Biophysics

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Fun read:
Cell biology numbers. http://book.bionumbers.org/; https://bionumbers.hms.harvard.edu/search.aspx (to check BNID)
What is Life?
Em Purcell: Life at low Reynold's number

Syllabus

- Heat as a form of energy: Concept of free energy; free energy transduction; order/disorder in biology; forces and energies
- Molecular interactions: Physical basis and implications in biology
- Dimensions and Units: Dimensional analysis; biomolecules dimensions, arrangements, internal energies
- Special properties of water: Importance in biology
- Overview of structures inside cells: Dimensions, crowding, basic functioning principles, timescales of cellular processes; energies/forces inside live cells. Modes of information transfer;
- Distributions in nature: Origin, implications

Biophysics

Using Physics to understand Biology

Biology?

Life?

Physical Laws in Biological systems??

Physical Laws in other systems??

WHERE DO WE START FROM??????

...Classwork 1

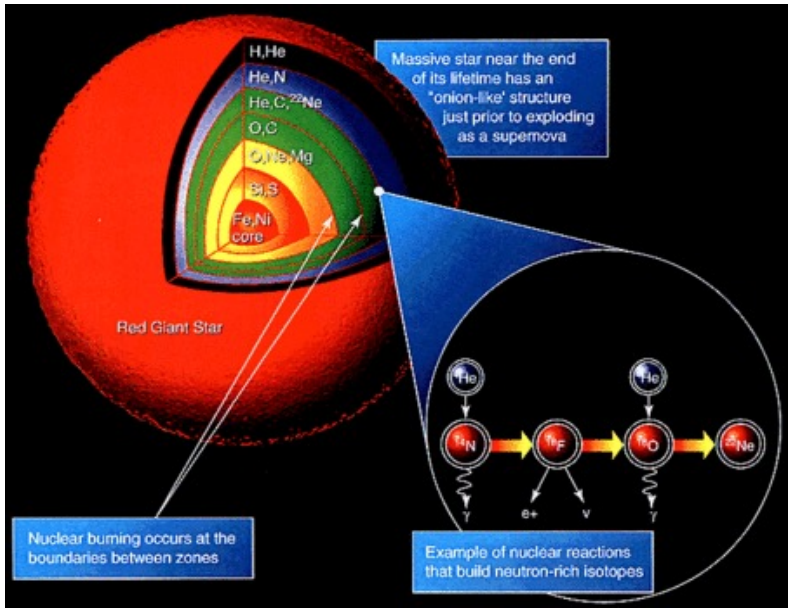
http://whatislife.stanford.edu/LoCo_files/What-is-Life.pdf

What makes us??

Table 2.1 Elements in the Human Body

Element	Symbol	Percentage of Body Mass (including water)	
Oxygen	O	65.0%	96.3%
Carbon	C	18.5%	
Hydrogen	H	9.5%	
Nitrogen	N	3.3%	
Calcium	Ca	1.5%	3.7%
Phosphorus	P	1.0%	
Potassium	K	0.4%	
Sulfur	S	0.3%	
Sodium	Na	0.2%	
Chlorine	Cl	0.2%	
Magnesium	Mg	0.1%	

Trace elements (less than 0.01% of mass): Boron (B), chromium (Cr), cobalt (Co), copper (Cu), fluorine (F), iodine (I), iron (Fe), manganese (Mn), molybdenum (Mo), selenium (Se), silicon (Si), tin (Sn), vanadium (V), zinc (Zn)



Where was that made?

What makes us??

