

Figure Design

20.109 Communication Workshop 1

Dr. Chiara Ricci-Tam

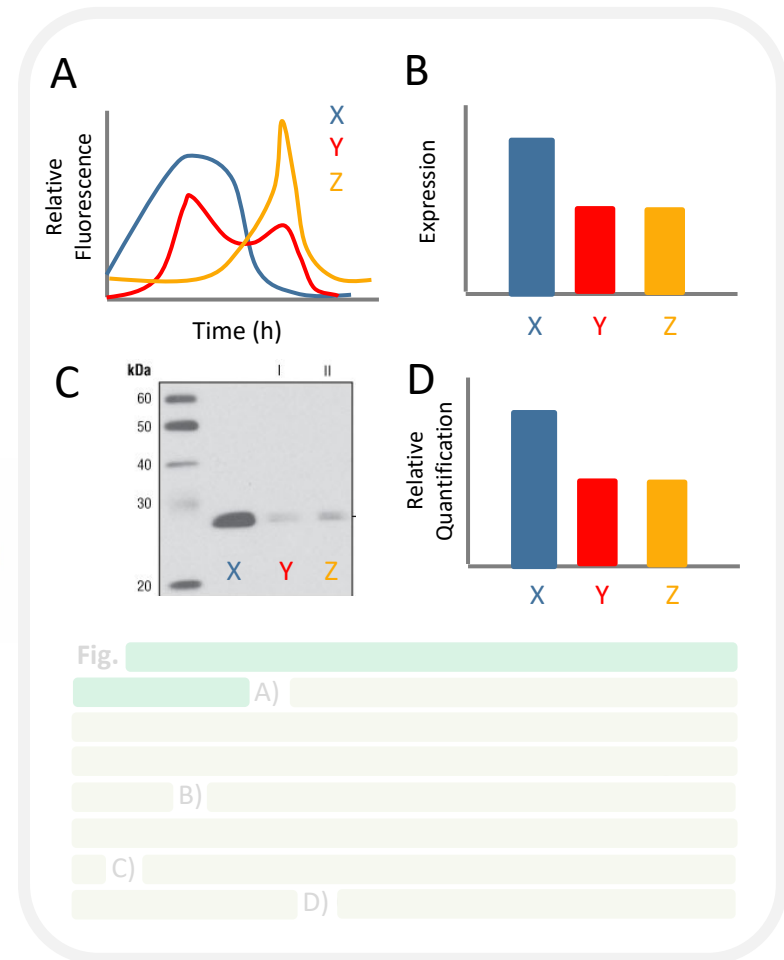
Dr. Sean Clarke

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

Research 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

Many of these are **actions**—understanding confers ability

Communicating effectively is an **essential skill** as a scientist—and it takes **practice**

For any work to have **impact**, it must be communicated effectively



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

Workshop 3: Abstracts & Titles

Workshop 4: Oral Presentations

Workshop 5: Manuscripts

Workshop 6: Proposals

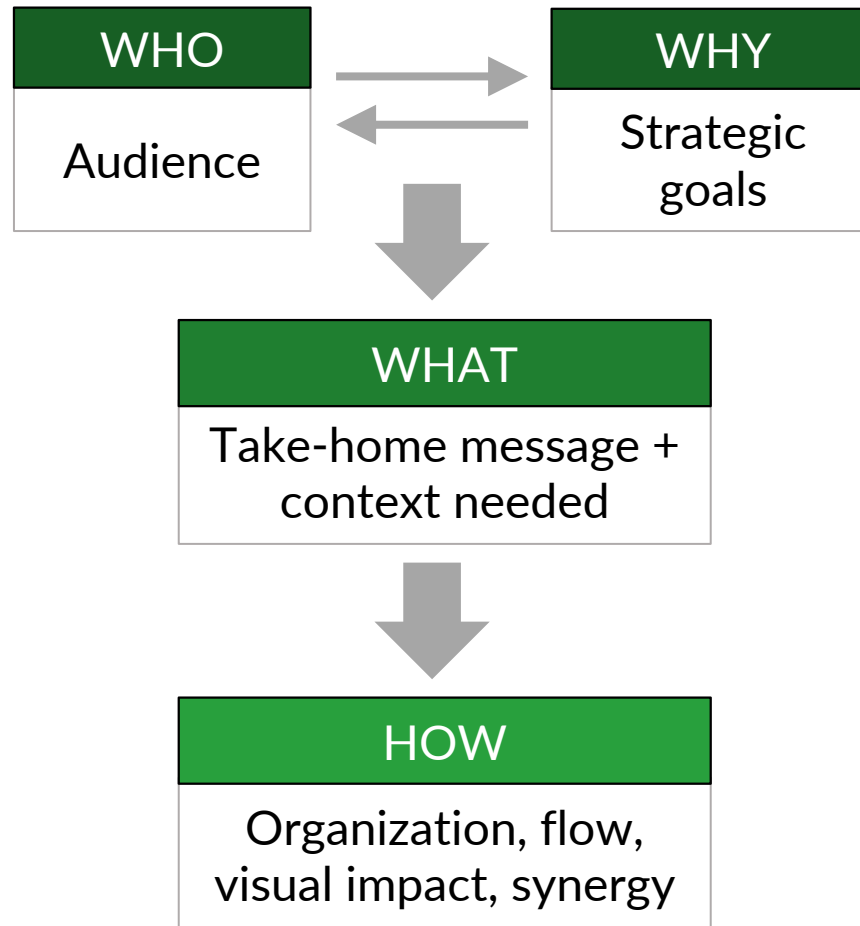
Data summary (Mod 1 report)

Journal article presentation

Research article (Mod 2 report)

Research proposal presentation

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



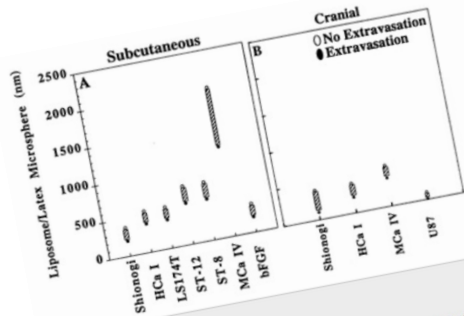
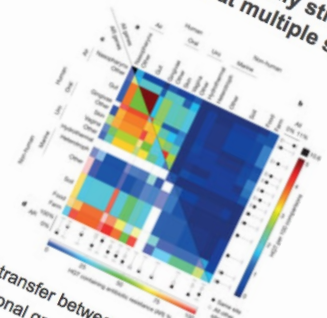


Figure 1

The vascular pore cutoff size for six different types of tumors grown in the dorsal window (A) and in the cranial window (B) was evaluated. The solid circles represent tumors grown in the cranial window (B) and the open circles represent tumors grown in the dorsal window (A). The size range between the first and the last particle that did not extravasate indicates the vascular pore cutoff size. The majority of tumors have a vascular pore cutoff size range between 500 and 1000 nm. The interaction of the tumor with the subcutaneous microenvironment (B) leads to a smaller vascular pore cutoff size than the interaction of the tumor with the cranial microenvironment (A). Comparison of bFGF-induced vessels (bFGF) with the subcutaneous pore sizes demonstrates that the presence of bFGF alone can lead to pores of induced vascular pore sizes.

