Figure Design

20.109 Communication Workshop 1

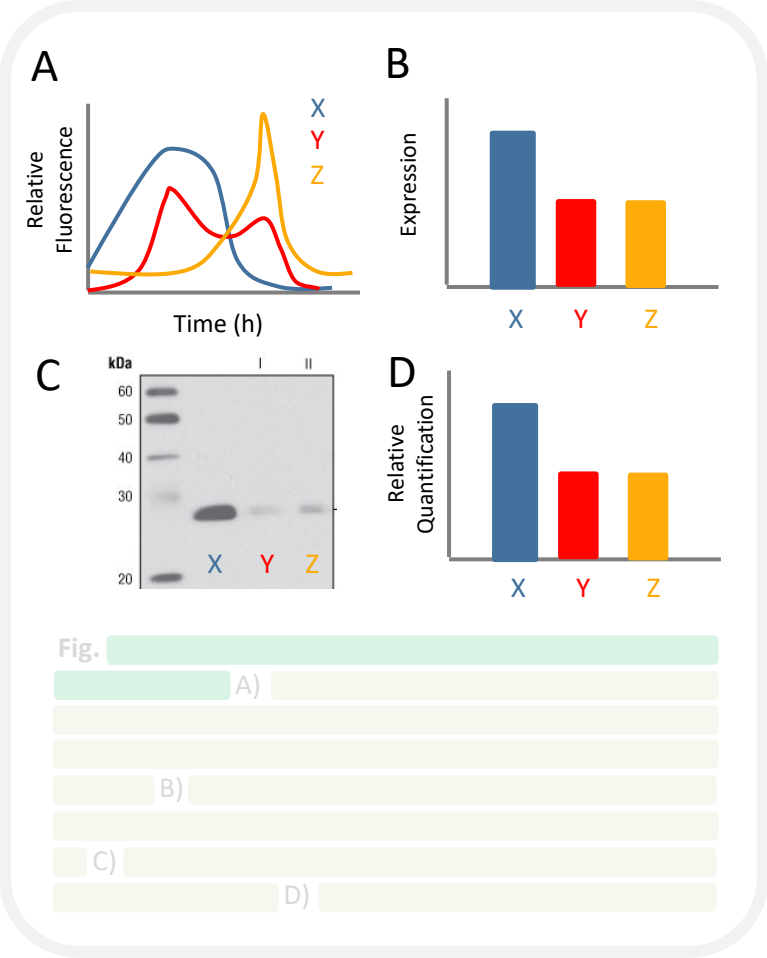
Dr. Chiara Ricci-Tam

Dr. Sean Clarke

MIT BE
BIOLOGICAL ENGINEERING

Communication Lab

Helping you communicate effectively.
mitcommlab.mit.edu/be/



Reflection Activity

1. What is science communication?
   What are some ways to communicate science?

2. What makes you feel that any communication has been successful?
   As a receiver? As a sender?

1. What is science communication?

What are some ways to communicate science?

There are many ways to communicate science. In this class we will focus on the tasks that are highlighted below:

Papers
Opinion Editorial Pieces
Podcasts
Videos
Journal Article Presentations
Blog posts
Twitter
Talking to friends/family
Illustrations
Posters
Pitches
Proposals
Review Articles
TED Talks

2. What makes you feel that any communication has been successful?

As a receiver? As a sender?

A few common metrics of "successful" communication:

You can ask questions after

You can explain it to someone else

You get a good grade

People cite your paper

It leads to more exciting science

Science communication is complex

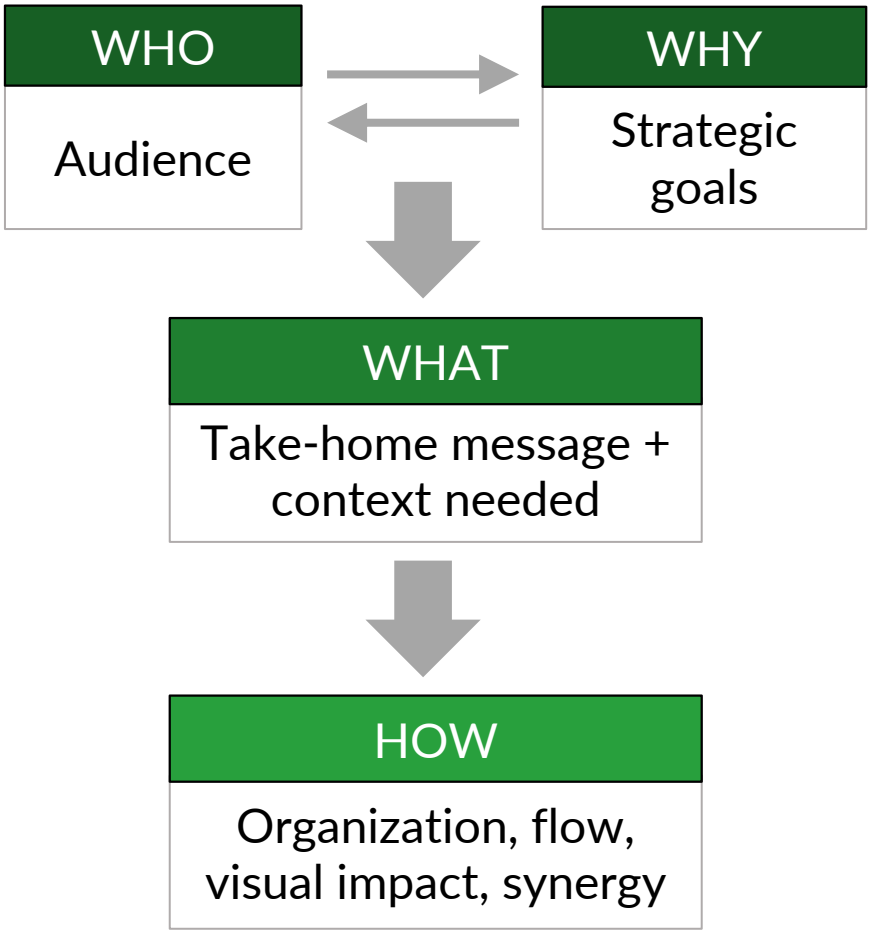
Educational principles to follow:

