

L6.3: Cellular Design Principles Wrap Up

Prof. Rickus



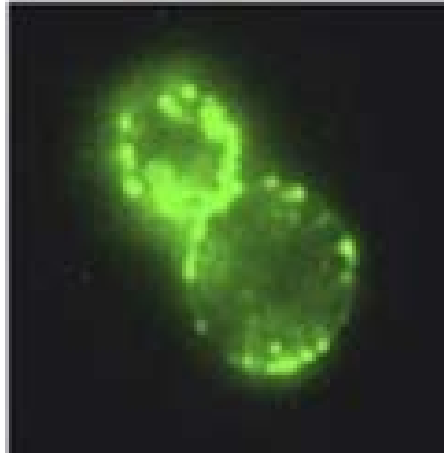
Grounded in the Numbers

E. coli



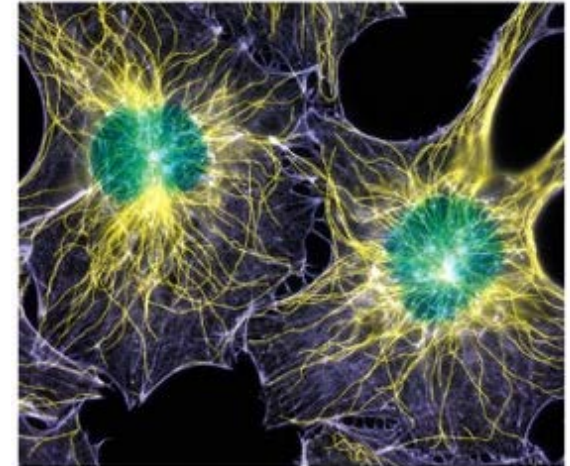
Phys. Biology of the Cell

S. cerevisiae



Mariska Lilly et al. FEMS Yeast Res
2009;9:1236-1249

Human Fibroblast



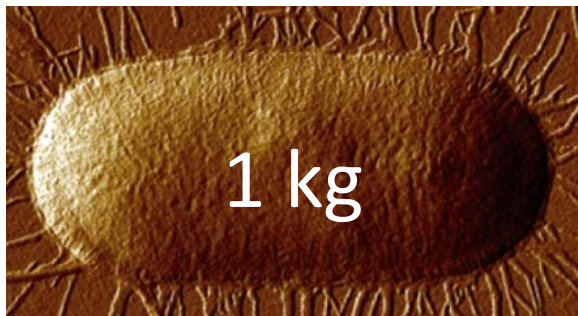
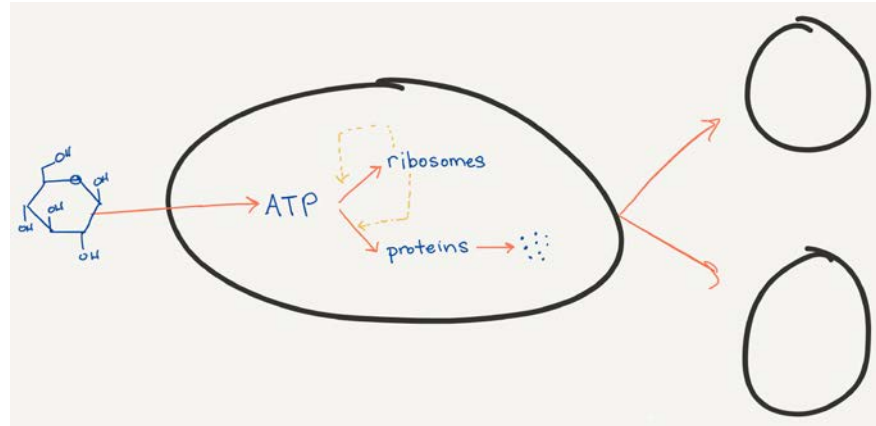
Phys. Biology of the Cell

