Start to think about these questions

Why should we care about scientific communication? Rewards, scenarios?

What makes you feel that communication has been successful?

As a receiver?

As a sender?

What makes you feel that communication has been successful?

As a receiver?

Clear message, logic flows, you can find your way around, actionable, visual appeal

As a sender?

Reward (citation, grade, funding)
Feedback: questions or criticism

When we struggle to understand talks or papers, we often blame ourselves.

"I got stuck."

"huge logical leap"

"way too much going on"

"what am I supposed to look at?"

but poor communication is often the barrier, not your scientific understanding.

Our workshops cover

WHEN scientific communication is confusing

WHY it's confusing

HOW to fix the problems

…and apply these fixes to 20.109 assignments

How the workshops will go

1. Discuss real examples
2. Derive principles and strategies
3. Practice
4. Go home with a checklist/rubric

Practice with a fellow at the MIT BE BIOLOGICAL ENGINEERING Communication Lab !

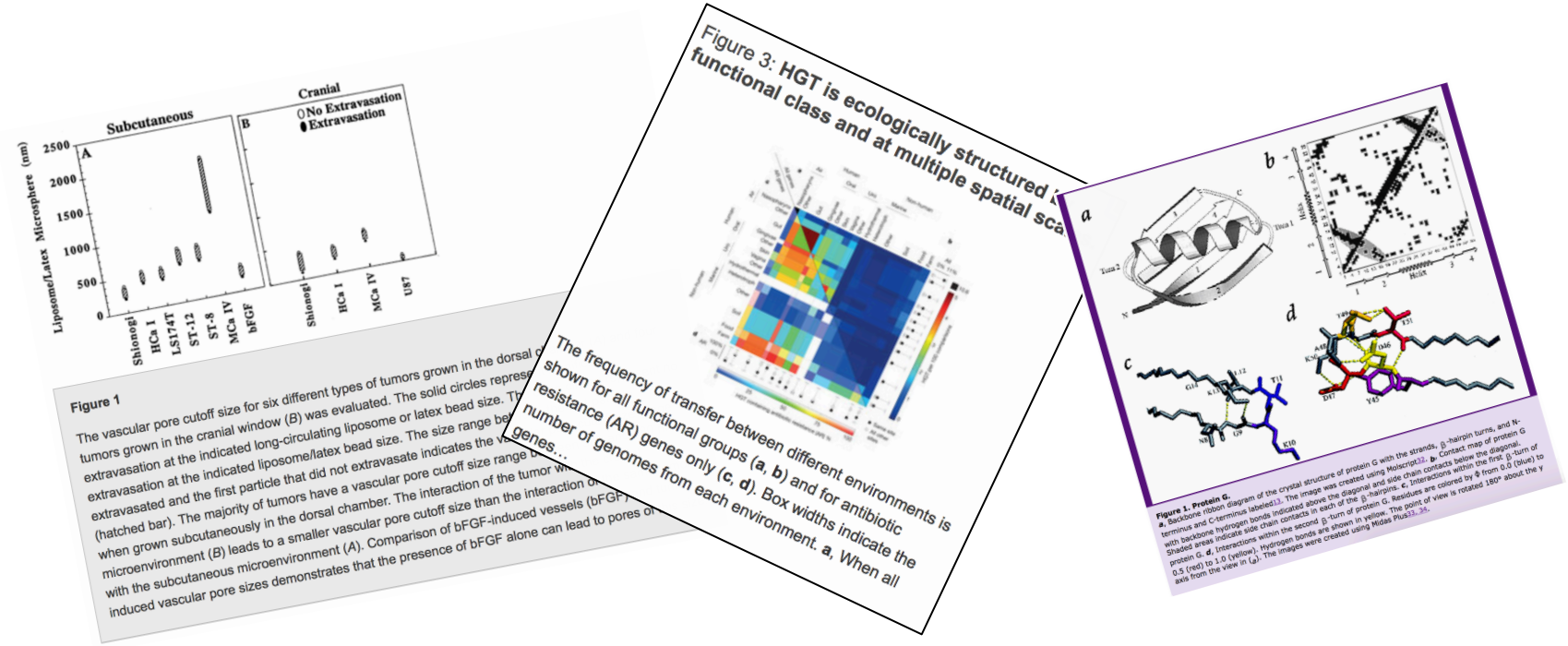
Designing Effective Figures

20.109 Spring 2018 Communication Workshop 1

Dr. Sean Clarke and Dr. Prerna Bhargava

MIT BE BIOLOGICAL ENGINEERING | Communication Lab

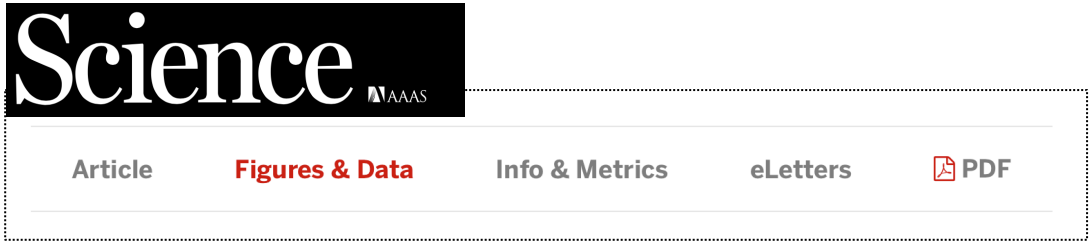
be.mit.edu/communicationlab

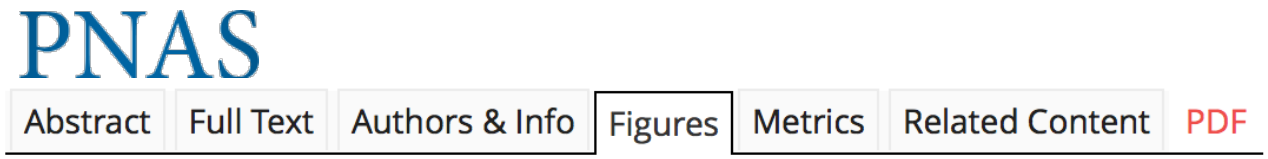


Figures (and captions)

Why start here?

Experts and many audiences may ONLY READ your title, abstract, and FIGURES.





