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?

Research Proposals

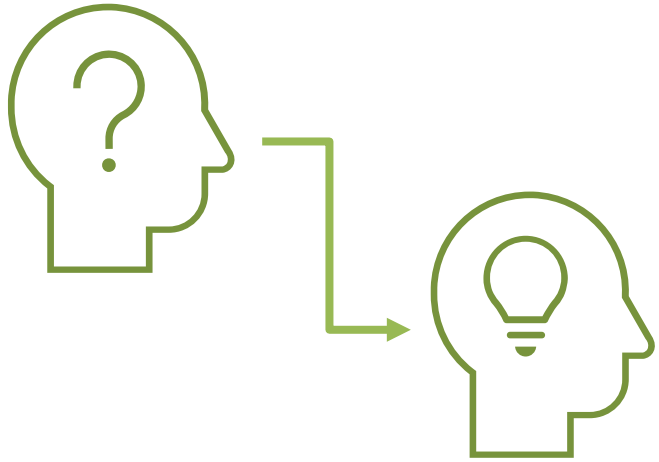
20.109 Communication Workshop 6

Dr. Chiara Ricci-Tam

Dr. Sean Clarke

MIT BE
BIOLOGICAL ENGINEERING

Communication Lab



Helping you communicate effectively.

mitcommlab.mit.edu/be/

We have seen a variety of communication assignments in 109…

abstracts

titles

figures

journal article presentations

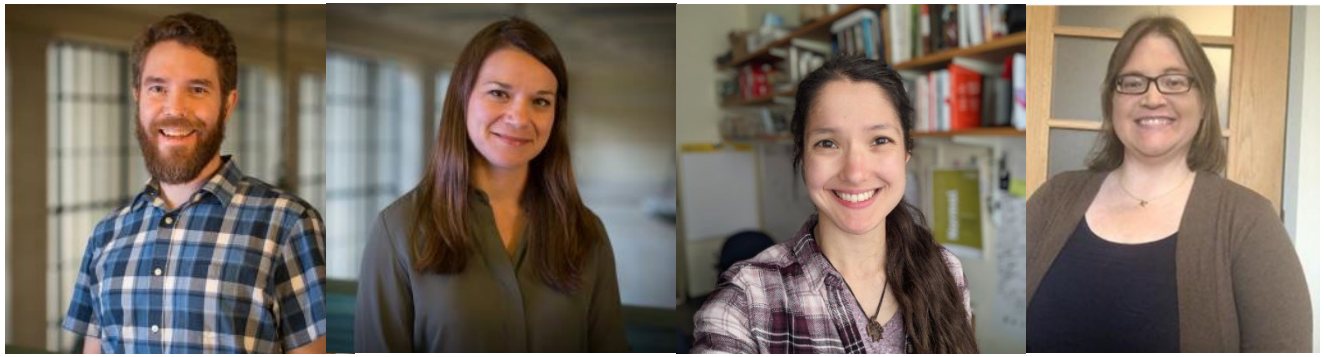
research papers

Those all build to **proposals**!

Team presentation of your idea

12 minutes + Q & A

Audience: BE enthusiasts and experts
(your peers & teaching staff)



The same principles apply for all tasks

Figures
Titles and Abstracts
Manuscripts
Oral Presentations
Proposals

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

A few basic tactics will get you VERY FAR

- **Clear visuals** with high signal to noise
- **Strong title messages** on slides
- **Storytelling** with clear messages and logic
- **Hourglass structure** to draw the audience in

All help make a good proposal too!

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 audience that the proposed work is **significant** and **achievable**.

How might you get the audience on your side?

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:

- Briefly intro yourselves and the project
- Give sufficient background to identify a **clear PROBLEM and APPROACH** (but not too much)
- State **the overall aim and goals** (aka “specific aims”)
- Describe each goal’s **METHODS** and logic
- Show you’ve thought about predicted outcomes, alternate approaches, needed resources
- **IMPACT (scientific or societal)** if all goes well

In background, cover:

- **the problem/question** you propose to address (*why?*)
- **current state** of the field (*why now?*)

1

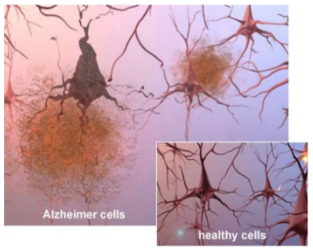
Alzheimer's affects 5.4 million Americans

- Information about disease and progression

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

2

β-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

State your overall research problem and goals (*what*?, *how*?)