10 μm

Cell Type	Volume	
<i>E. Coli</i> (culture)	$\sim 1 \mu\text{m}^3$	$\sim 1 \text{ fL}$
<i>S. Cerevisiae</i>	$\sim 1000 \mu\text{m}^3$	$\sim 1 \text{ pL}$
Human Fibroblast	$\sim 10000 \mu\text{m}^3$	$\sim 10 \text{ pL}$

Cellular Machines

minimal E.coli machine



≈



Typical 1 kg of E.coli power consumption of ~ 10 light bulbs

Photoreceptor as a Machine

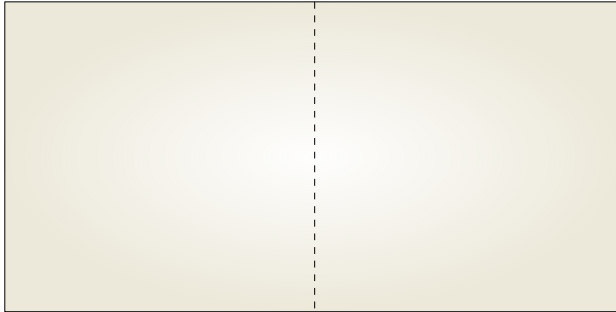


10 μm

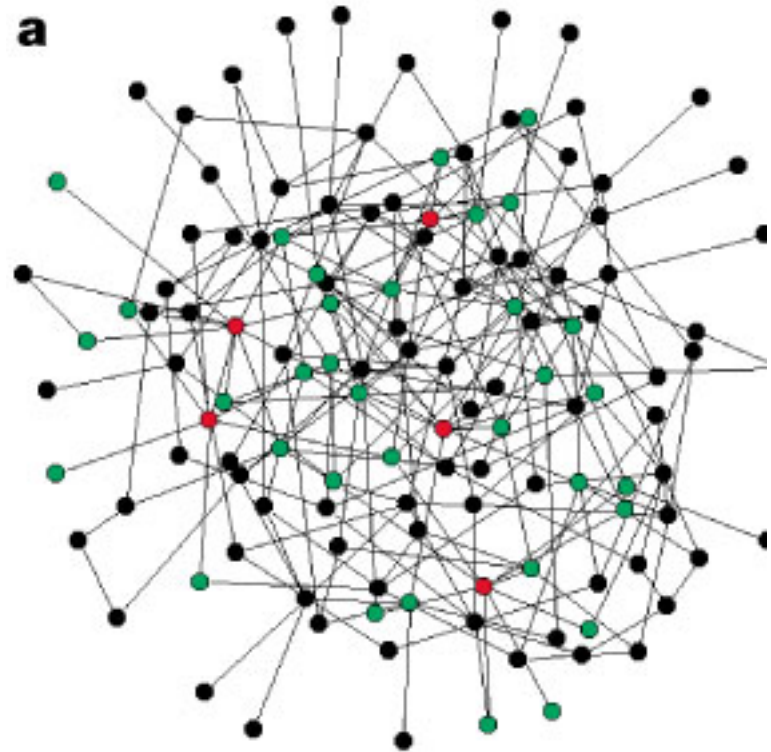
F. Rieke and D. A. Baylor (1998)
Reviews of Modern Physics

Design Principles of Cell Structure

Physical Size & Shape



Interaction Networks

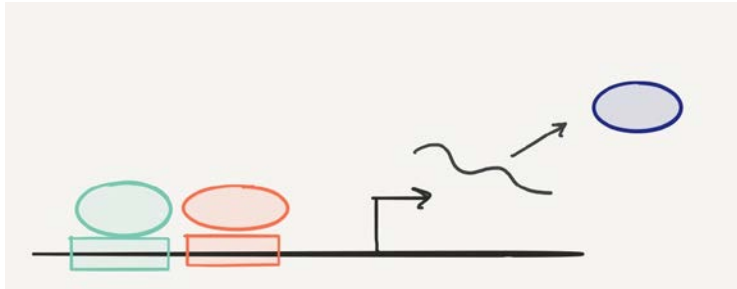


Rafelski & Marshall. *Nature Reviews Molecular Cell Biology* 9, 593-602 (August 2008)