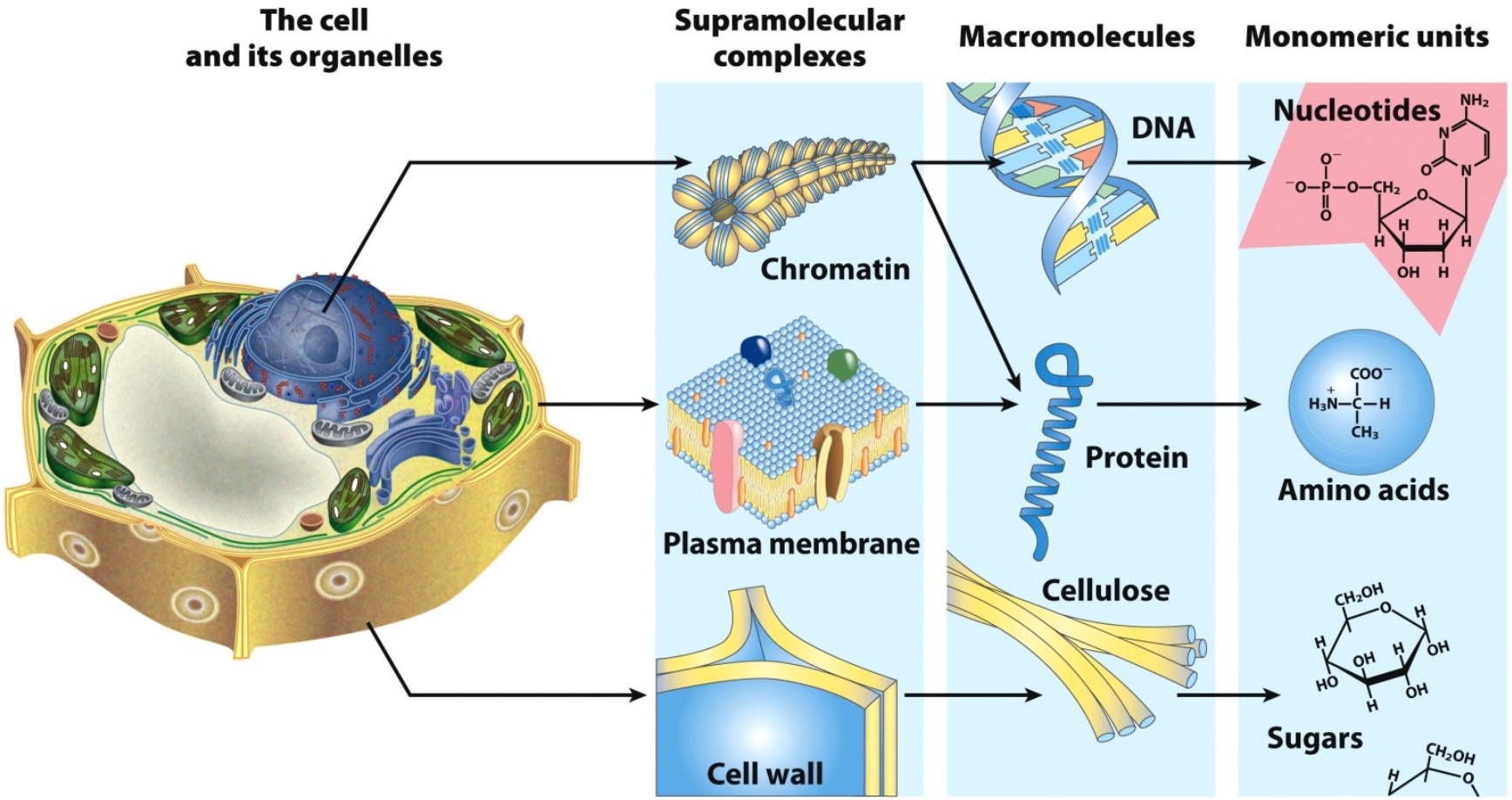


Figure 1-11
Lehninger Principles of Biochemistry, Sixth Edition

What makes us??

