Welcome to 20.109

Laboratory Fundamentals of Biological Engineering

F14 Orientation Lecture, 9/4/14

Brain warm-up

- What do the following words have in common?

Doughnut
Notebook
Golf Course

Brain warm-up

- What do the following words have in common?

Doughnut
Notebook
Golf Course

Cough
Tear
Rain

Brain warm-up

- What do the following words have in common?

Doughnut
Notebook
Golf Course

Cough
Tear
Rain

Present
Violin
Ship

Brain warm-up

- These words have formed a club:

Ambidextrous	Exhaustion
Auctioned	Tambourine
Cauliflower	Troublemaking

- Which celebrity can join the club and why?

Channing Tatum

Shia LaBeouf

Julia Roberts

Emma Watson

Beyonce Carter

Your first 20.109 challenge:

- What do these three words have in common?

Gull

Sunshine

Gold

Laboratory Fundamentals of Biological Engineering

- Introductions
- Modular Structure of Course
  - *Module 1: DNA Engineering*
  - *Module 2: Systems Engineering*
  - *Module 3: Biomaterials Engineering*
- Core 20.109 Mission
  - *Building a better bioengineer.*
  - *What's in it for you?*
- Logistics
  - *Everything you really want to know -- today*

20.109 Instruction Team

Technical

Prof. Runstadler (Mod 1)

Prof. Samson (Mod 2)

Prof. Belcher (Mod 3)

Shannon Hughes (T/R)

Noreen Lyell (W/F)

Leslie McClain (W/F)

