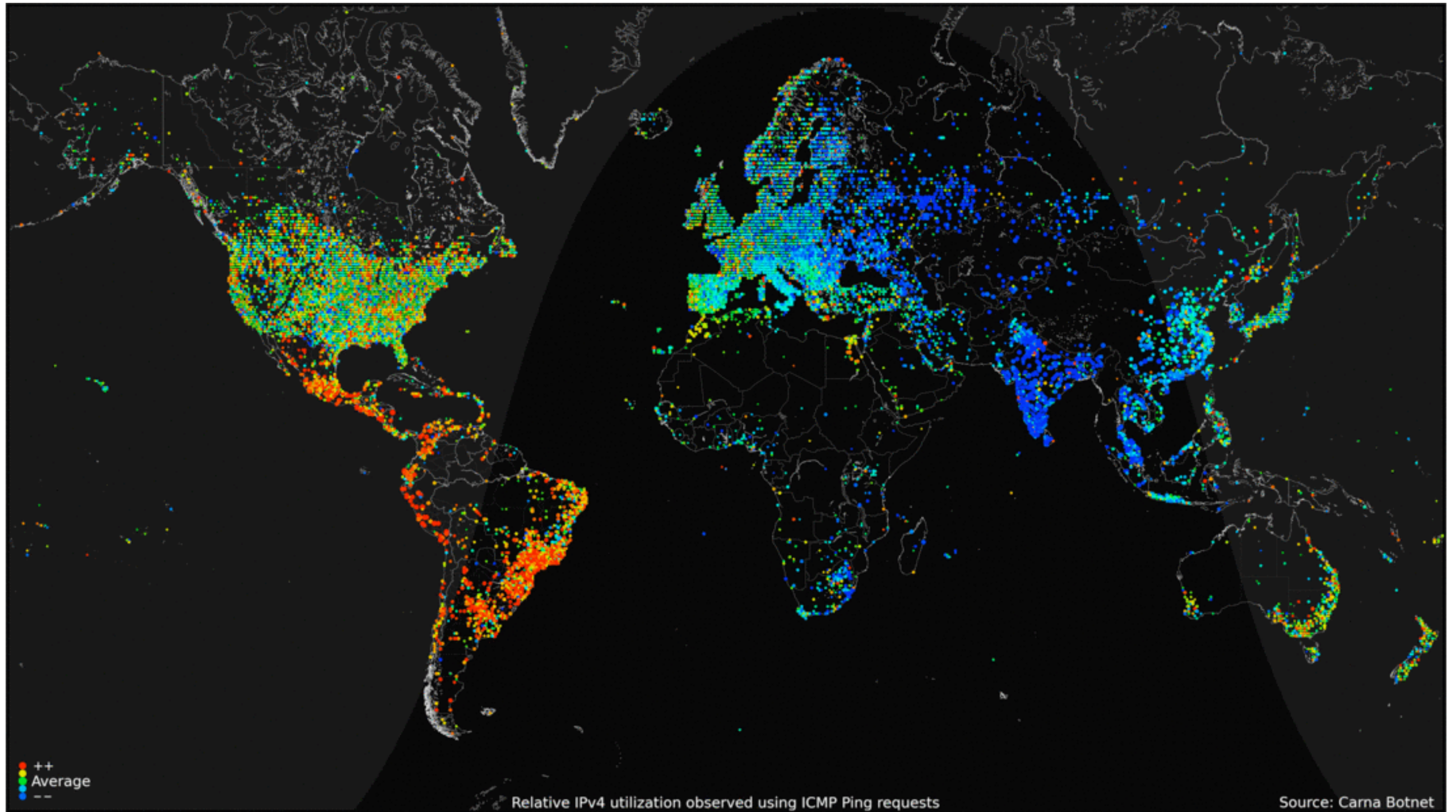


Welcome to 20.109

Laboratory Fundamentals of Biological Engineering

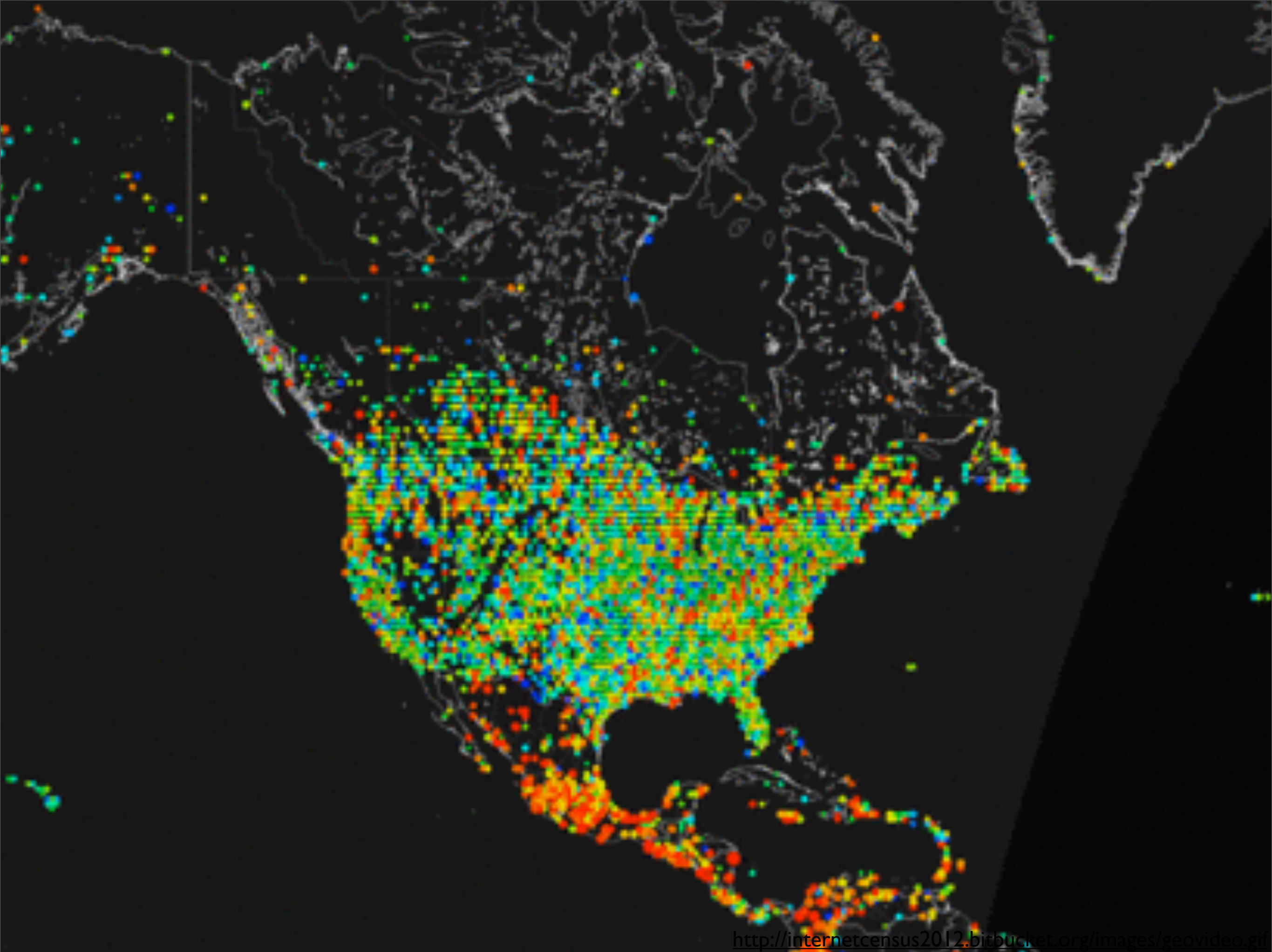
FI3 Orientation Lecture, 9/5/13

The start of an MIT semester:



Internet usage over 24 hours

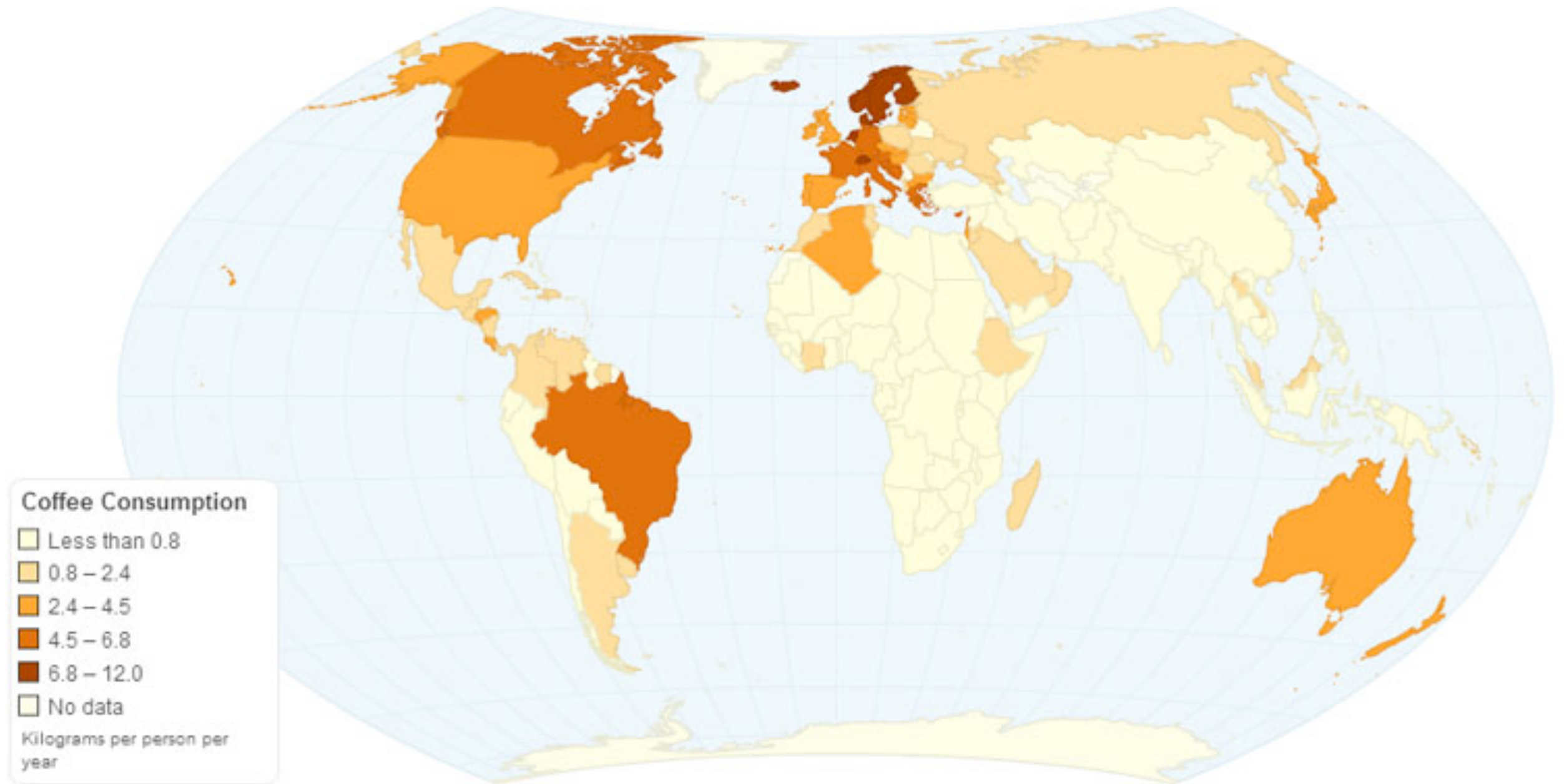
<http://internetcensus2012.bitbucket.org/images/geovideo.gif>



<http://internetcensus2012.bitbucket.org/images/geovideo.gif>

How do you do it?

Kilograms of coffee per person per year...



How do you do it?

Kilograms of coffee per person per year...



<http://chartsbin.com/view/581>

Laboratory Fundamentals of Biological Engineering

- *Teaching Team

- *Core 20.109 Mission

*Building a better bioengineer.
What's in it for you?*

- *Modular Structure of Course

Module 1: DNA Engineering

Module 2: Systems Engineering

Module 3: Biomaterials Engineering

- *Logistics

Everything you really want to know -- today

20.109 Instruction Team

Technical

Bevin Engelward (Mod 1)
Shannon Hughes (Mod 2, T/R)
Angie Belcher (Mod 3)
Agi Stachowiak (W/F)
Aneesh Ramaswamy (T/R)