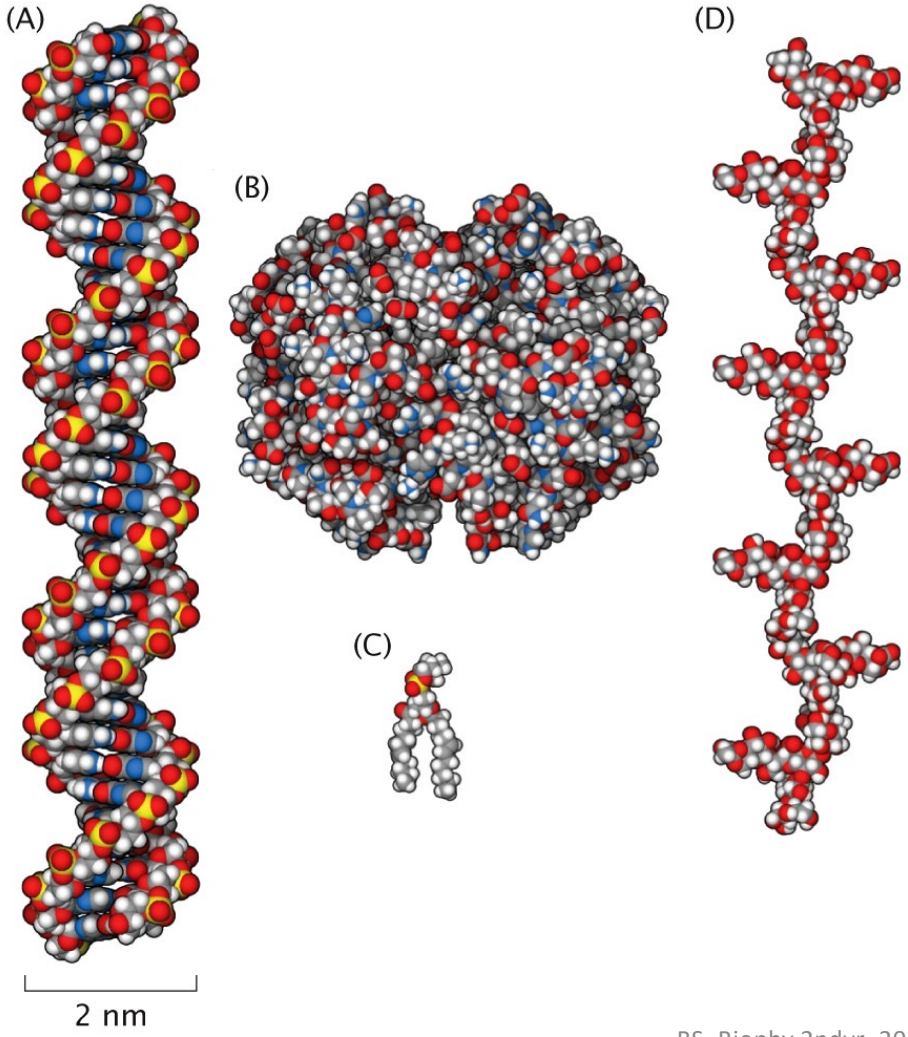
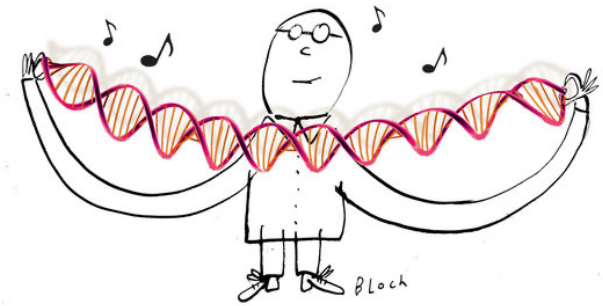


Figure 1.1 Physical Biology of the Cell, 2ed. (© Garland Science 2013)

Synthetic life



Peering Over the Fortress That Is the Mighty Cell
http://www.nytimes.com/2010/06/01/science/01angi.html?pagewanted=all&_r=0

June 2010

https://www.ted.com/talks/craig_venter_unveils_synthetic_life

•A bag of chemicals?
•What's so special?

•How do we understand/explain the net behaviour of this bag

When the Venter team inserted the synthetic version of the Mycoplasma mycoides genome into the cellular housing of the Mycoplasma capricolum bacterium, the newcomer took full advantage of the resident cytoplasmic wares.