Teaching Assistants

Module 1: Djenet Bousbaine

Module 2: Novalia Pishesha

Module 3: Cherry Gao

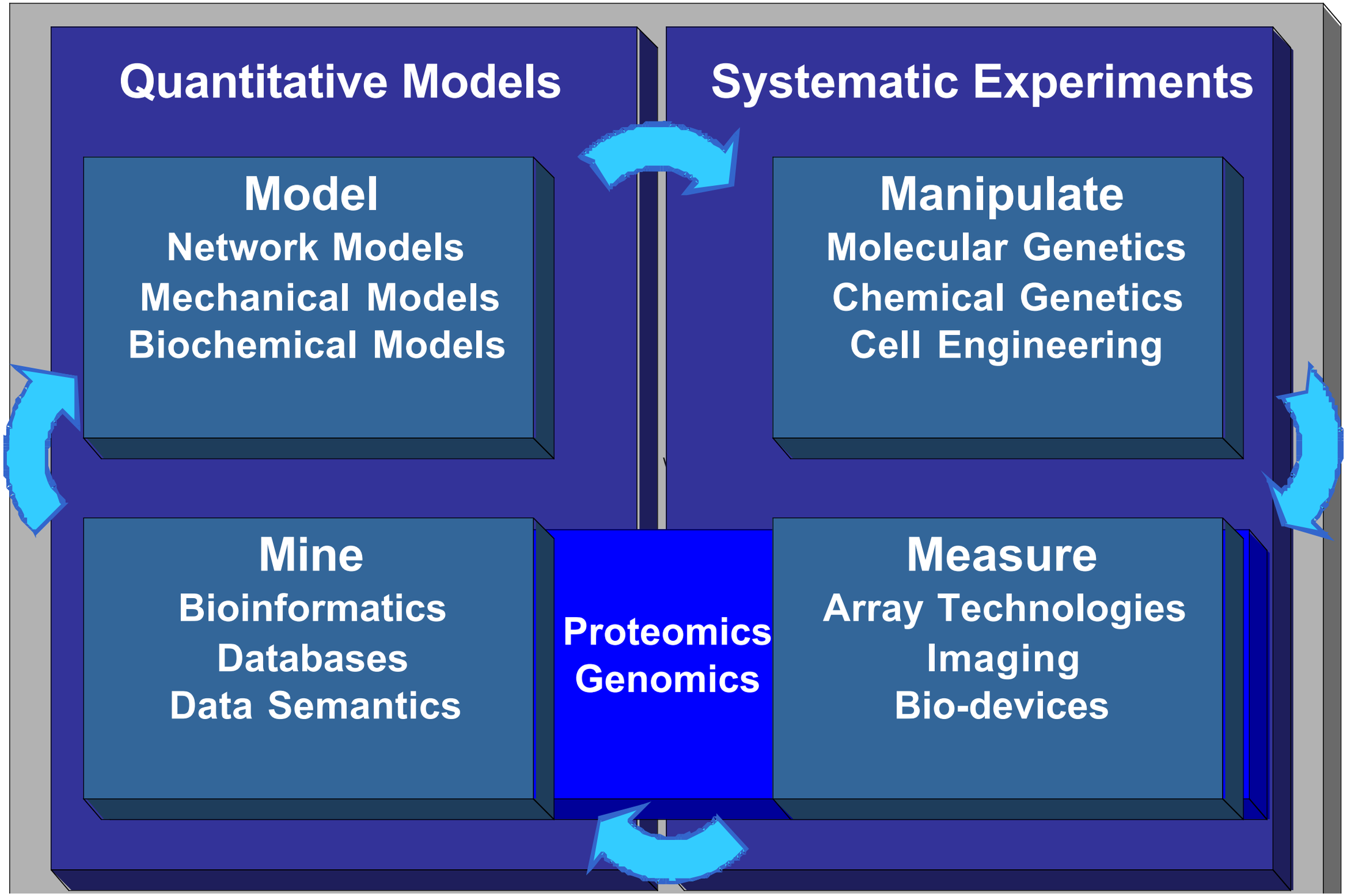
Communications

Leslie Ann Roldan (Writing)

Atissa Banuazizi (Oral Presentations)

image credit: www.abccollector.com

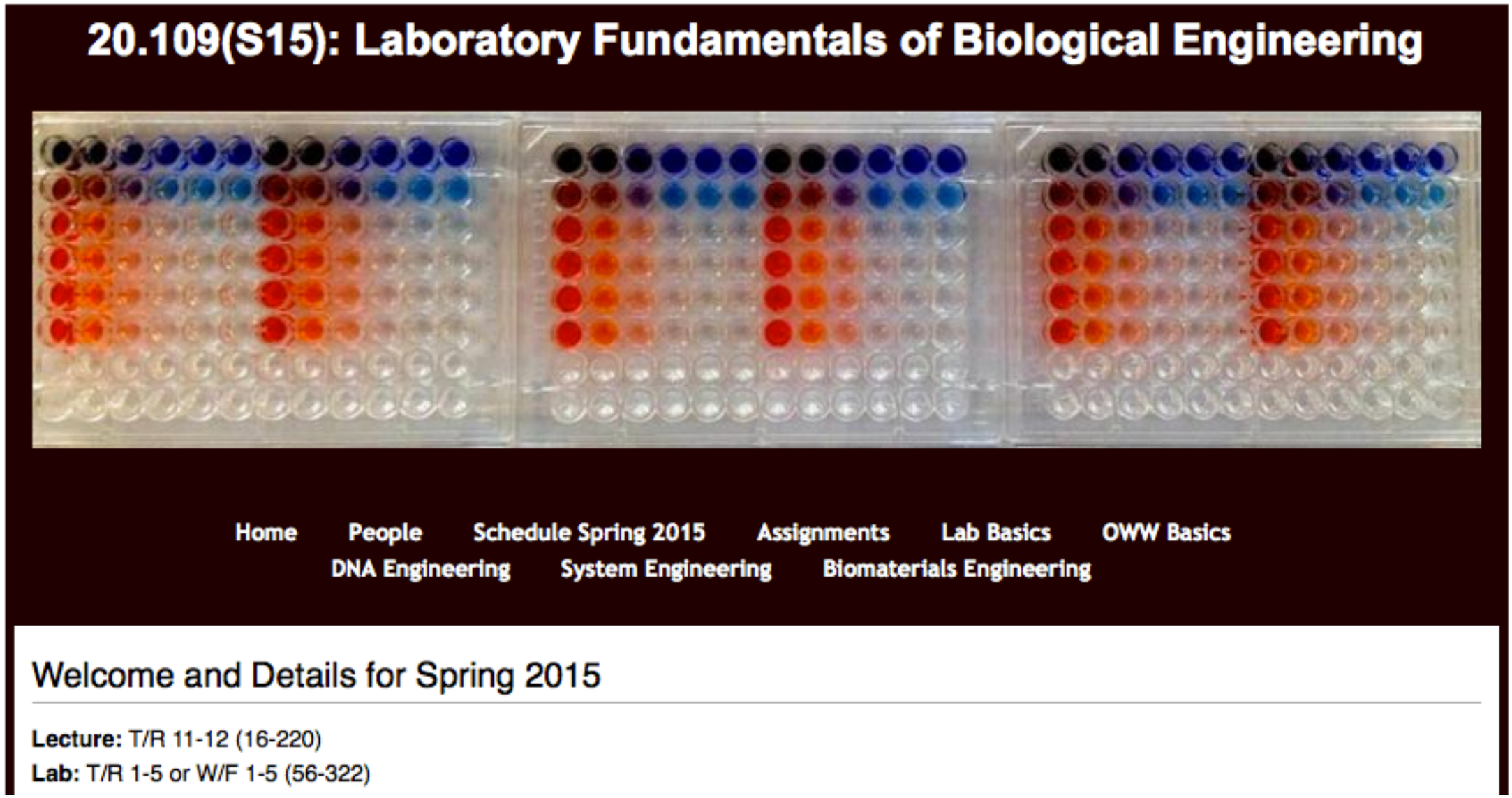
MIT BE Core Mission



* Definition of biological engineering according to Doug Lauffenburger

20.109: The Plan

20.109(S15)