Figure 3: HGT is ecologically structured by functional class and at multiple spatial scales



The frequency of transfer between different environments is shown for all functional groups (a, b) and for antibiotic resistance (AR) genes only (c, d). Box widths indicate the number of genomes from each environment. a, When all

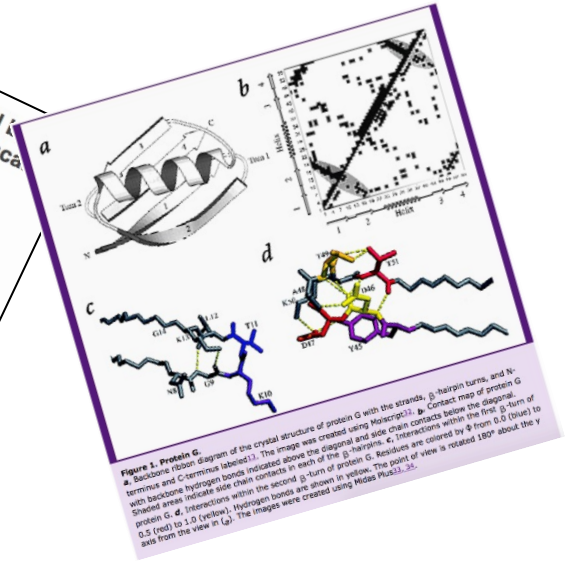
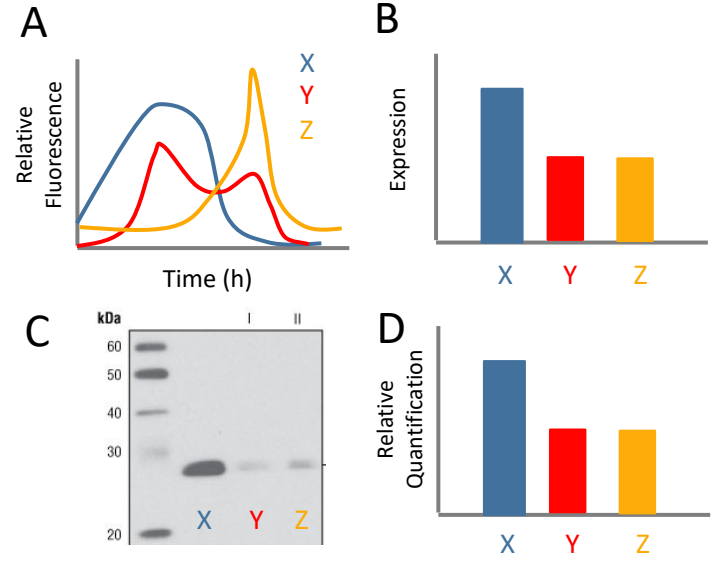


Figure 1: Protein G. a, Backbone ribbon diagram of the crystal structure of protein G with the strands, β -hairpin turns, and N-terminus and C-terminus labeled. The image was created using Molscript. b, Contact map of protein G with backbone hydrogen bonds indicated above the diagonal and side chain contacts below the diagonal. Shaded areas indicate side chain contacts in each of the β -hairpins. c, Interactions within the second β -turn of protein G. d, Interactions within the second β -turn of protein G. Residues are colored by ϕ from 0.0 (blue) to 0.5 (red) to 1.0 (yellow). Hydrogen bonds are shown in yellow. The point of view is rotated 180° about the y axis from the view in (a). The images were created using PyMol 2.5.

Figures

Why are figures so important?



Figures are an essential component of scientific publications

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

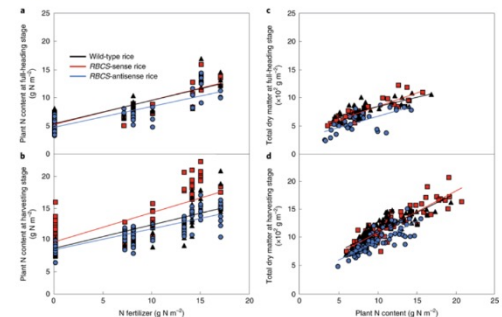
The green revolution's breeding of semi-dwarf rice cultivars in the 1960s improved crop yields, with large increases in the use of fertilizer. However, excess N application has caused environmental problems, including acid rain and the eutrophication of rivers and oceans. To use N to improve crop yields, while minimizing the associated environmental costs, there is a need for rice cultivars with higher N-use efficiency and higher yield. Here we show that transgenic rice overproducing ribulose-1,5-bisphosphate carboxylase-oxygenase (Rubisco)—the key enzyme in photosynthesis—exhibits increased yields with improved N-use efficiency for increasing biomass production when receiving high N-fertilization in an experimental paddy field. This field experiment demonstrates 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) fertilizer¹. 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?)

