

Welcome to 20.109

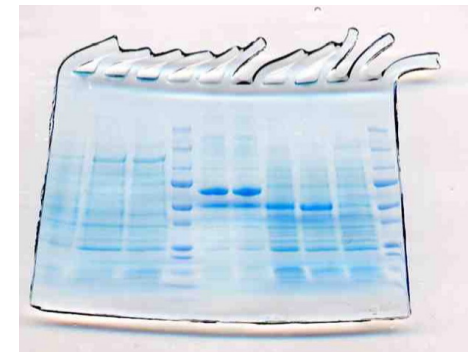
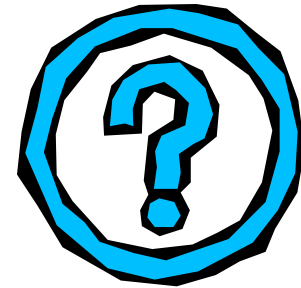
**Laboratory Fundamentals of
Biological Engineering**

Orientation Lecture

Spring 2013

Introducing 20.109

- Why you're here
 - course mission
 - digression: on learning
- What you'll do
 - three experimental modules
 - assessments/communication
 - course logistics



Course mission for 20.109

- To teach cutting edge research skill and technology through authentic investigation
- To inspire rigorous data analysis and its thoughtful communication
- To prepare students to be the future of Biological Engineering

20.109 faculty introductions

- Technical
 - Prof. Jon Runstadler (Mod 1)
 - Prof. Alan Jasanoff (Mod 2)
 - Dr. Agi Stachowiak (Mod 3; T/R section)
 - Dr. Shannon Hughes-Alford (W/F section)
- Communications
 - Leslie Ann Roldan (T/R section, writing)
 - Marilee P. Ogren (W/F section, writing)
 - Atissa Banuazizi (oral presentations)
- Teaching assistants
 - Ian Tay (Mod 1)
 - Mark Mimee (Mod 2)
 - Dr. Thomas Crouzier (Mod 3)



Spring 2011: babies' learning best practices



Baby	109er
Driven by wanting to <i>do</i>	Limits to grade desire
Intuitive experimenter	Your ideas/designs/input
Wants to communicate	Taxing but rewarding
Needs to fail repeatedly	<i>Analysis</i> counts, not lab success; report revision

On investigation: solid food recommendations in the literature

Spring 2012: the terrible twos

- Toddlerhood
 - becoming an individual
 - expressing own desires
 - ... sometimes unhealthily
 - still wants guidance/support...
 - ... on his own terms
- Sophomores
 - academic self-definition
 - bioengineer, not frosh core
 - still want guidance/support...
 - ... but not too much



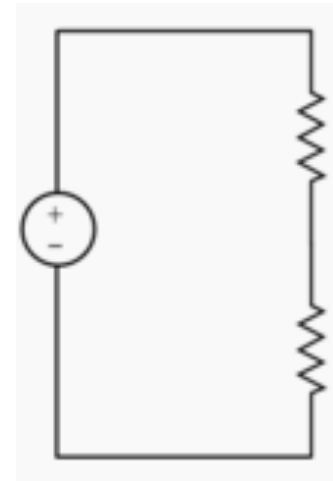
How would we investigate tantrum-control methods?

Now: the language (and conceptual)
explosion and independence

but first

Two recent formative experiences... for me

- Developing materials for 20.309
 - ages (or never) since I thought about this stuff
 - no matter how well-taught... learners' needs vary
 - two phases: exploratory; well-defined project
 - writing electronics primer solidified my thinking
- Co-teaching IAP communications workshop
 - recurring theme: **writing** \leftrightarrow **thinking**
 - George Whitesides: “writing *is* your research”
 - importance of process