Module 1 DNA Engineering (J. Runstadler)
Module 2 System Engineering (L. Samson)
Module 3 Biomaterials Engineering (A. Belcher)

openwetware.org/wiki/20.109(F15)

DNA Engineering: Module 1

Experimental Goals:

- Compare microbiome of gulls found in Boston area.
- Improve detection of flu virus in gulls for public health application.

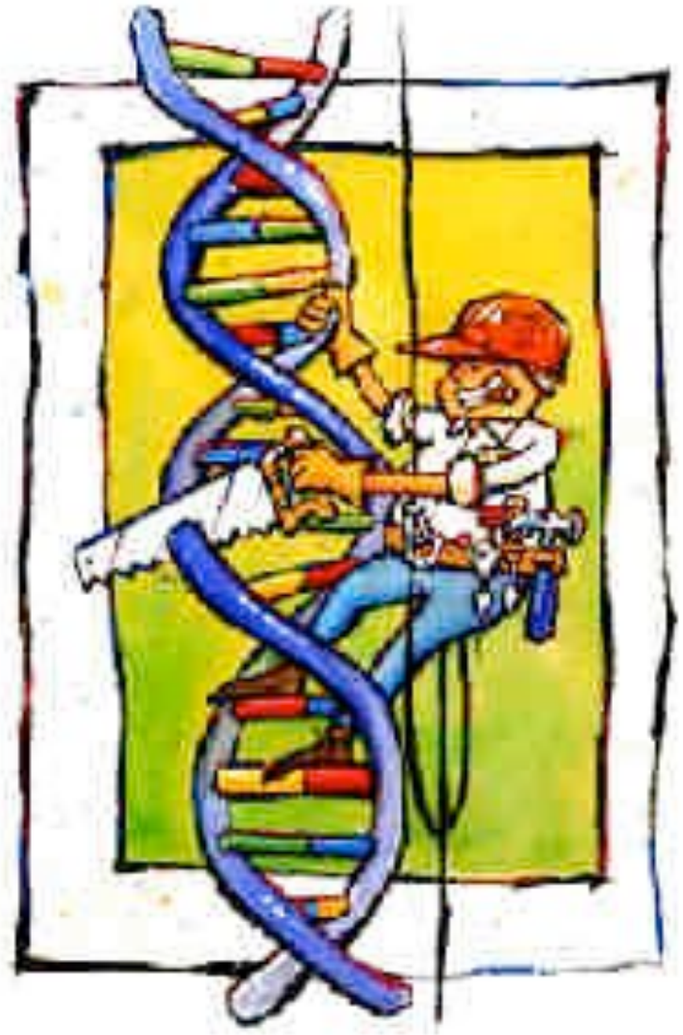
Skills gained in Mod1:

Amplify and clone DNA, Design quantitative PCR primers

Computational sequence and phylogenetic analysis

Familiarity with scientific literature and data presentation

Systems Engineering: Module 2



Experimental Goals:

- Measure DNA repair with a genetically engineered sensor
- Quantify the contribution of important proteins in the DNA repair pathway