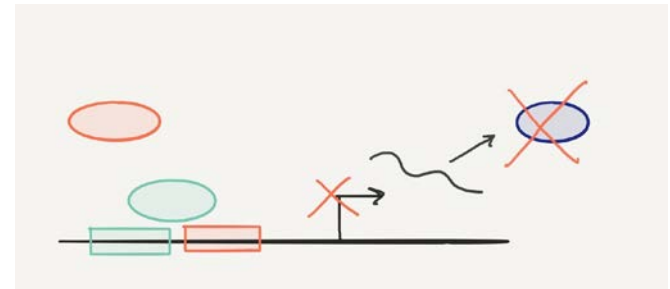
Réka Albert, Hawoong Jeong and Albert-László Barabási
Nature **406**, 378-382(27 July 2000)

Modeled Gene Expression

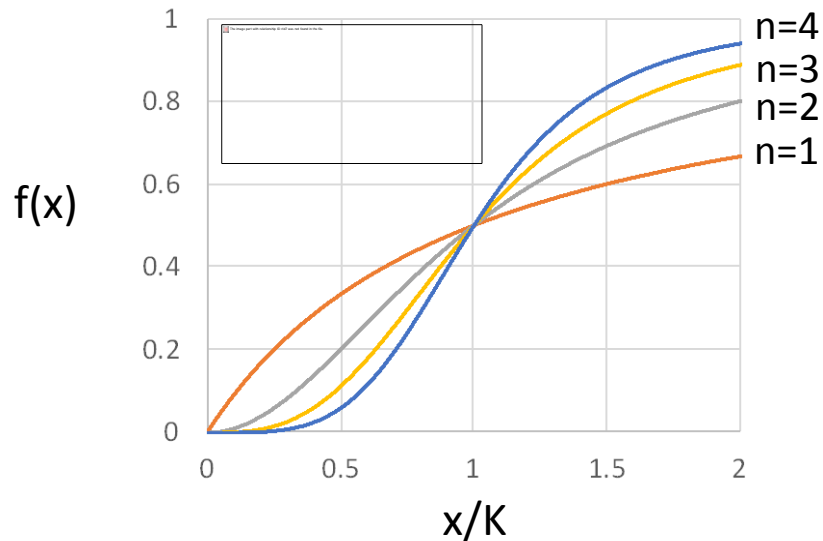
activator



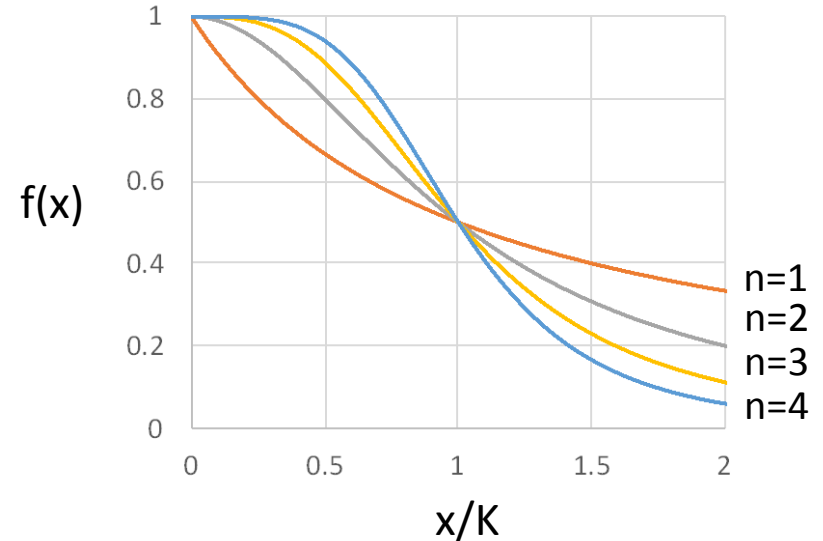
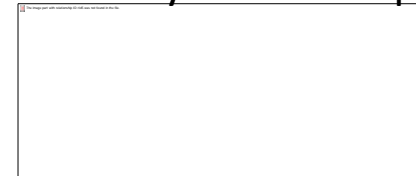
repressor