So let's make them

compelling

honest

supporting your story

Activity: Identify the basic figure components

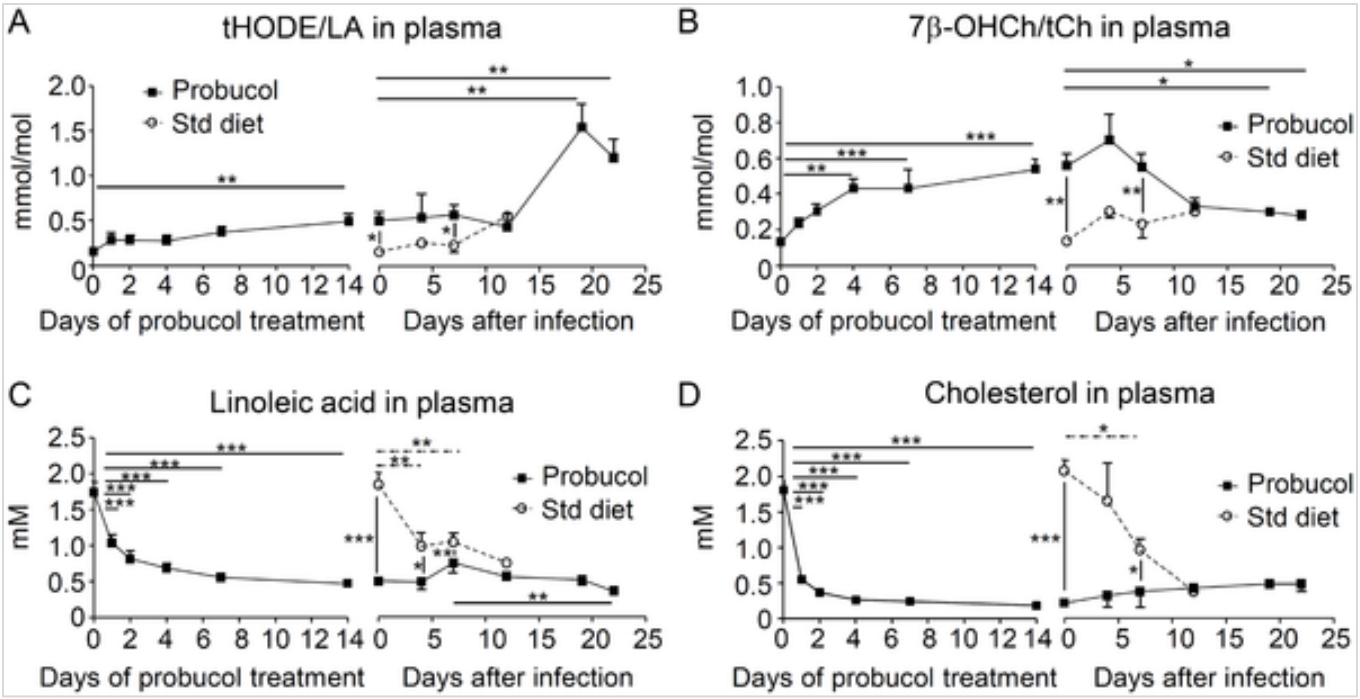


Fig 4. The ratios of lipid peroxidation products to parent lipids in plasma increased after probucol pre-treatment. Six-week-old C57BL/6J mice were treated with 1% w/w probucol in the diet for 2 weeks and then infected with 0.2 mL of 1 × 10^5 erythrocytes /mL infected with *Plasmodium yoelii* XL-17. Plasma samples were obtained at day 0, 1, 2, 4, 7, and 14 after starting the probucol diet (n = 5 per group) and at day 0, 4, 7, 12, 19, and 22 post-infection (n = 2 to 7). The ratio of total hydroxyoctadecadienoic acid (HODE), a peroxidation product of linoleic acid (LA), to linoleic acid (tHODE/LA) in plasma (A) and the ratio of 7β-hydroxycholesterol (7β-OHCh), a peroxidation product of cholesterol, to total cholesterol (7β-OHCh/tCh) in plasma (B) were measured. The concentration of LA (C) and tCh (D) were measured by using gas chromatography-mass spectrometry (GC-MS). All data are expressed as mean ± SE. Statistical analysis was carried out by analysis of variance (ANOVA). *$p < 0.05$, **$p < 0.025$, and ***$p < 0.001$. The solid bars indicate the significant changes in probucol-treated groups and the dotted bars indicate the significant changes in standard (Std) diet-fed mice.

Basic figure components

Figure = message + data

Choice of data

- Only data that are critical to the conclusion

Presentation choices

- Type of graph or display, legends & labeling, design choices
- Uncluttered
- Allow quick evaluation of conclusions, without referring to legend or caption.

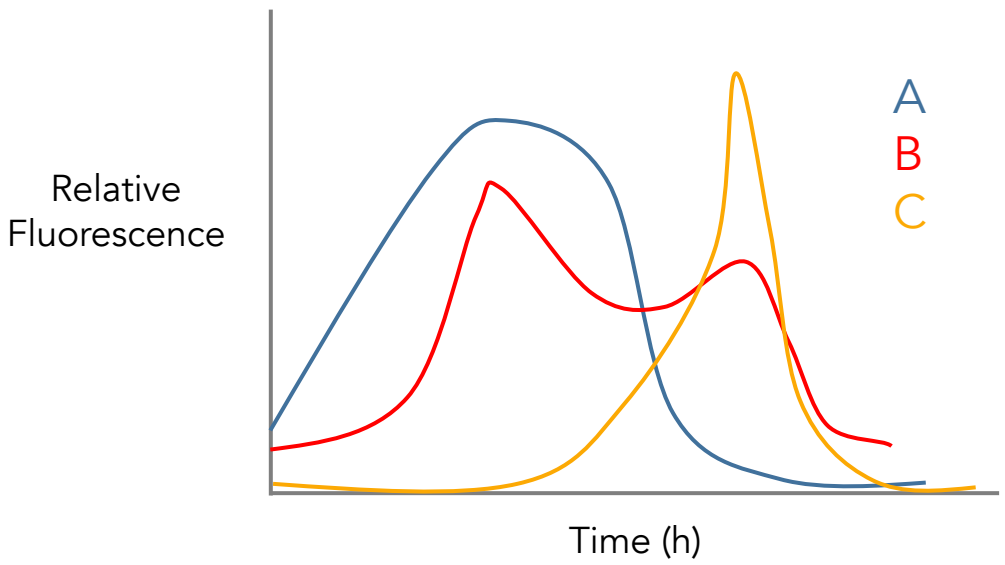


Fig. 1: A, B, and C have different dynamics under Condition X. A, B, and C were sampled using Method 1 and their fluorescence quantified with Method 2. Fluorescence data normalized to negative control.

Basic figure components

Figure = message + data

Title

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

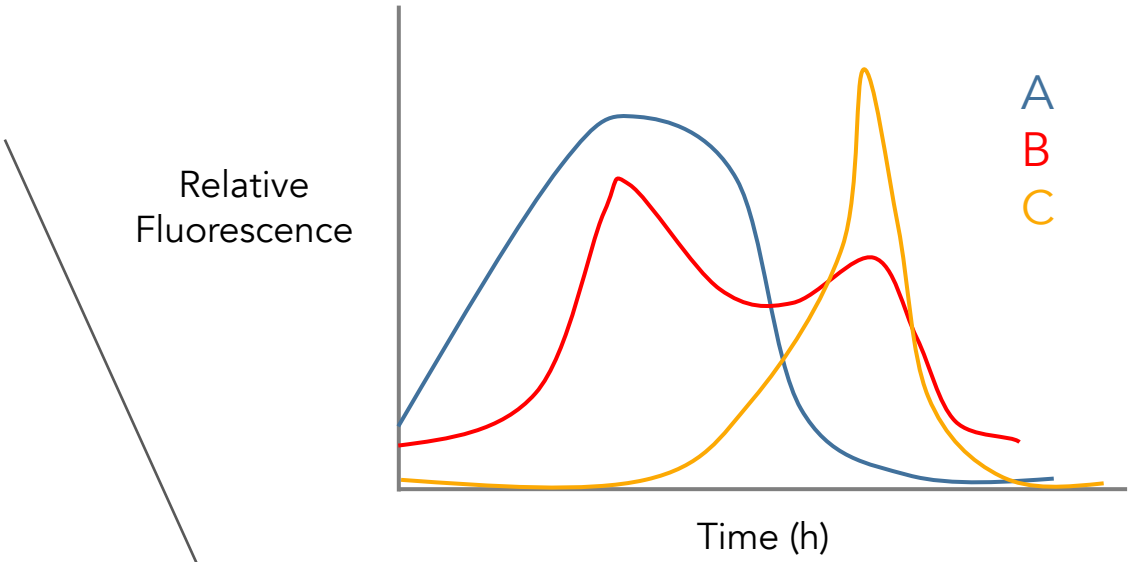
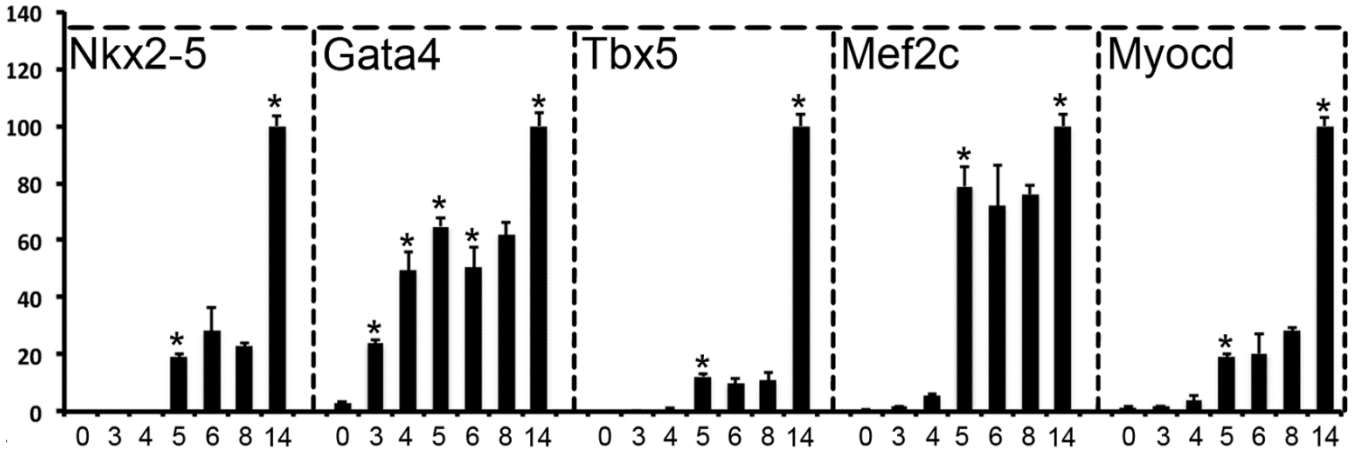


Fig. 1: A, B, and C have different dynamics under Condition X. A, B, and C were sampled using Method 1 and their fluorescence quantified with Method 2. Fluorescence data normalized to negative control.