Clear, concise research statement

3-4 goals (a.k.a. aims) to prove your hypothesis

Research aim: use ADC to convert β-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 β-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

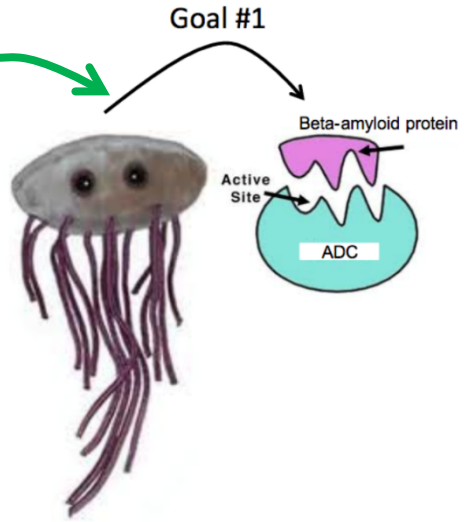
Title of your goal

Schematic of goal/ method/ expected results

Key methods

Potential limitations and alternative approaches

Optimize production of ADC in *E. coli*

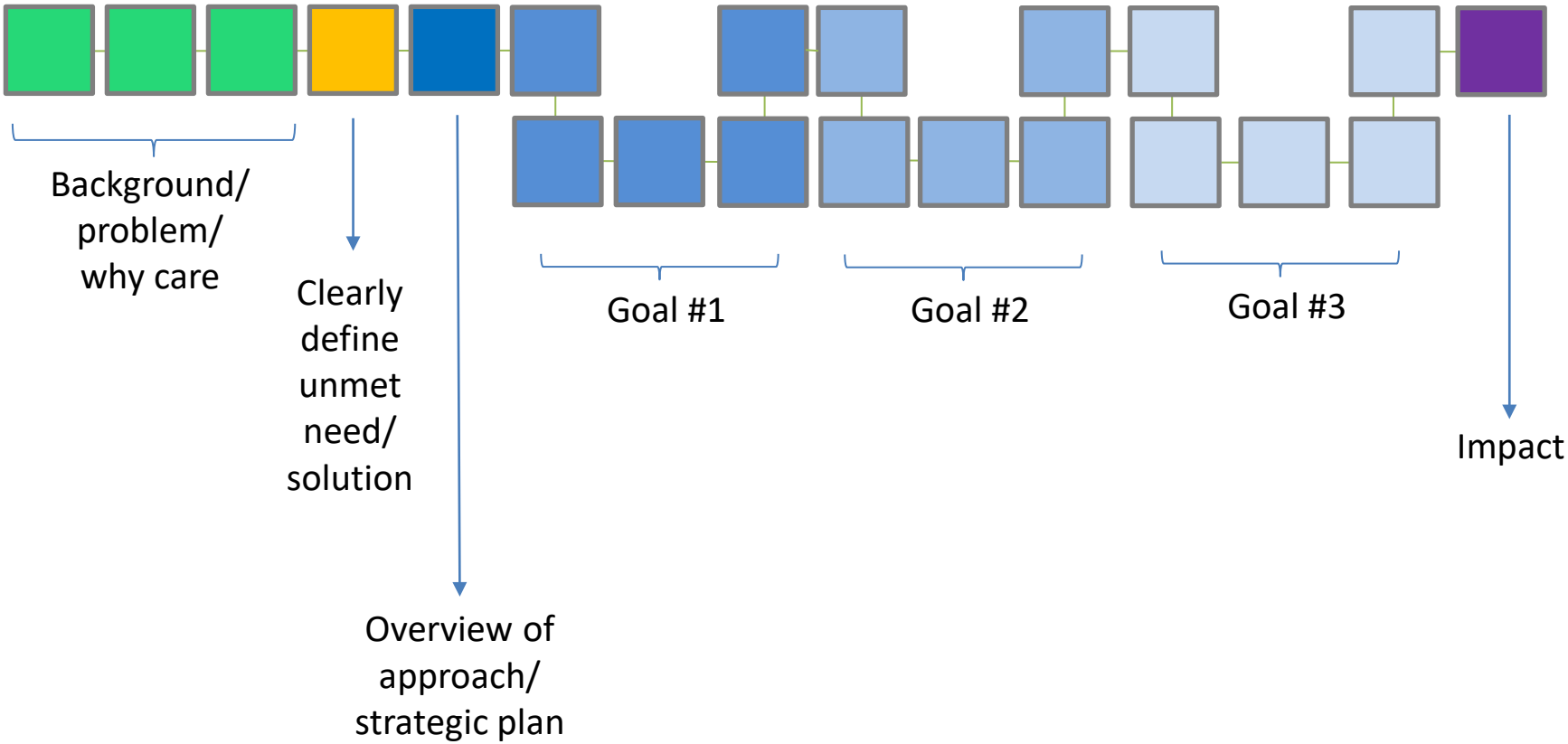


- Engineer BL21(DE3) to express ADC
  - Clone ADC into pXYZ
  - Test protein expression
  - Additional steps…
- Potential setback
  - Possible solution

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?