Biophysics

Measuring: New methods to see/measure better

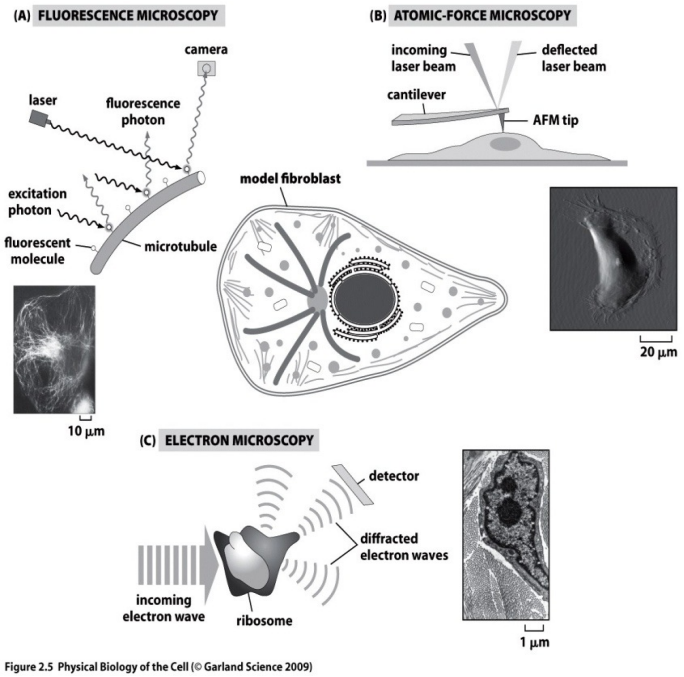
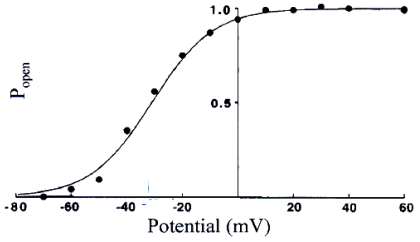


Figure 2.5 Physical Biology of the Cell (© Garland Science 2009)

Molecules
Structures
Cells
Populations
Networks

Modelling:

$$P_{\text{open}} = \frac{1}{e^{q_a(V_{50}-V)/kT} + 1}$$



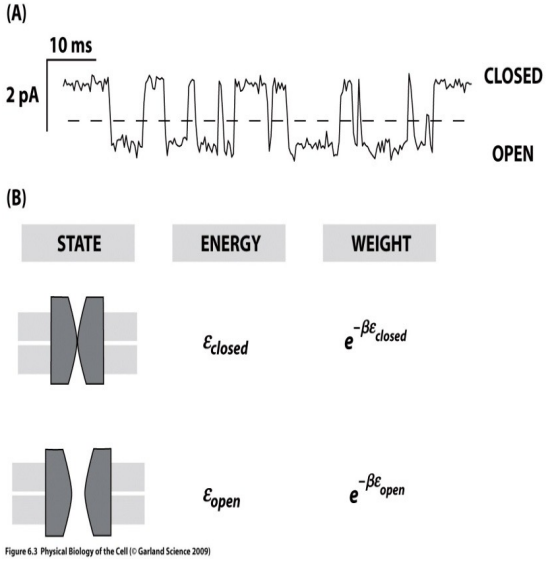


Figure 6.3 Physical Biology of the Cell (© Garland Science 2009)