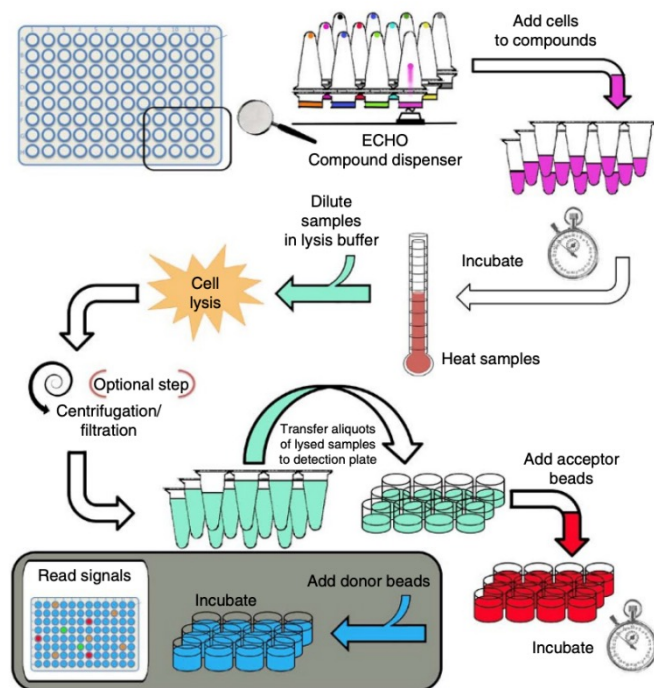
Today we'll derive key principles from some example figures

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

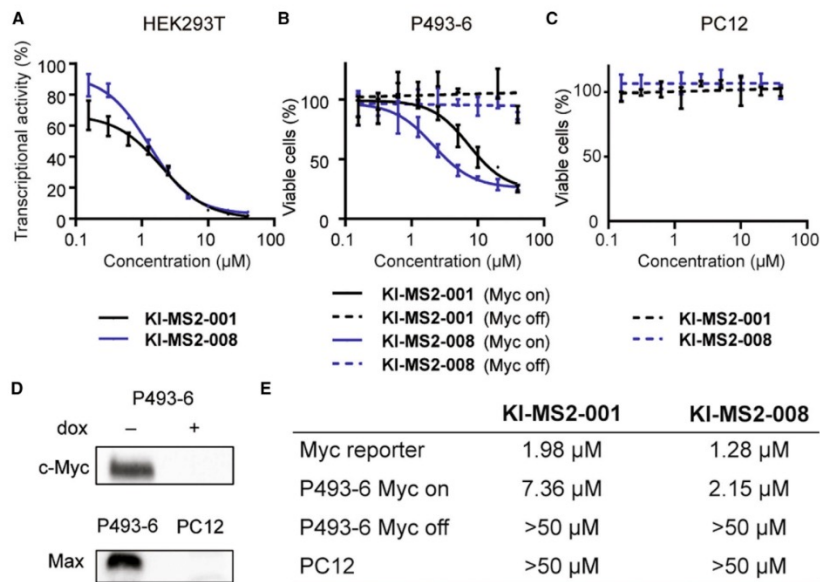
You'll have an opportunity to try it out on your own data later.

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

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



Schematic



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

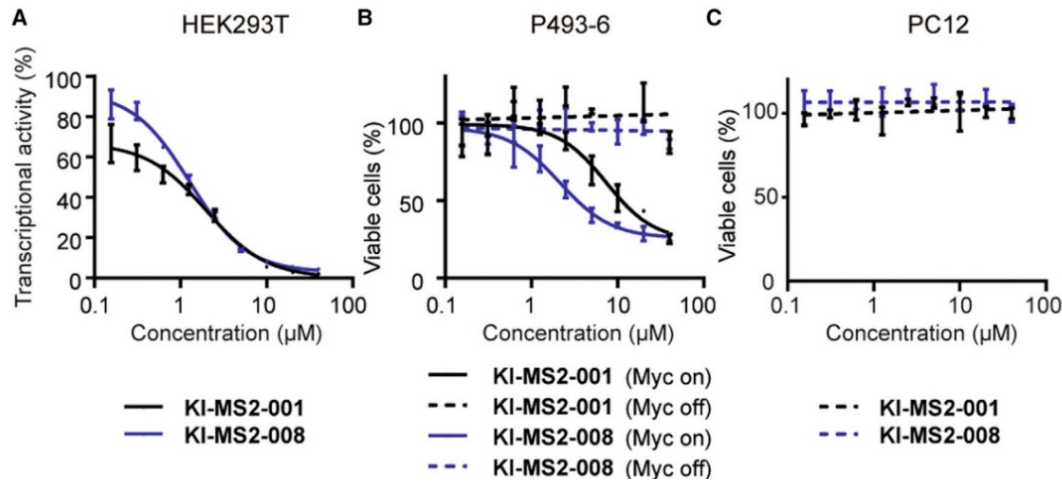


Figure 2. KI-MS2-001 and KI-MS2-008 Modulate Myc-Driven Transcription in Cells and Inhibit Viable Cell Levels in a Myc-Dependent Manner

(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 \pm 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 \pm 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 \pm SD).

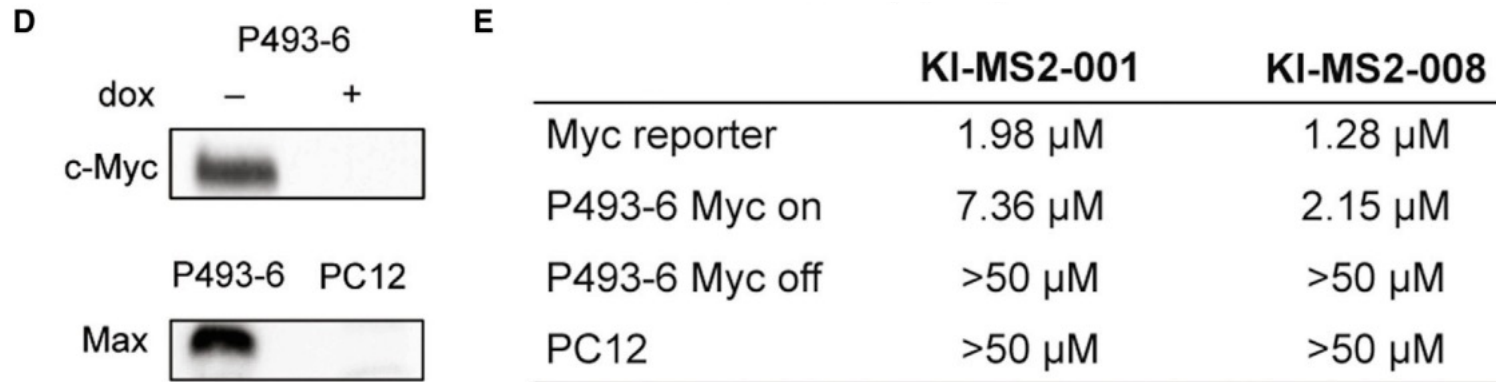
Choice of data

- 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.

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



Could you quantify this data in any way?