Message: Use titles to state a figure's message, not the method



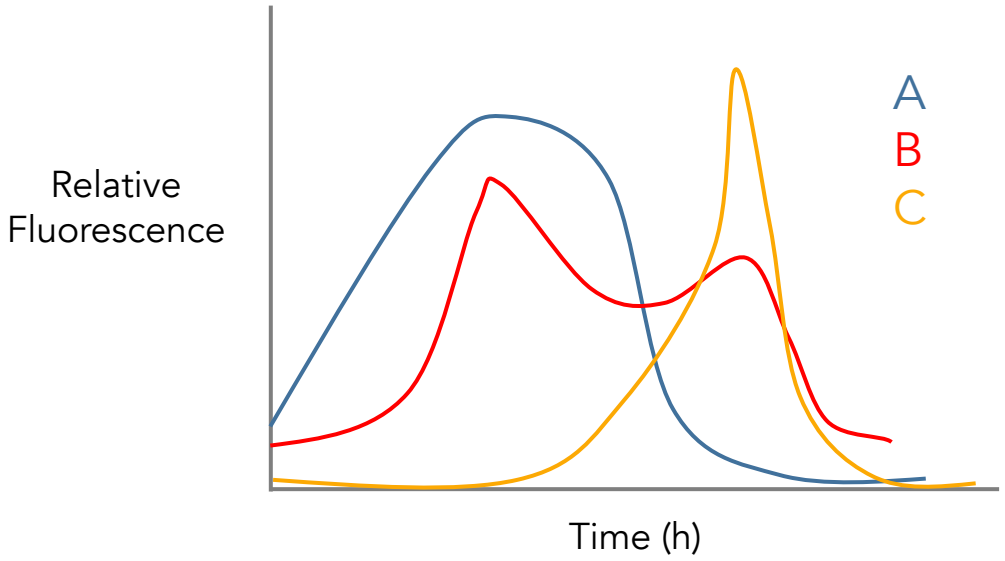
Gene expression analysis performed on differentiating mouse iPS cells

Expression of early cardiac transcription factors increases over time in differentiating mouse iPS cells

Christoforou N, *et al.* (2013) PLoS ONE 8(6): e65963.
doi:10.1371/journal.pone.0065963

Basic figure components

Figure = message + data



Caption

- Descriptive, not explanatory/interpretive
- Only enough methodological detail to make it clear how results were obtained.

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.

All the figures you make need all of these components

Schematics

Diagrams

Photos

…count as figures too.

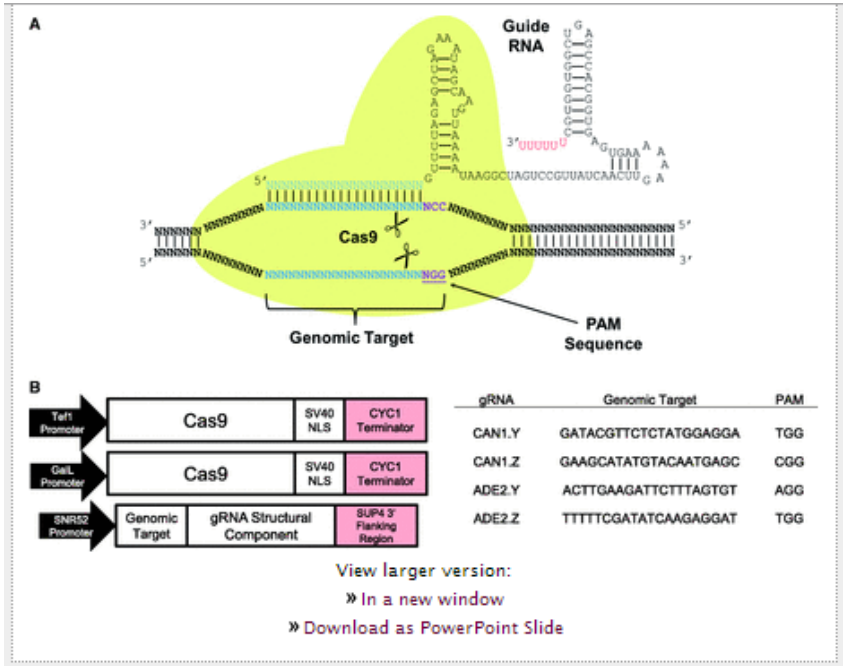


Figure 1.
Diagram of Cas9 complex and schematic of genetic constructs. (**A**) Illustration of Cas9 protein interacting with CRISPR gRNA to direct endonuclease activity proximal to the PAM sequence. (**B**) Design of the Cas9 and gRNA constructs. Cas9 gene contained a SV40 nuclear localization signal and was expressed under the Gal-L inducible promoter in CAN1 experiments and the TEF1 constitutive promoter in ADE2 experiments. The gRNA was

DiCarlo et al., 2013 Nuc. Acids. Res.

Steps to turn your pile of data into figures…

1 MESSAGE

What is your take-home message?
What is the message of each figure?
What data do you include in each figure to convey your message?

2 DATA

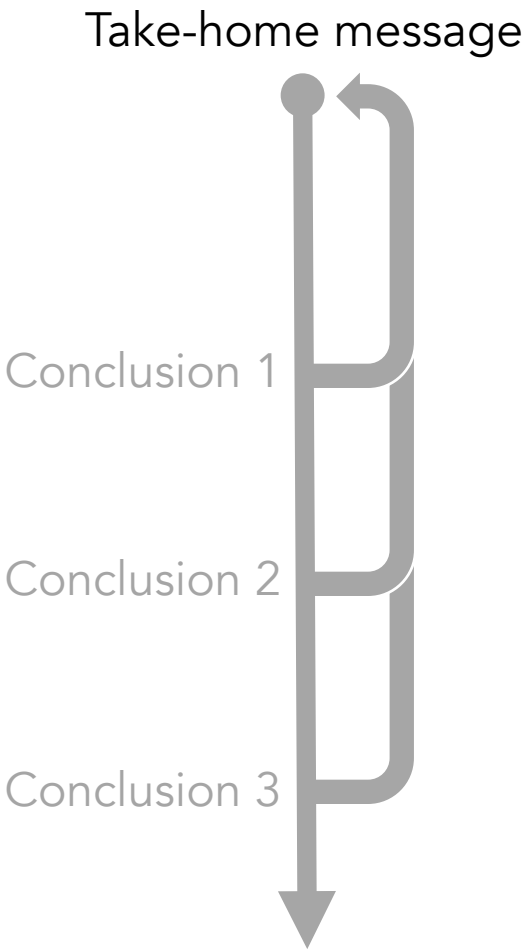
How can you present your data to support your message?

3 DESIGN

What are some key design choices to think about?

Message: Create a single storyline.

Identify your **take-home message**; everything else leads to it.

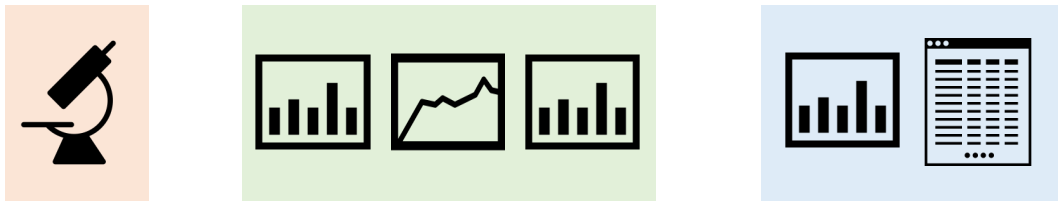


Message: To find your story, organize your messages and figures.