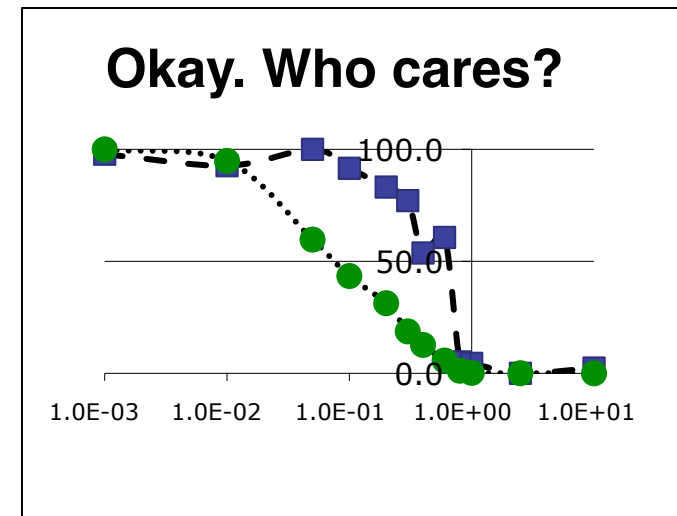
The language (and conceptual) explosion

- Emerging concepts and ?s
 - *what's that?*
 - *what happened?*
 - *where's grandad go?*
 - *might be under*
 - *what's that man doing?*
 - *no why yet ("ummm")*
- Acquiring grammar and tone
 - *what lion makes sound?*
- Mature thinking spurs desire for independence
 - *I want to do it myself!*
 - or at least try



109 version of that explosion

- Evaluating data
 - need to strive for *why* (not just *what*)
 - making connections
 - a deep level of abstraction
- Acquiring professional language
 - requires immersion (read, read, read!)
 - requires LOTS of practice
 - requires rich feedback
- Trajectory of independence
 - technical material
 - communications



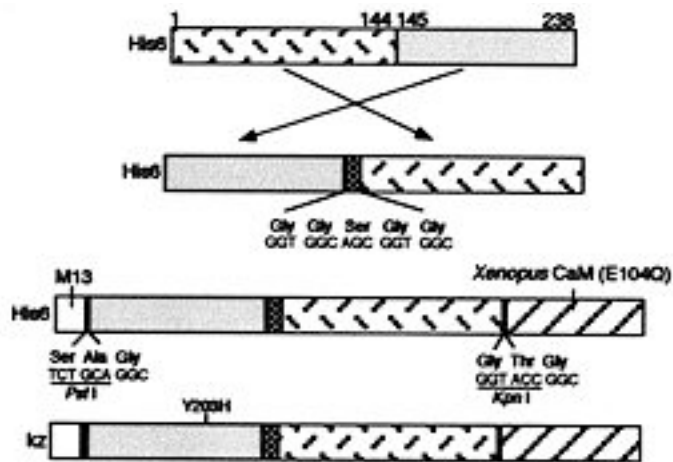
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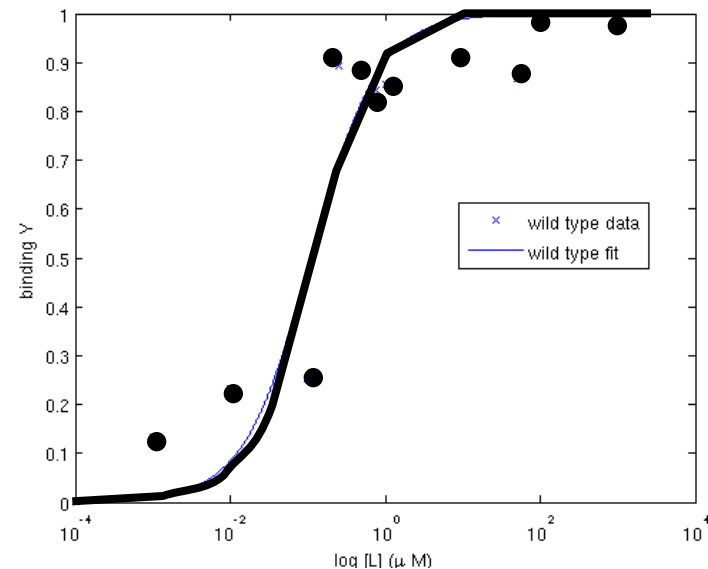
Engineering principles + modern biology