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

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

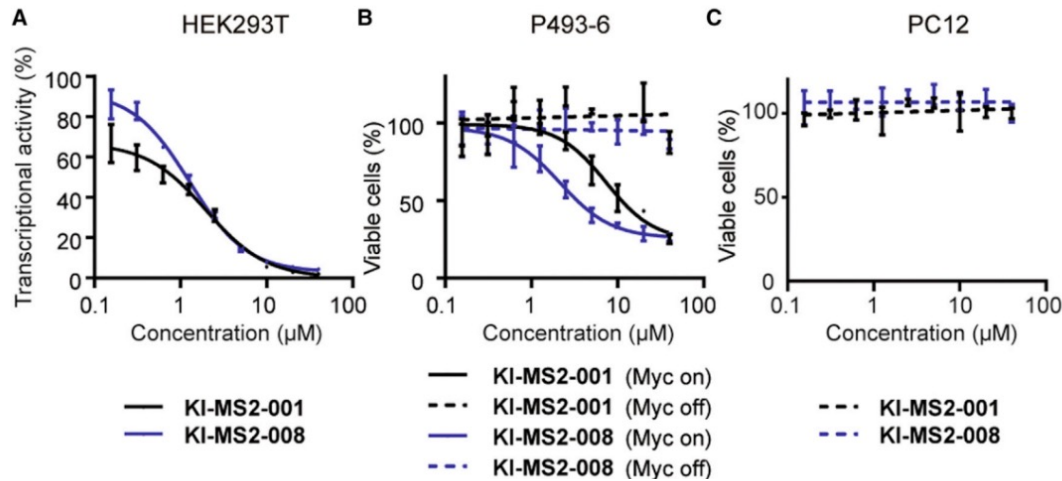


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Title

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

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

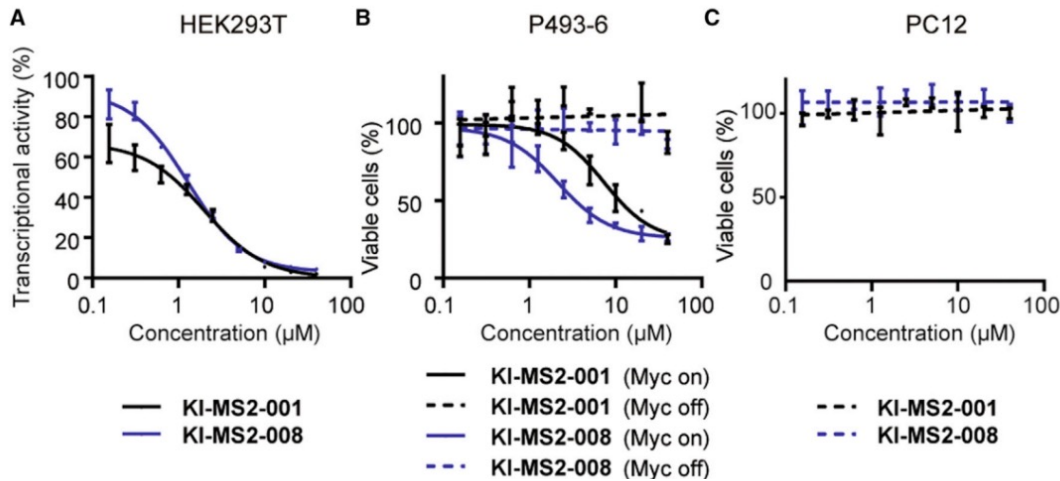


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Caption

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

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

I'll put some figures up on the screen.

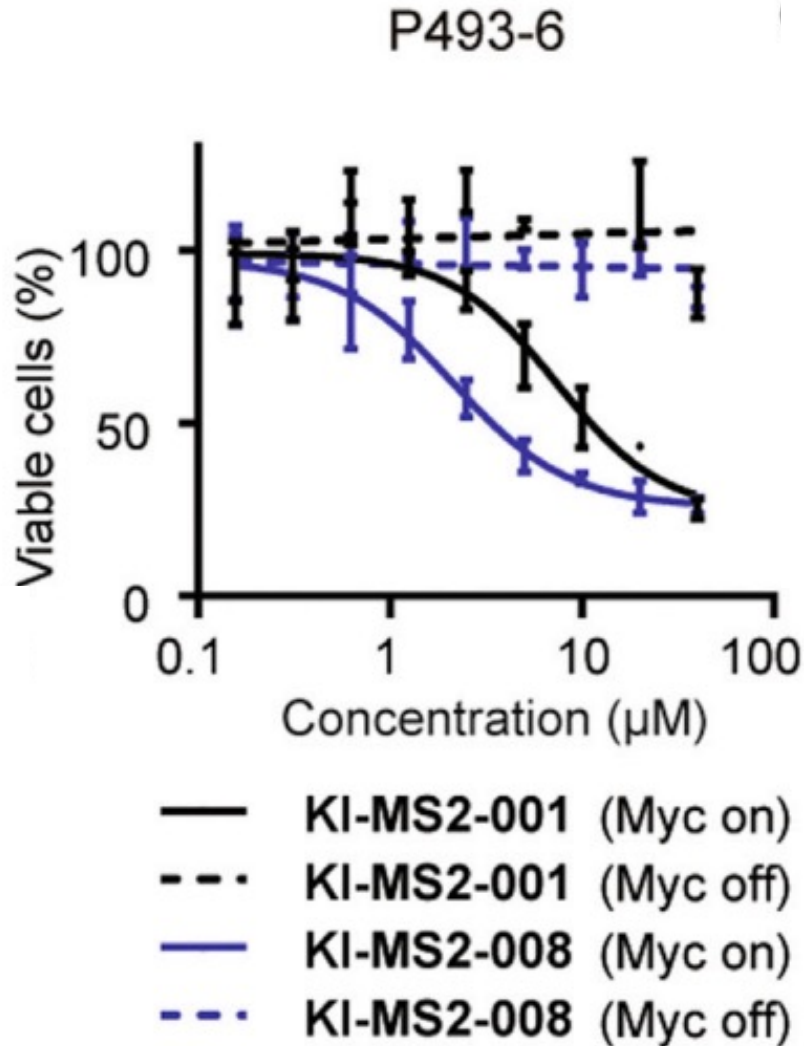
Tell me what you think.