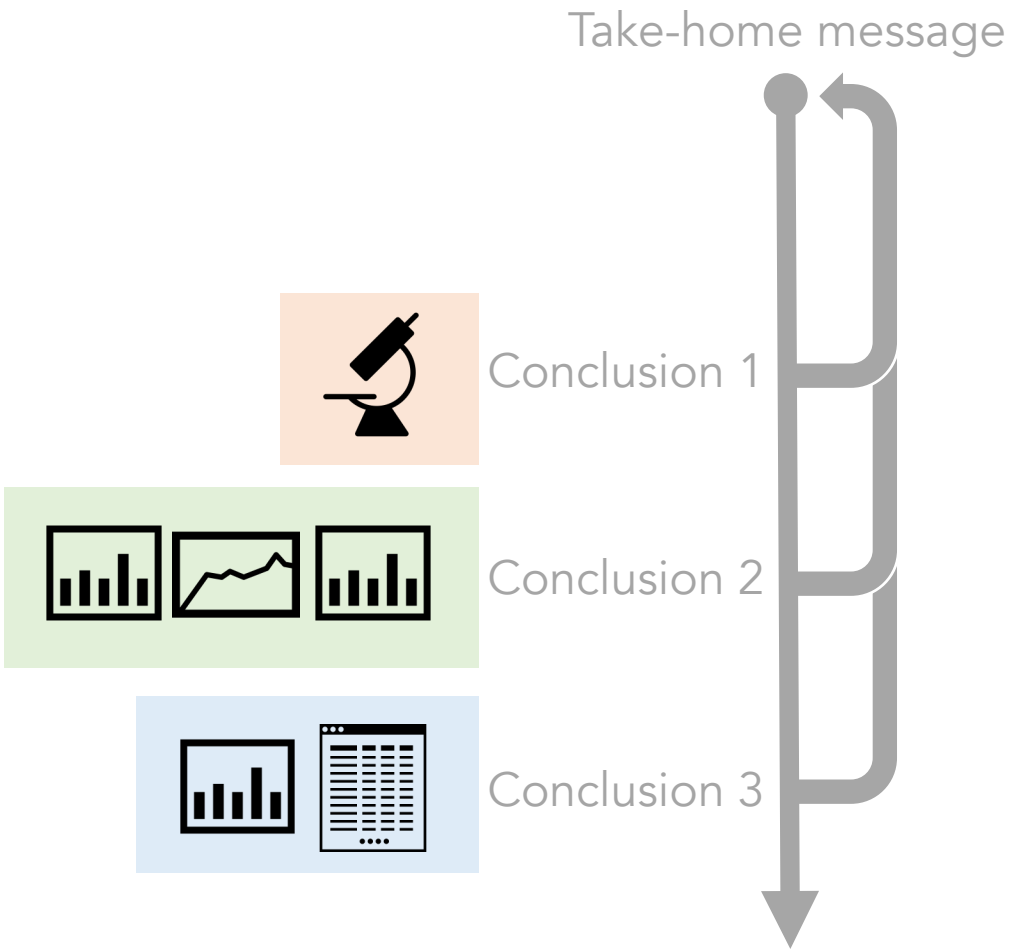
Rearrange until you've created a **logical series** of conclusions.

Message: Organize your Figures into modules.

Identify **modules** that correspond to **conclusions.**



Message: Modules correspond to conclusions



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

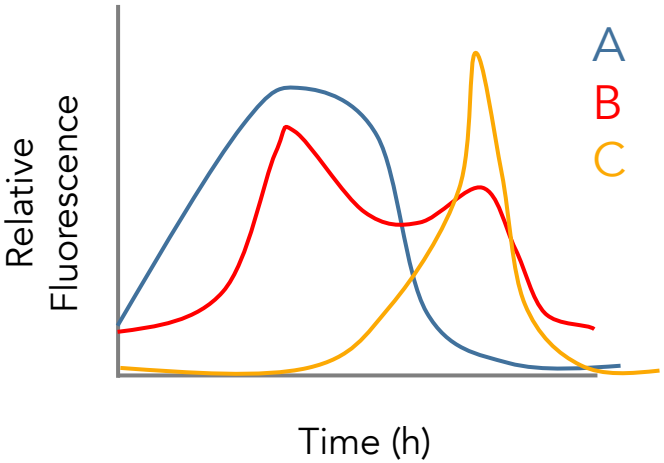


Fig. 1: A, B, and C have different dynamics under Condition X. A, B, and C were sampled using Method 1 and their fluorescence quantified with Method 2. Fluorescence data normalized to negative control.

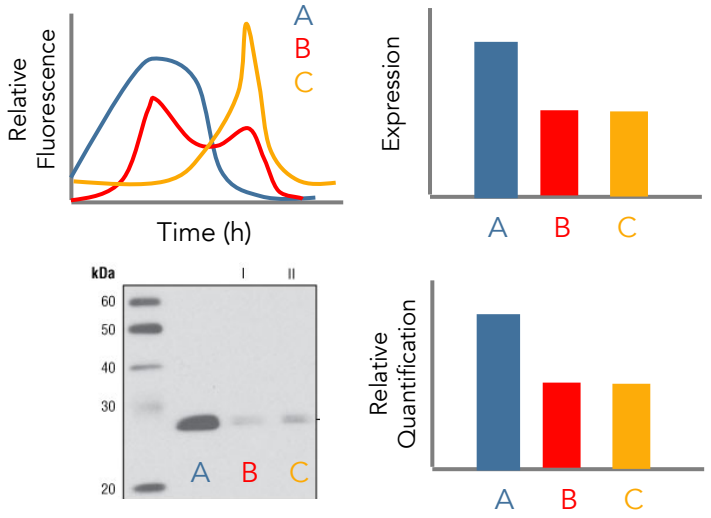


Fig. 1: A, B, and C have different dynamics under Condition X. A) A, B, and C were sampled using Method 1 and their fluorescence quantified with Method 2. Fluorescence data normalized to negative control. B) Gene expression data of samples A, B, and C, under condition X. Samples were collected at time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

Steps to turn your pile of data into figures…

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2 DATA

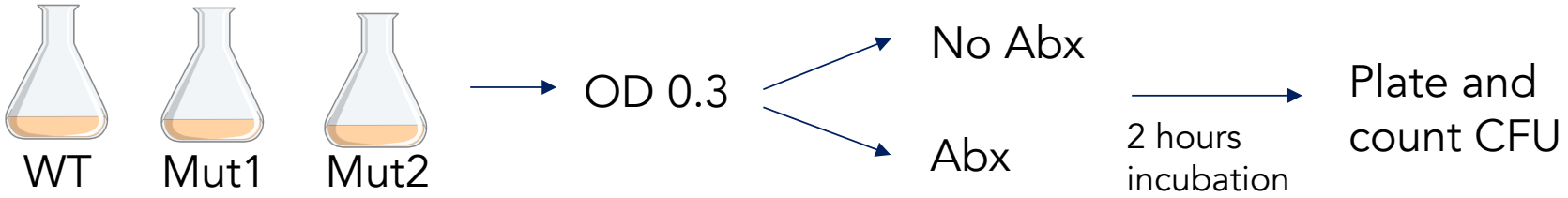
How can you present your data to support your message?

3 DESIGN

What are some key design choices to think about?

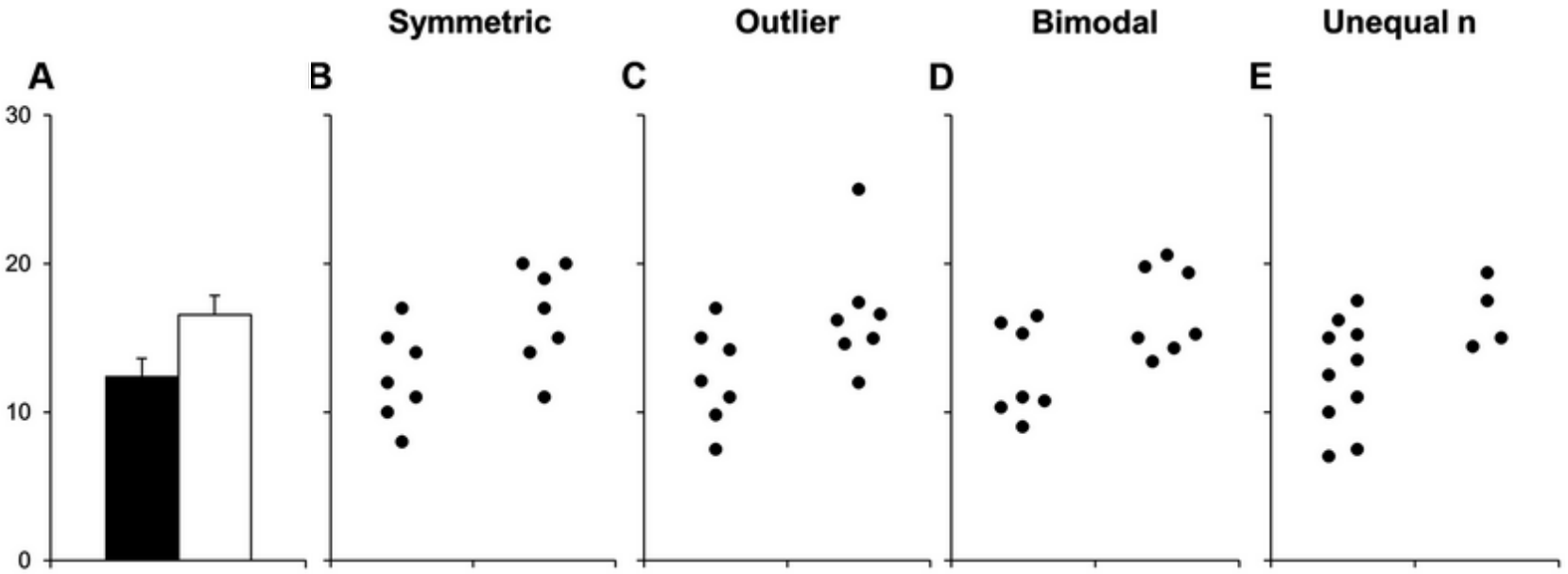
Activity:

What stories can we tell with this data? How do they affect figure choices?