Teaching Assistants

Module 1: Lizzie Ngo
Module 2: Kim Davis
Module 3: Griffin Clausen



image credit: www.abccollector.com

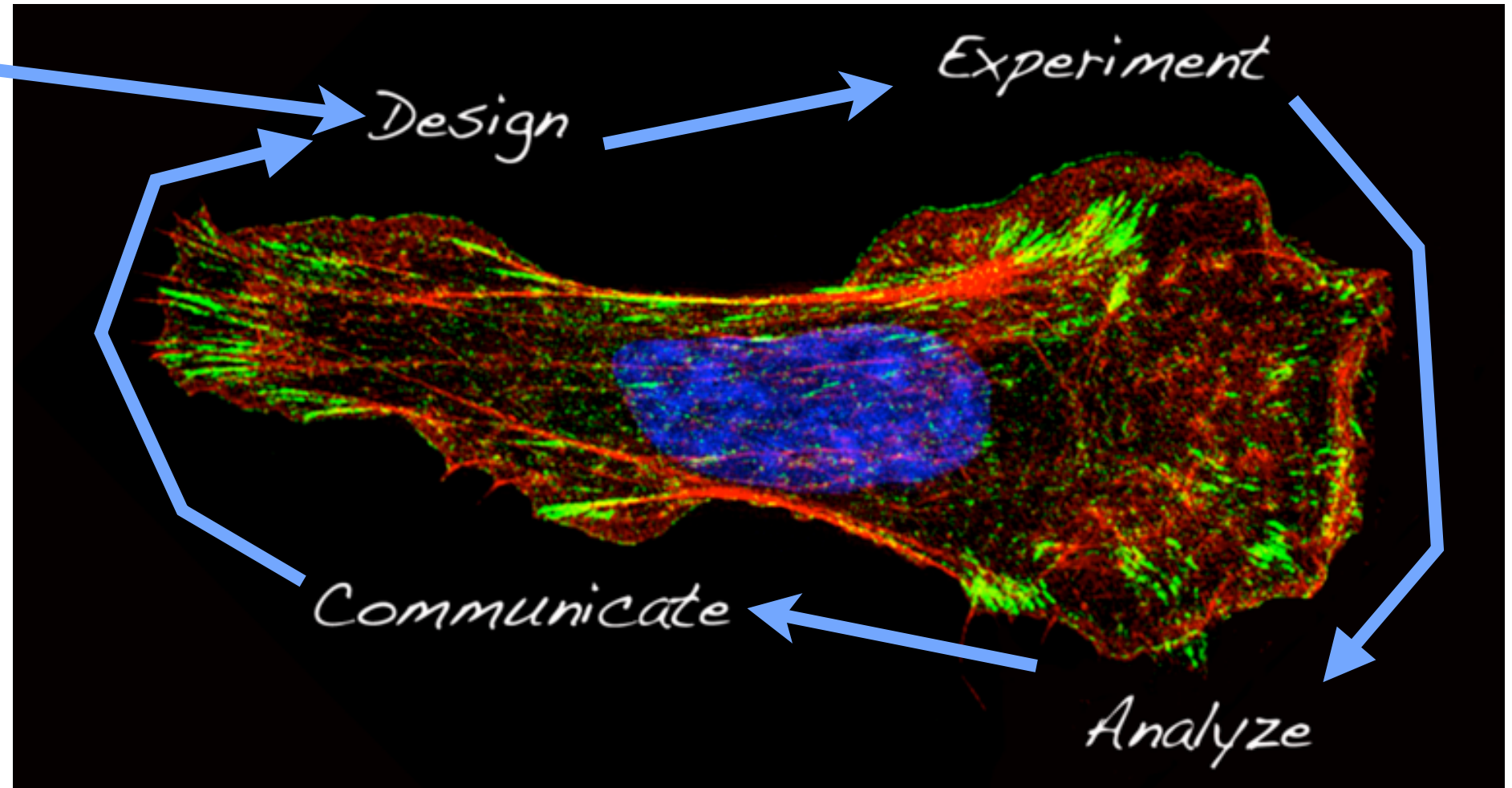
20.109 Core Mission

- *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

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: Design

We aim to prevent “just follow the protocol” syndrome.

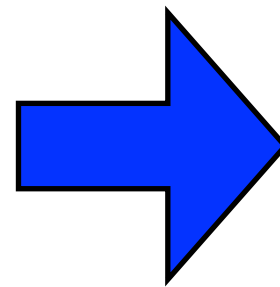
What is the best technique?

So much jargon...

procedural

Where the heck
do I find *that*?

How can we be sure (hint: controls!)



you decide

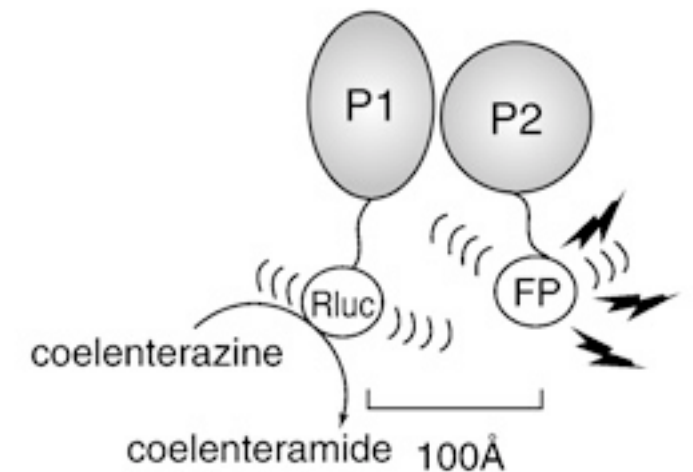
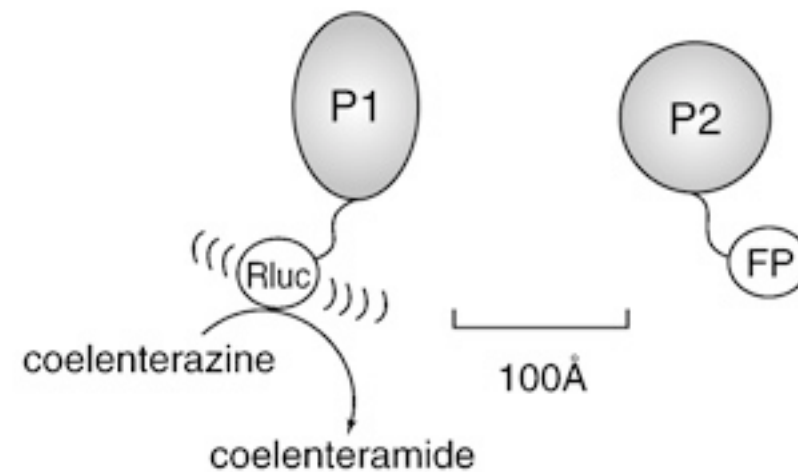
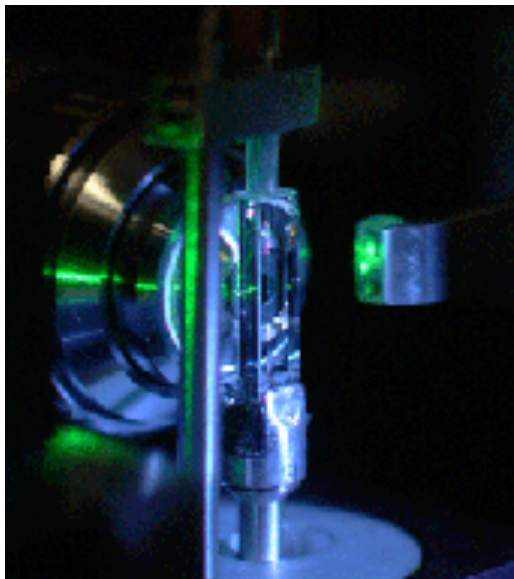


Image credits various free clip art licenses

20.109: Experiment

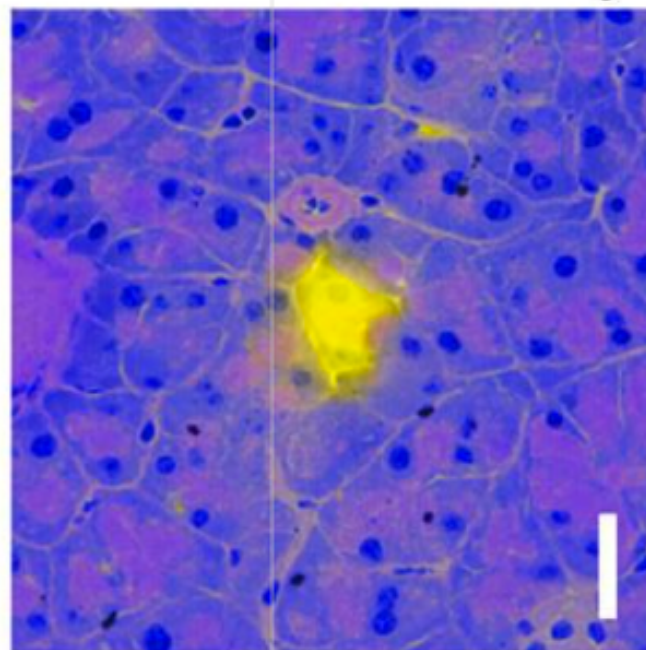
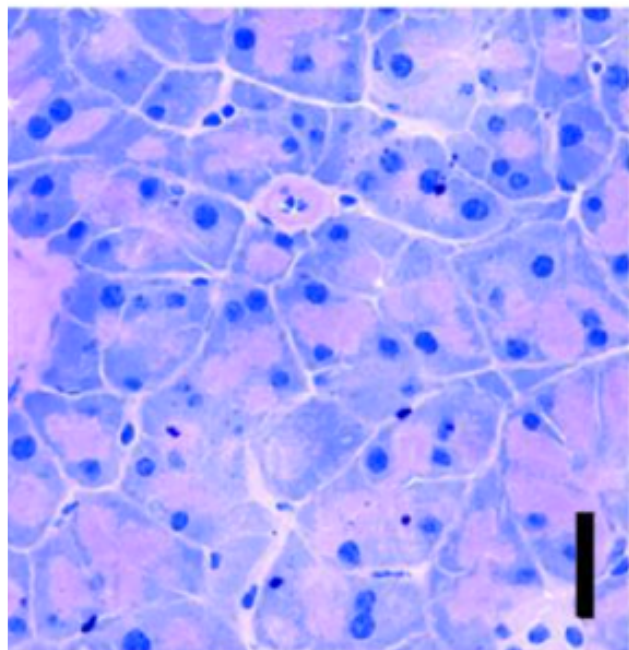
BRET: Bioluminescence Resonance Energy Transfer