Things to consider:

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

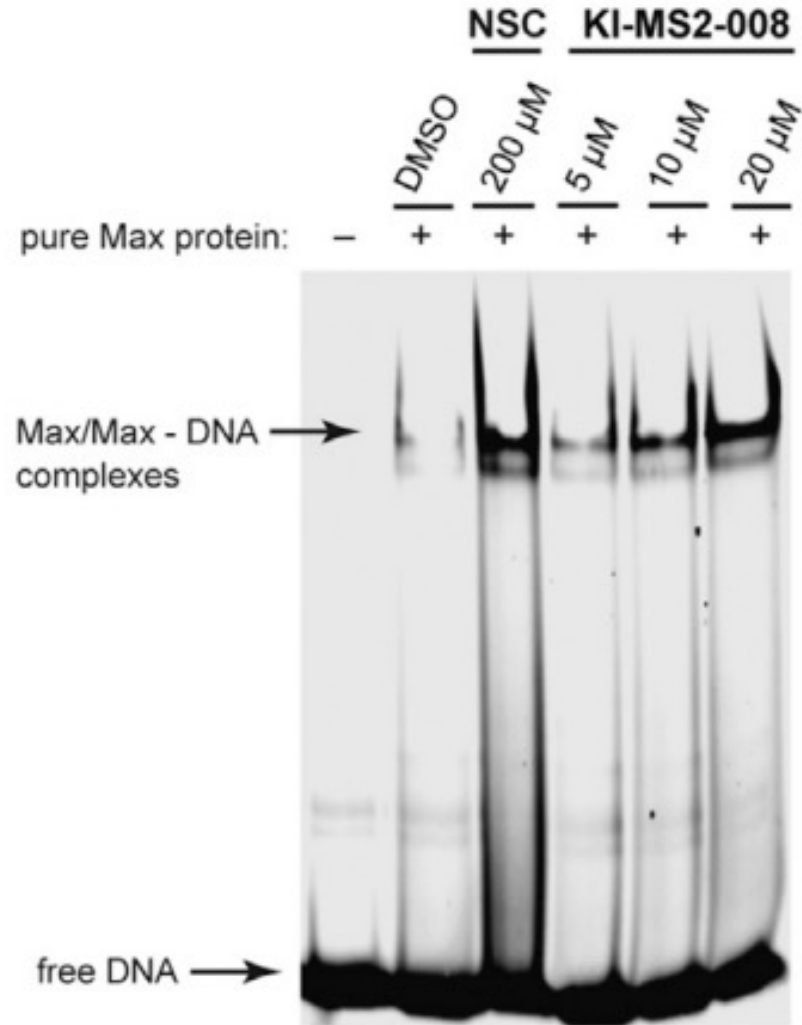
Where does your eye go with this figure?

Example 1 of 6



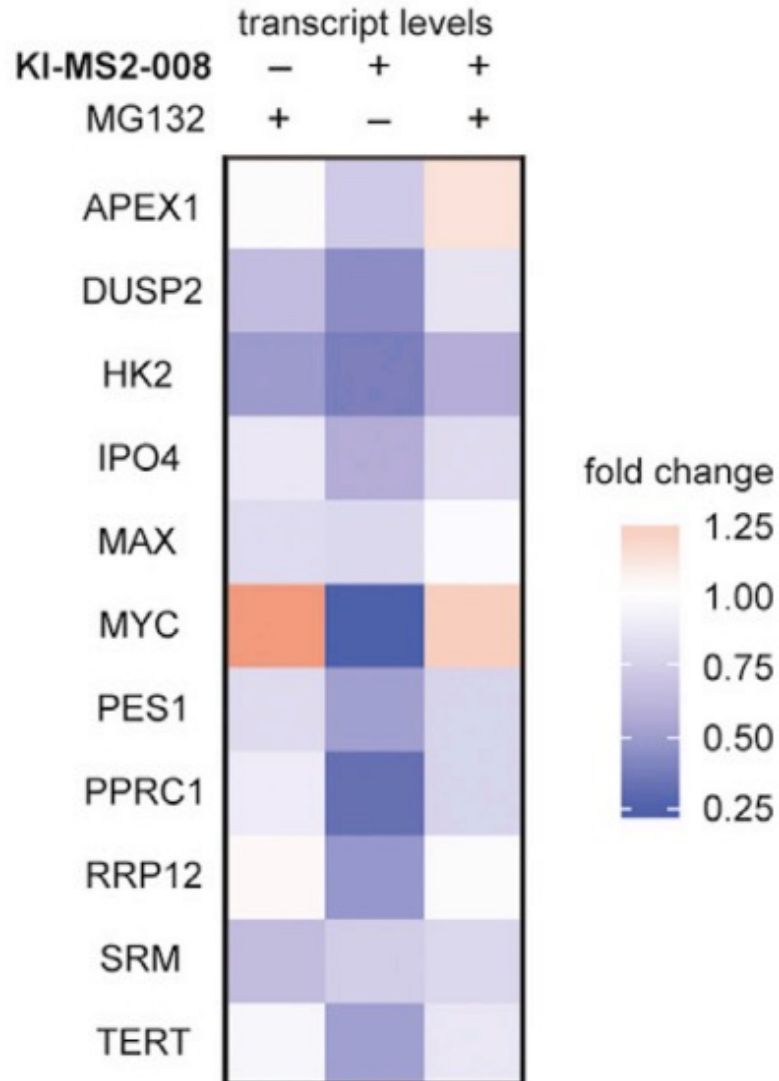
Where does your eye go with this figure?