Your whole presentation might look like this



Remember the fundamental tips for good slide design

- **Maximize signal to noise**
- One message per slide
- Slide title is a message
- Use visuals/schematics when you can
- Minimally sufficient information

Adapt to presenting as a team

- Decide who will say what
- Can 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
- Q&A: Share answers
- If worked on parts separately, do a final revision to ensure consistency between your individual sections

PRACTICE PRACTICE PRACTICE

Proposals are challenging!

1. How do I develop a goal that is significant *and* achievable?

2. What steps are needed to achieve it?

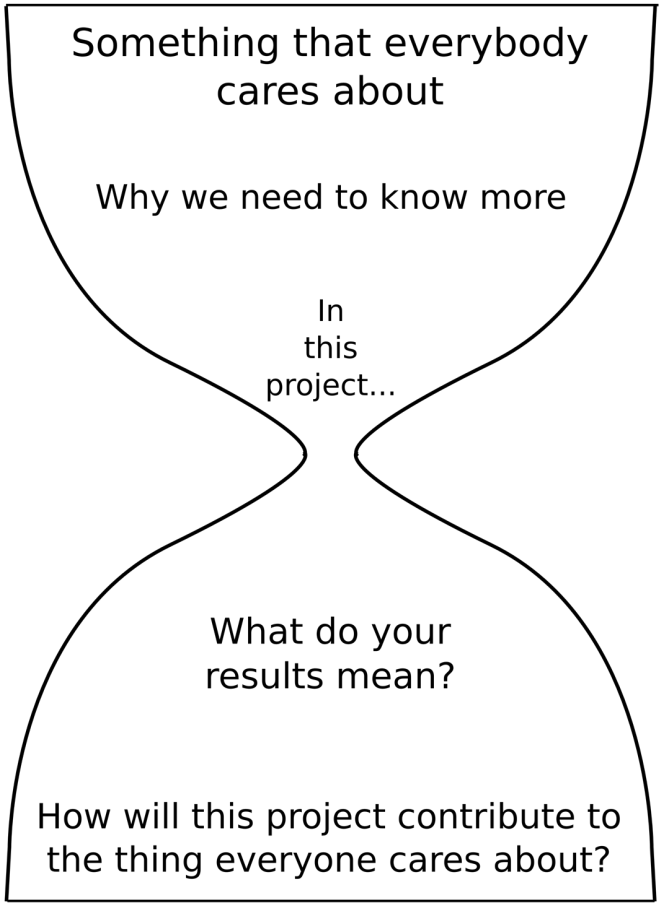
Once you have a research problem, you'll need specific aims (goals) to solve it

1. Identify the knowledge gap and plan to fill it, clearly

2. Identify aims/goals for executing your research plan

Make a clear **match** from the problem you identify to your proposed work

Remember to use the hourglass!