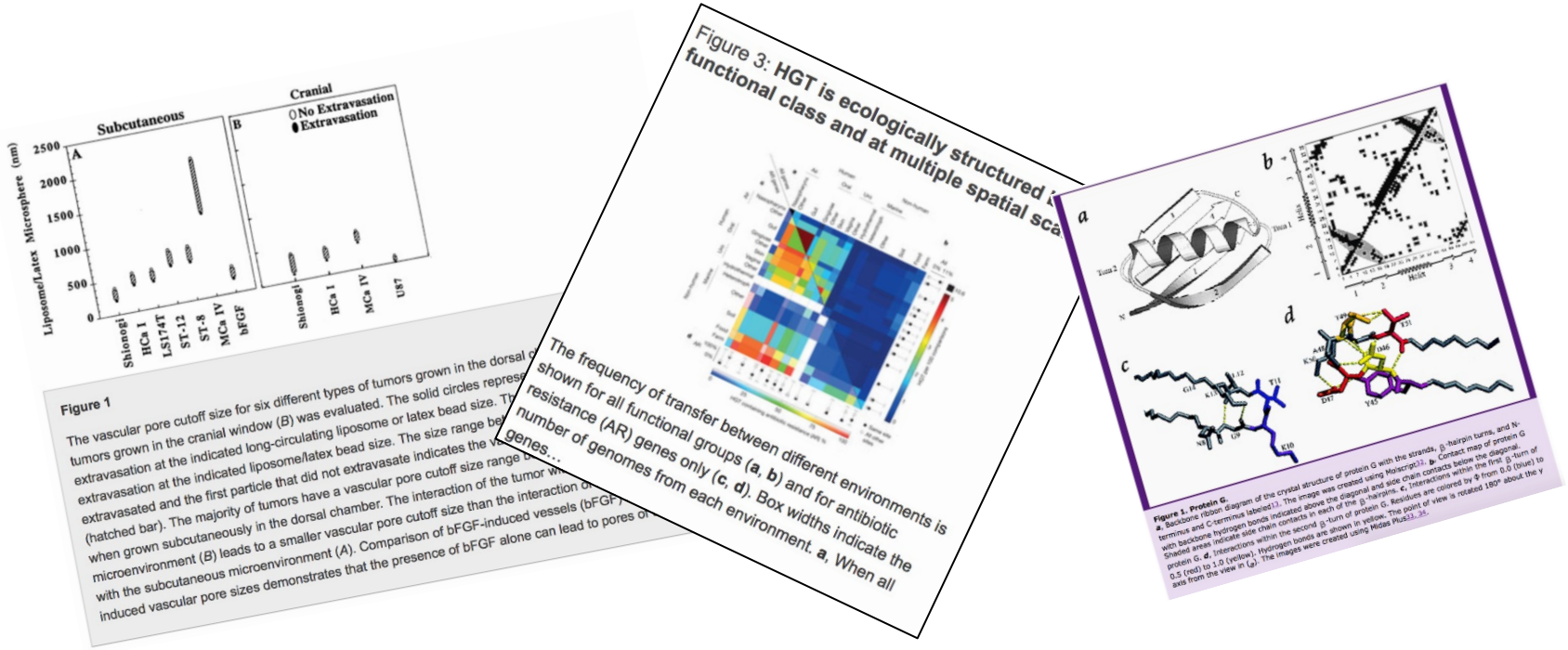
- Science communication is discipline specific
- Best way to learn science communication is to do it and get feedback
- Learn the basic rules and then find your own style

In this class, we have six Communication Workshops to support your major assignments

Workshop 1: Figures (overview)	
Workshop 2: Figure Captions & Titles	Data summary (Mod 1 report)
Workshop 3: Abstracts & Titles	
Workshop 4: Oral Presentations	Journal article presentation
Workshop 5: Manuscripts	Research article (Mod 2 report)
Workshop 6: Proposals	Research proposal presentation

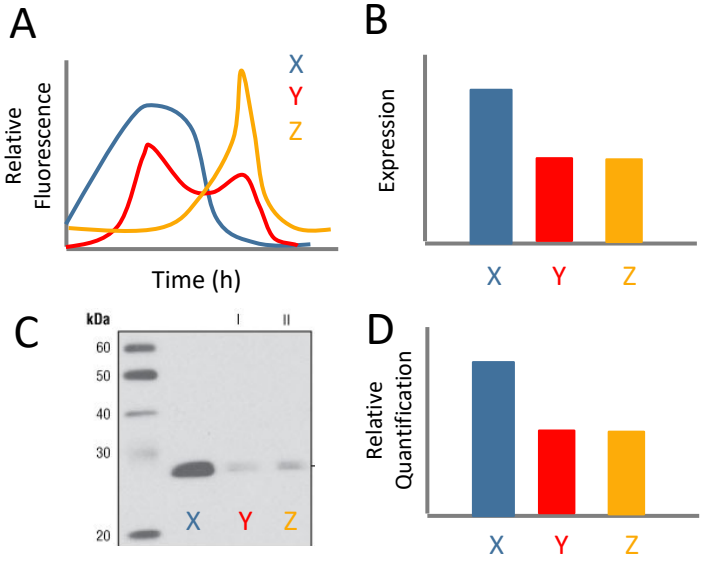
We approach all communication tasks with a focus on **message**





Figures

Why are figures so important?



Science AAAS

Article | Figures & Data | Info & Metrics | eLetters | PDF

PNAS

Abstract | Full Text | Authors & Info | Figures | Metrics | Related Content | PDF

nature food

Article | Published: 18 February 2020

Transgenic rice overproducing Rubisco exhibits increased yields with improved nitrogen-use efficiency in an experimental paddy field

Abstract

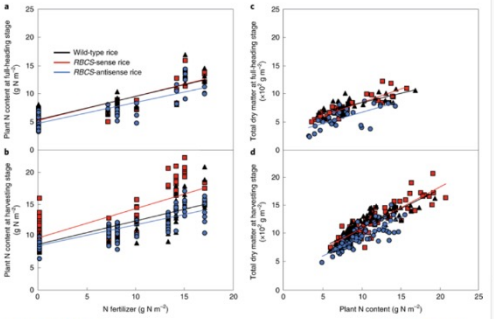
The green revolution's breeding of semi-dwarf rice cultivars in the 1960s improved crop yields, with large increases in the use of ertilizer. However, excess N application has caused onmental problems, including acid rain and the n of rivers and oceans. To use N to improve crop yields, ing the associated environmental costs, there is a need ops with higher N-use efficiency and higher yield Here we show that transgenic rice overproducing isphosphate carboxylase–oxygenase (Rubisco)—the key otosynthesis—exhibits increased yields with improved ncy for increasing biomass production when receiving rtilization in an experimental paddy field. This field emonstrates an improvement in photosynthesis linked to yield increase due to a higher N-use efficiency in a major crop.

Main

Global population growth since the 1960s has been sustained, in part, by increased food supply due to the green revolution's successful dwarfing of major crops such as rice and wheat combined with a large input of nitrogen (N) fertilizer[1]. Large inputs of N fertilizer and

Sections | Figures | References

Fig. 1: The effect of N fertilizer on the plant N content of the above-ground section of plants and the total dry matter of wild-type, RBCS-sense and RBCS-antisense rice plants at the full-heading and harvesting stages.



View in article | Full size image

Fig. 2: Relationships between grain (brown rice) yield, yield components and the plant N content of the above-ground section per unit land area in wild-type, RBCS-sense and RBCS-antisense plants at the harvesting stage.

Figures must convince your audience of your data's impact and credibility.

- Expert audiences may ONLY read:

1. title
2. abstract
3. FIGURES

- Figures tell your story compellingly and honestly.
- Figures present your "naked" data for evaluation (does the data support your paper's claim?)

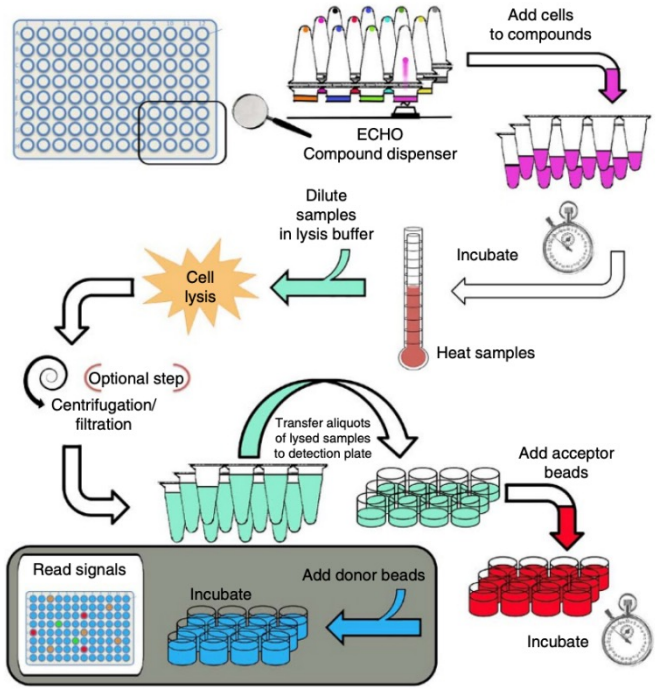
Today we'll derive key principles from some example figures!