Example 2 of 6



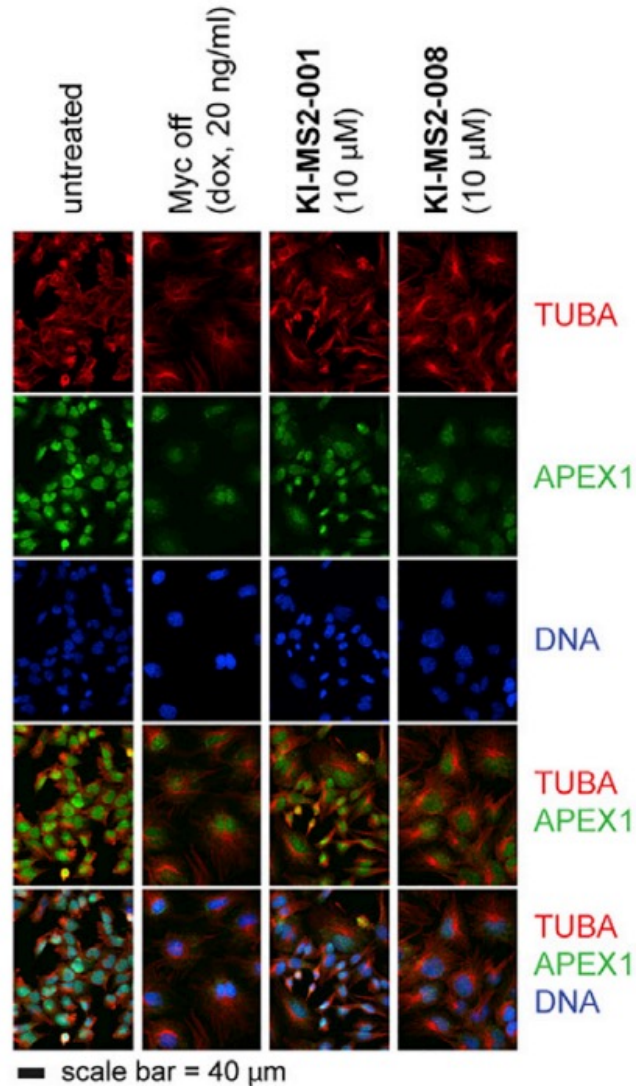
Where does your eye go with this figure?

Example 3 of 6



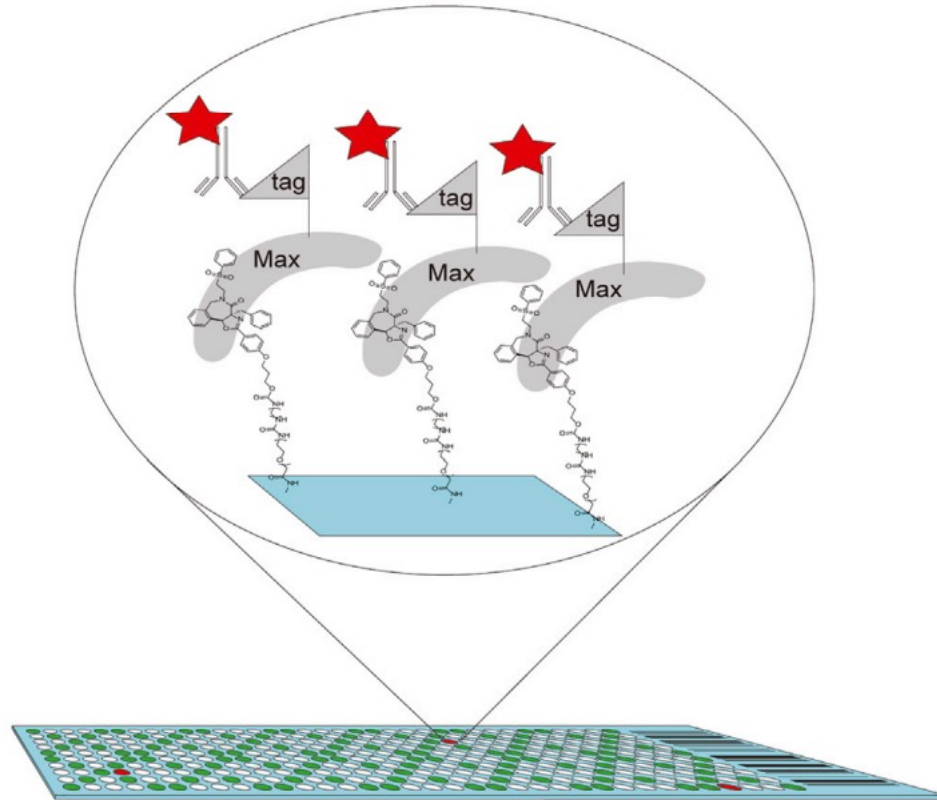
Where does your eye go with this figure?

Example 4 of 6



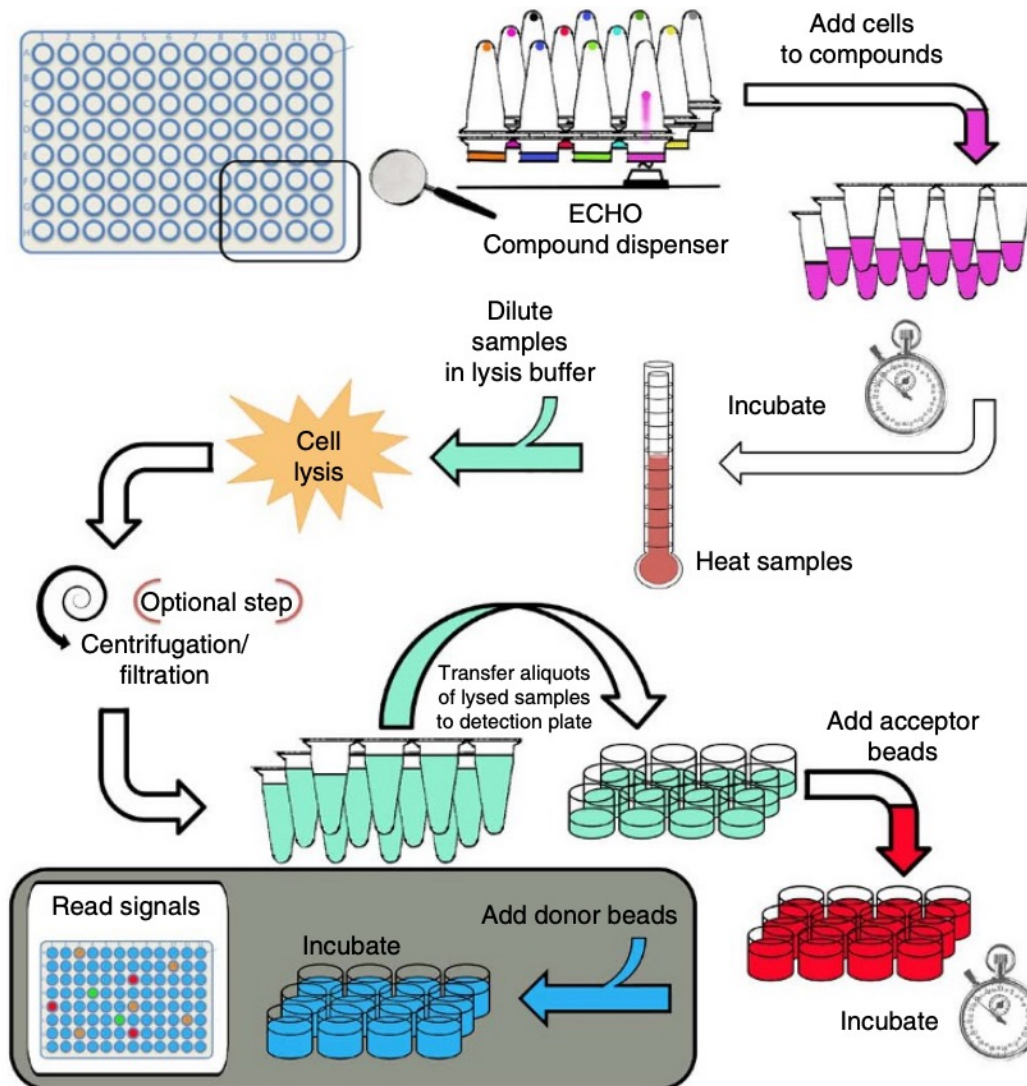
Where does your eye go with this figure?