Knowledge gap, Unknown

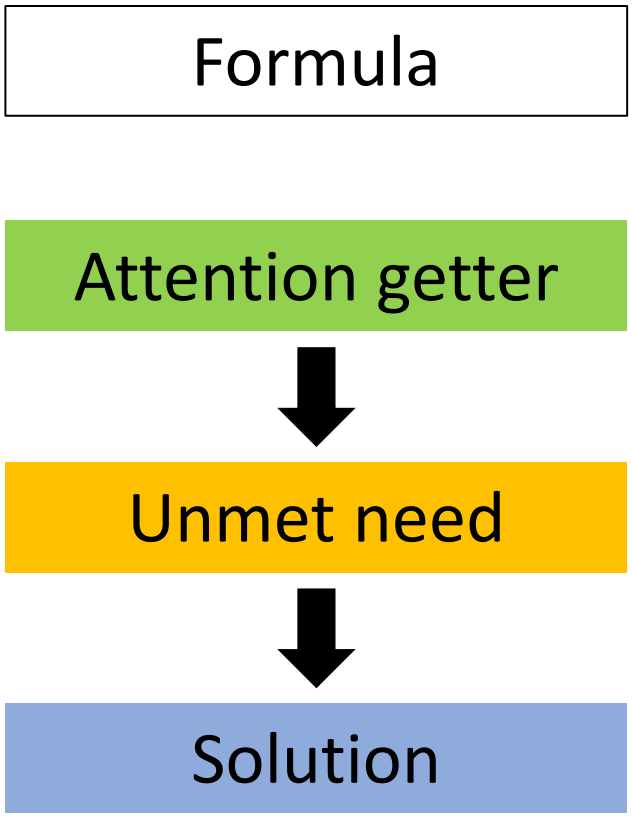
HERE WE PROPOSE…

One way to figure out your problem/solution is to put together a **pitch**

A short summary of your proposal and its value

Keep it **short** (~30 seconds), use **plain language**, and **set the stage** for your presentation

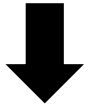
Communicate “so what” message of why we should care



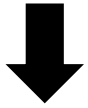
An example pitch

Formula

Attention getter



Unmet need



Solution

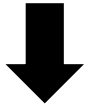
Human papillomavirus (HPV) infections cause nearly all cases of cervical cancer worldwide. While there are over 150 genotypes of HPV, only a handful of genotypes cause cervical cancer and current diagnostics cannot provide same day results for which genotype is present.

That's why I am building a rapid diagnostic to genotype HPV and screen for cancer risk using programmable toehold switches and CRISPR enzymes to detect specific DNA or RNA sequences.

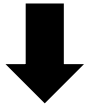
An example pitch

Formula

Attention getter



Unmet need



Solution

Human papillomavirus (HPV) infections cause nearly all cases of cervical cancer worldwide. While there are over 150 genotypes of HPV, only a handful of genotypes cause cervical cancer and current diagnostics cannot provide same day results for which genotype is present.

That's why I am building a rapid diagnostic to genotype HPV and screen for cancer risk using programmable toehold switches and CRISPR enzymes to detect specific DNA or RNA sequences.

Put your punchline up front

Formula

Attention getter

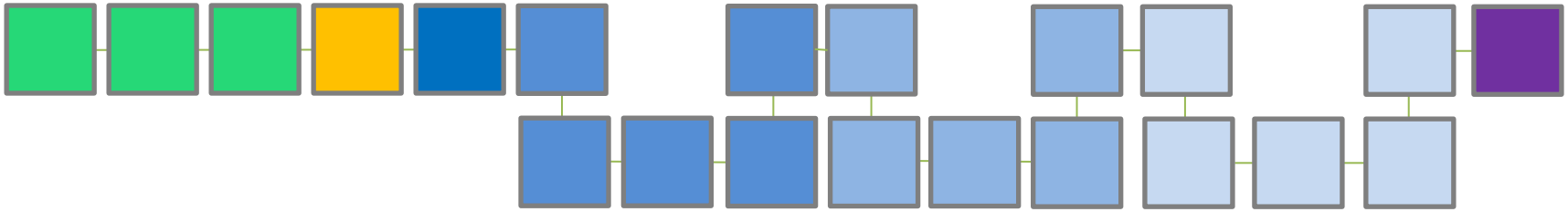
Solution

Unmet need

Impact

I am building a diagnostic to genotype HPV and screen for cancer risk by rapidly identifying the handful of HPV strains that cause cervical cancer out of over 150 genotypes that exist. This will allow us to provide a rapid, same-day diagnostic for Human Papillomavirus, an infection that cause nearly all cases of cervical cancer worldwide. Using this diagnostic we can accurately treat patients in a timely manner.

Your pitch can help design slides



Human papillomavirus (HPV) infections cause nearly all cases of cervical cancer worldwide. While there are over 150 genotypes of HPV, only a handful of genotypes cause cervical cancer and current diagnostics cannot provide same day results for which genotype is present.

That's why I am building a rapid diagnostic to genotype HPV and screen for cancer risk using programmable toehold switches and CRISPR enzymes to detect specific DNA or RNA sequences.