- Just a primer today, focusing on printed figures
- Look for best practices
- Don't just throw rocks

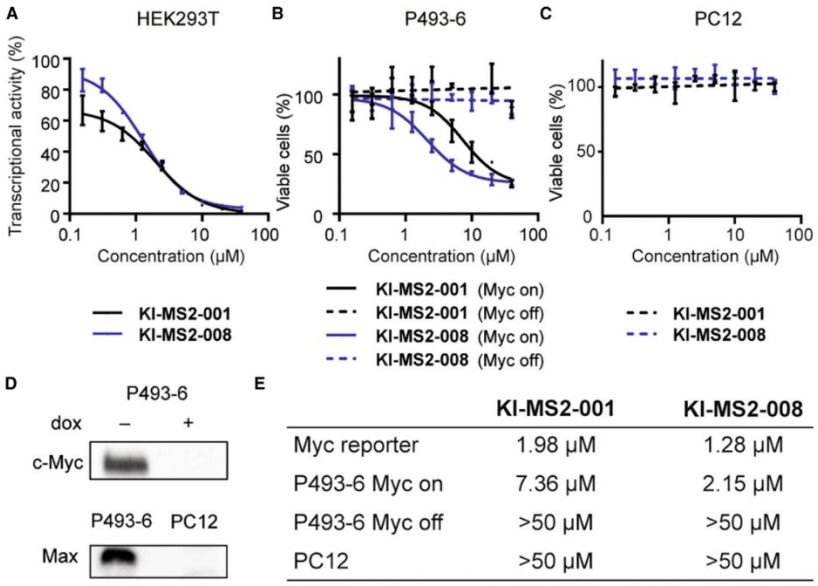
You'll have an opportunity to try it out on your own data.

Next workshop: bring your questions and figure-making thoughts!

There are two common kinds of figures: **schematics** and **data figures**



Schematic



	KI-MS2-001	KI-MS2-008
Myc reporter	1.98 μM	1.28 μM
P493-6 Myc on	7.36 μM	2.15 μM
P493-6 Myc off	>50 μM	>50 μM
PC12	>50 μM	>50 μM

Data Figure

All figures have these four elements

Choice of data

- Only data critical to the conclusion
- Honest data and controls

Presentation choices

- Type of graph or display, legends & labeling, design choices
- Uncluttered elements
- Allow quick evaluation of conclusions without relying on the legend or caption.

Title

- Take-home **message**
- What conclusion should the **reader evaluate** when looking at the figure?

Caption

- **Descriptive**, not explanatory/interpretive
- Only enough method detail to make it clear how results were obtained.
- All types of figures should have captions

There are many design choices that can help your reader understand your message

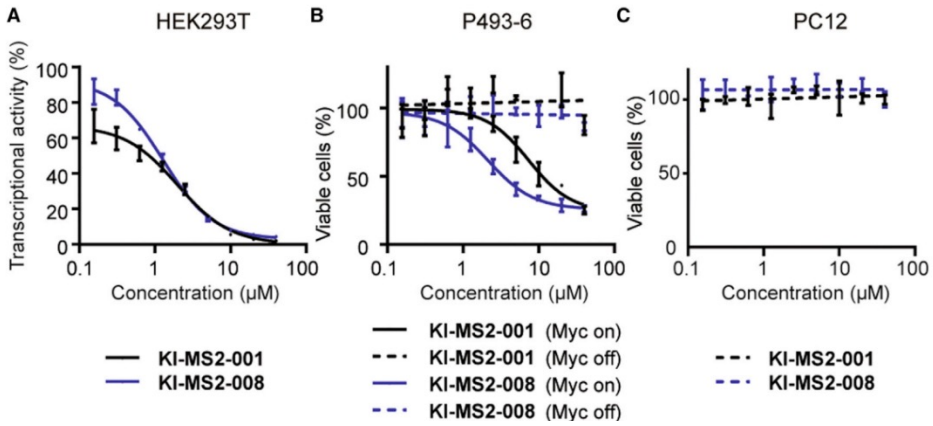


Figure 2. KI-MS2-001 and KI-MS2-008 Modulate Myc-Driven Transcription in Cells and Inhibit Viable Cell Levels in a Myc-Dependent Manner
(A) Dose-response curves for the Myc dual luciferase reporter assay in HEK293 cells in response to KI-MS2-001 or KI-MS2-008 treatment after 16 h (n = 3 technical replicates, error bars represent mean ± SD). (B) Dose-response curves for P493-6 viable cell levels in response to KI-MS2-001 or KI-MS2-008 treatment with Myc expression left on or shut down with doxycycline after 3 days (n = 3 technical replicates, error bars represent mean ± SD). (C) Dose-response curves for PC12 viable cell levels in response to KI-MS2-001 or KI-MS2-008 treatment after 5 days (n = 3 technical replicates, error bars represent mean ± SD).

Choice of data

- Only data critical to the conclusion
- Honest data and controls

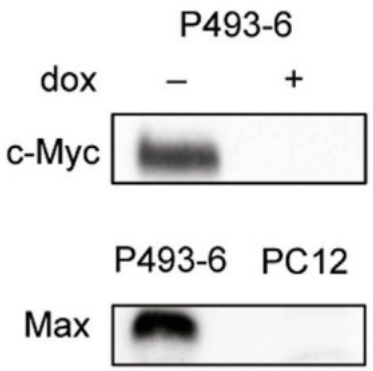
Presentation choices

- Type of graph or display, legends & labeling, design choices
- Uncluttered elements
- Allow quick evaluation of conclusions without relying on the legend or caption.

Struntz et al, 2019

You also have the choice of how to present or augment your data

D



E

	KI-MS2-001	KI-MS2-008
Myc reporter	1.98 μM	1.28 μM
P493-6 Myc on	7.36 μM	2.15 μM
P493-6 Myc off	>50 μM	>50 μM
PC12	>50 μM	>50 μM

Could you quantify this data in any way?

Would it be better to show this data in a different form?

Sharma et al, PLoS One 2007

Your title should highlight your figure's take-home message

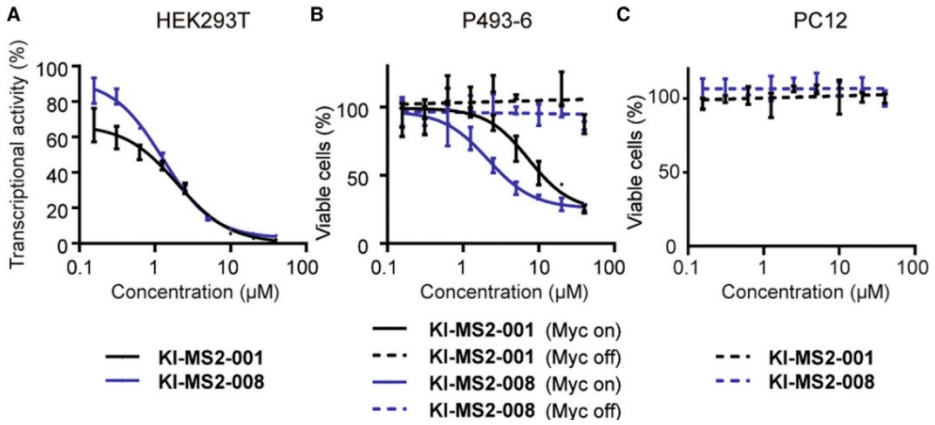


Figure 2. KI-MS2-001 and KI-MS2-008 Modulate Myc-Driven Transcription in Cells and Inhibit Viable Cell Levels in a Myc-Dependent Manner

(A) Dose-response curves for the Myc dual luciferase reporter assay in HEK293 cells in response to KI-MS2-001 or KI-MS2-008 treatment after 16 h (n = 3 technical replicates, error bars represent mean ± SD). (B) Dose-response curves for P493-6 viable cell levels in response to KI-MS2-001 or KI-MS2-008 treatment with Myc expression left on or shut down with doxycycline after 3 days (n = 3 technical replicates, error bars represent mean ± SD). (C) Dose-response curves for PC12 viable cell levels in response to KI-MS2-001 or KI-MS2-008 treatment after 5 days (n = 3 technical replicates, error bars represent mean ± SD).