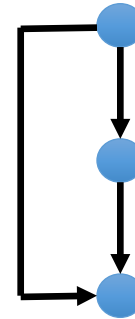
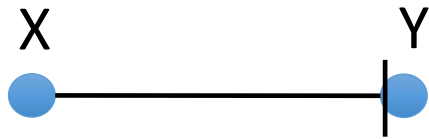
probability of transcription



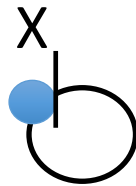
probability of transcription



Gene Circuit Motifs: Dynamics & Function



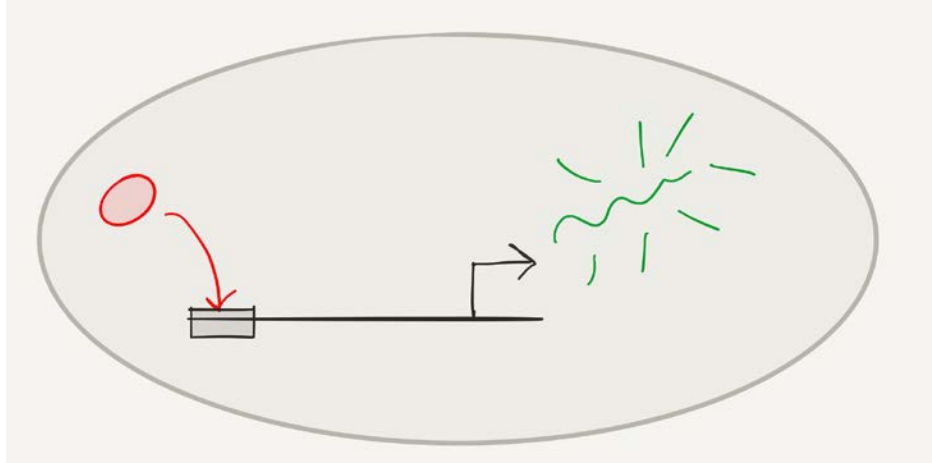
noise filtering



faster response time

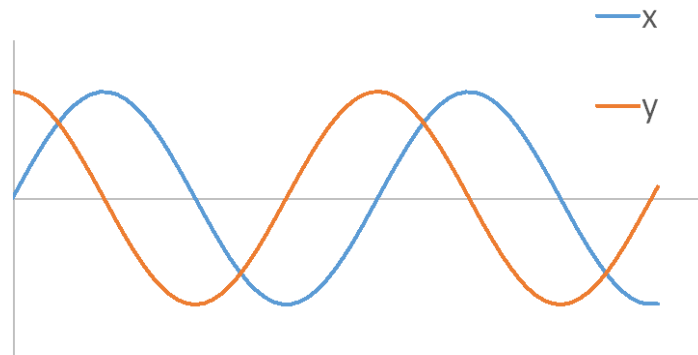
Cells as Sensors

Signal

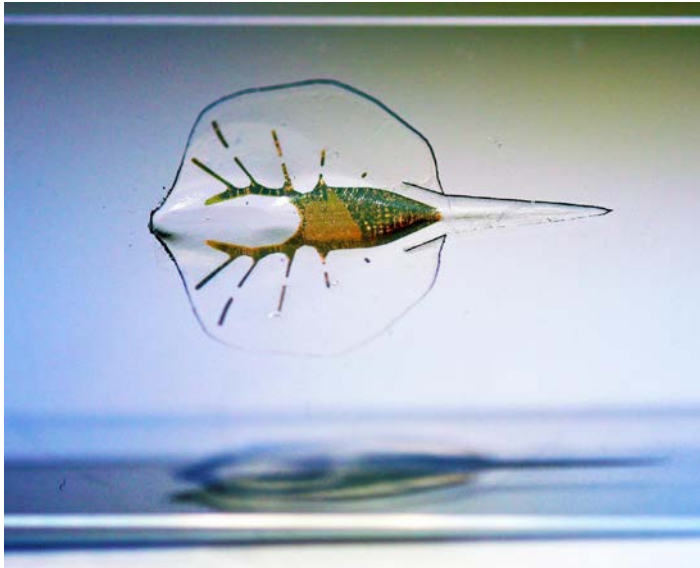


Response

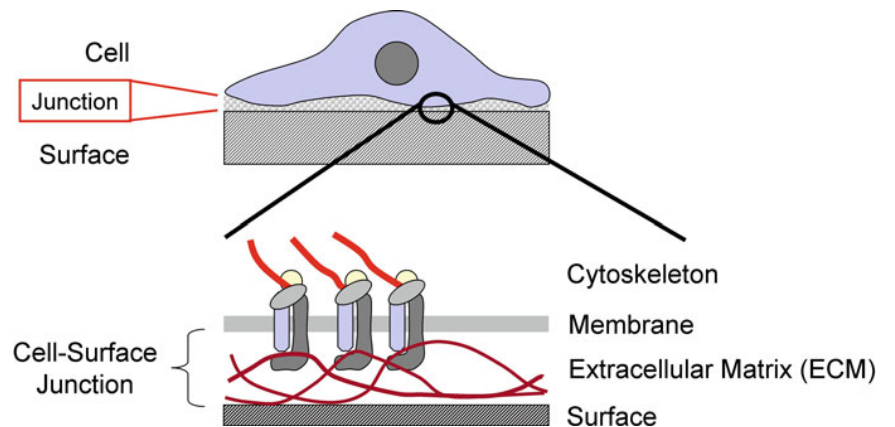
Cells as Oscillators



Translation to Engineering: BioHybrids