Manipulate and Make

Measure ↔ **Model**

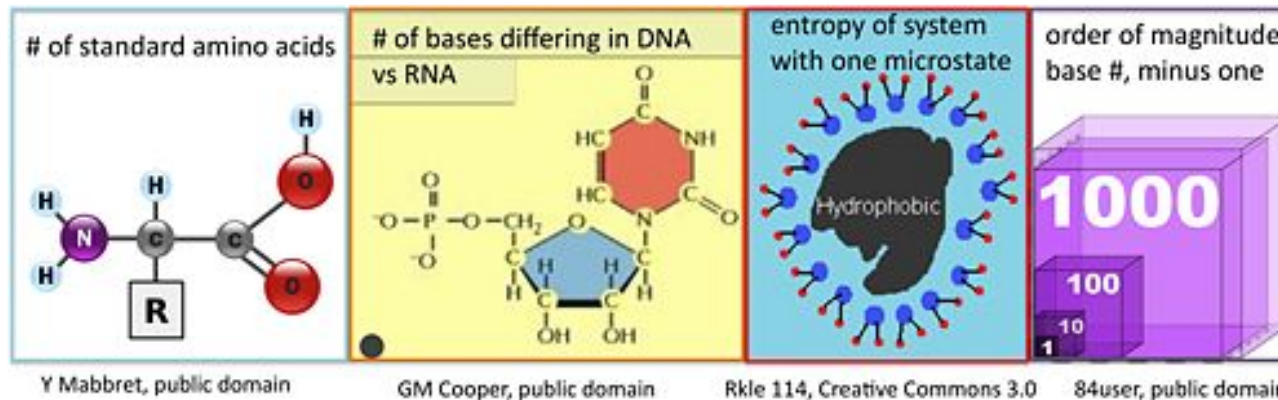


Nagai *et al.*



Myriad length scales, systems, and applications

20.109(S13): Laboratory Fundamentals of Biological Engineering



Home
DNA Engineering

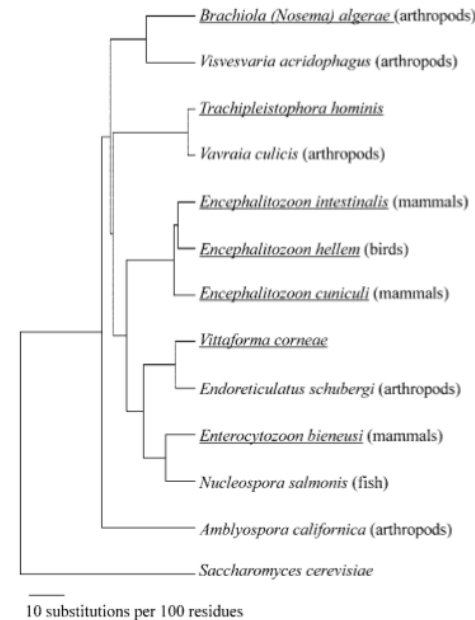
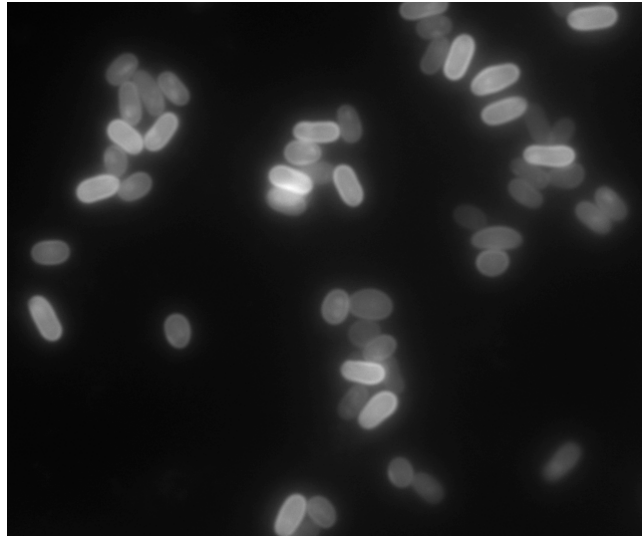
Schedule Spring 2013
Protein Engineering

Assignments
Cell Engineering

- Module 1 DNA Engineering (J. Runstadler)
- Module 2 Protein Engineering (A. Jasanoff)
- Module 3 Cell Engineering (A. Stachowiak)

[openwetware.org/wiki/20.109\(S13\)](http://openwetware.org/wiki/20.109(S13))