Title

- Take-home **message**
- What conclusion should the **reader evaluate** when looking at the figure?

Struntz et al, 2019

The caption should give just enough info for the reader to understand **how the data was generated**

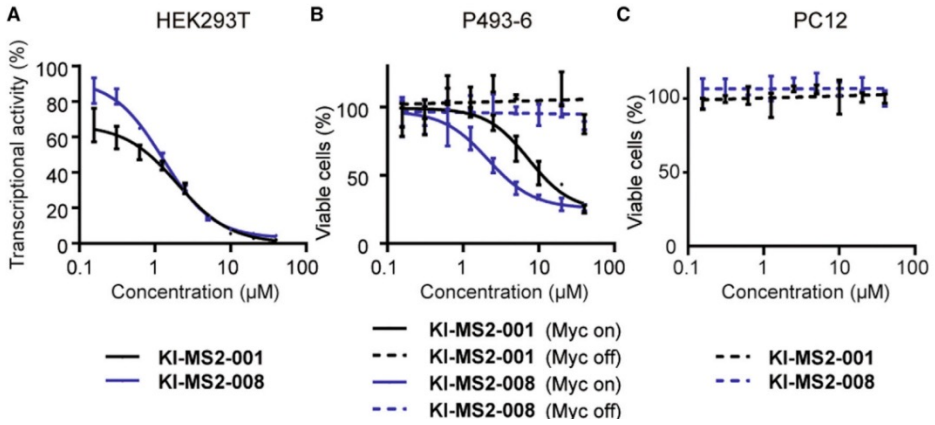


Figure 2. KI-MS2-001 and KI-MS2-008 Modulate Myc-Driven Transcription in Cells and Inhibit Viable Cell Levels in a Myc-Dependent Manner

(A) Dose-response curves for the Myc dual luciferase reporter assay in HEK293 cells in response to KI-MS2-001 or KI-MS2-008 treatment after 16 h (n = 3 technical replicates, error bars represent mean ± SD). (B) Dose-response curves for P493-6 viable cell levels in response to KI-MS2-001 or KI-MS2-008 treatment with Myc expression left on or shut down with doxycycline after 3 days (n = 3 technical replicates, error bars represent mean ± SD). (C) Dose-response curves for PC12 viable cell levels in response to KI-MS2-001 or KI-MS2-008 treatment after 5 days (n = 3 technical replicates, error bars represent mean ± SD).

Caption

- **Descriptive**, not explanatory/interpretive
- Only enough method detail to make it clear how results were obtained.
- All types of figures should have captions

Struntz et al, 2019

A well designed figure gets your audience to identify your message **quickly**….

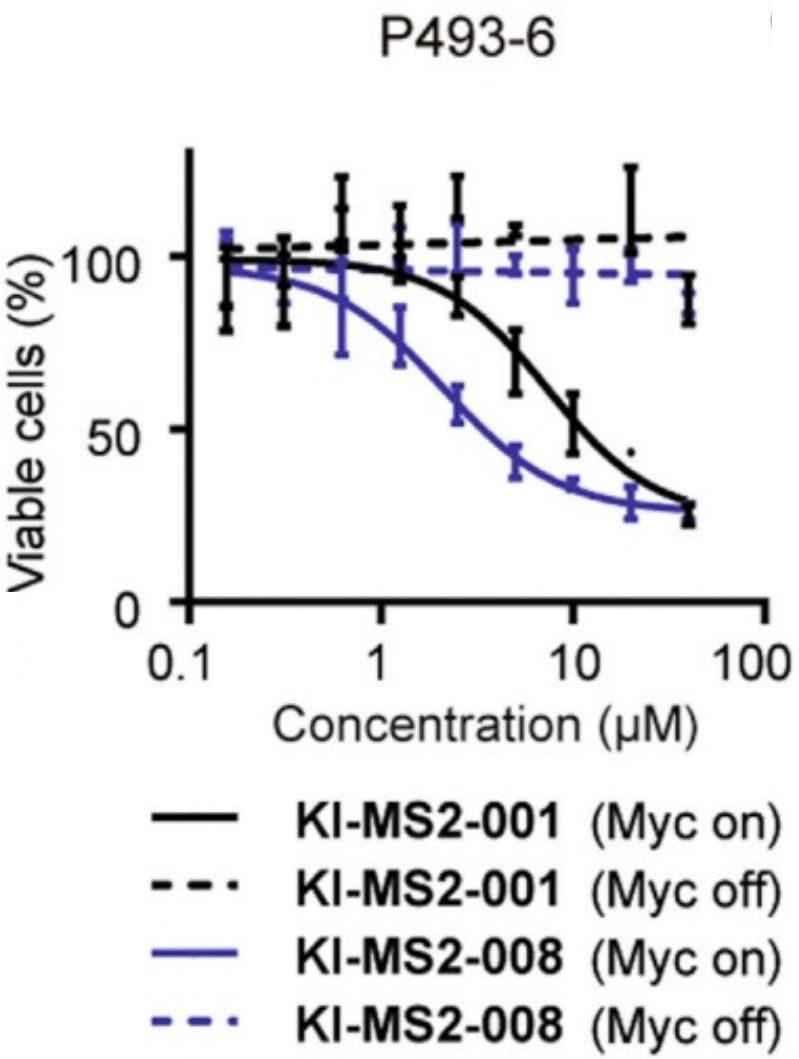
I'll put some figures up on the screen.

Tell me what you think.

Things to consider:

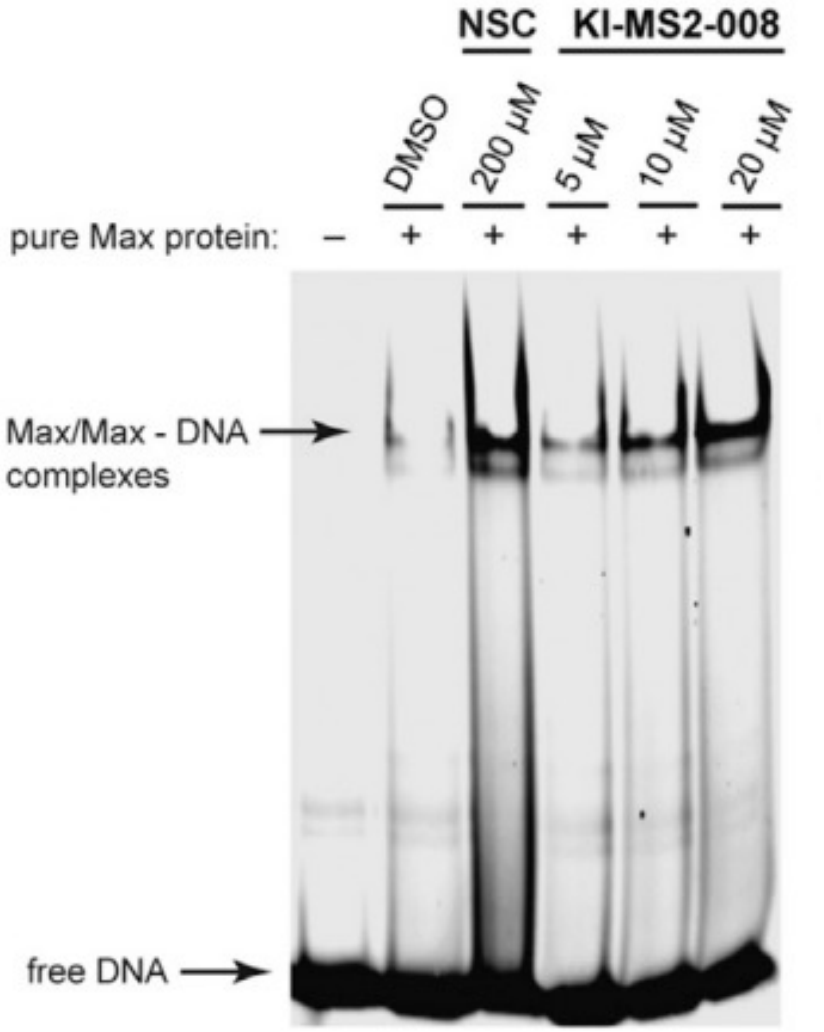
- What stands out to you?
- Can you understand what is happening?
- Is there anything that is distracting?