Flow Cytometry



H&E

Fluorescent overlay



We will do relevant and cutting edge experiments.

20.109: Experiment

We will do relevant and cutting edge experiments.

And we do it safely:



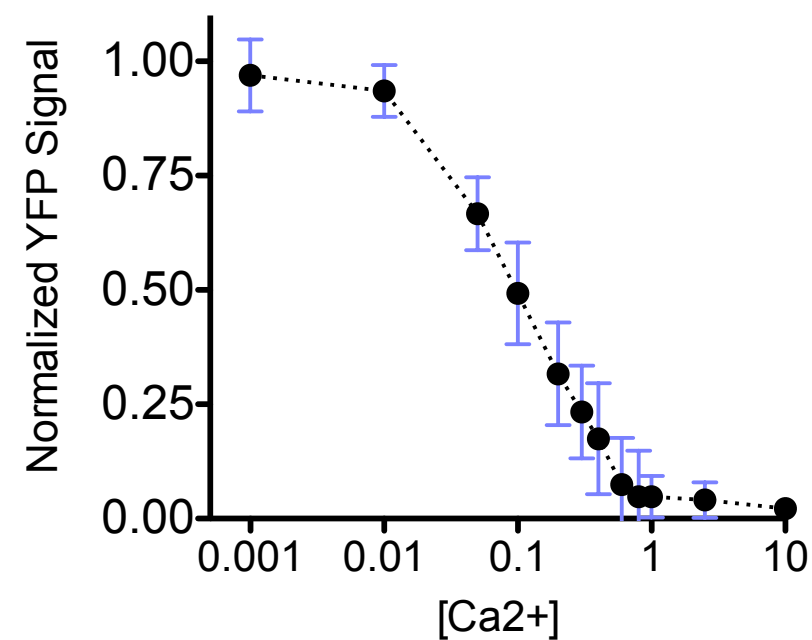
http://blogs.discovermagazine.com/bodyhorrors/2013/03/20/mouth_pipetting/#.Uh-277x56TJ

20.109: Analyze

Step one: What are the data?

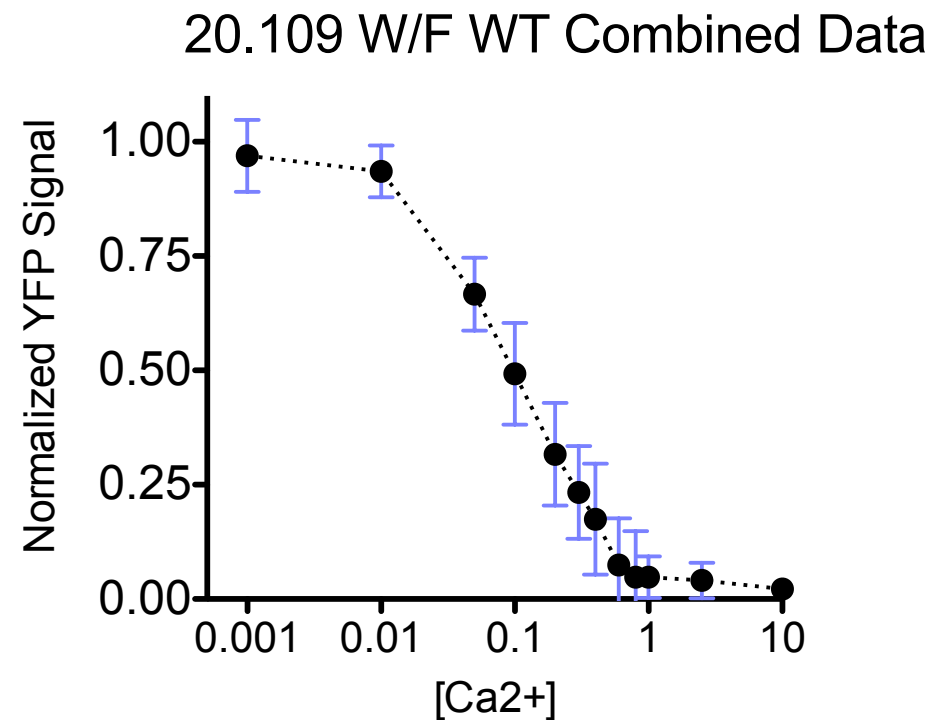
X Title	Data Set-A												
X	A:Y1	A:Y2	A:Y3	A:Y4	A:Y5	A:Y6	A:Y7	A:Y8	A:Y9	A:Y10	A:Y11	A:Y12	A:Y13
0.001	1.000000	1.000000	0.848243	1.000000	0.713133	0.950588	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
0.010	0.806115	0.880406	1.000000	0.973925	1.000000	1.000000	0.894219	0.919256	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

