L6.3: Cellular Design Principles
Wrap Up

Prof. Rickus
Grounded in the Numbers

<table>
<thead>
<tr>
<th>Cell Type</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. Coli</em> (culture)</td>
<td>~1 µm³</td>
</tr>
<tr>
<td></td>
<td>~1 fL</td>
</tr>
<tr>
<td><em>S. Cerevisiae</em></td>
<td>~1000 µm³</td>
</tr>
<tr>
<td></td>
<td>~1 pL</td>
</tr>
<tr>
<td>Human Fibroblast</td>
<td>~10000 µm³</td>
</tr>
<tr>
<td></td>
<td>~10 pL</td>
</tr>
</tbody>
</table>
Cellular Machines

Typical 1 kg of E.coli power consumption of ~ 10 light bulbs
Photoreceptor as a Machine

F. Rieke and D. A. Baylor (1998)
Reviews of Modern Physics
Design Principles of Cell Structure

Physical Size & Shape

Interaction Networks


Modeled Gene Expression

**activator**

**repressor**

Probability of transcription

\[ f(x) = \frac{x}{K} \]

\[ f(x) = 1 - \frac{x}{K} \]

\[ n=1 \quad n=2 \quad n=3 \quad n=4 \]
Gene Circuit Motifs: Dynamics & Function

- faster response time
- noise filtering
Cells as Sensors

Cells as Oscillators
Translation to Engineering: BioHybrids


SYNTHETIC LIFE

? SCALE / COMPLEXITY

SYNTHETIC

NATURAL

NON-LIVING

LIVING

JAMES BALOG GETTY IMAGES

ROSI ET AL 2005

SYNTHETIC LIFE
Western Bioethics Based in Principlism

- **Beneficence**
  - Do good

- **Non-Maleficence**
  - Do No Harm

- **Justice**
  - Treat all people fairly

- **Autonomy**
  - Respect the views and choices of individuals
What will you design?