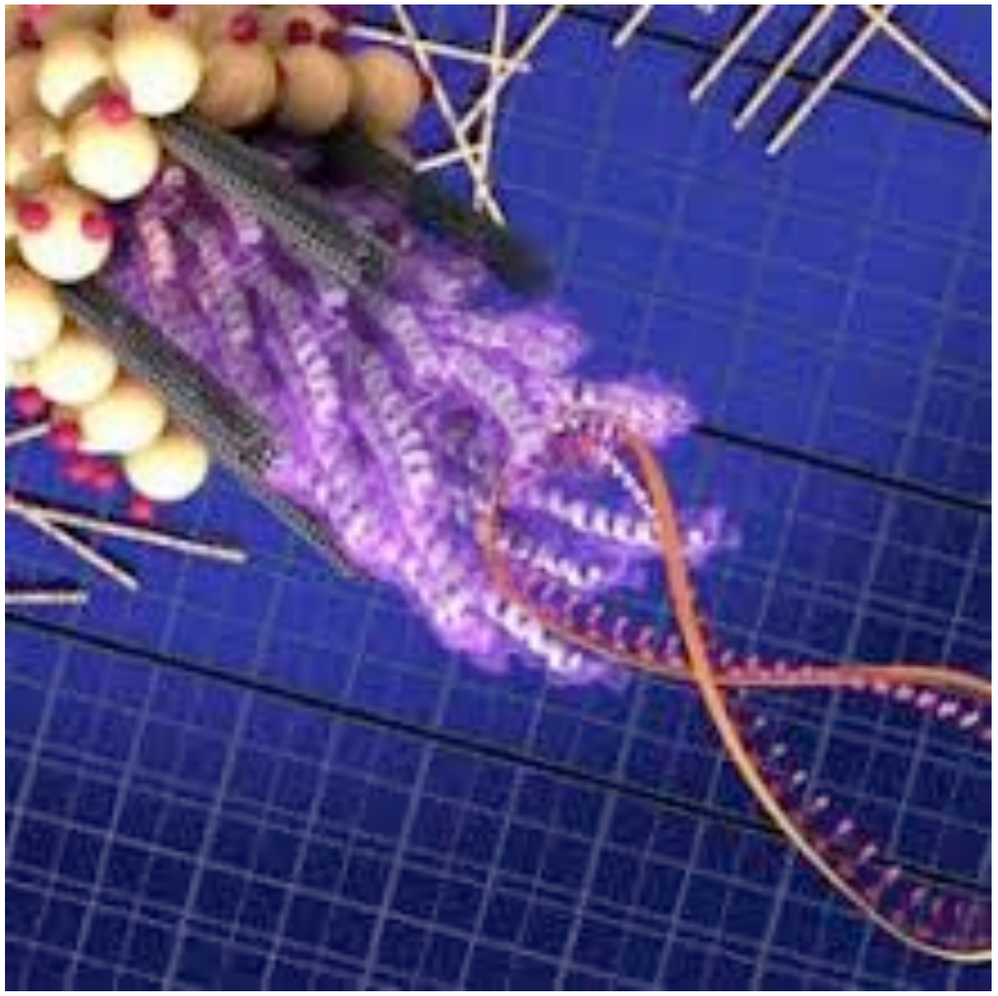
Skills gained in Mod2:

Mammalian tissue culture and DNA transfection

Experimental design and statistical analysis of flow cytometry data

Preparation of a journal quality scientific paper

Biomaterial Engineering: Module 3



Experimental Goals:

- Biotemplate phage nanoparticles with inorganic material
- Create and test a dye sensitized solar cell

Skills gained in Mod3:

Biomaterial production from M13 phage

Fabrication of bio-based devices and comparison across class wide data

Presentation of a novel research proposal utilizing 20.109 knowledge

20.109 Core Mission

- To prepare students to be the future of Biological Engineering

- To teach cutting edge research skill and technology through an authentic research experience

- To inspire rigorous data analysis and its thoughtful communication

Written and oral scientific communication

Module	Topic	Assignment	% of Final Grade
1	DNA Engineering	Methods section	5
		Data Summary + Abstract	15
2	System Engineering	Research article	25
		Journal club presentation	10
3	Biomaterial Engineering	Research idea presentation	20
		Mini report	5

Remaining 20% comes from daily work and participation.

Written and oral scientific communication

NATURE METHODS | EDITORIAL

Should scientists tell stories?

Nature Methods **10**, 1037 (2013) | doi:10.1038/nmeth.2726
Published online 30 October 2013

A narrative can effectively communicate scientific information. But when telling a perfect story becomes an end in itself, the scientific process can be easily compromised.

Subject terms: Scientific community and society · Publishing · Culture

Everyone loves a good story, and writers of many kinds use narrative techniques to get their message across. A recent Points of View article (Krzywinski and Cairo, *Nat. Methods*

Written and oral scientific communication

“One may argue that in an idealized scholarly world, scientists should avoid storytelling. They should instead describe their original hypothesis, detail their experiments in the order conducted and present the data in the rawest form reasonable for interpretation. At the end they should state their conclusions.

But there are many problems with this scenario. Scientists are not automata and, in today's world, operate under substantial time pressures. Even if the scientist's colleagues in this idealized setting had the patience and time to navigate through a long, uninterpreted, purely factual exposition and to sufficiently grasp what was done and its significance, it would still be a cripplingly inefficient process. Furthermore, to borrow from the title of science historian Steven Shapin's recent book of essays, science is conducted by people “situated in time, space, culture and society, and struggling for credibility and authority.” An argument for papers written purely as a factual blow-by-blow account of experiments does not sufficiently take into account this reality.”