Where does your eye go with this figure?

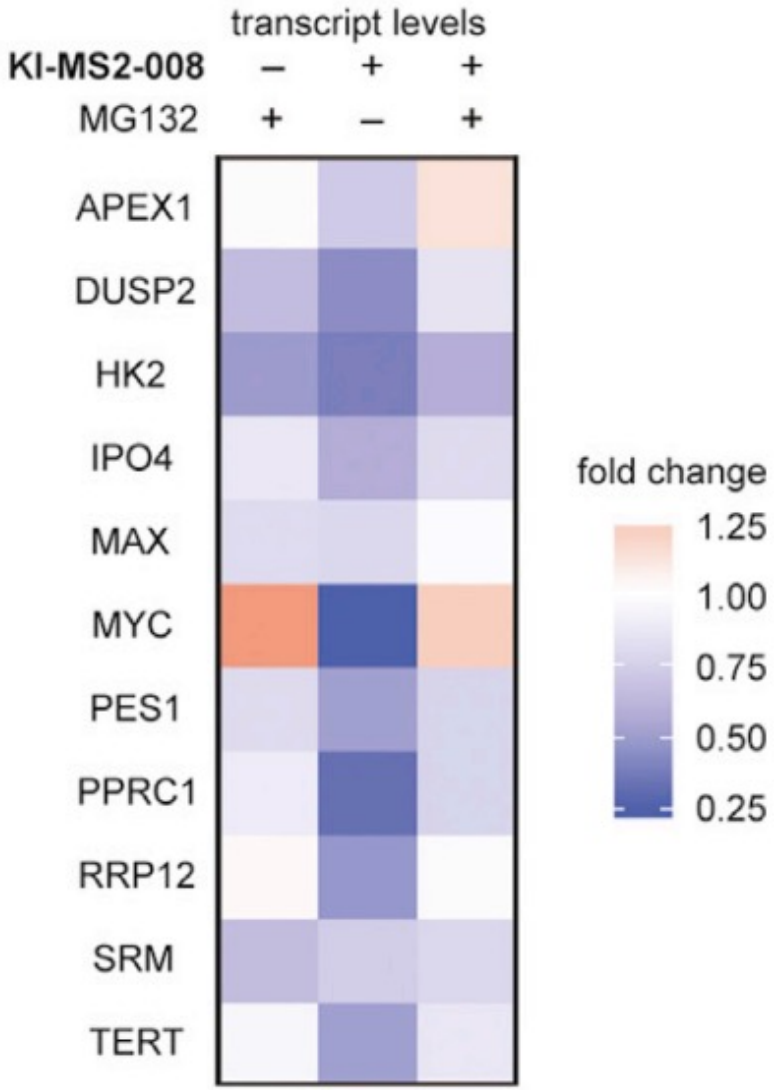


Struntz et al, 2019

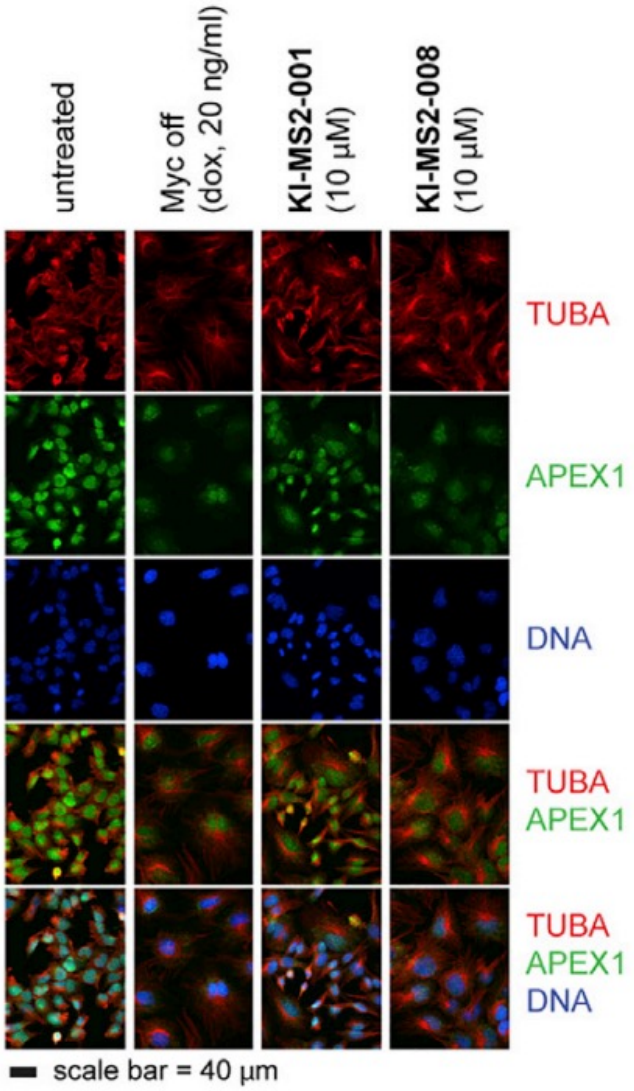
Where does your eye go with this figure?



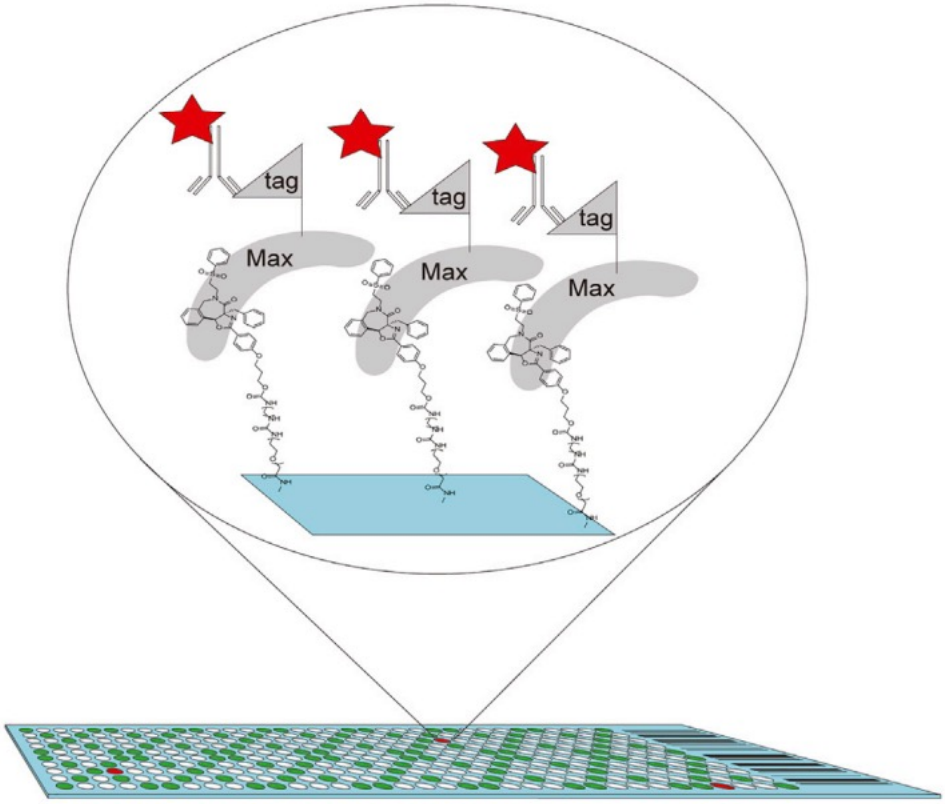
Where does your eye go with this figure?



