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
Module day 3: test cell viability

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

Working principle? Relative cell-permeability

Assay readout: fluorescence
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”
Engineering principles, after D. Endy


• 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?
Application to synthetic biology

- 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.

Data standards: what and why?

- 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


• 2007 US govt. strategic plan
  – standards listed as part of “implementation strategy,” though not as one of eight “strategic priorities”

### Table 6. Normalized Concept Dominance (i.e., Taking Present Progress into Consideration)

<table>
<thead>
<tr>
<th>Concept</th>
<th>O/P</th>
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<tbody>
<tr>
<td>Angiogenic control</td>
<td>3.3</td>
</tr>
<tr>
<td>Stem cell science</td>
<td>3.2</td>
</tr>
<tr>
<td>Molecular biology/systems biology</td>
<td>2.8</td>
</tr>
<tr>
<td>Cell sourcing and cell/tissue characterization</td>
<td>2.7</td>
</tr>
<tr>
<td>Clinical understanding/interaction</td>
<td>2.2</td>
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<tr>
<td>Immunologic understanding and control</td>
<td>2.0</td>
</tr>
<tr>
<td>ManufacturingSCALE-UP</td>
<td>1.1</td>
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<tr>
<td>Regulatory transparency</td>
<td>1.1</td>
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<tr>
<td>Standardized models</td>
<td>1.1</td>
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<tr>
<td>Enhanced biomaterial functionality</td>
<td>0.8</td>
</tr>
<tr>
<td>Multidisciplinary understanding/cooperation</td>
<td>0.8</td>
</tr>
<tr>
<td>Expectation management/communication</td>
<td>0.4</td>
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<tr>
<td>Pharmacoeconomic/commercial pathway</td>
<td>0.3</td>
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<tr>
<td>Multilevel funding</td>
<td>0.0</td>
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</tbody>
</table>
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.


Next time: cell viability; transcript-level assays.