Written and oral scientific communication

We are not abandoning you to the unknown...

(1) WRAP instructors:

- Leslie Ann Roldan
  - Lectures/discussions in class
  - Written feedback on drafts
  - Office hours by appointment
- Atissa Banuazizi
  - Lectures/discussions in class
  - One-on-one review of videotaped talk
  - Office hours by appointment

(2) BE Communications Lab:

- Writing fellows available to provide peer coaching

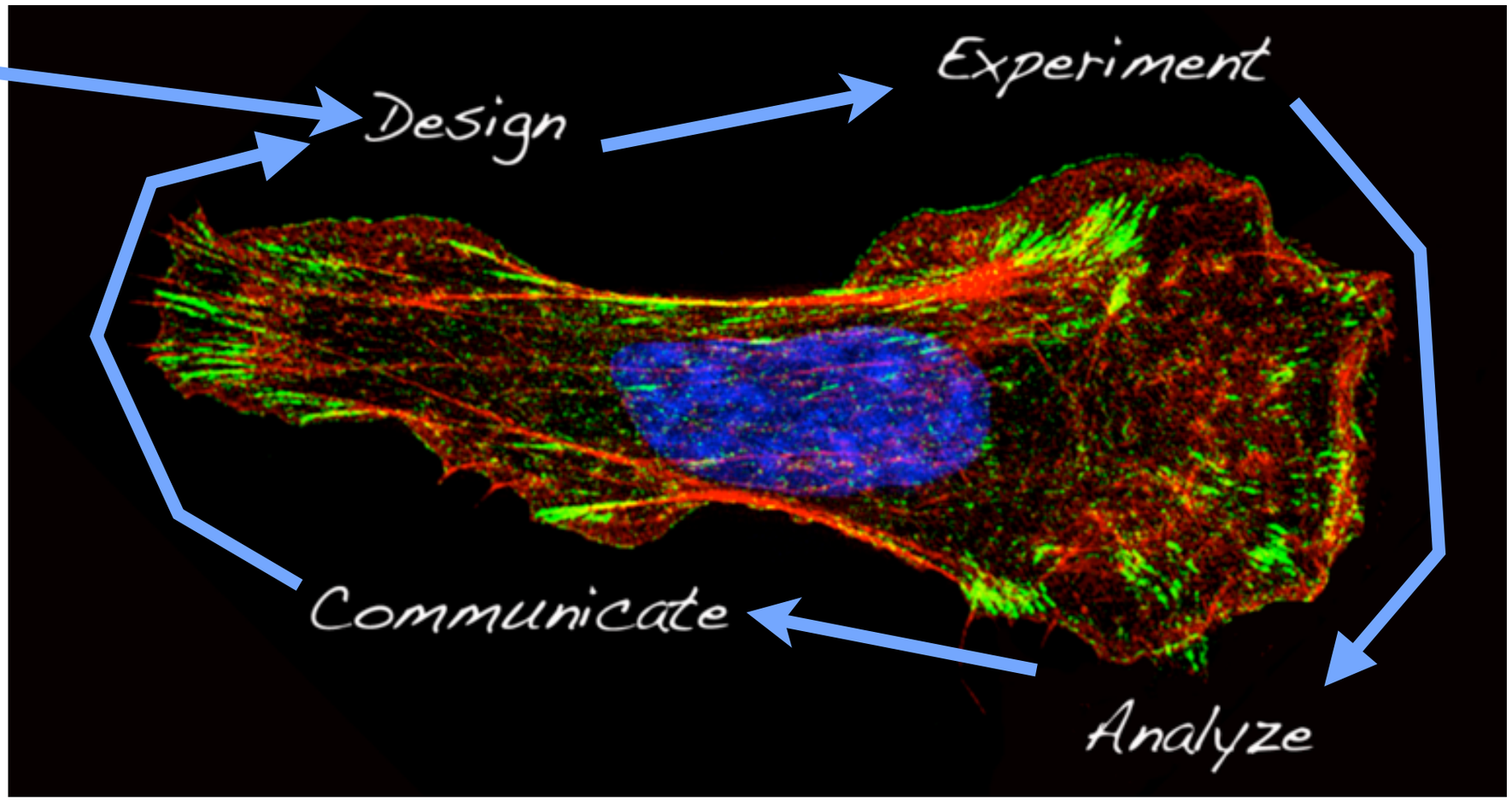
(3) 20.109 instructors:

- Extensive feedback on drafts -- chances to revise major reports

20.109's Standard Workflow

We start here

But, you can't design an experiment if you haven't 'analyzed' some data!