DNA engineering: investigating pathogens



Mathis et al. (2005), Clin
Microbiol Rev (18):423

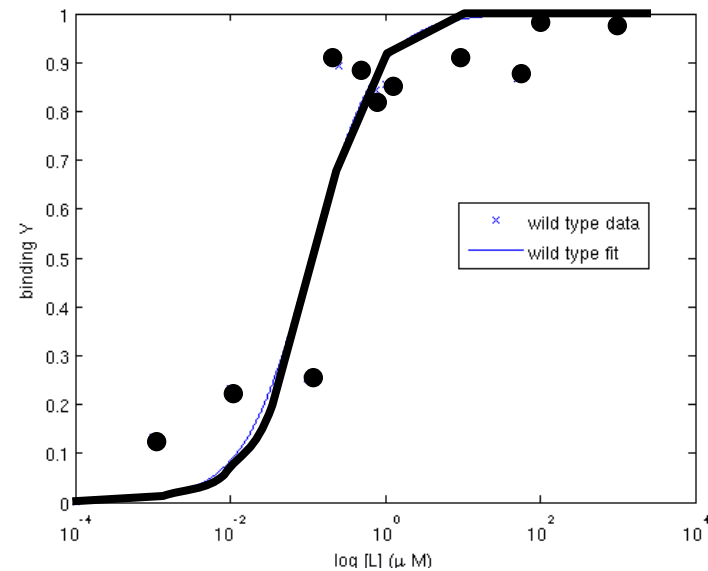
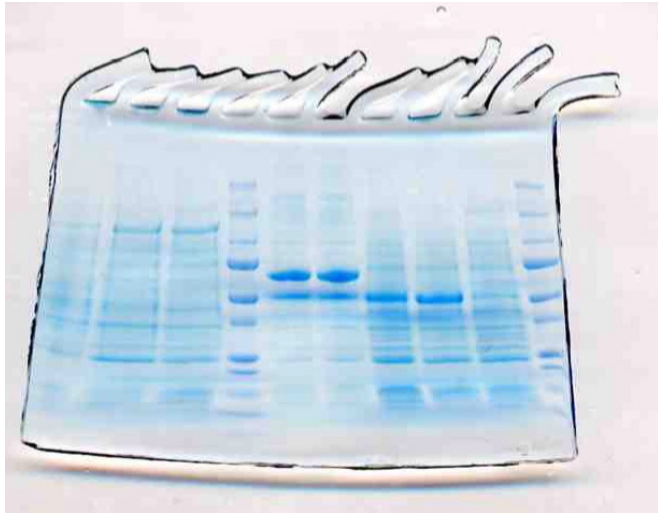
Experimental Goals

Design: diagnostic primers

- Assess primer sensitivity/specificity
- Compare pathogen profiles in different bird populations
- Amplify and clone DNA
- Use computational tools: sequence and phylogenetic analyses
- Discuss/present scientific literature

Lab+Analytical Skills

Protein engineering: calcium sensor redesign



Experimental Goals

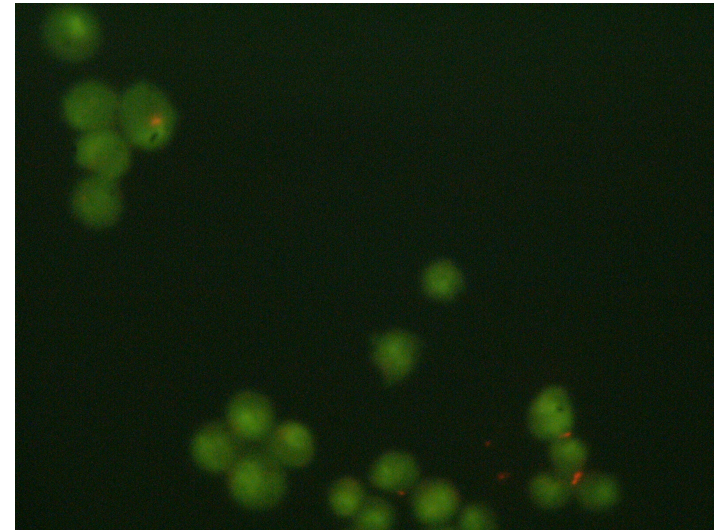
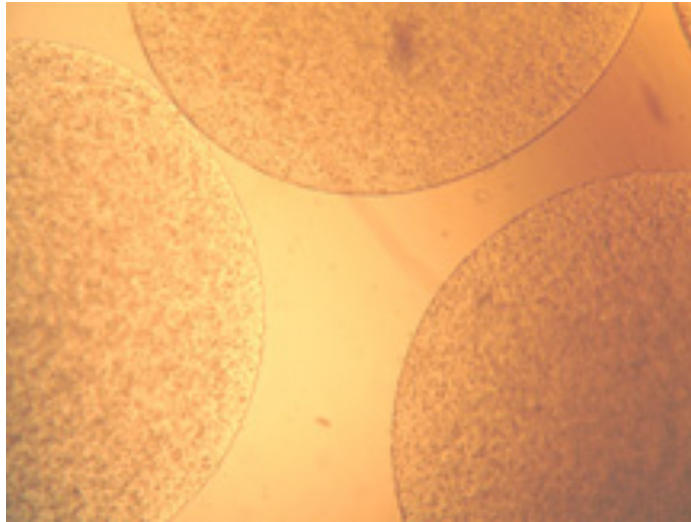
Design: Modify DNA + protein