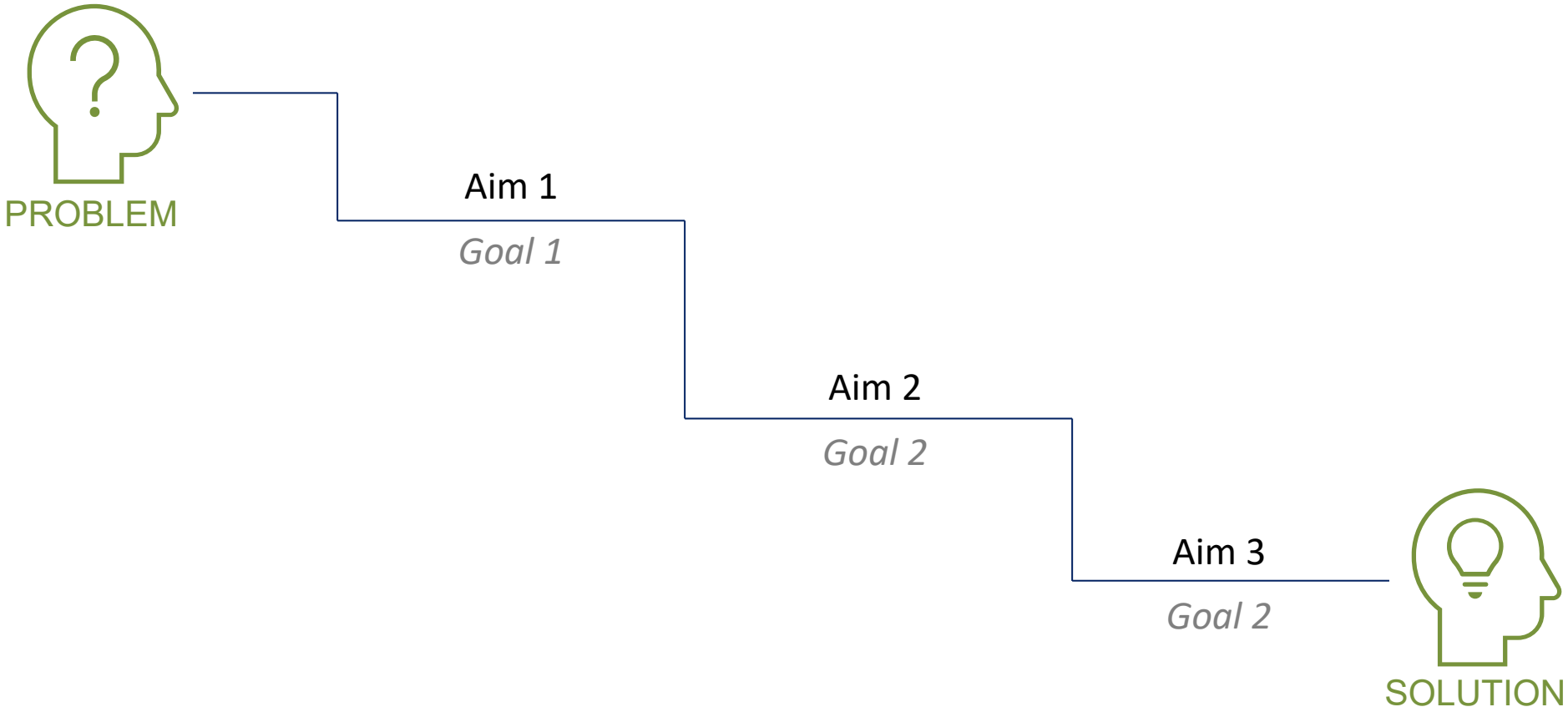
Once you have a research problem, you'll need **specific aims** (goals) to solve it

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

best first steps
logical order
feasibility

List out all your **assertions** and identify the critical **questions** that need to be answered to provide **evidence** for those assertions

Your specific aims should address critical steps needed to achieve your larger project



Your specific aims should address critical steps needed to achieve your larger project

Proposal is to convert plaques with the novel enzyme ADC

PROBLEM

Alzheimer's is a big problem, β-amyloid plaques contribute

Aim 1| Produce ADC

Aim 2| Determine if ADC can get rid of plaque protein

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

SOLUTION

Get rid of plaques to cure Alzheimer's

Order of your aims matters and depends on your goals / where you are in the project