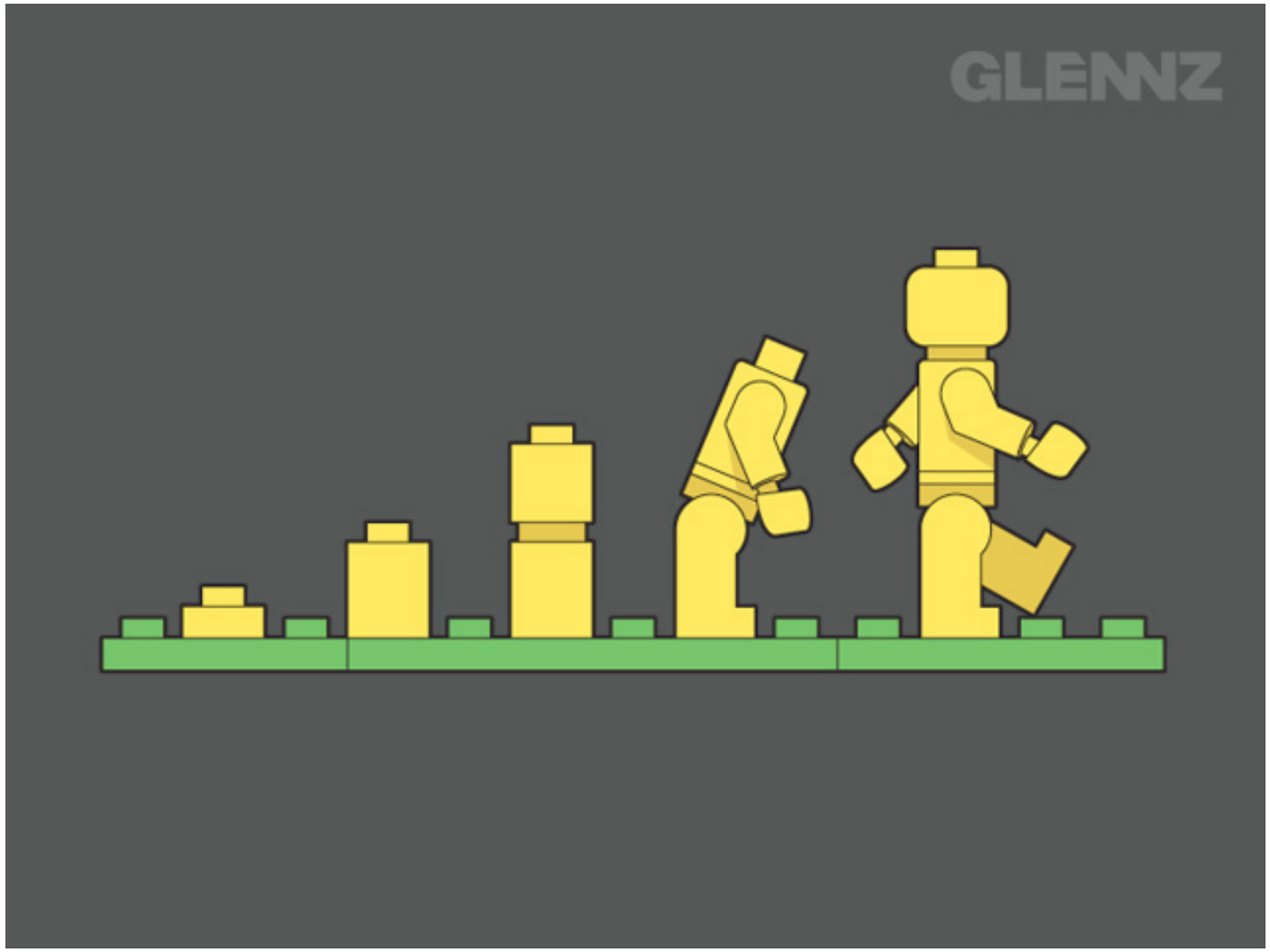
20.109: Design

We aim to prevent "just follow the protocol" syndrome.

Image credit: www.tasss.com

20.109: Experiment

You'll notice a pattern emerge...



"Supposing is good, but finding out is better."~Mark Twain

Image credit: http://blog.glennz.com/evolution/ Buy the t-shirt!

20.109: Experiment

We will do *relevant and cutting edge* experiments.

