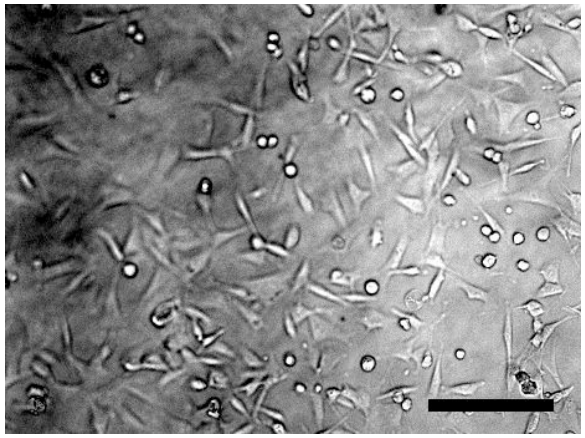
Standards in Scientific Communities

Module 3, Lecture 3

20.109 Spring 2009

Lecture 2 review

- What properties of hydrogels are advantageous for soft TE?
- What is meant by bioactivity and how can it be introduced?
- What are the two major matrix components of cartilage and how do they support tissue function?

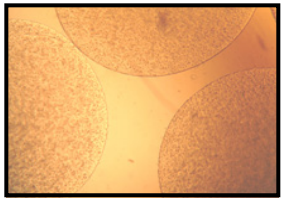


Topics for Lecture 3

- Module 3 so far
- Standards in scientific communities
  - general engineering principles
  - standards in synthetic biology
  - standards in data sharing
  - standards in tissue engineering
- Writing exercise and discussion

Module progress: week 1

- Day 1: culture design
  - What did you test?



- Day 2: culture initiation
  - Cells receiving fresh media every 2-4 days

Aside: salvaging a mistake

- Small errors can have big consequences (cf. NASA)
- How to make best choices in aftermath of an error
  - a decimal point error
  - time pressure
  - limited reagents

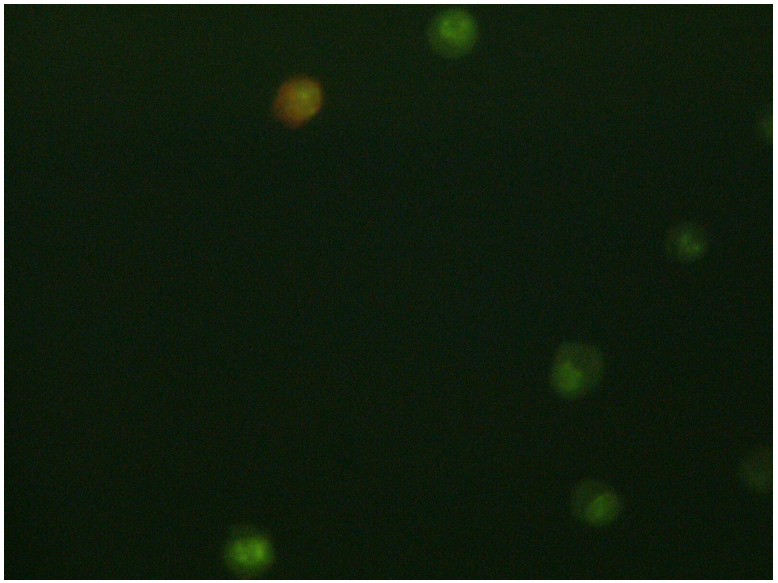
Units Blunder Sent Craft Into Martian Atmosphere: NASA