Park et al 2016. Science. 353:6295

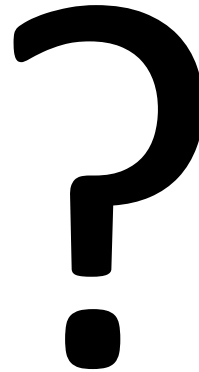


the ECM pre-adsorbed upon the substrate surface (adapted from [12])

s of

Michaelis et al 2012. Adv Biochem Engin/Biotechnol
126: 33–66

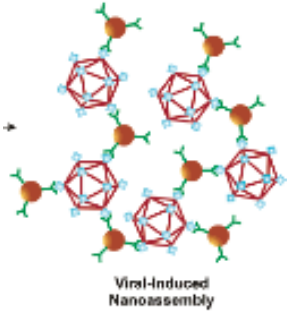
SYNTHETIC LIFE



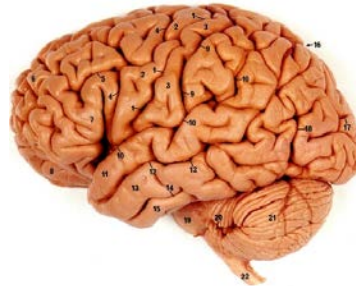
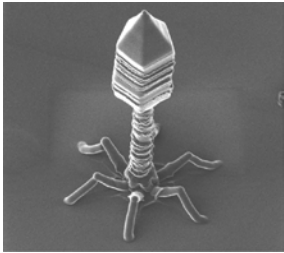
SYNTHETIC

SCALE / COMPLEXITY

NATURAL



ROSI ET AL 2005



JAMES BALOG GETTY IMAGES



FreeFoto.com



NON-LIVING

LIVING

LIVING

NON-LIVING

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?