PROBLEM

Alzheimer's is a big problem, β-amyloid plaques contribute

Aim 1| Produce ADC

Aim 1| Determine if getting rid of plaques can affect model Alzheimer's

Aim 2| Determine if ADC can get rid of plaque protein

Aim 2| Determine if ADC can get rid of plaque protein

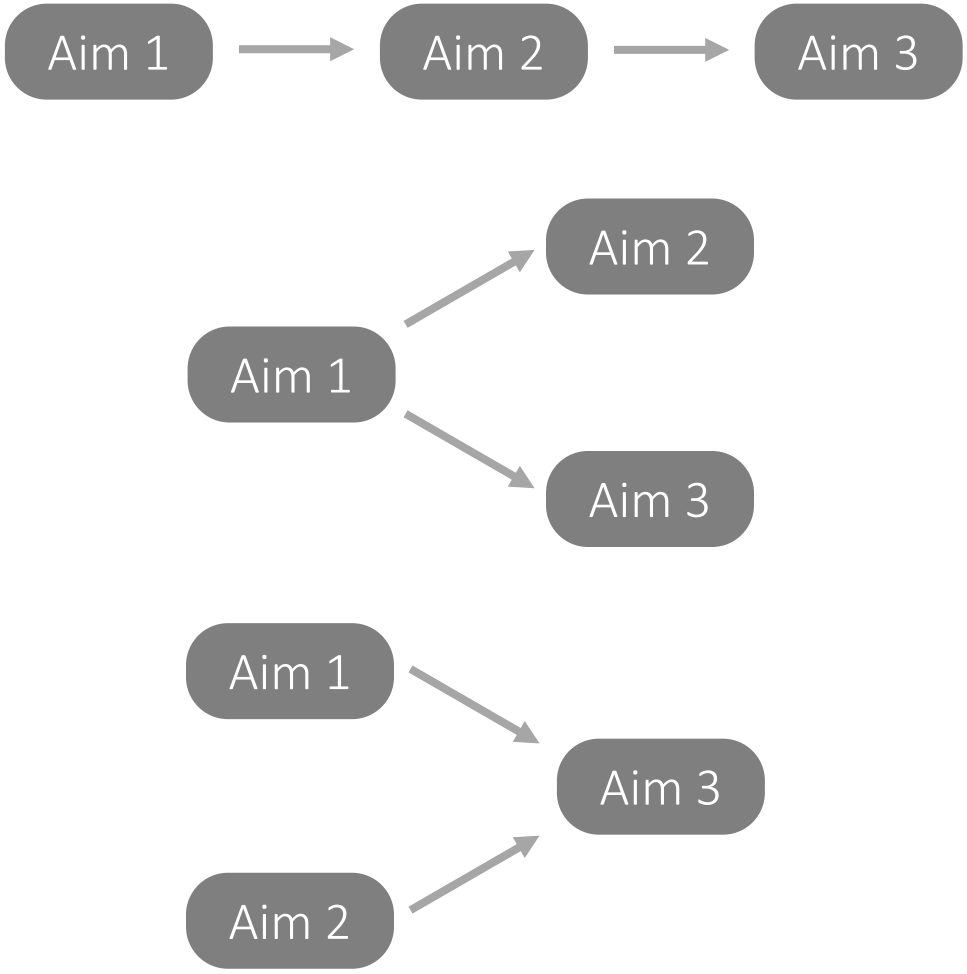
Aim 3| Determine if getting rid of plaques can affect model Alzheimer's

Aim 3| Produce ADC

SOLUTION

Get rid of plaques to cure Alzheimer's

Your aims may be connected to each other in different ways



Your aims *can* be interdependent, but only if you can demonstrate that they will not fail

"What would it look like for this Aim to be successful?"

Aim titles should be concrete

Each aim should have a clear goal that is easily defined.

Use wording that assures success.

Use verbs that convey a clear endpoint.

Specific: isolate, determine, identify, define, discover, elucidate, ascertain
Vague: examine, explore, evaluate, study, investigate

Focus on the outcome rather than the method.

Vague (for hypothesis-driven aims): perform, measure, characterize, describe, compare, catalog, correlate

Use parallel grammatical structure.

Make the aim statements clear and concise.

https://www3.mdanderson.org/library/education/pdf/crafting-strong-specific-aims-handout.pdf

Let's write some aims!

Aim 1| Produce ADC

Aim 2| Determine if ADC can get rid of plaque protein

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

Research aim: use ADC to convert β-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 β-amyloid plaques
- Goal 3: Measure efficacy of engineered ADC *in vivo* using a mouse model of Alzheimer's disease

“What would it look like for this Aim to be successful?”

Aim titles should be concrete

Each aim should have a clear goal that is easily defined.

The feasibility of each aim should be justified.

Make it clear **how** and **which** data would be gathered, and how they would be **interpreted**.