Strain	Dosage	Replicate 1	Replicate 2	Replicate 3	Average (CFU)
WT	Baseline	1.8e5	3.2e5	7.8e5	4.3e5
WT	No Abx	1.0e9	1.3e9	8.0e8	1.0e9
WT	Abx	2.3e2	2.8e2	5.5e2	3.5e2
Mut1	Baseline	2.5e5	8.3e5	4.6e5	5.1e5
Mut1	No Abx	5.5e7	2.3e7	1.1e7	3.0e7
Mut1	Abx	4.3e5	7.5e5	2.2e5	4.7e5
Mut2	Baseline	5.3e5	3.2e5	1.3e5	3.3e5
Mut2	No Abx	3.4e9	2.2e9	3.0e9	2.9e9
Mut2	Abx	2.2e9	5.3e9	1.2e9	2.9e9

Data: Consider which plot type best allows the reader to evaluate your conclusion.



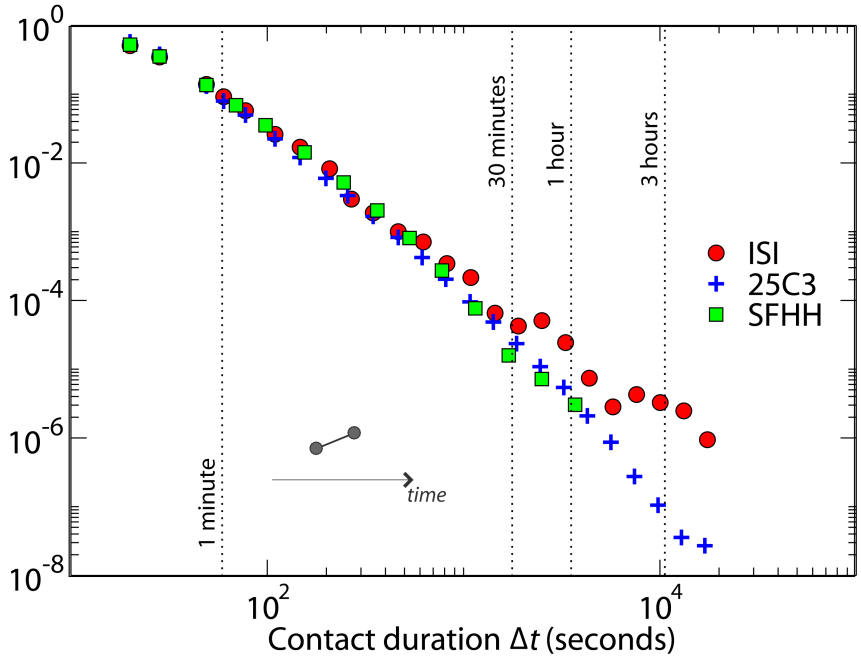
Bar charts assume a Gaussian distribution.

Scatter plots reveal the true distribution.

Weissgerber et al. (2015), Beyond Bar and Line Graphs: Time for a New Data Presentation Paradigm. *PloS Biology*

Data: Only show as much data as you need to convey your message.

Probability distribution of human interactions at 3 conferences



At a poster session, 50% of your audience walks away after 20 seconds

Time talking	Probability listening
0 sec	100%
20 sec	50%
1 min	10%
2 min	5%
5 min	<1%

Cattuto et al., 2010, PLoS ONE

Activity: Improve this published figure

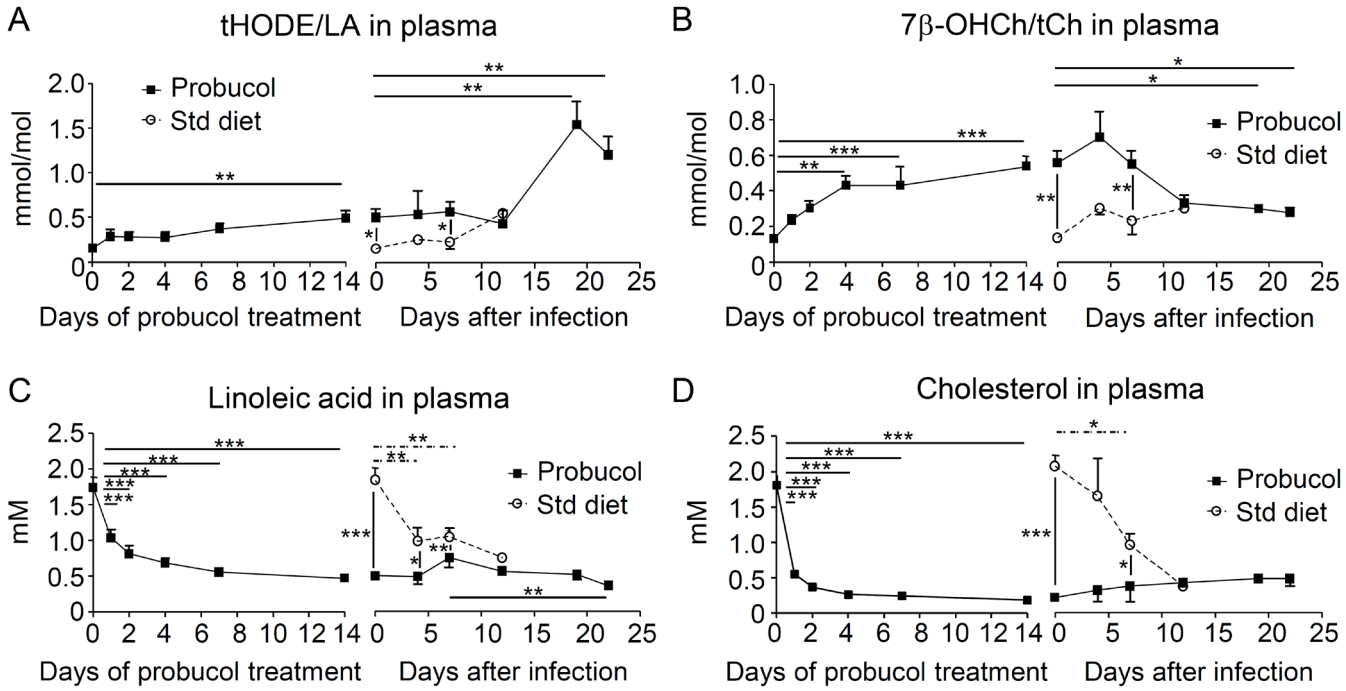


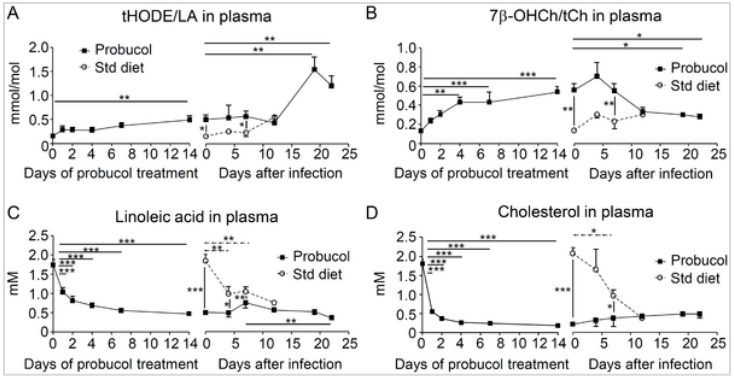
Fig 4. The ratios of lipid peroxidation products to parent lipids in plasma increased after probucol pre-treatment.
Six-week-old C57BL/6J mice were treated with 1% w/w probucol in the diet for 2 weeks and then infected with 0.2 mL of 1 × 10^5 erythrocytes /mL infected with *Plasmodium yoelii* XL-17. Plasma samples were obtained at day 0, 1, 2, 4, 7, and 14 after starting the probucol diet (n = 5 per group) and at day 0, 4, 7, 12, 19, and 22 post-infection (n = 2 to 7). The ratio of total hydroxyoctadecadienoic acid (HODE), a peroxidation product of linoleic acid (LA), to linoleic acid (tHODE/LA) in plasma (A) and the ratio of 7β-hydroxycholesterol (7β-OHCh), a peroxidation product of cholesterol, to total cholesterol (7β-OHCh/tCh) in plasma (B) were measured. The concentration of LA (C) and tCh (D) were measured by using gas chromatography-mass spectrometry (GC-MS). All data are expressed as mean ± SE. Statistical analysis was carried out by analysis of variance (ANOVA). *$p < 0.05$, **$p < 0.025$, and ***$p < 0.001$. The solid bars indicate the significant changes in probucol-treated groups and the dotted bars indicate the significant changes in standard (Std) diet-fed mice.