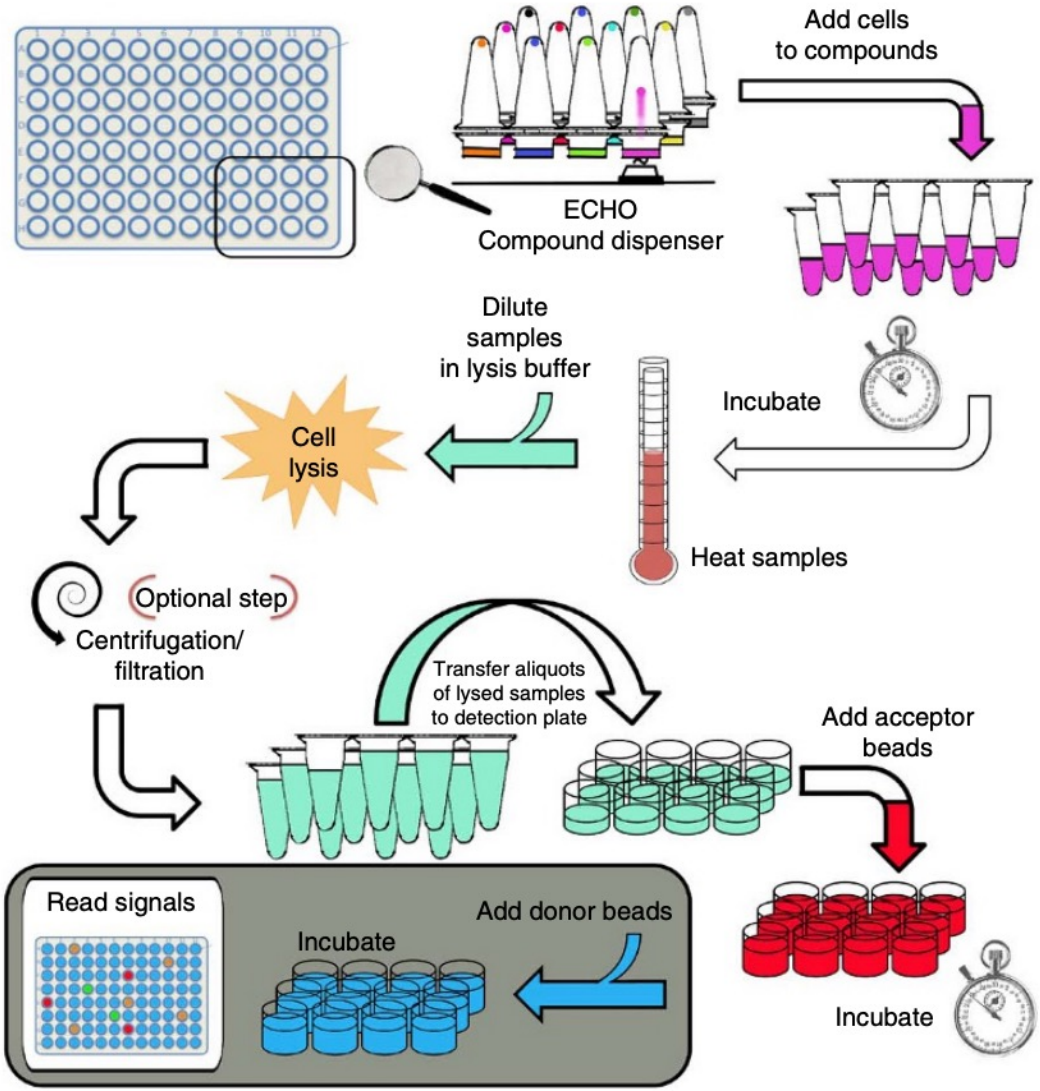
Where does your eye go with this figure?



Where does your eye go with this figure?



Where does your eye go with this figure?



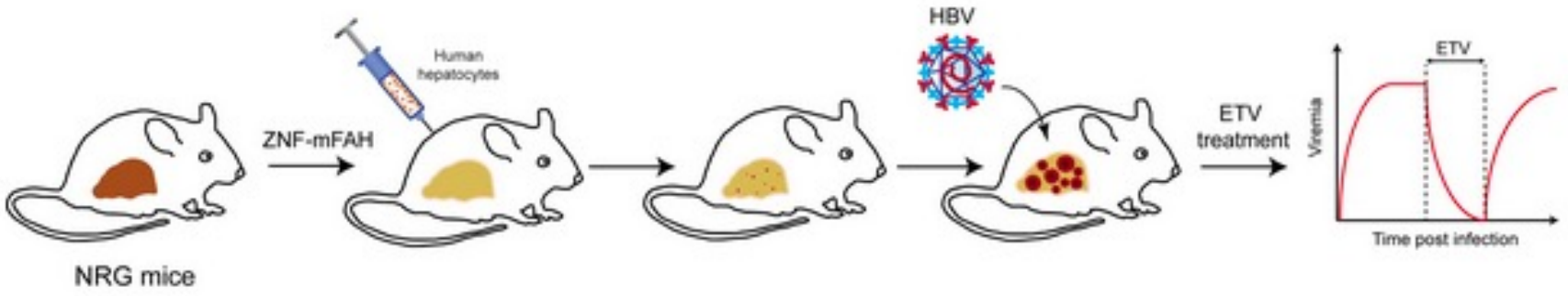
(and fun!)

This is a helpful exercise because it helps you to quickly test if the message of your figure is coming across clearly.

After you make a figure, ask a friend to look at it and tell you where their eye goes or how their eye moves across the page.

Based on this feedback, you can edit your figure!

Follow key design principles when designing a schematic



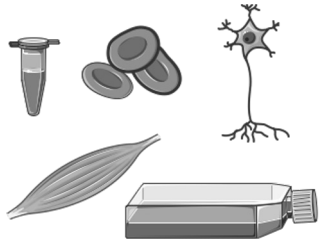
- Readers read left to right and top to bottom
- Use intuitive alignments
- Use grayscale + a few consistent colors
- Use consistent fonts, font sizes, and line thicknesses

You don’t need to reinvent the wheel when making beautiful schematics!

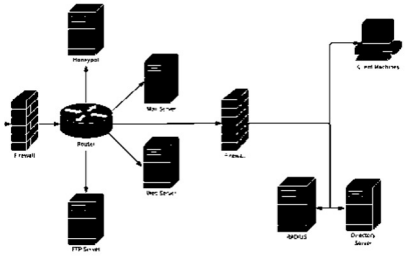
Servier Powerpoint Image Bank

Biorender

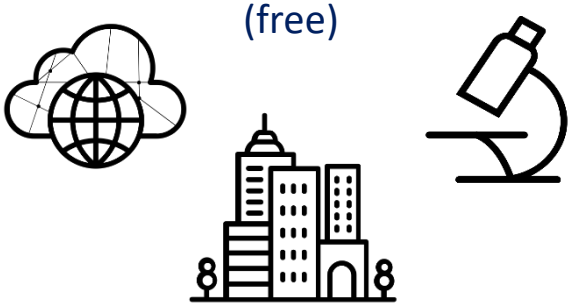
BioIcons
(https://github.com/duerrsimon/bioicons)

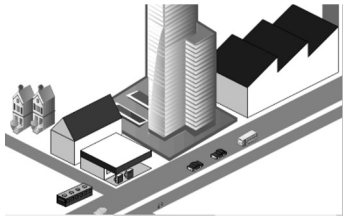


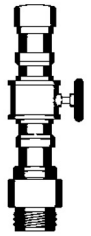
MS Visio & Lucidchart
Networks, engineering, circuits, charts
($$) & (free)



Noun Project
Everything
(free)







…but if you want to, now is a good time to try out some vector design programs

Adobe Illustrator Intro Videos – Free through MIT now

(and the entire Adobe Suite)

(https://helpx.adobe.com/illustrator/how-to/ai-basics-fundamentals.html?playlist=/services/playlist.helpx/products:SG_ILLUSTRATOR_1_1/learn-path:get-started/set-header:ccx-designer/playlist:ccl-get-started-1/en_us.json&ref=helpx.adobe.com)

BE Comm Lab Illustrator Guide

https://mitcommlab.mit.edu/be/2021/09/09/introduction-to-illustrator-and-helpful-resources/

Inkscape – Free, open source

https://inkscape.org/learn/tutorials/

If you are interested in learning more about visual design, you can check out:

Jean Luc Dumont – Trees, Maps, and Theorems
https://www.principiae.be/book/X0301.php

Claus O. Wilke – Fundamentals of Data Visualization
https://clauswilke.com/dataviz/

Resources

Please respect the copyrights and licenses of the creators

Data Visualization Checklist

Evergreen Data. "Stephanie Evergreen Data Visualization Checklist." Accessed January 25, 2021. https://stephanieevergreen.com/data-visualization-checklist/.