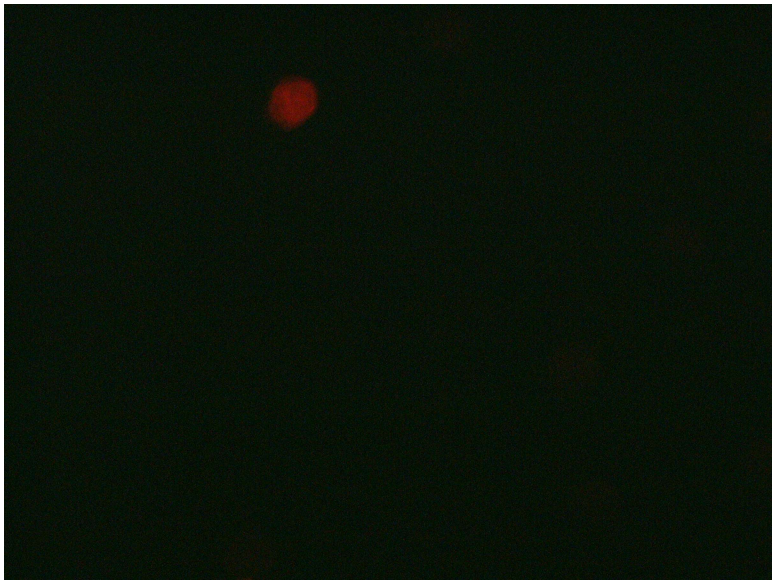
By Daniel Sorid

Staff Writer
posted: 05:43 pm ET
30 September 1999

www.space.com

Module day 3: test cell viability





Green stain: SYTO10 = viability
Red stain: ethidium = cytotoxicity

} Assay readout: fluorescence

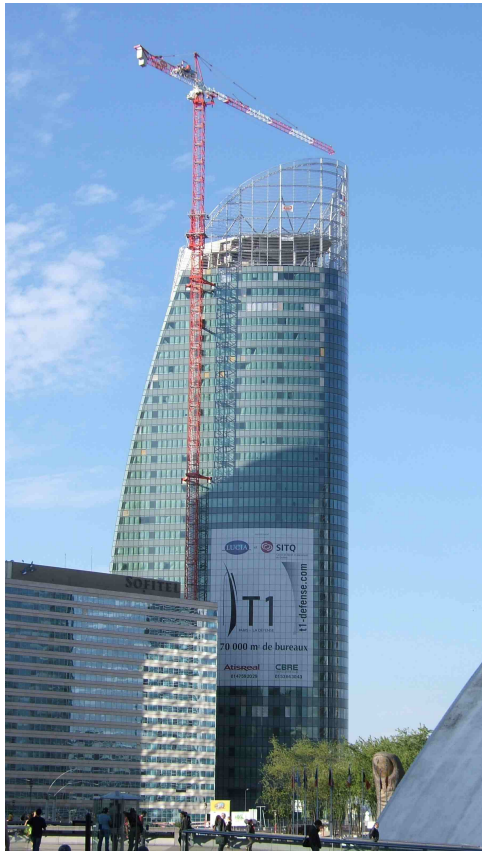
Working principle? **Relative cell-permeability**

Thinking critically about module goals

- Purpose of experiment
  - Local
  - Global
- All well and good, but…
- Can we move beyond empiricism – tissue *engineering*
- E.g., broadly useful biomaterials
  - monomers and mechanism for controlled degradability
  - "a lot of chemical calculations later, we estimated that the anhydride bond would be the right one"
  - Robert Langer, *MRS Bulletin* **31**(2006).