20.109 W/F WT Combined Data

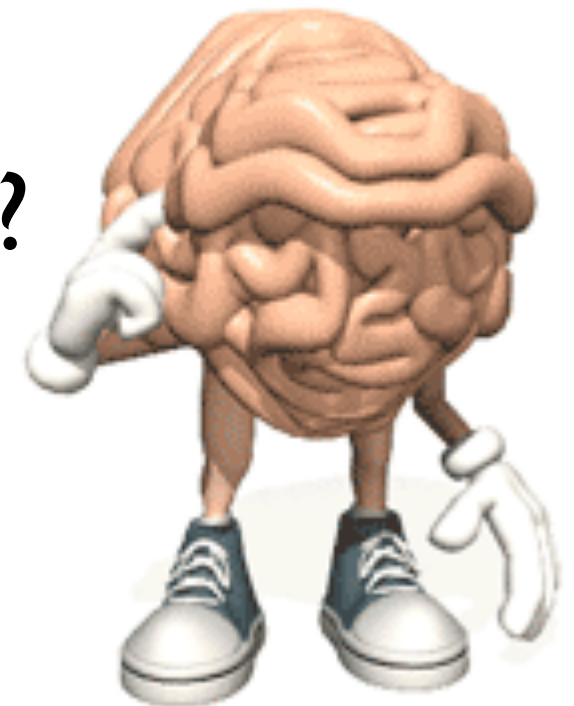


20.109: Analyze

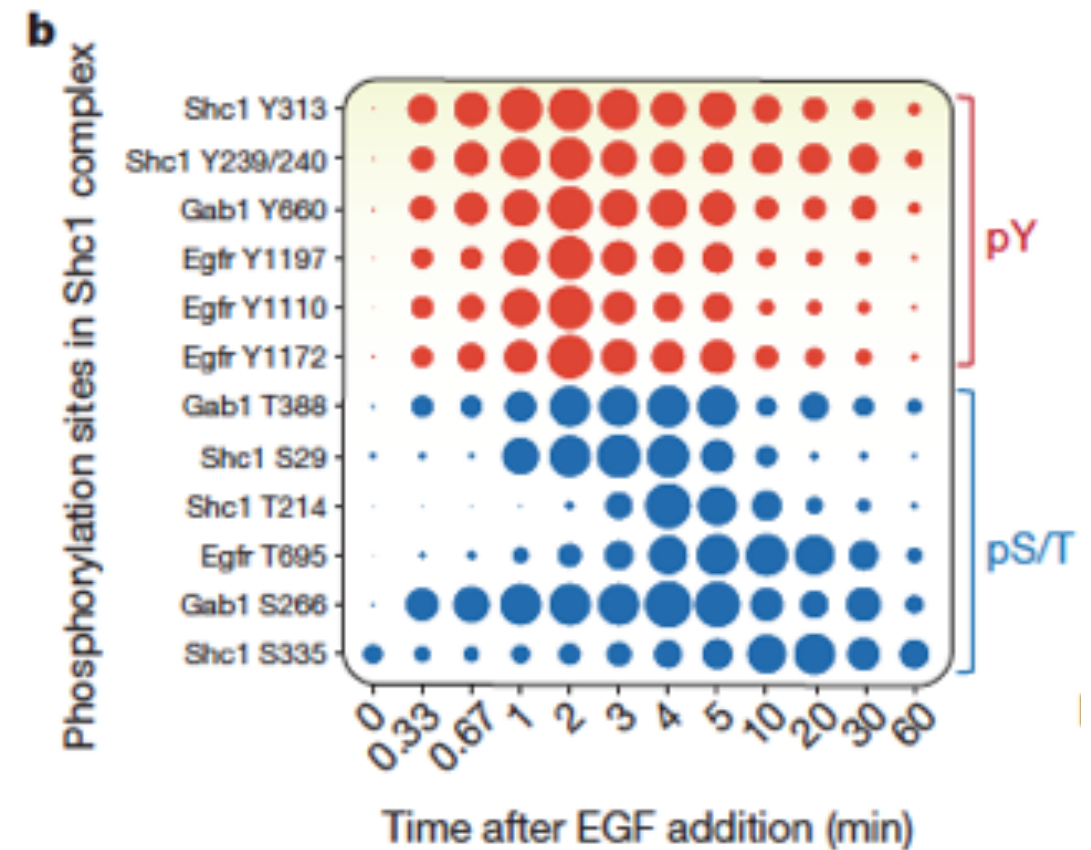
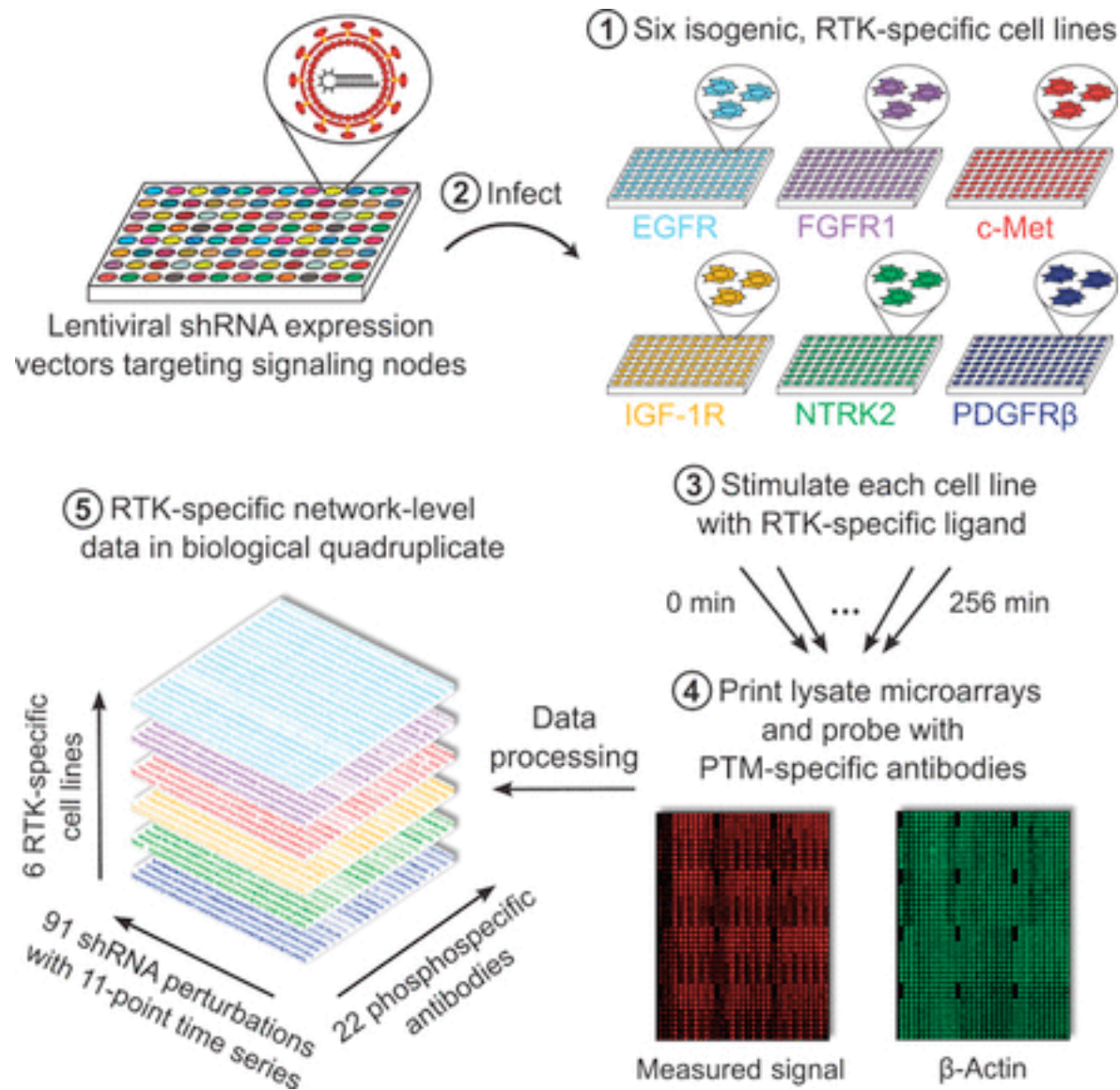
Step one: What are the data?



Step two: What are the data telling you?



20.109: Communicate



Tell your story!

20.109: Design

We aim to prevent “just follow the protocol” syndrome.