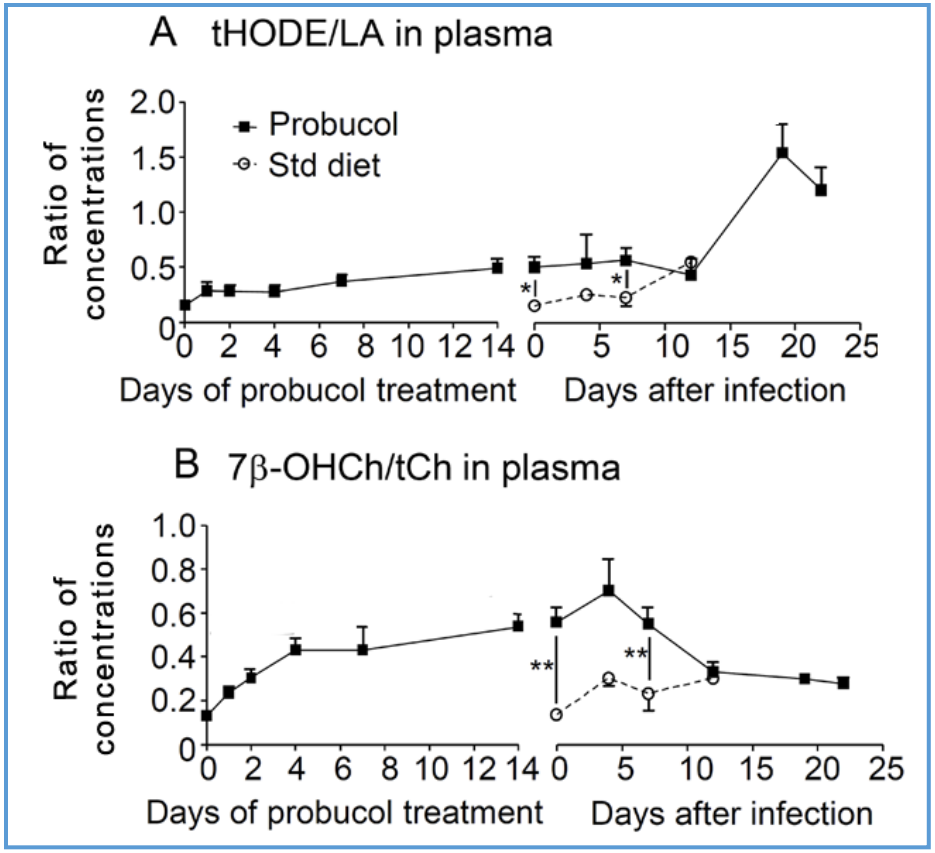
Herbas MS *et al* (2015) **PLoS ONE** 10(8): e0136014.

Evaluate these figure choices

- 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?

Only include the minimum information necessary to express the message honestly.





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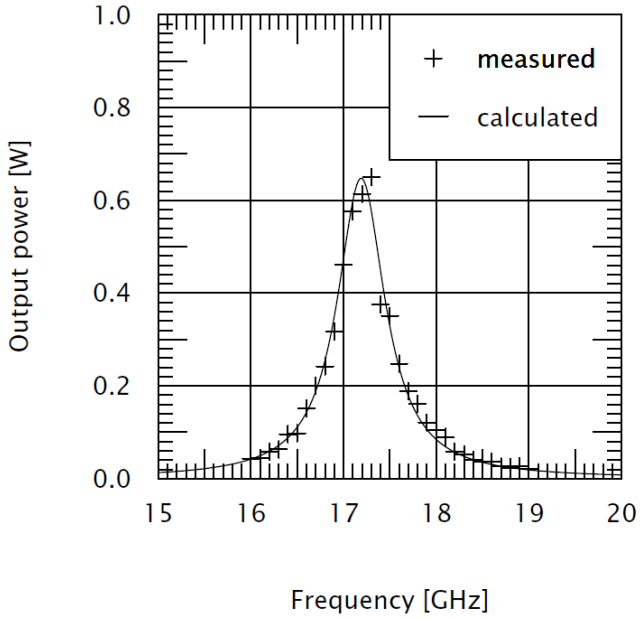
Design: Maximize signal-to-noise

Reward yourself for cutting things

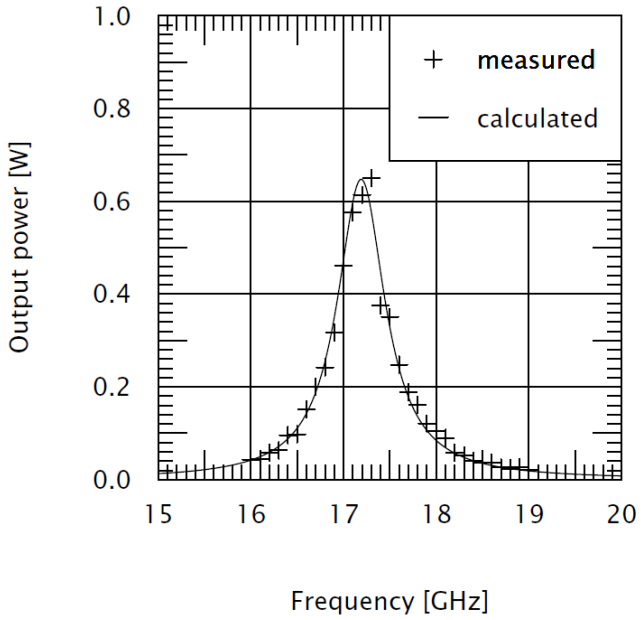


Adapted from Jean-luc Doumont, *Trees, Maps, and Theorems*

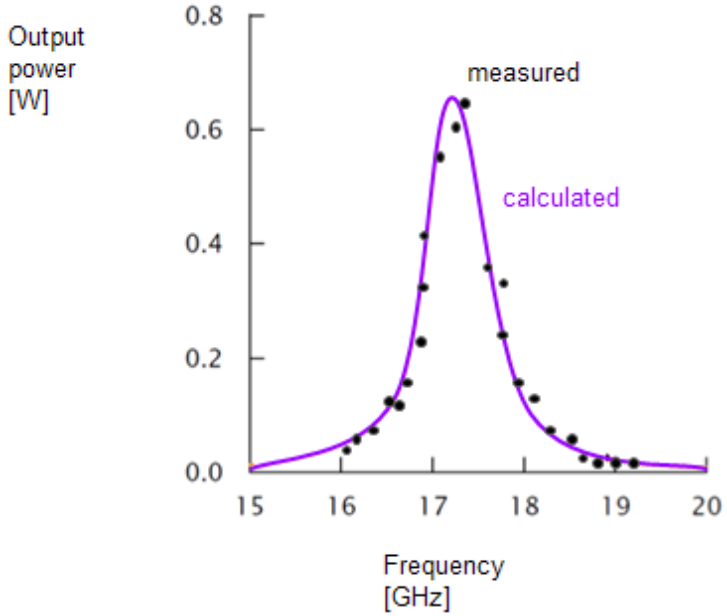
Design: Maximize signal-to-noise

State your message.
Eliminate anything that distracts from it.