Engineering principles, after D. Endy

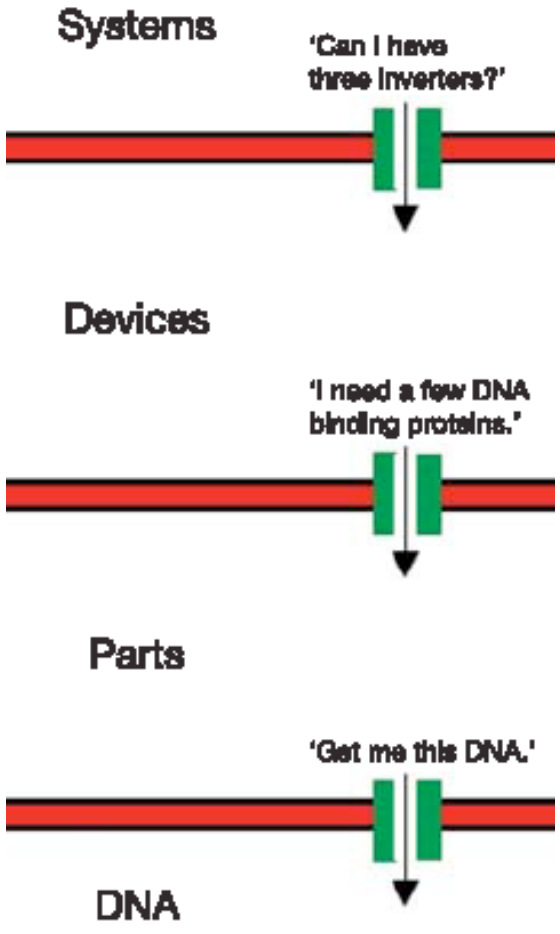
- D. Endy, *Nature* **438**:449 (2005)
- Is biology too complex to engineer, or does it simply require key "foundational technologies"?
- Systematic vs. *ad hoc* approach
- Abstraction
  - software function libraries
  - copy-editor vs. editor
- Decoupling
  - architecture vs. construction
  - design vs. fabrication
- Standardization
  - screw threads, train tracks, internet protocols
  - what would we standardize to engineer biology?



Public domain image (Wikimedia Commons)

Application to synthetic biology

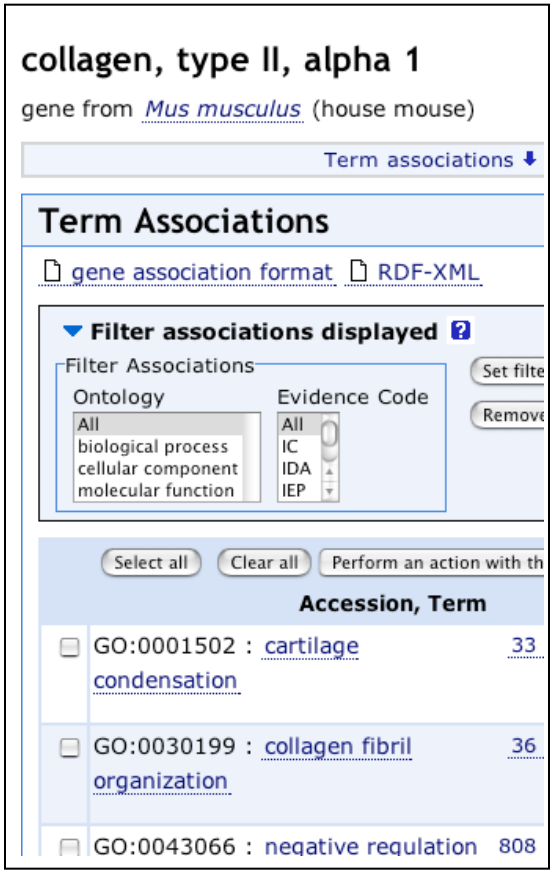
- D. Endy, *Nature* **438**:449 (2005)
- Synthetic biology, in brief: “programming” cells/DNA to perform desired tasks
  - artimisinin synthesis in bacteria
  - genetic circuits
- Abstraction
  - DNA → parts → devices → systems
  - materials processing to avoid unruly structures
- Decoupling
  - DNA design vs. fabrication (rapid, large-scale)
- Standardization
  - Registry of Standard Biological Parts
  - standard junctions, off-the-shelf RBS, etc.



From D. Endy, *Nature* **438**:449

Data standards: what and why?

- Brooksbank & Quackenbush, *OMICS*, **10**:94 (2006)
- High-throughput methods yield much data
- Standards for **collection** and/or **sharing**
  - shared language (human and computer)
  - compare experiments across labs
  - avoid reinventing the wheel
  - integration of information across levels
- Examples from Module 2
  - MIAME for microarrays
  - Gene Ontology (protein functions)
- Who drives standards?
  - scientists, funding agencies, journals, industry



www.geneontology.org

How valued are TE standards?