Example 5 of 6



Where does your eye go with this figure?

Example 6 of 6



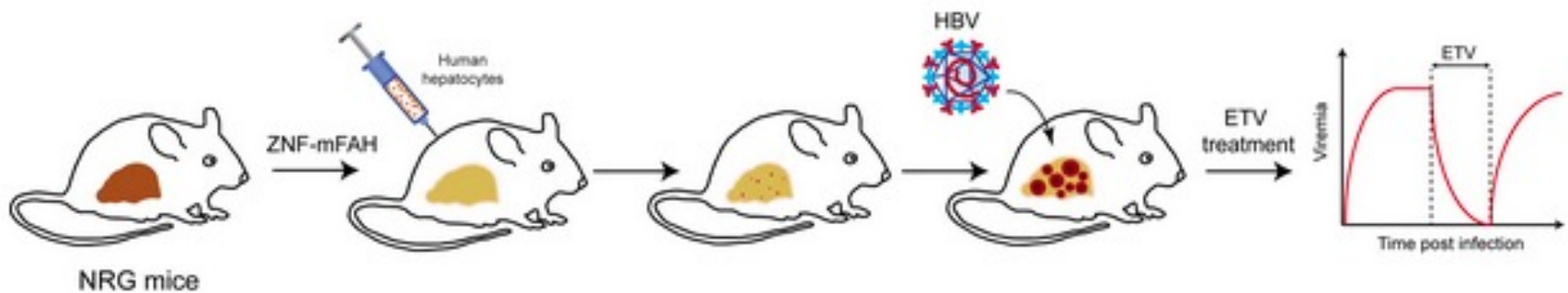
(and fun!)

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

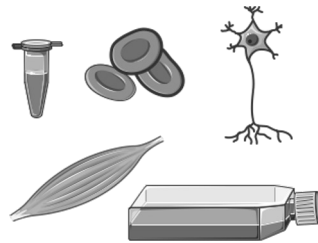
You don't need to reinvent the wheel when making beautiful schematics!

Servier Powerpoint Image Bank

Biorender

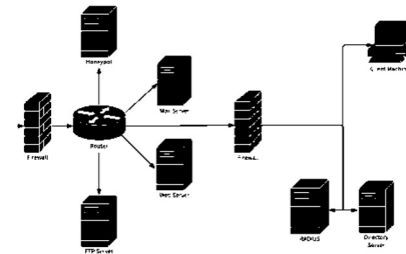
Biolcons

(<https://github.com/duerrsimon/bioicons>)



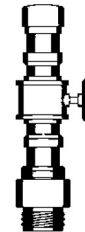
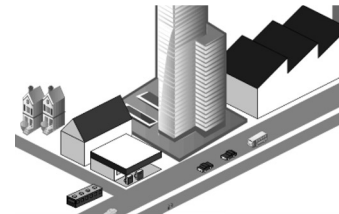
MS Visio & Lucidchart

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 (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

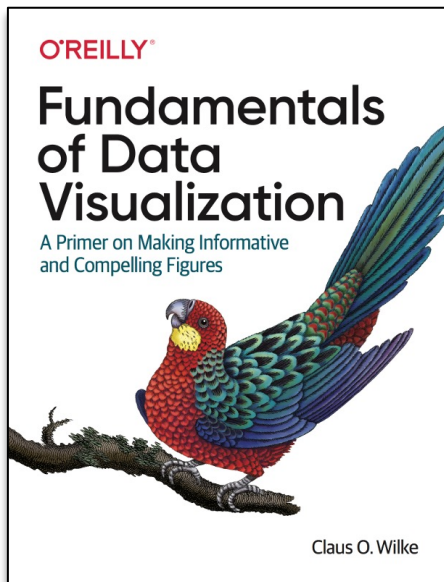
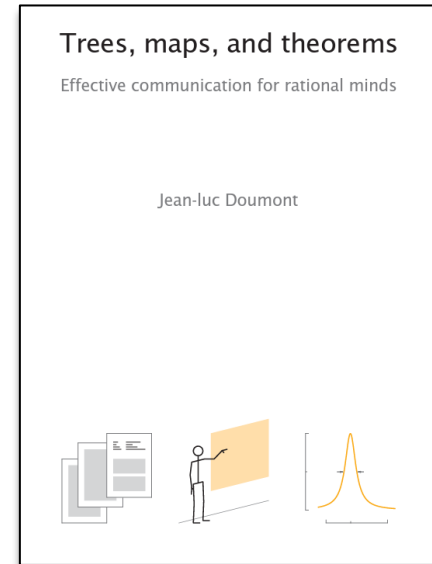
<https://inkscape.org/learn/tutorials/>

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

Trees, Maps, and Theorems

Jean Luc Doumont

<https://www.principiae.be/book/X0301.php>



Fundamentals of Data Visualization

Claus O. Wilke

<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 Vocabulary: <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...