Power vs. frequency

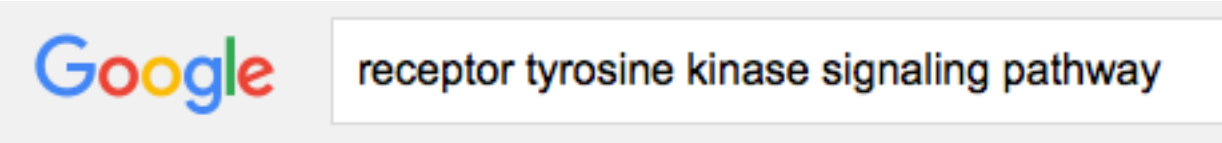


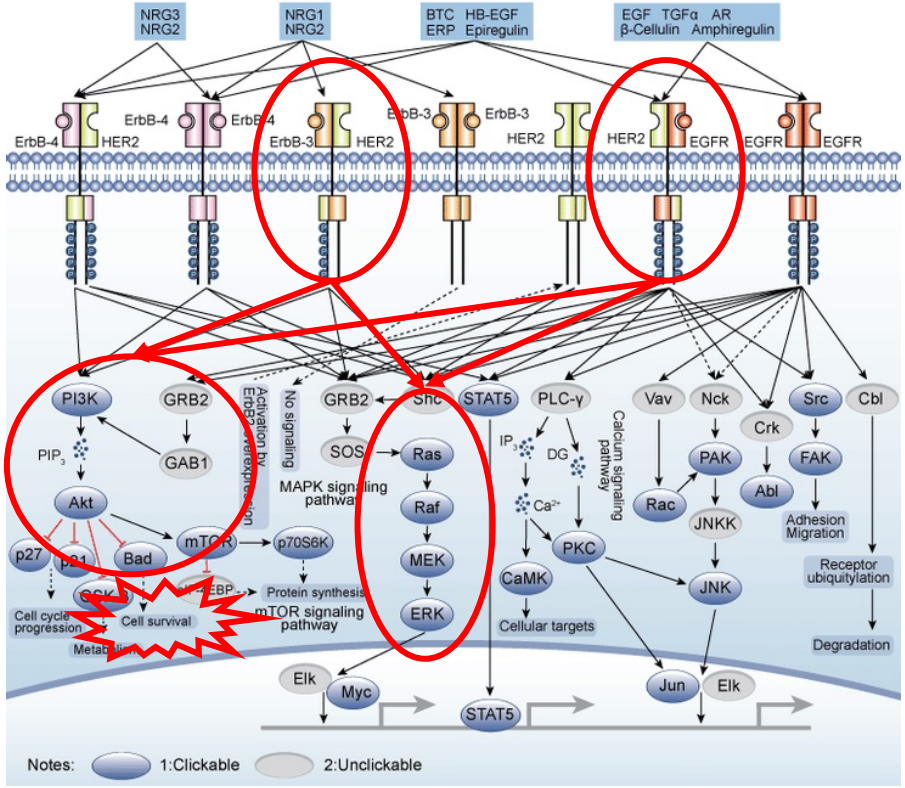
True power spectrum agrees with prediction



Adapted from Jean-luc Doumont, *Trees, Maps, and Theorems*

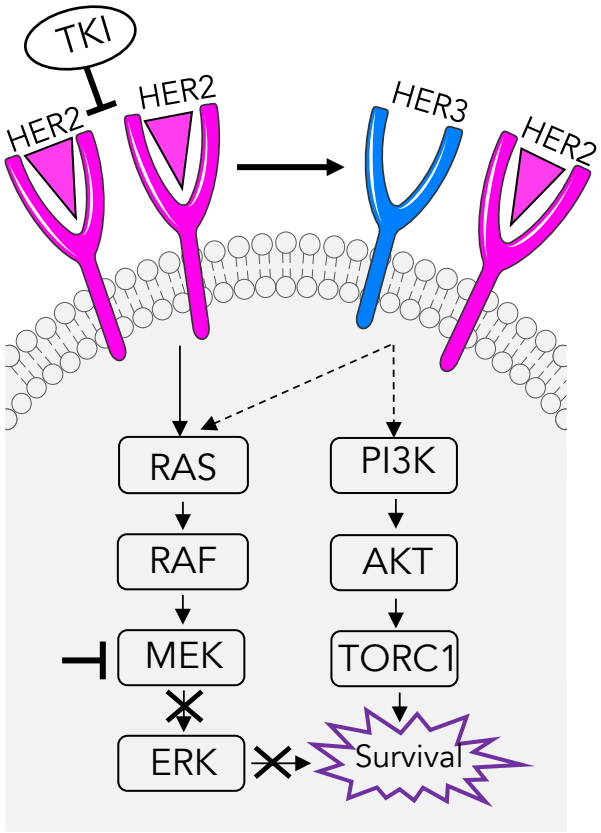
Design: Make schematics with a message





Slide credit: L. Stopfer & G. Sun

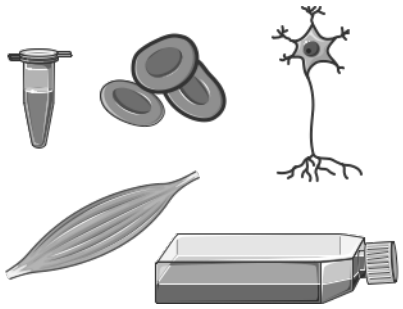
Design: Schematics have messages too



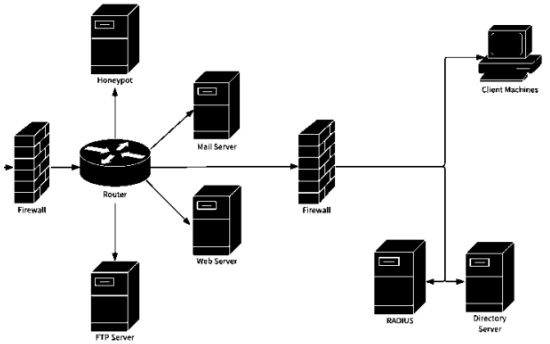
Slide credit: L. Stopfer & G. Sun

Design: You don't need to reinvent the wheel

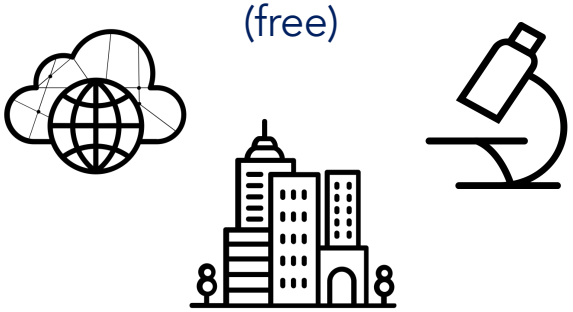
Servier Powerpoint Image Bank
Biology, lab equipment
(free)

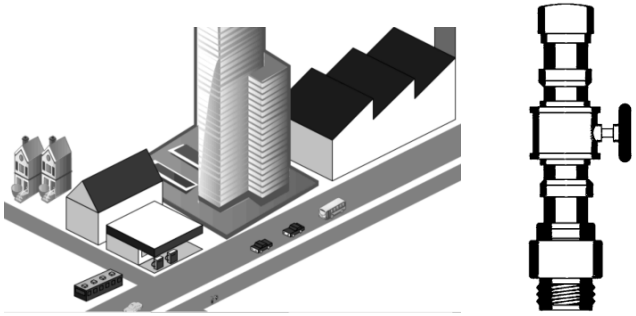


MS Visio & Lucidchart
Networks, engineering, circuits, charts
($$) & (free)



Noun Project
Everything
(free)