For each **aim**, we want to know:

a) Experimental Rationale
b) Experimental Plan
c) Expected Results
d) Potential Challenges and Solutions

- Why you are doing this
- What you will do
- What you will learn
- What happens if this doesn't work as expected
- How this will further your project

Explain **why** you picked a specific approach

a) Experimental Rationale
b) Experimental Plan
c) Expected Results
d) Potential Challenges and Solutions

Why did you choose this approach and not another one to answer your question?

What evidence exists that supports its feasibility?

Tell us what you plan to do

a) Experimental Rationale
b) Experimental Plan
c) Expected Results
d) Potential Challenges and Solutions

Outline major methods, experiments, tests.

How do you obtain the data needed to dis/prove your hypothesis?

Tell us what you expect to see

a) Experimental Rationale
b) Experimental Plan
c) Expected Results
d) Potential Challenges and Solutions

Use schematics and other visuals to help us imagine outcomes.

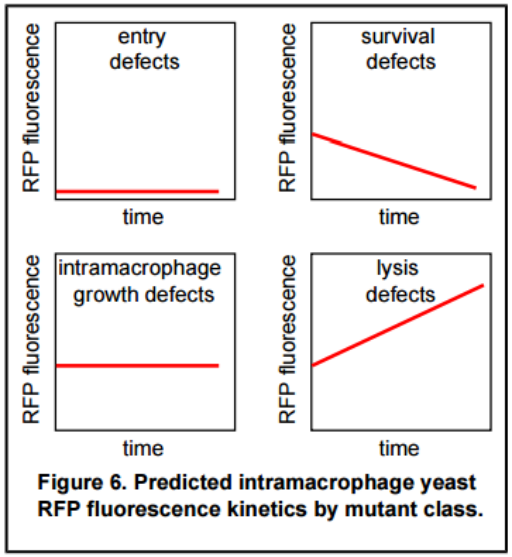


Figure 6. Predicted intramacrophage yeast RFP fluorescence kinetics by mutant class.

Tell us what you will do if you don't get expected results

a) Experimental Rationale
b) Experimental Plan
c) Expected Results
d) Potential Challenges and Solutions

Every method has shortcomings. Reviewers will predict many: anticipate their concerns.

Suggest alternative approaches.

Demonstrate both the robustness of your plan, and the depth of your knowledge of the field.