Looks different than F☺ma

Take a macromolecule

..or a patch of membrane

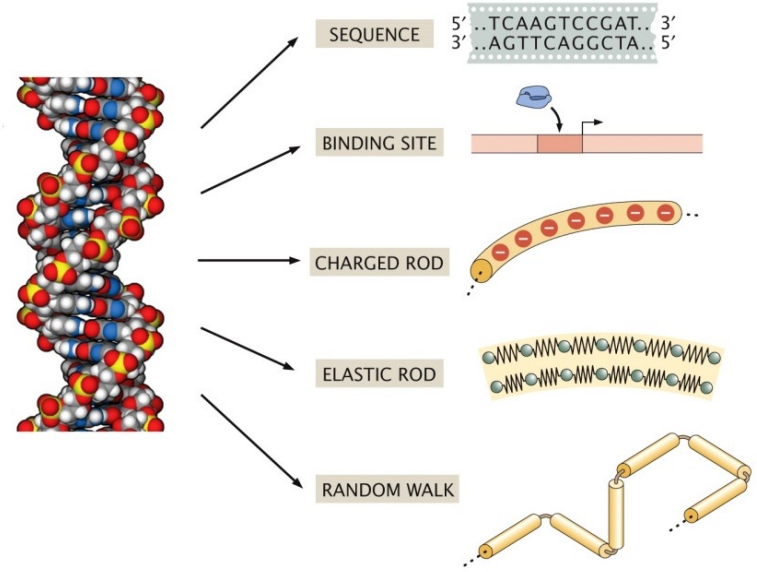


Figure 1.5 Physical Biology of the Cell, 2ed. (© Garland Science 2013)

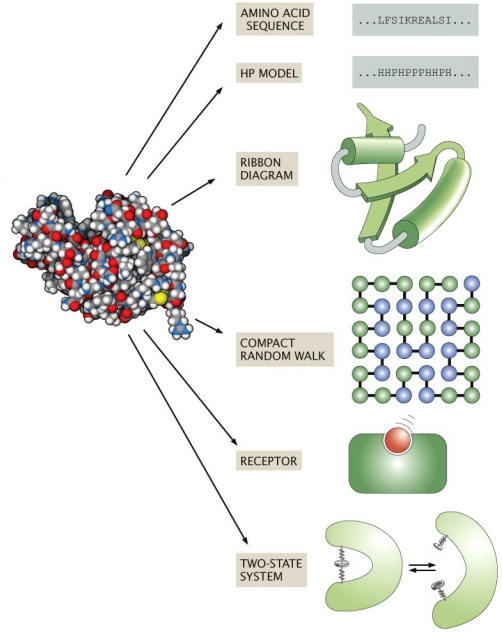


Figure 1.6 Physical Biology of the Cell, 2ed. (© Garland Science 2013)

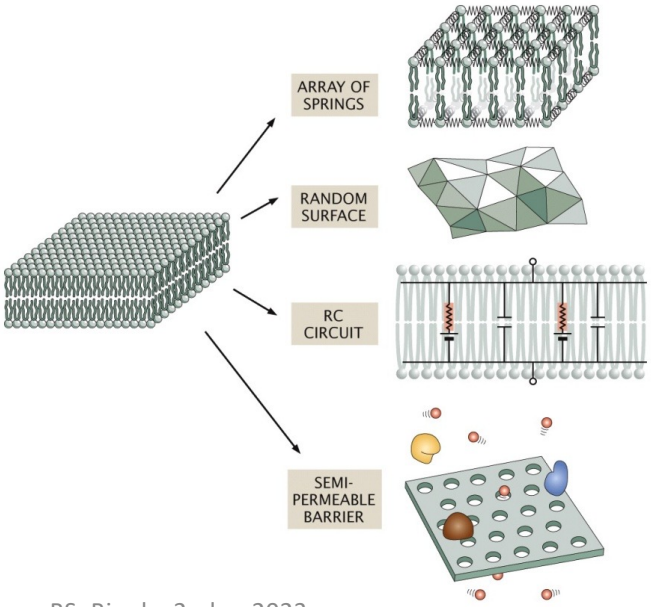


Figure 1.7 Physical Biology of the Cell, 2ed. (© Garland Science 2013)