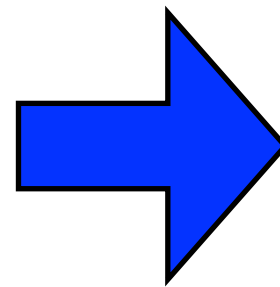
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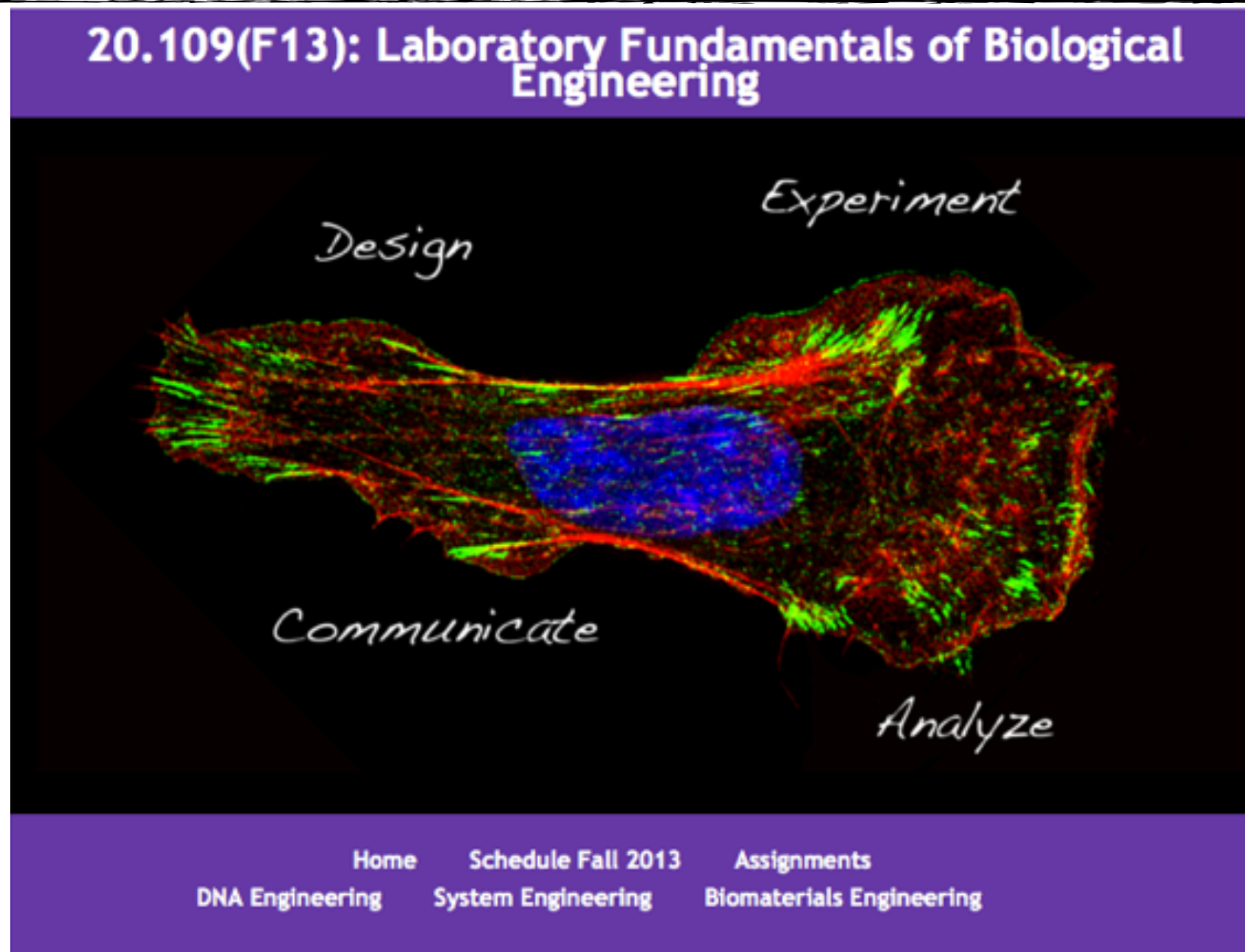


you decide



Image credits various free clip art licenses

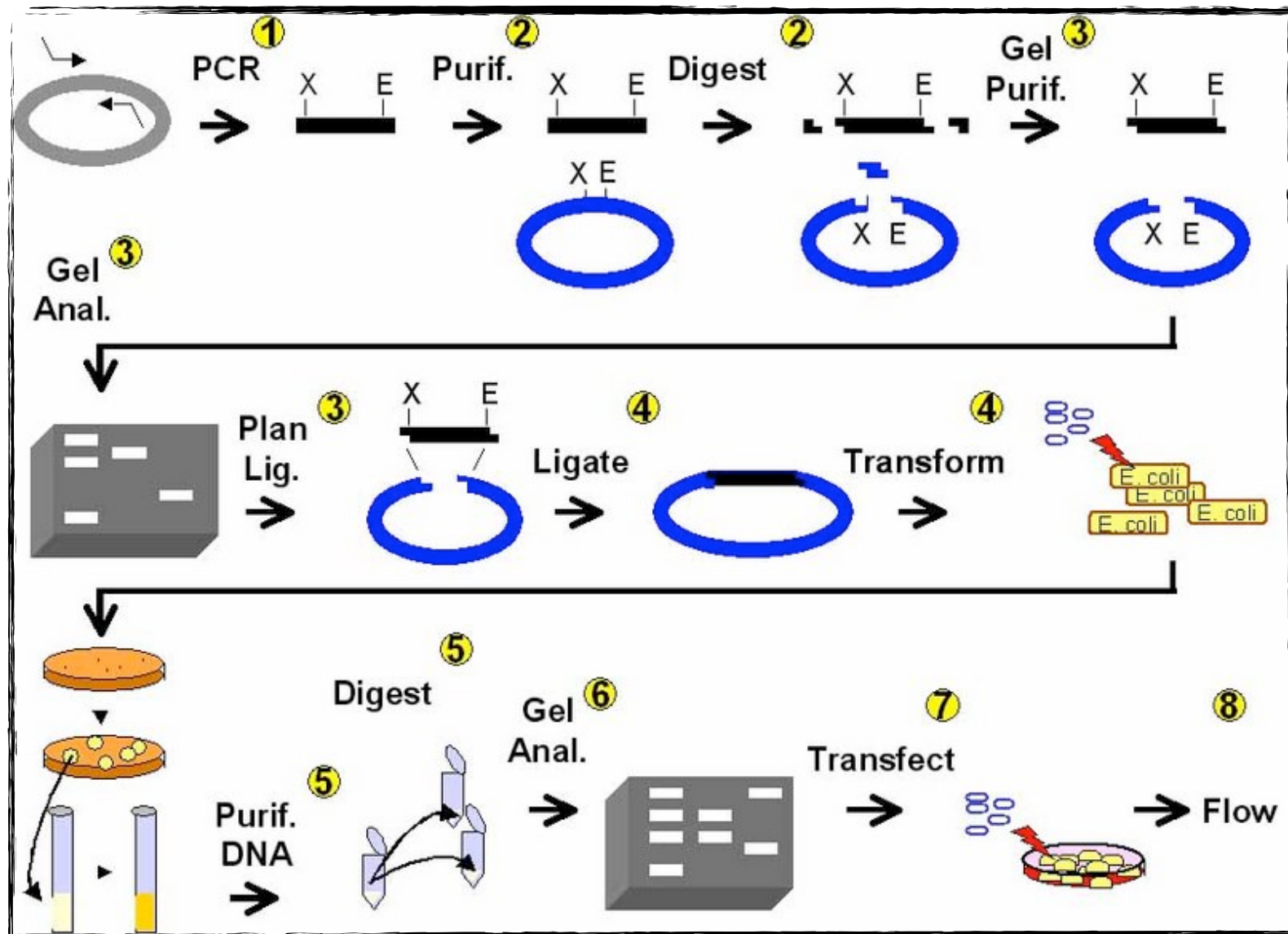
20.109: The Plan



Module 1	DNA Engineering (B. Engelward)
Module 2	Module 2 (S. Hughes)
Module 3	Module 3 (A. Belcher)

[openwetware.org/wiki/20.109\(F13\)](http://openwetware.org/wiki/20.109(F13))

DNA Engineering: Module I



Experiments:

- * Design and create vectors for expressing fluorescent protein in mouse embryonic stem cells.
- * Use fluorescence to analyze recombination of variously damaged DNA substrates.