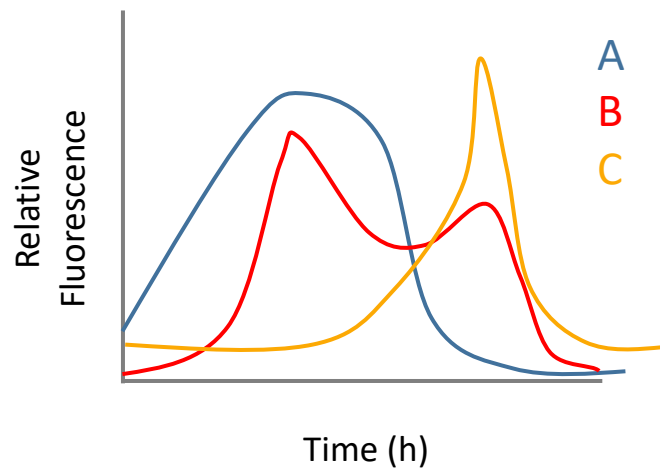


Fig. 1: A, B, and C have different dynamics under Condition X. A, B, and C were sampled using Method 1 and their fluorescence quantified with Method 2. Fluorescence data normalized to negative control.

...or multiple panels that contribute to the same takeaway message

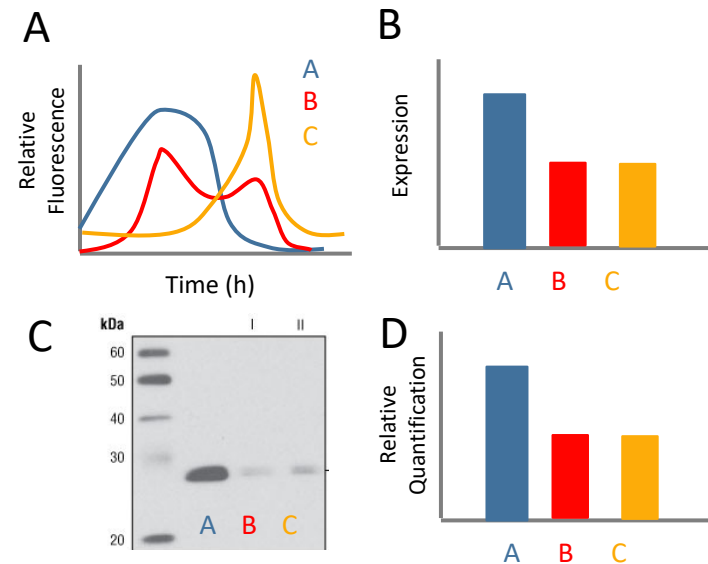


Fig. 1: A, B, and C have different dynamics under Condition X. A) A, B, and C were sampled using Method 1 and their fluorescence quantified with Method 2. Fluorescence data normalized to negative control. B) Gene expression data of samples A, B, and C, under condition X. Samples were collected at time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

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



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

SEARCH THE SITE:

e.g. Article, Poster, CV

Fellowship Applications

- Graduate School Personal Statement
- NSF Personal Statement
- NSF Research Proposal
- Postdoc Fellowships: Index of Life Sciences Fellowships
- AAAS STPF Applicant Statement

Career Focused Tasks

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

Presentations

- Slideshow
- Public Speaking
- Virtual Presentations

Poster Design

- Introduction to Poster Design

Figure Design

- Introduction to Figure Design

Manuscripts

- Abstract
- Introduction
- Methods
- Results
- Discussion

MIT BE-specific

- BATS seminar
- BE Undergraduate Research Symposium

Science Policy

- Introduction to Policy Communication

GitHub Resources

- Introduction to Resources

Coding

- Coding, File Organization, and Documentation



Career Exploration

March 11, 2022

If you are starting to think about what you want to do with a degree in Biological Engineering, check out this post on career exploration. Learn about the various



Introduction to Illustrator and Helpful Resources

September 9, 2021

Vector images are an important component of figure design. While the learning curve is steep, Illustrator is the best way to make images. In this series of blog posts, we introduce you to Illustrator and the things you might need to know how



Asking for Recommendation Letters

July 20, 2021

Applying for graduate school or fellowships can be daunting. To make the process more stressful, we often need several letters of recommendation for a complete application. Below are some tips on who to ask and how to ask for a letter of recommendation.



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

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

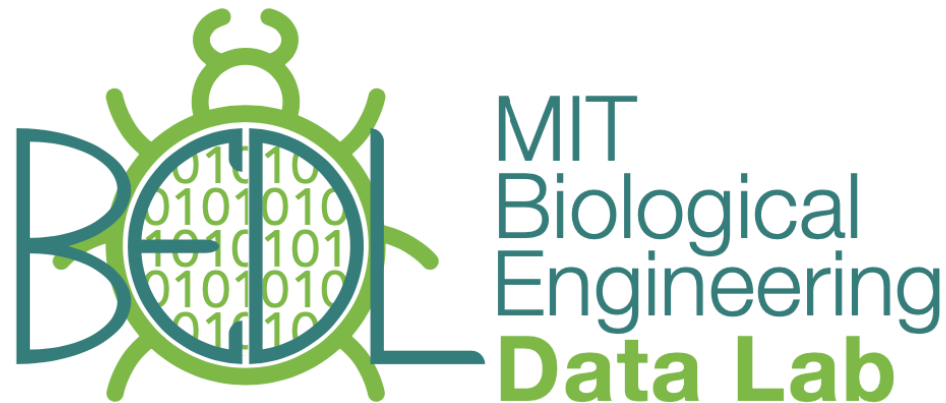
- **Just-in-time** coaching: you can come to an appointment at any stage of your communication process (from early brainstorming to final revisions), and get help right at the time you need it
- Our goal is to **nurture, not evaluate**: we seek to provide an outside perspective and help you progress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



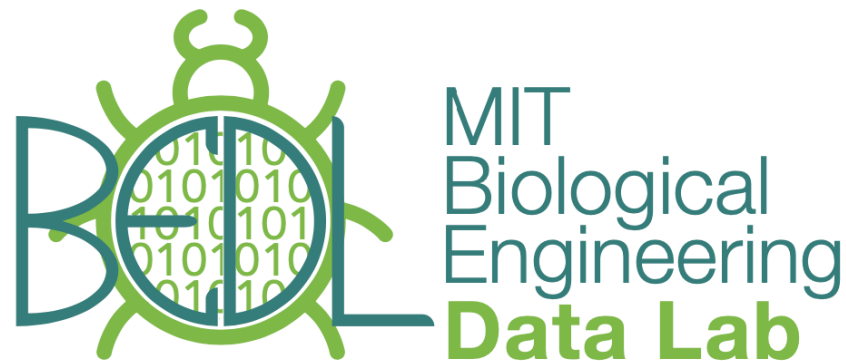
For support with **data analysis** and **coding**,
check out the **MIT BE Data Lab**



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