Take a cell

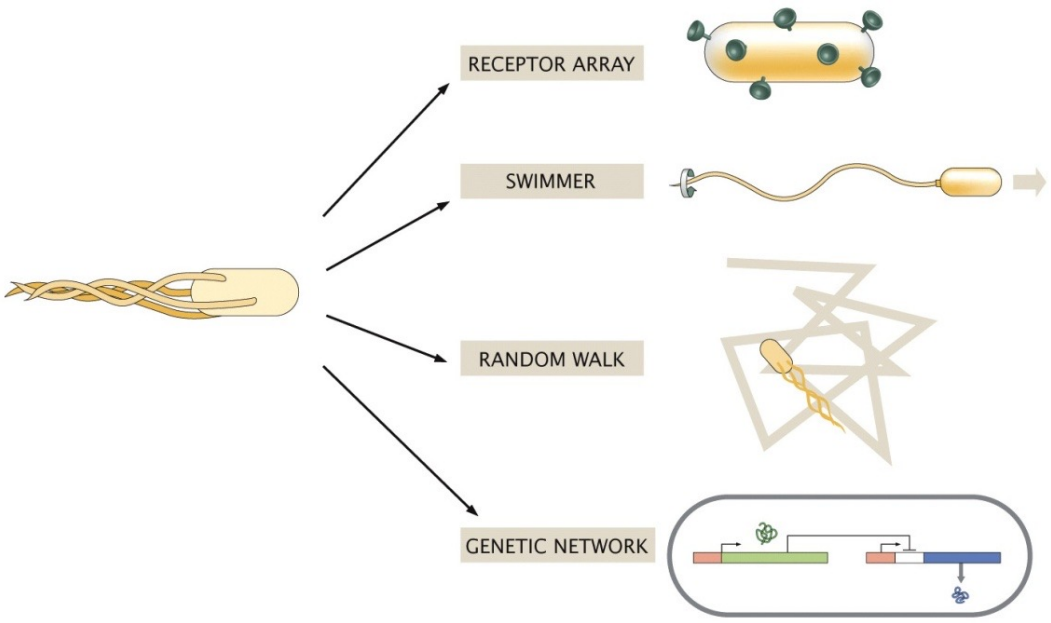


Figure 1.8 Physical Biology of the Cell, 2ed. (© Garland Science 2013)