Selecting A Visualization Type

- Search by Function: https://datavizcatalogue.com/index.html
- Search by Data Type: https://www.data-to-viz.com/
- Chart Chooser diagram: https://www.labnol.org/software/find-right-chart-type-for-your-data/6523/
- Visual Vocabularly: http://ft-interactive.github.io/visual-vocabulary/

Visual Encodings

- Properties and Best Uses of Visual Encodings: http://complexdiagrams.com/properties

Managing Color

- ColorBrewer 2.0: http://colorbrewer2.org/
- ColorLab Colorblindness Simulator: http://colorlab.wickline.org/colorblind/colorlab/
- I Want Hue color palette generator http://tools.medialab.sciences-po.fr/iwanthue/
- Colour Contrast Analyser (CCA): https://developer.paciellogroup.com/resources/contrastanalyser/

Examples

Schwabish, Jonathan A. "An Economist's Guide to Visualizing Data." *Journal of Economic Perspectives* 28, no. 1 (February 2014): 209–34. https://doi.org/10.1257/jep.28.1.209.

Schwarz, C J. "A Short Tour of Bad Graphs," 2016, 29. http://people.stat.sfu.ca/~cschwarz/Stat-650/Notes/PDF/ChapterBadgraphs.pdf

"Top Ten Worst Graphs." Accessed January 30, 2020. https://www.biostat.wisc.edu/~kbroman/topten_worstgraphs/.

All the data in a figure should support one clear message.

This could be through a single panel…

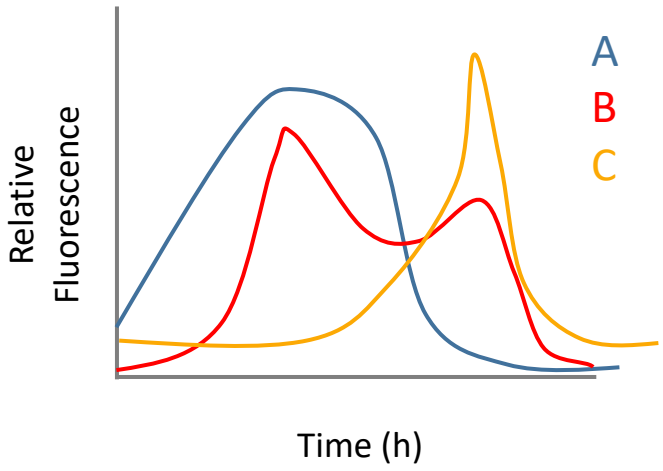


Fig. 1: A, B, and C have different dynamics under Condition X. A, B, and C were sampled using Method 1 and their fluorescence quantified with Method 2. Fluorescence data normalized to negative control.

…or multiple panels that contribute to the same takeaway message

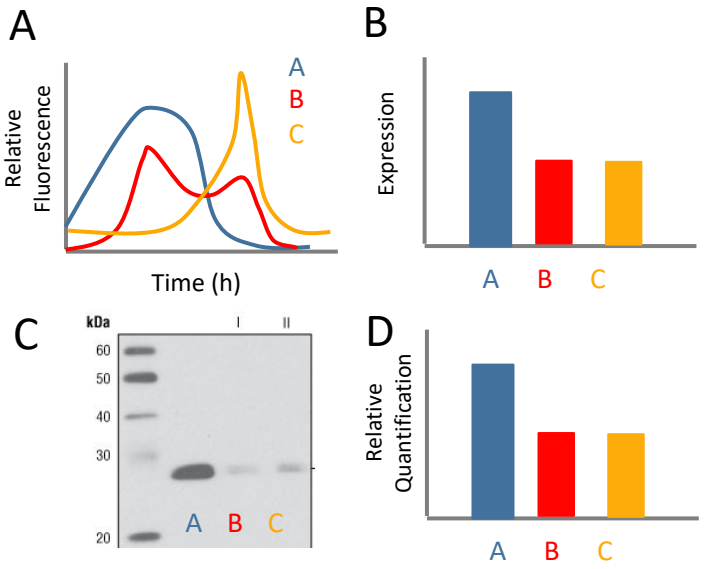


Fig. 1: A, B, and C have different dynamics under Condition X. A) A, B, and C were sampled using Method 1 and their fluorescence quantified with Method 2. Fluorescence data normalized to negative control. B) Gene expression data of samples A, B, and C, under condition X. Samples were collected at time T. C) Western blot analysis of samples A, B, and C, under condition X. D) Quantification of Western Blot.

Identify your process for making figures that highlight the message you are trying to communicate

1 MESSAGE — What is the message of each figure?

2 DATA — What data do you include in each figure to convey your message?

2 DATA — How can you present your data to support your message?

3 DESIGN — What are some key design choices to think about?

For every figure, ask yourself…

- ❑ Is the central message validated by the data shown?
- ❑ Which data are irrelevant?
- ❑ Are there any data/labels missing?
- ❑ What could be done to better highlight the most important data?
- ❑ Is there a better way to present the data?
- ❑ Do the statistics actually add anything here?

Optimize your figures with these reminders

High-level questions

- *Strategic purpose:*
  - What do you want to convey?
  - How will you and/or your audience use this figure?
- *Organizational structure:*
  - Where does this figure fit into the communication?
  - Why?

Checklist

- ❑ Choice of data
- ❑ Title/caption
  - Can the figure stand alone?
- ❑ Consistent layout
  - Fonts, spacing, colors
- ❑ Text amount and placement
- ❑ Scale, axes, tick marks
- ❑ Error analysis
- ❑ Ink-to-whitespace ratio

These are our next steps

- Slides and tips will be on the wiki

Your next steps

- Bring a draft figure and your questions to our next workshop
- Refer to the following slides to learn about resources available to you through the BE Communication Lab and BE Data Lab

56-211 Team

Dr. Chiara Ricci-Tam

BECL Manager
Lecturer

Dr. Sean Clarke

Principal Lecturer
Biotech Liaison

MIT BIOLOGICAL ENGINEERING
COMMUNICATION LAB

From early brainstorming to final edits, we offer **discipline-specific** **feedback for your communication tasks**

- **Written** (reports, manuscripts, proposals, theses)
- **Visual** (slide / poster / figure design)
- **Oral** (public speaking, presentation design)
- **Career** (application essays, cover letters, resumes, interviewing, networking)

Use our **online guides** any time!

mitcommlab.mit.edu/be

CommKit | GitHub Resources | Templates | Blog Posts

Fellowship Applications
- Graduate School Personal Statement
- NSF Personal Statement
- NSF Research Proposal
- Postdoc Fellowships: Index of Life Sciences Fellowships

Career Focused Tasks
- Cover Letter: For a Faculty Position
- Cover Letter: General
- CV/Resume
- Elevator Pitch
- Interviewing
- Professional Bio
- Professional Email

Figure Design
- Introduction to Figure Design

Poster Design
- Introduction to Poster Design

Presentations
- Slideshow
- Public Speaking

Manuscripts
- Abstract
- Introduction
- Methods
- Results
- Discussion

MIT BE-specific
- BATS seminar

Science Policy
- Introduction to Policy Communication

GitHub Resources
- Introduction to Resources

Coding
- Coding, File Organization, and Documentation

Paper got accepted? Do the work to increase visibility!