- Mutagenize wild-type plasmid
- Express and purify protein
- Assess effect on protein

Lab+Analytical Skills

- Culture bacteria
- Manipulate and analyze DNA
- Prepare and characterize protein
- Use MATLAB for modeling

Cell engineering: making cartilage



Experimental Goals

Design: Culture conditions

- Study how environment affects cell health, and expression + production of tissue-specific proteins

Lab+Analytical Skills

- Culture mammalian cells
- Fluorescence microscopy
- Measure specific mRNAs
- Identify protein from mixture
- Present a novel research idea

Communication and grading

50% Written Work

Module 1: laboratory report; primer analysis

Module 2: research article

Module 3: data summary

30% Oral Presentations

Module 1: published article

Module 3: original proposal

20% Daily(ish) work

7% Homework

5% Quizzes

5% Lab Notebooks

3% Participation

Writing & oral communication faculty

- Marilee P. Ogren and Leslie Ann Roldan
 - Lectures/discussions in class
 - Written feedback on draft report sections
 - Office hours by appointment
- Atissa Banuazizi
 - Lectures/discussions in class
 - One-on-one review of videotaped talk
- BE Writing Lab
 - Writing Fellows provide peer coaching

Scientific writing must tell a story


- Stories help us remember
 - Archimedes, Newton, Kekulé
- You discover the narrative that the data tell
- Then convince an **audience** of your findings
 - logical structure
 - step-by-step explanations
 - repetition of central ideas
 - clear, effective visuals
 - ethical choices

Your data should be true even if your story is wrong

~ Darcy Kelley, Columbia (from *The Canon*, N. Angier)

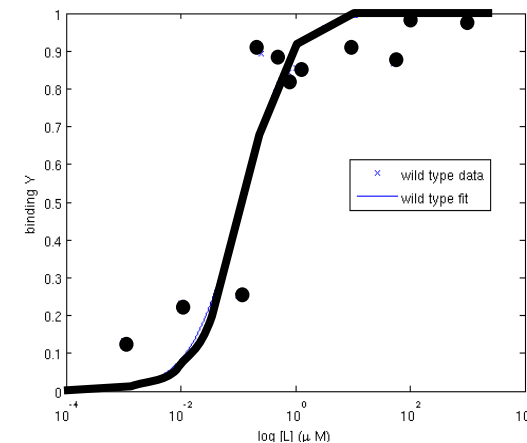
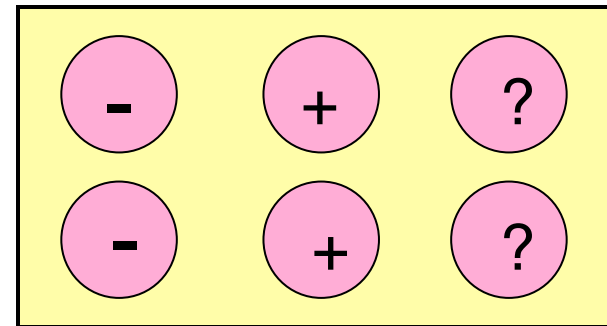
Towards independent research and professionalism

	<u>Mod 1</u>	<u>Mod 2</u>	<u>Mod 3</u>
Design	procedural	conceptual	free reign
Writing	report as pair → revision	report alone	team report
	homeworks/drafts individually		
Reading	as group read one deeply	as group cite more	skim many (read some!)



After 20.109, you should be able to...

- Organize a lab notebook
- Implement laboratory protocols
- Design novel experiments with appropriate controls
- Interpret qualitative data
- Analyze quantitative data
- Recognize utility of models
- Examine the scientific literature
- Communicate in multiple modes
- Present salient points of your own and others' ideas



Course Logistics

Lecture Tuesdays and Thursdays 11-12, 4-237

Lab Tuesdays and Thursdays 1-5, 56-322

 Wednesdays and Fridays 1-5, 56-322

There are no(*) make-up labs

Collaboration with integrity is encouraged:

Assignments done together should reflect equal contributions.

Assignments done individually can be *discussed* together.