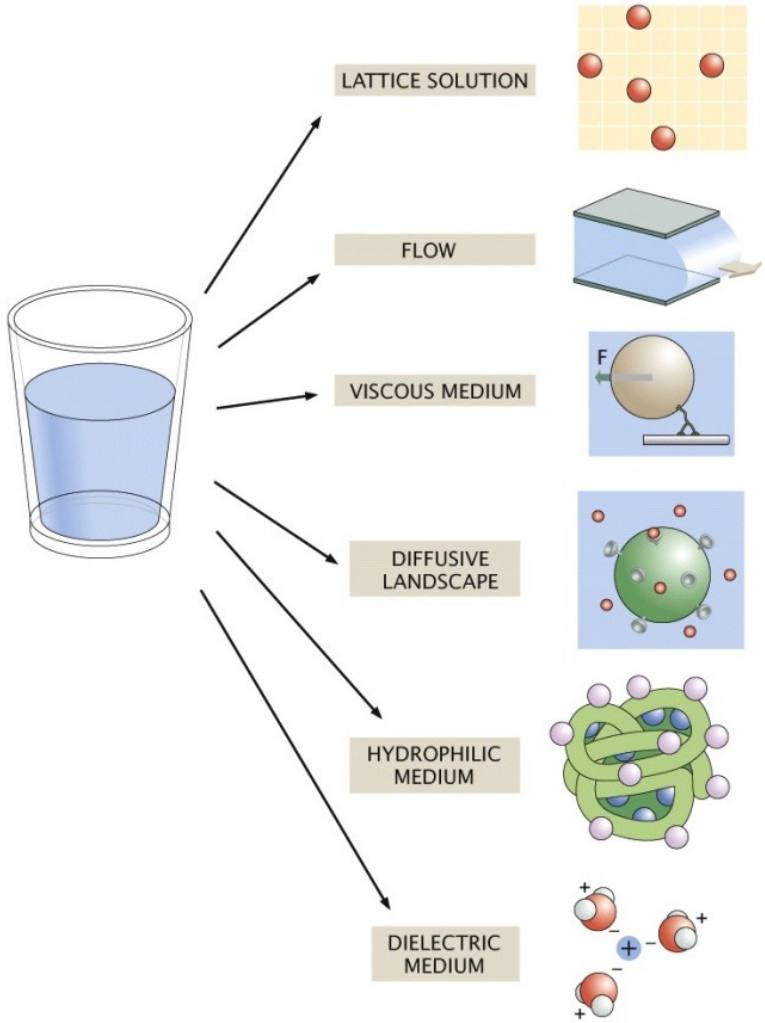


Figure 1.9 Physical Biology of the Cell, 2ed. (© Garland Science 2013)