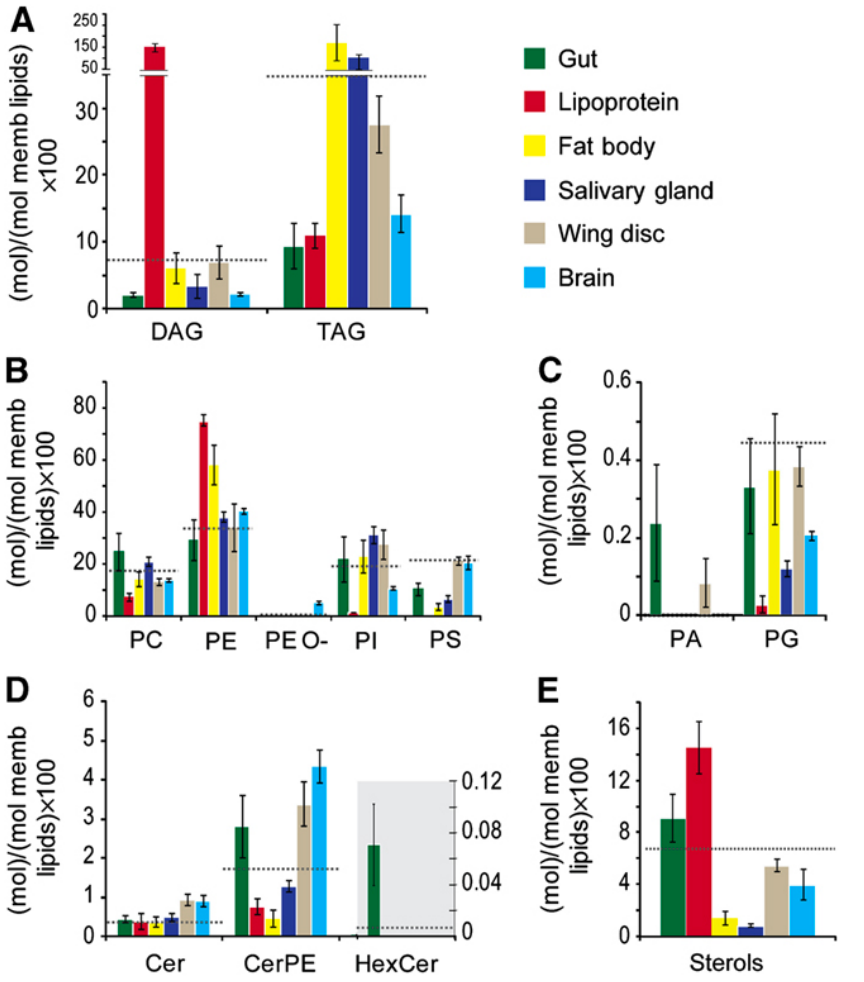




Design: Maximize signal-to-noise

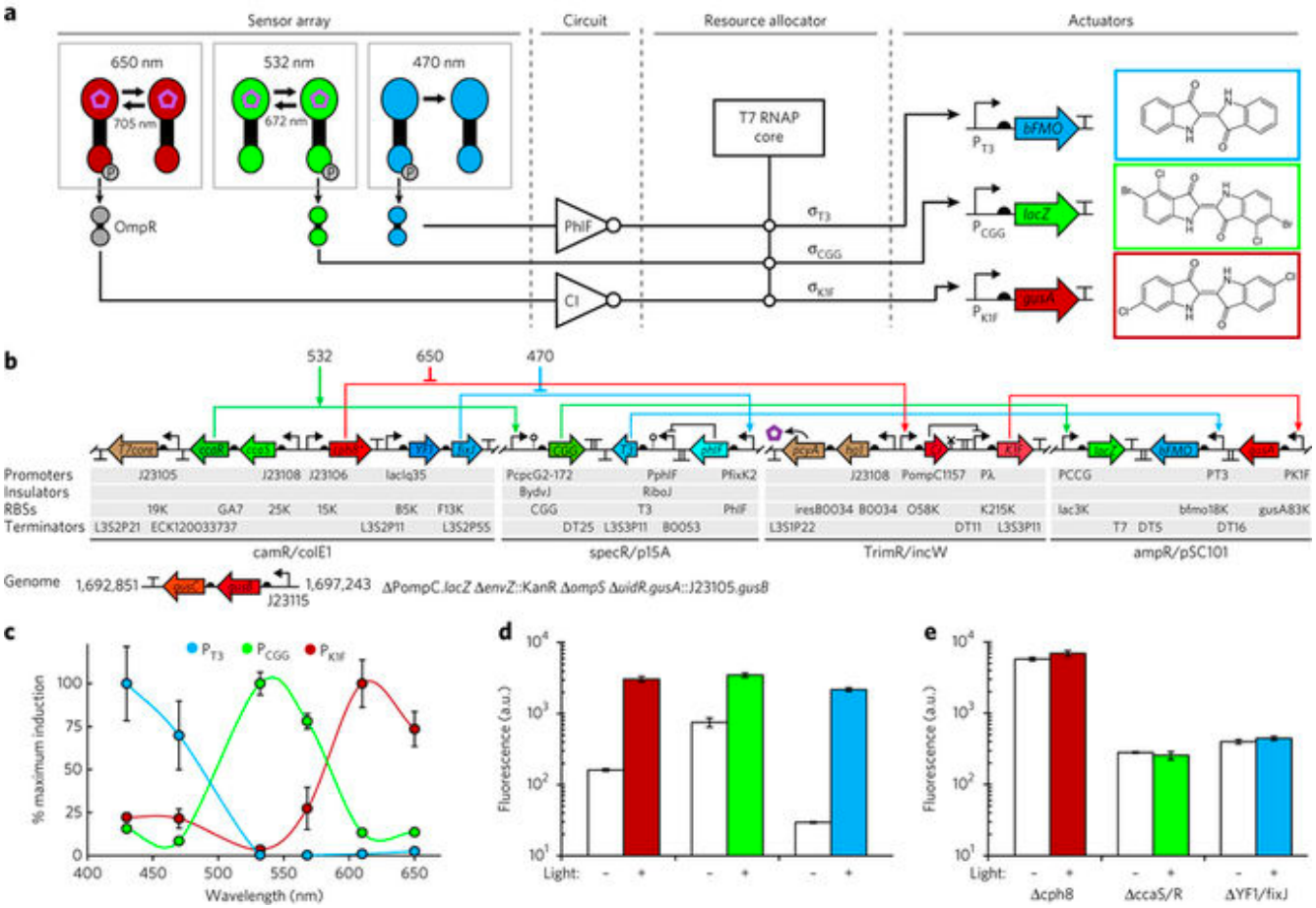
Minimize # style choices and be consistent

- Grayscale with a consistency of colors



Design: Maximize signal-to-noise

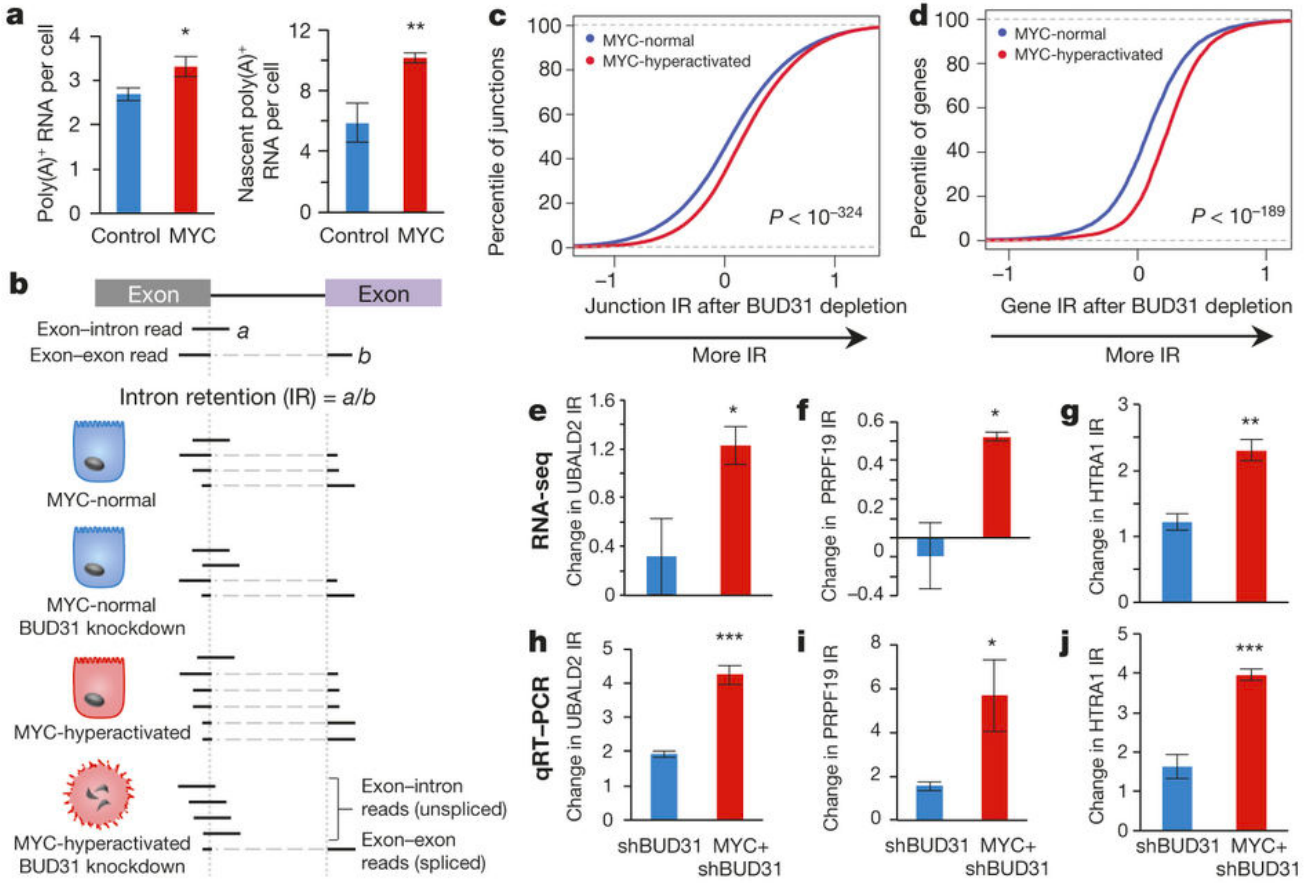
- Try Grayscale or consistent colors



Design: Maximize signal-to-noise

Consider

Font and size
Line thickness
Alignment



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1 MESSAGE

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3 DESIGN

What are some key design choices to think about?

Go forth and figure

Wiki has this and more

Put these tips to work

Prerna and Sean in lab to answer questions

Next week we'll get concrete about Abstracts!

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
- ❑ Type of plot for the data
- ❑ Title/Caption
  - Can figure stand alone?
- ❑ Consistent features
  - Fonts, spacing, colors
- ❑ Text amount and placement
- ❑ Scale, axes, tick marks
- ❑ Error analysis
- ❑ Ink-to-whitespace ratio