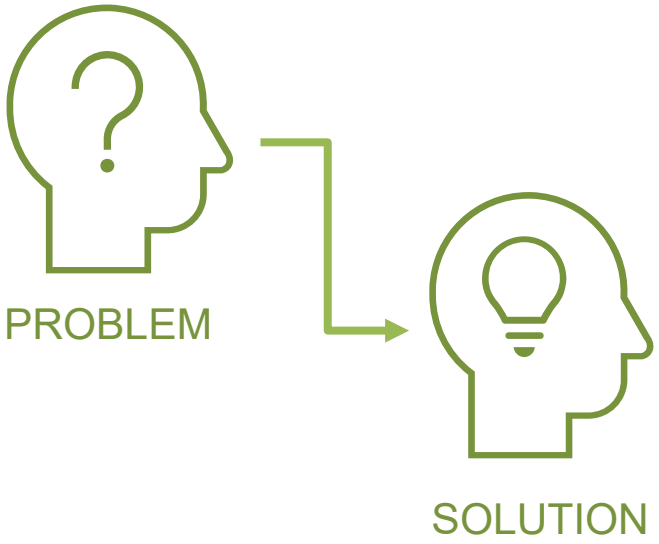
ACTIVITY

Identify your goals

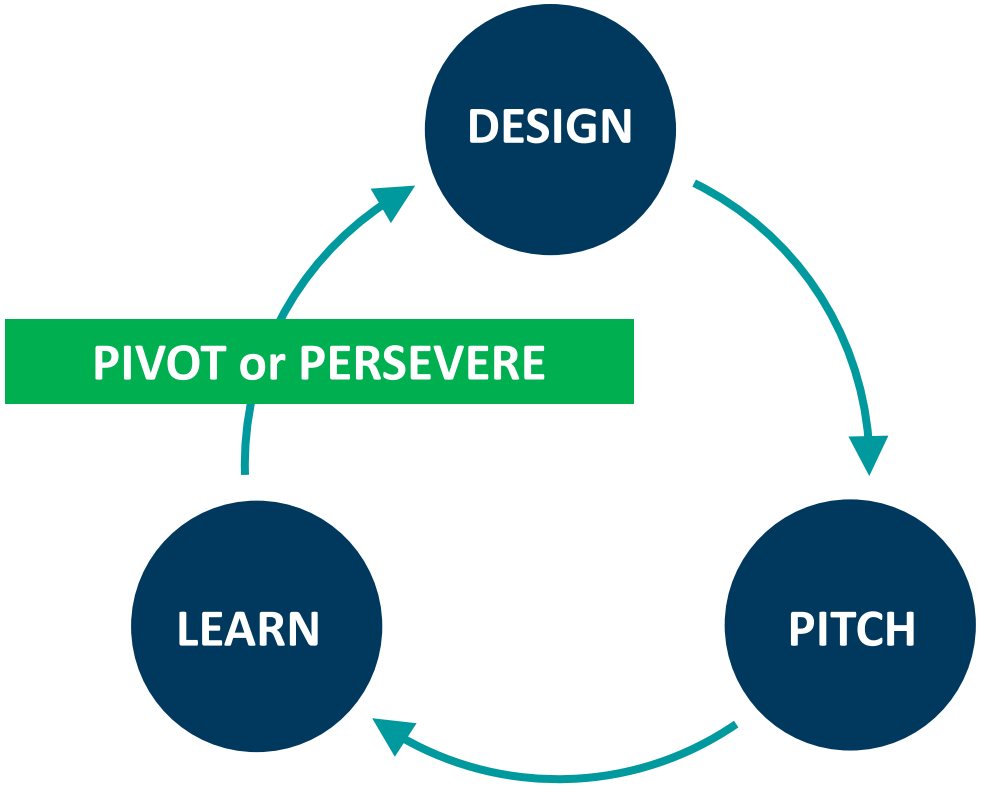
Build 3-4 aims that you could use in your proposal

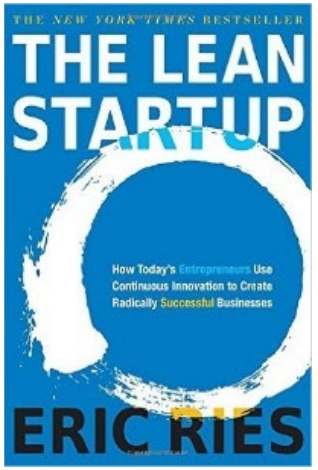
https://tinyurl.com/**20-109-comm**

Think about concrete goals that address a critical step in your design process



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 **intuition**

See the wiki for an example slide deck

Engineered bacteria for the conversion of amyloid plaques to dark chocolate

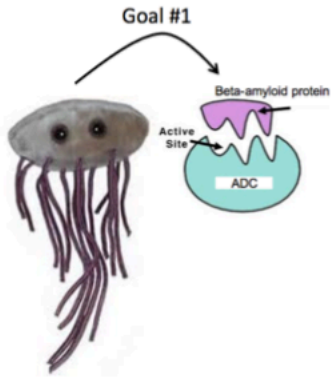
Shannon K. Hughes and Noreen L. Lyell

Research aim: use ADC to convert β-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 β-amyloid plaques

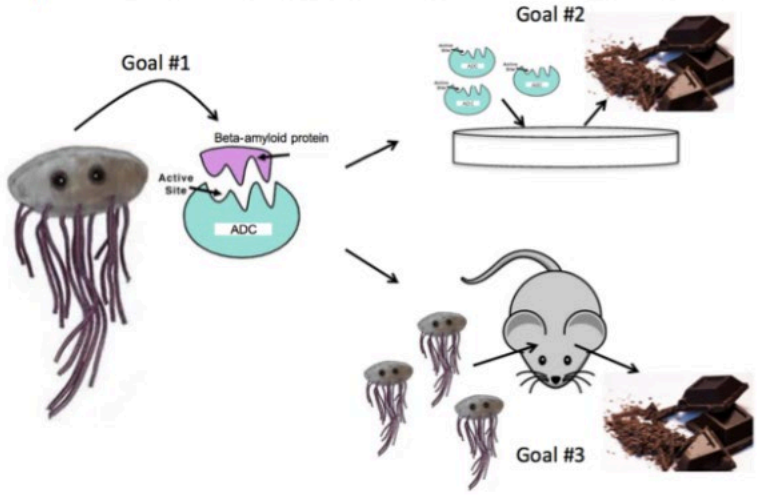
al 3: Measure efficacy of engineered ADC

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

Conversion of β-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 with questions or suggestions!)
- Previous workshops on wiki, BECL

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 noise)
- ❑ Include schematics to help your audience
- ❑ Be organized to share the speaking between presenters