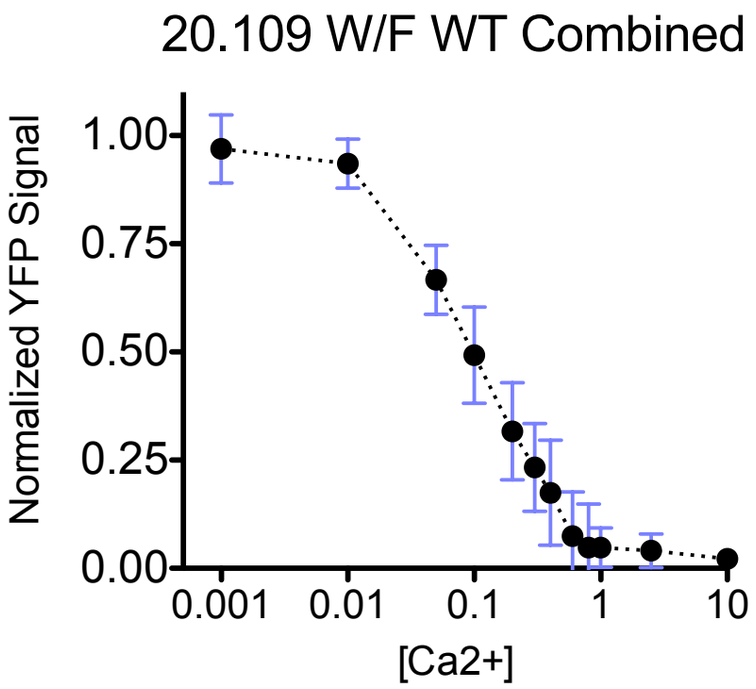
And we do it safely:

http://blogs.discovermagazine.com/bodyhorrors/2013/03/20/mouth_pipetting/#.Uh-277x56TJ

20.109: Analyze

Step one: What are the data?

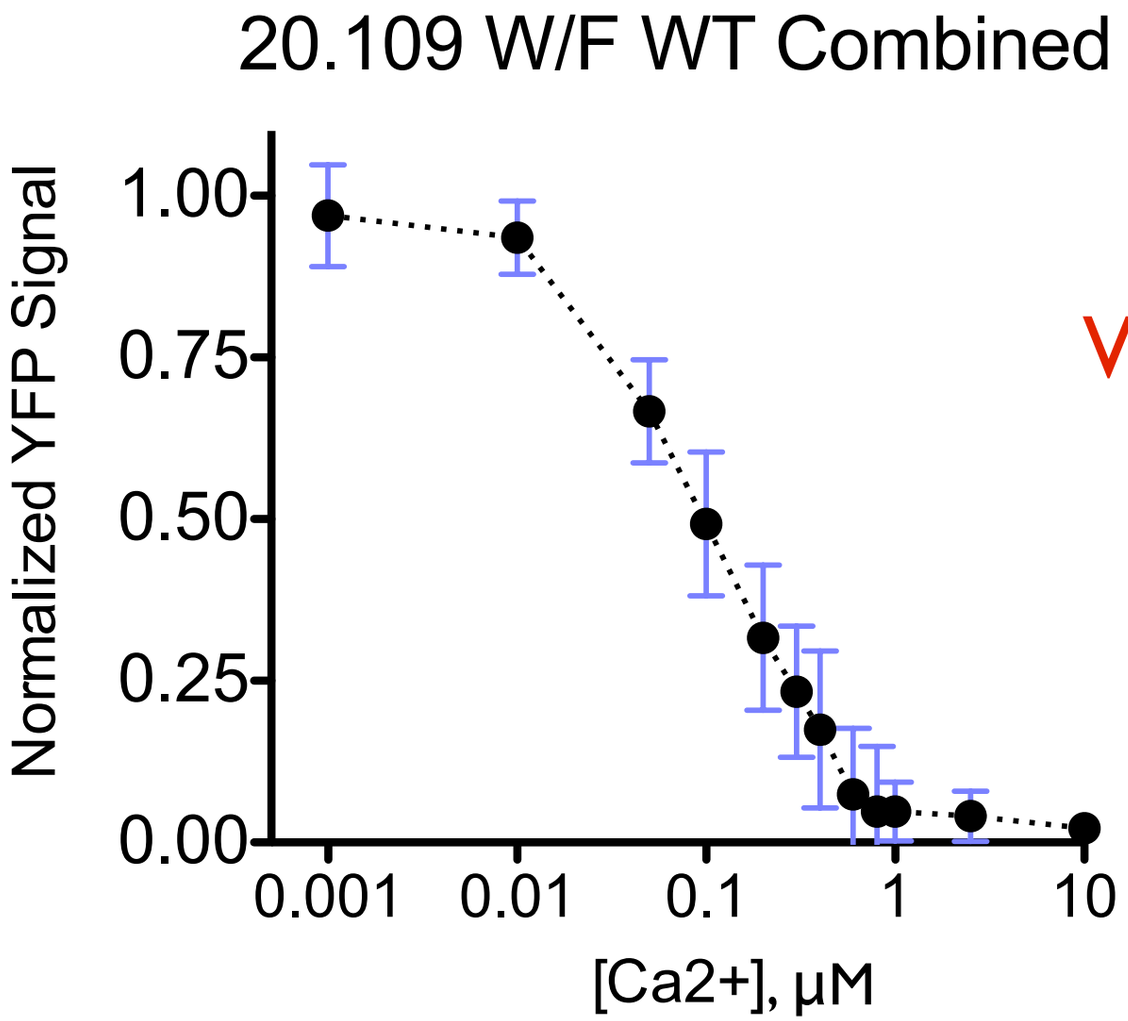
X Title	Data Set-A												
X	A:Y1	A:Y2	A:Y3	A:Y4	A:Y5	A:Y6	A:Y7	A:Y8	A:Y9	A:Y10	A:Y11	A:Y12	A:Y13
0.001	1.000000	1.000000	0.848243	1.000000	0.713133	0.950588	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
0.010	0.806115	0.880406	1.000000	0.973925	1.000000	1.000000	0.894219	0.919256	0.931213	0.921518	0.972005	0.849801	0.918947
0.050	0.548535	0.735558	0.708449	0.779236	0.539573	0.641501	0.596857	0.594858	0.637694	0.598490	0.760630	0.674994	0.655455
0.100	0.502015	0.613624	0.338126	0.648407	0.347801	0.439509	0.364033	0.389130	0.438887	0.410905	0.665287	0.573336	0.425153
0.200	0.257326	0.357331	0.282499	0.605311	0.150865	0.255431	0.196695	0.242768	0.280211	0.259752	0.429967	0.357416	0.222382
0.300	0.152803	0.217029	0.210579	0.518589	0.237044	0.263803	0.123727	0.120837	0.174456	0.179095	0.155648	0.264536	0.194816
0.400	0.177765	0.083181	0.067909	0.459838	0.105253	0.129052	0.078437	0.064896	0.116523	0.113035	0.216040	0.099032	0.122746
0.600	0.071051	0.000753	0.045545	0.422433	0.018956	0.041174	0.030107	0.022286	0.050173	0.064494	0.035743	0.066997	0.055030
0.800	0.024218	0.000000	0.020483	0.411027	0.020630	0.000000	0.016070	0.019293	0.022485	0.000000	0.051325	0.000000	0.046801
1.000	0.026194	0.098671	0.015087	0.000910	0.093265	0.098757	0.000000	0.000000	0.000000	0.013153	0.054582	0.060170	0.077899
2.500	0.004186	0.094503	0.000000	0.000000	0.026212	0.043179	0.047481	0.028909	0.004165	0.009882	0.038296	0.074874	0.066173
10.000	0.000000	0.059246	0.059780	0.012342	0.000000	0.002607	0.040768	0.006809	0.007207	0.016250	0.000000	0.022207	0.000000