- 2007 strategic plan for TE clinical success by 2021
- Standards suggested by 8 of 24 int'l leaders in TE
- Taking into account both need and progress so far, standards 7th of 14 areas

P.C. Johnson et al., *Tissue Eng* **13:**2827 (2007)

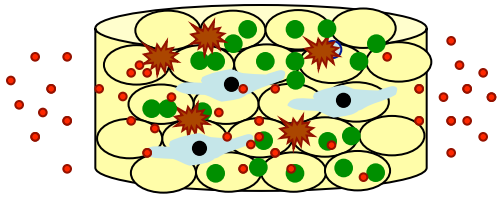
TABLE 6. NORMALIZED CONCEPT DOMINANCE (I.E., TAKING PRESENT PROGRESS INTO CONSIDERATION)

	O/P
Angiogenic control	3.3
Stem cell science	3.2
Molecular biology/systems biology	2.8
Cell sourcing and cell/tissue characterization	2.7
Clinical understanding/interaction	2.2
Immunologic understanding and control	2.0
Manufacturing/scale-up	1.1
Regulatory transparency	1.1
Standardized models	1.1
Enhanced biomaterial functionality	0.8
Multidisciplinary understanding/cooperation	0.8
Expectation management/communication	0.4
Pharmacoeconomic/commercial pathway	0.3
Multilevel funding	0.0

- 2007 US govt. strategic plan
  - standards listed as part of "implementation strategy," though not as one of eight "strategic priorities"

How useful are TE standards?

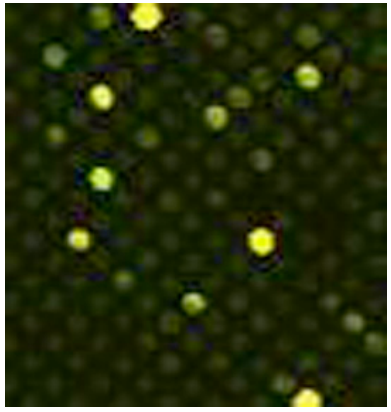
- See 2005 editorial by A. Russell
  - proposes need for standards in both data collection and sharing
- Choose and respond to a student excerpt (10-15 min)
- Pros/cons/etc.



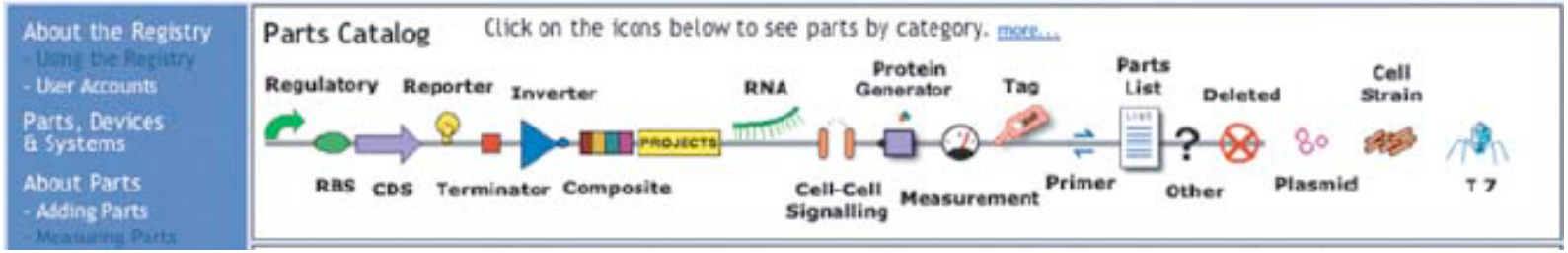
Is this TE construct standardizable?

Lecture 3: conclusions

- Standardizing data sharing and collection is of interest in several BE disciplines.
- Other general engineering principles or specific strategies may take precedence over standardization in a particular field.



Microarray data



From D. Endy, *Nature* **438**:449 (standardization of biological “parts”)

Next time: cell viability; transcript-level assays.