August 19, 2020

You did a lot of work to get your paper accepted. Now do a little bit more to make sure people know about your paper! Learn some ways that people share their work with the world!

Editing Checklist

August 11, 2020

Working on writing a long document. Use our editing checklist when you think you are done to make sure you don't miss any details!

Fellowships – Fall 2020

July 29, 2020

It's that time of year again! Fellowship deadlines are fast approaching. Writing a fellowship is an important exercise for any scientist and winning a fellowship is important for any career.

Remote Teaching Tips and Tricks

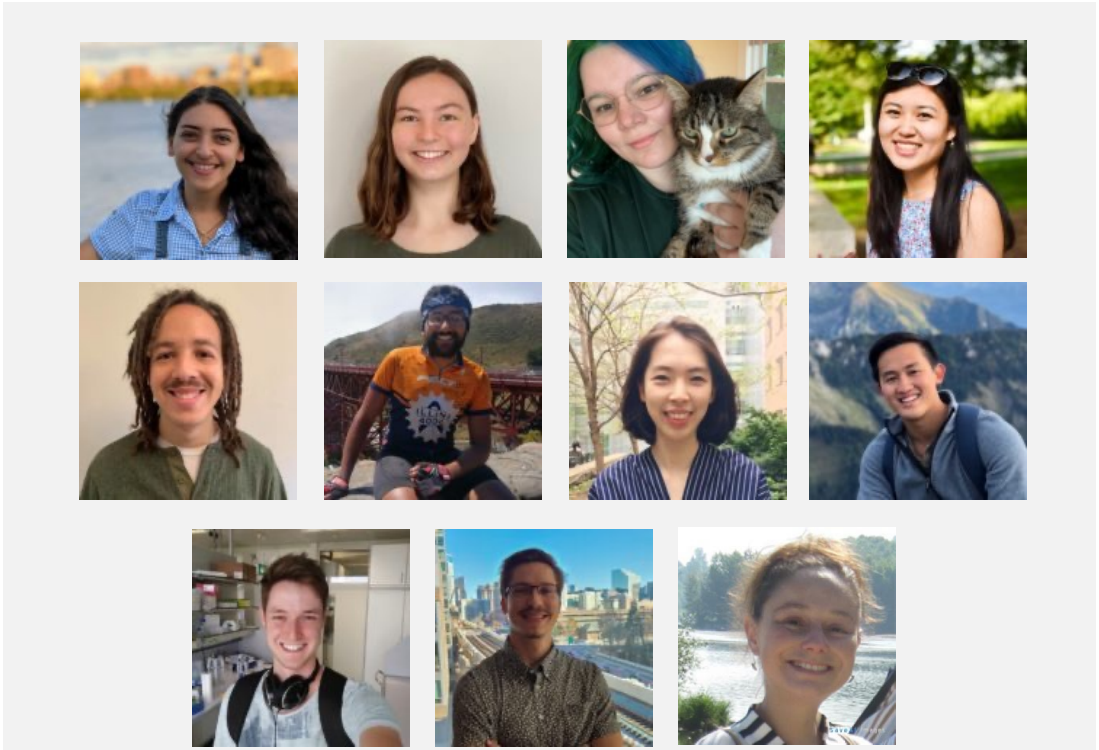
July 20, 2020

Remote teaching comes with its own challenges. The BE Comm Lab, in collaboration with the BE-TLL Teaching Fellow Program, compiled this list of remote teaching tips and tricks.

MIT BIOLOGICAL ENGINEERING COMMUNICATION LAB

Make a coaching **appointment**

mitcommlab.mit.edu/be



Our team of trained Comm Lab Fellows are available to help you revise, rehearse, and get a fresh perspective

MIT BIOLOGICAL ENGINEERING
COMMUNICATION LAB

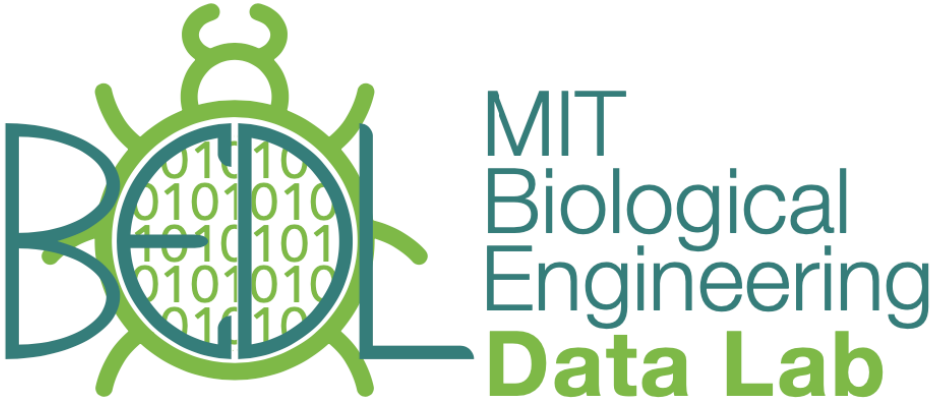
Policies: what you can expect from **us**

- **Just-in-time** coaching: you can come to an appointment at any stage of your communication process (from early brainstorming to final revisions), and get help right at the time you need it
- Our goal is to **nurture, not evaluate**: we seek to provide an outside perspective and help you progress with **your communication goals**

Policies: what we expect from **you**

- Appointments need to be made **at least 1 day in advance**
- **Please respect the fellows time!** Show up on time, and give notice well in advance if you are going to be late or have to miss your appointment
- Double-check if you made an **in-person or virtual** appointment
- You gain more from a coaching session if you come into it with a goal for growth—**help us help you**

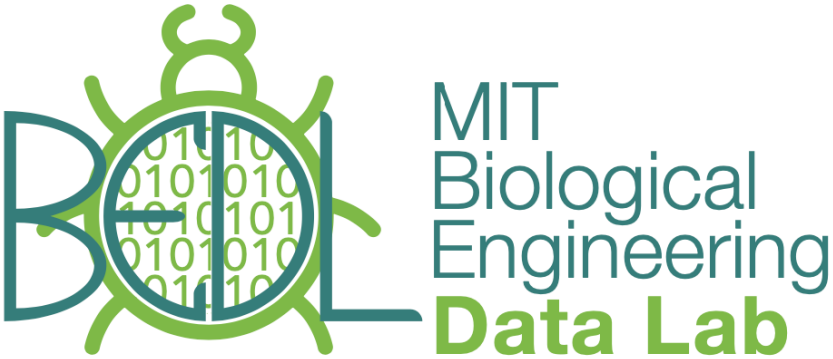
For peer coaching on **data analysis** and **coding**, check out the **MIT BE Data Lab**



A peer-to-peer educational community supporting computational novices, competent practitioners, and experts in their journey to learn new languages and use those languages to answer important world problems.

bedatalab.github.io

These resources are here to support you in your individual BE journey—reach out!



56-211 Team

BE Undergraduate Research Symposium

MIT BE BIOLOGICAL ENGINEERING

The MIT Department of Biological Engineering, Course 20

MIT BE BIOLOGICAL ENGINEERING

POSTERS WANTED!

Present your undergraduate research to **faculty**, **research scientists**, **graduate students**, and **peers** at a ***lively poster session*** with **FREE food**.

Friday, April 28th
1-3:30pm
2nd floor/ Building 16

NEXT STEPS?

1.Talk to your research advisor
2. Sign up here

Learn how to design and pitch your poster from the BE Comm Lab and have it printed for FREE!