Lab Skills:

Retrieve and manipulate sequences from databases

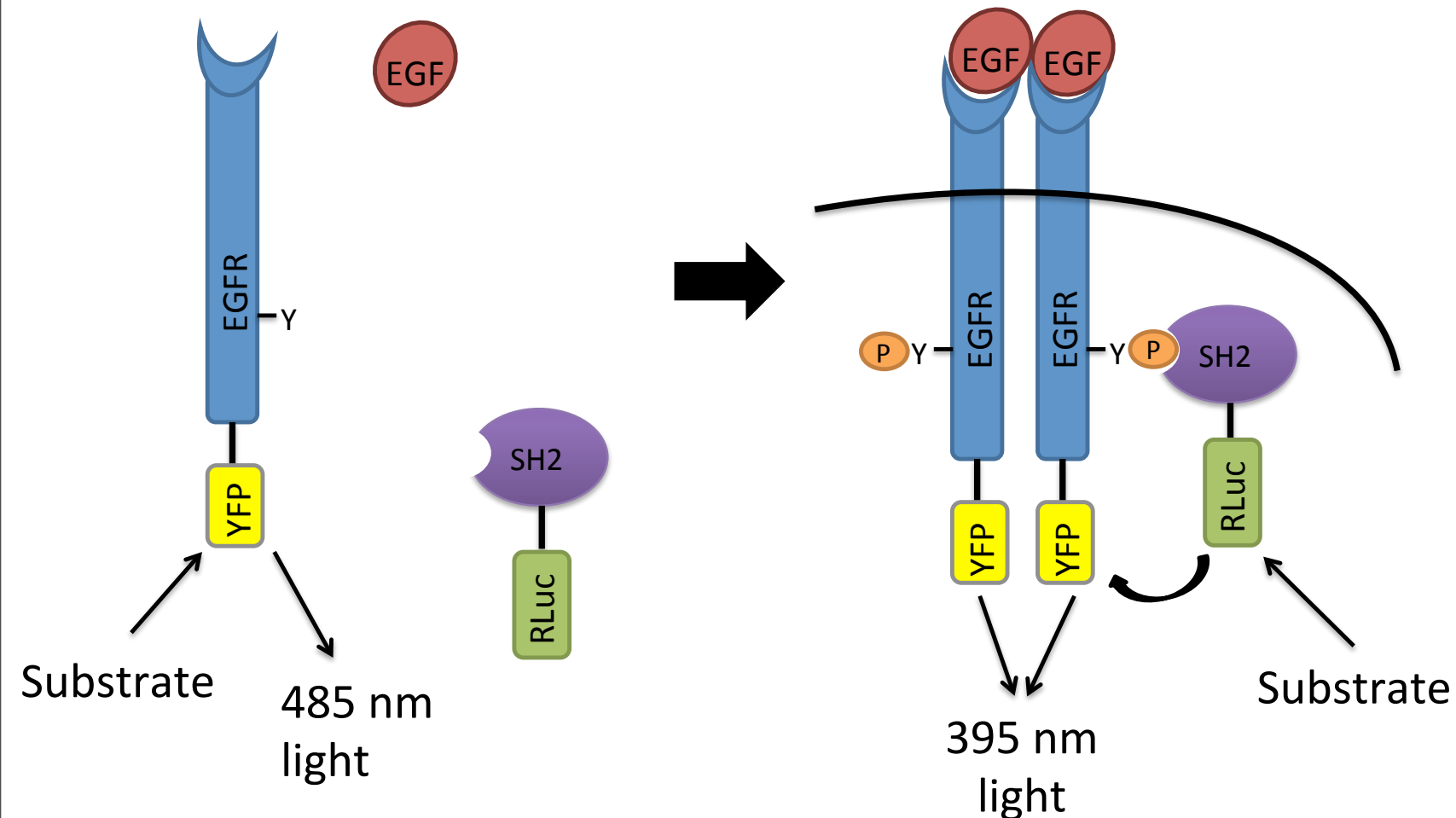
Clone PCR-amplified DNA fragments

Transfection of mammalian cells & Flow Cytometry

Systems Engineering: Module 2

Experiments:

- * Choose a cell phenotype of interest and quantify the underlying intracellular signaling network activation.
- * Compare low and high-throughput experimental paradigms for studying cell signaling.



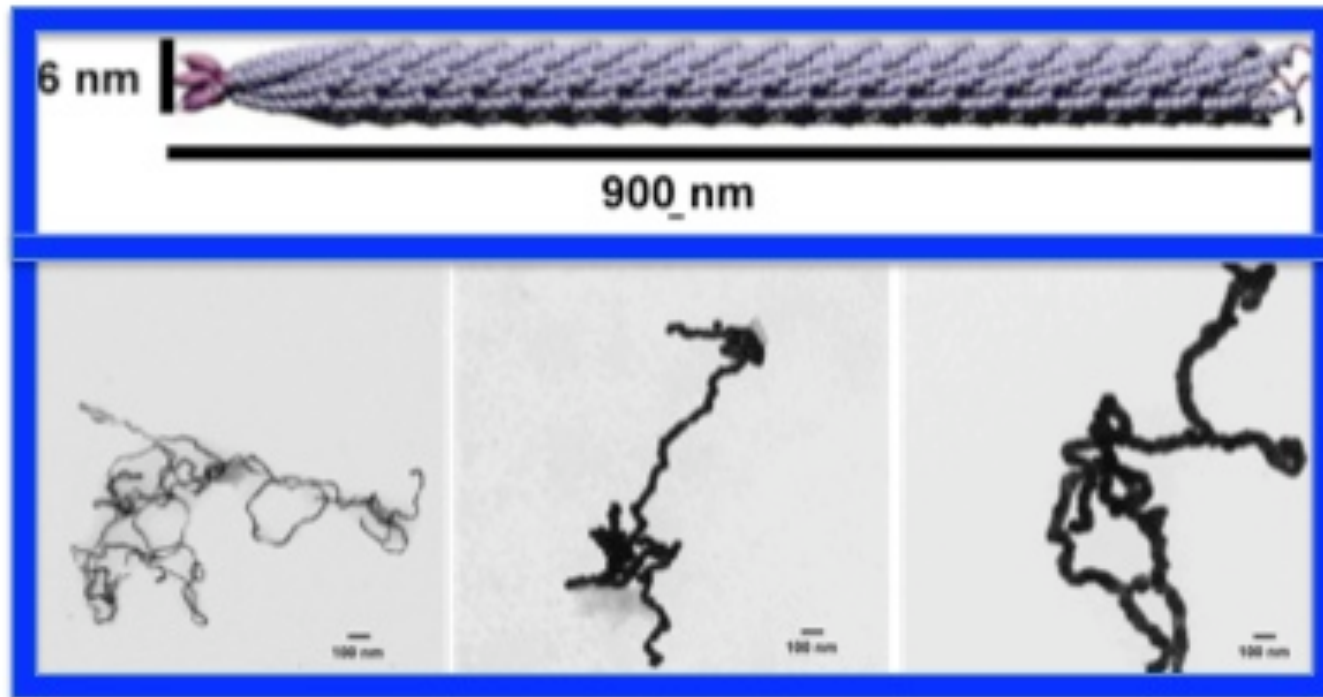
Lab Skills:

Critical evaluation of literature to choose experiments of interest
Protein biochemistry -- cell stimulation, lysis and Western blotting
BRET-based high throughput screen

Biomaterial Engineering: Module 3

Experiments:

- * Mineralize phage surface with gold or SWNT
- * TEM to visualize structure
- * Assemble and test solar cells



M13 nanowires

TEM image of gold nanowires from Youjin Lee

Lab Skills:

Bacteriophage M13 material production

Fabrication of bio-based devices

Parameter variation: effect of SWNT vs. gold at different ratios

Course Logistics

Lectures:

- * Tues/Thurs -- 11-12pm in 16-220
- * Prof. Engelward --> me --> Prof. Belcher (corresponds to module)

Lab:

- * Tues/Thurs -- 1-5pm in 56-322 (Aneesh & Shannon)
- * Wed/Fri -- 1-5pm in 56-322 (Agi)
- * **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

Written and oral scientific communication

Module	Topic	Assignment	% of Final Grade
1	DNA Engineering	Abstract & data summary	15
		Methods section	5
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

We are not abandoning you to the unknown...

(1) Writing across the curriculum 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

(2) BE Writing Lab:

* Writing fellows available to provide peer coaching (and assigned to you!)

(3) 20.109 instructors:

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

Written and oral scientific communication

- 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)

Slide from Agi Stachowiak

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

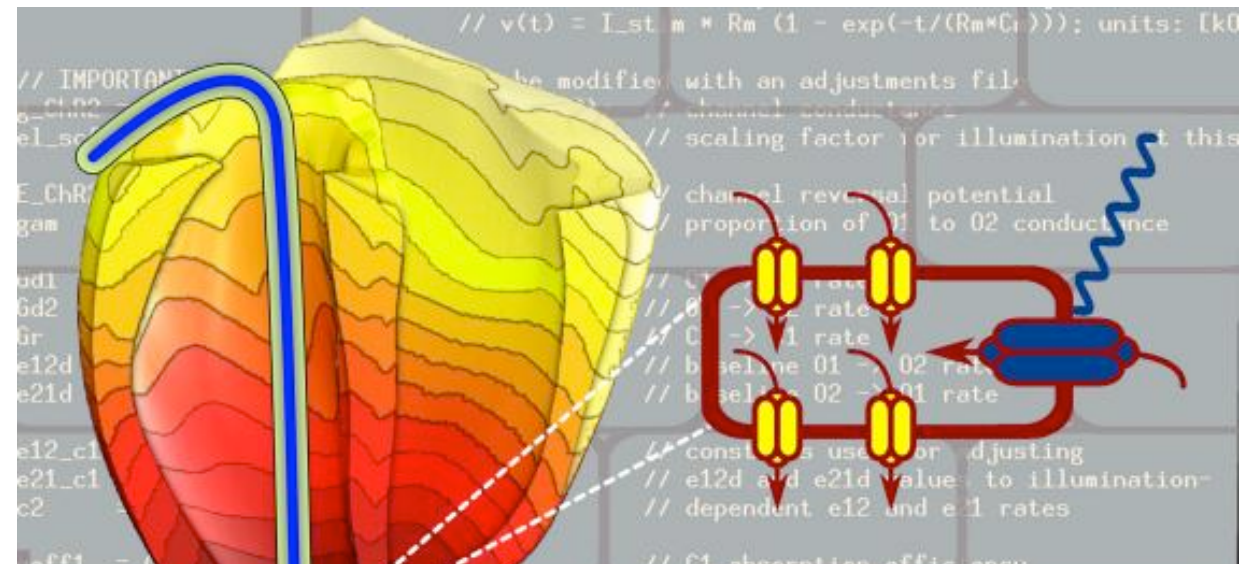
Some of our expectations of you

- 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:

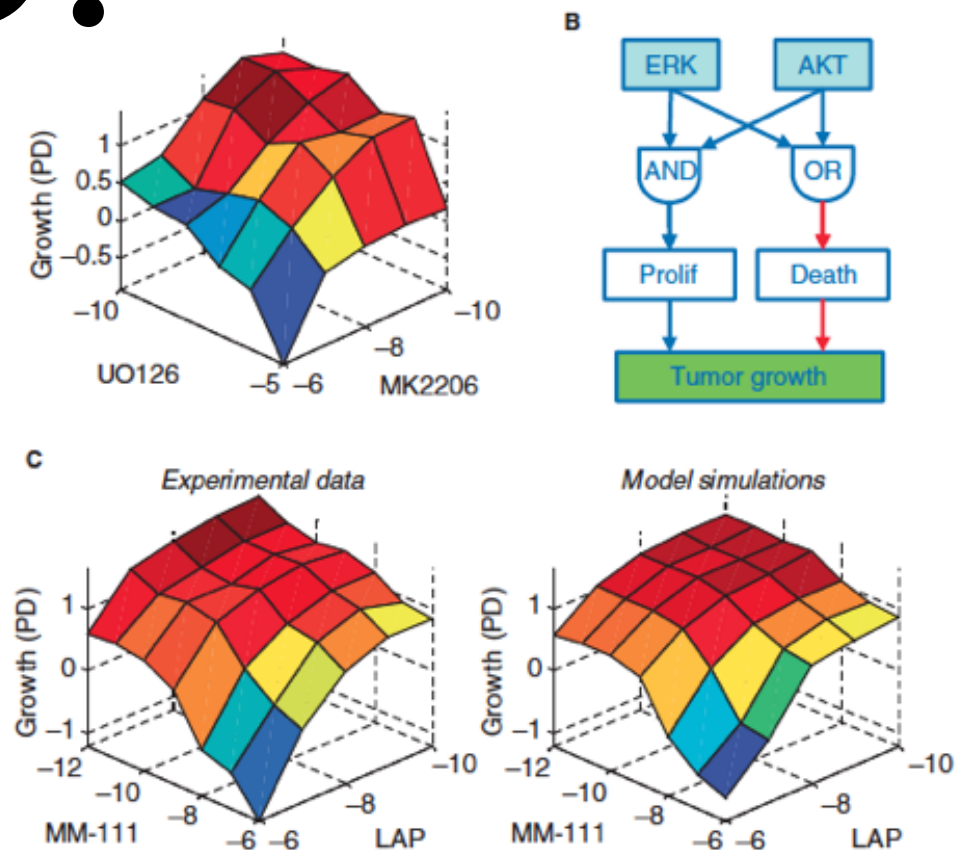
- Organize a constructive lab notebook
- Implement lab protocols & *troubleshoot*
- Design novel experiments with appropriate controls
- Interpret qualitative data
- Analyze quantitative data
- Recognize the utility of mathematical models
- Critically examine the scientific literature
- Communicate your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

...The future of biological engineering.



**Future Heart Attack Treatments Will Use
Volts, to Keep Your Heart Beating**
d Friday, Aug. 30, 2013, at 4:44 PM (Slate.com)

YOU!



Kirouac et al. *Sci Signaling*, Aug 2013