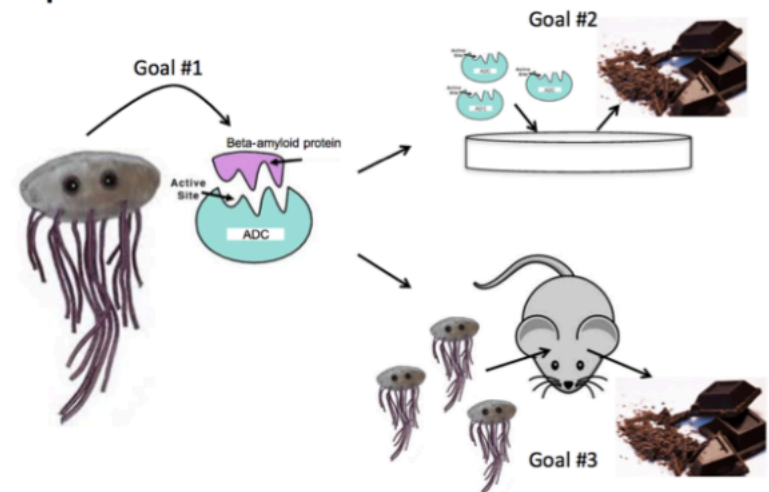
## Optimize production of ADC in *E. coli*



- Engineer BL21(DE3) to express ADC
  - Clone ADC into pXYZ
  - Test protein expression
  - Additional steps...
- Potential setback
  - Possible solution

Goal 3: Measure efficacy of engineered ADC

## Conversion of $\beta$ -amyloid plaques to usable product in treatment of Alzheimer's



# Here's additional help

- [From Prof. Jen Heemstra's blog: Research ideas, part 1: It's not magic](#) (also parts 2-4 on the side)
- [NIH Small Grant Program \(R03\)](#): appropriate scale
- [NIAID](#): includes alternate approaches
- [BE Research Guide](#): (email Howard Silver [hsilver](mailto:hsilver) with suggestions!)
- Previous workshops on wiki, BECL



It's going to be fun!



## Be sure your presentation includes:

- Sufficient background to orient the audience to the problem and current state of the field
- A strong problem statement/knowledge gap
- A clear proposal statement/hypothesis
- Clear aims/goals that follow a logic leading to the end goal
- Succinct methods highlighting what you will do
- Alternate approaches
- Strong impact statement

## Your slides and presentation should:

- Convey a single message per slide
- Have titles that are messages
- Only contain relevant material (reduce signal/noise)
- Include schematics to help your audience
- Be organized, with a plan about who will speak when