Data ≠ Understanding

20.109: Analyze

Step two: What are the data telling you?



What is the working range of this Ca^{2+} sensor?

Can we detect changes in extracelular [Ca^{2+}]?

http://farm2.static.flickr.com/1159/526560734_3c3ecebb08_o.gif

Course Logistics

Lectures:

- Tues/Thurs -- 11-12pm in 4-237
- Prof. Runstadler —> Prof. Samson --> Prof. Belcher

Lab:

- Tues/Thurs -- 1-5pm in 56-322 (Shannon)
- Wed/Fri -- 1-5pm in 56-322 (Noreen & Leslie)
- **There are no* make-up labs.**

Important details:

- You will work in pairs in the lab.
- Collaboration with integrity is key.

*some v. limited exceptions

Expectations

Some of your expectations of us

- that we will come to class and lab prepared
- that our assignments are clear and reasonable
- that we will treat every 109er with respect
- that we will give everyone equal chance at success

Some of our expectations of you

- that you will come to class and lab prepared
- that you will not interfere with each other's learning
- that you will invest the very best of yourself
- that you will offer honest and frequent feedback

After 20.109, you will be able to:

- Organize a constructive lab notebook
- Implement lab protocols & *troubleshoot*
- Design novel experiments with appropriate controls
- Interpret qualitative data
- Analyze quantitative data
- Recognize the utility of models
- Critically examine the scientific literature
- Communicate your science through writing and oral presentation
- Work as a team and provide constructive and helpful feedback and aid to other engineers/scientists

Your first 20.109 challenge:

- What do these three words have in common?

Gull

Sunshine

Gold