Solution

The Spring in biology

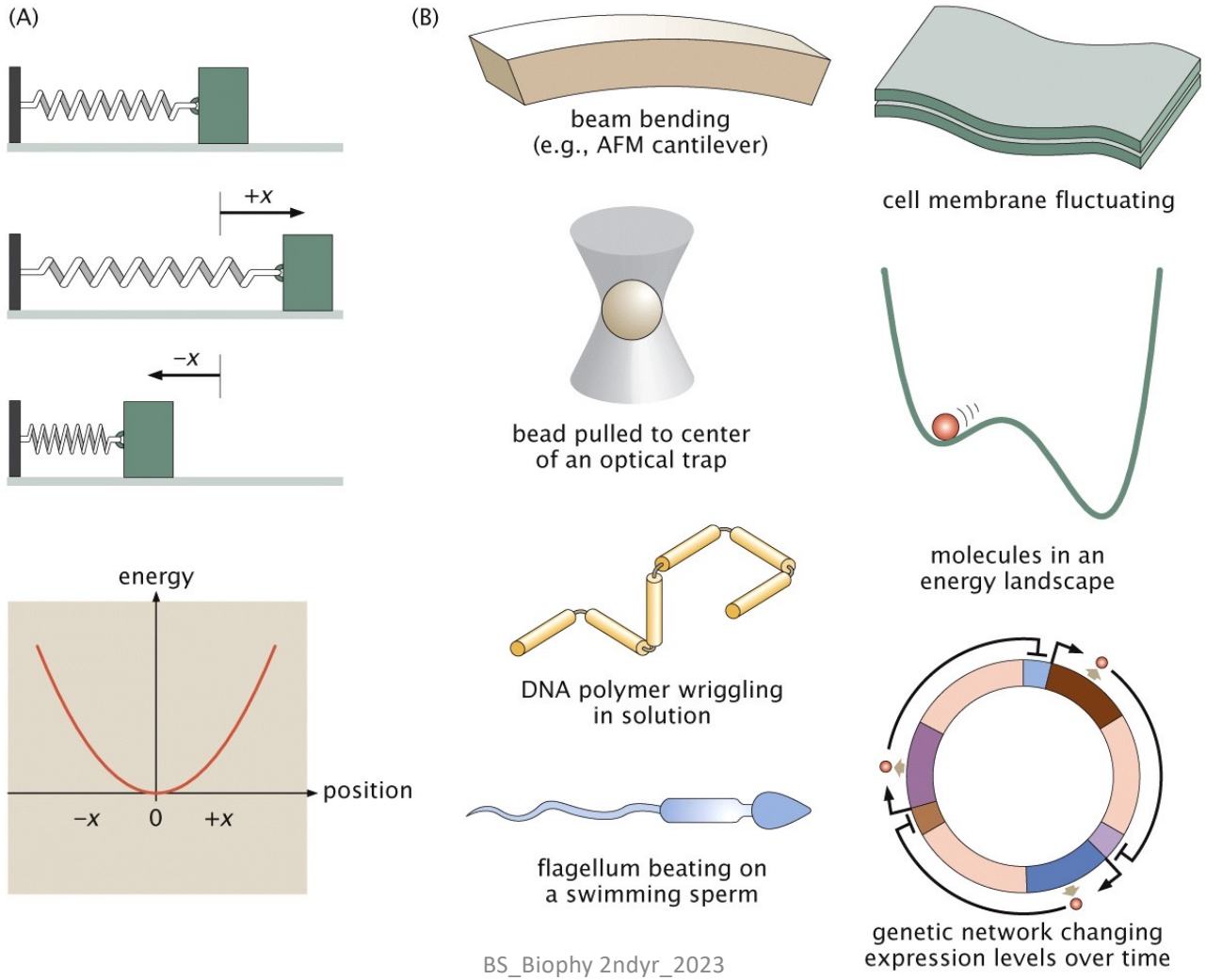


Figure 1.12 Physical Biology of the Cell, 2ed. (© Garland Science 2013)

The role of estimates

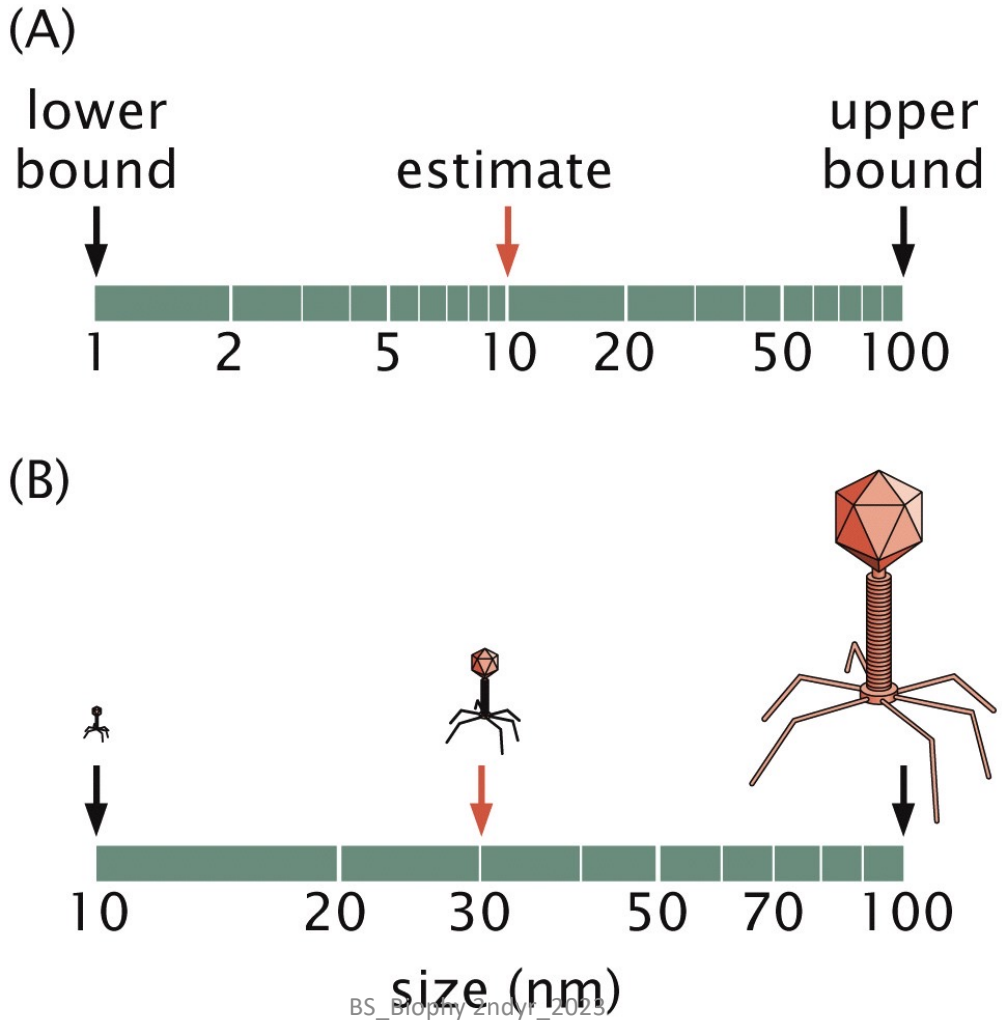
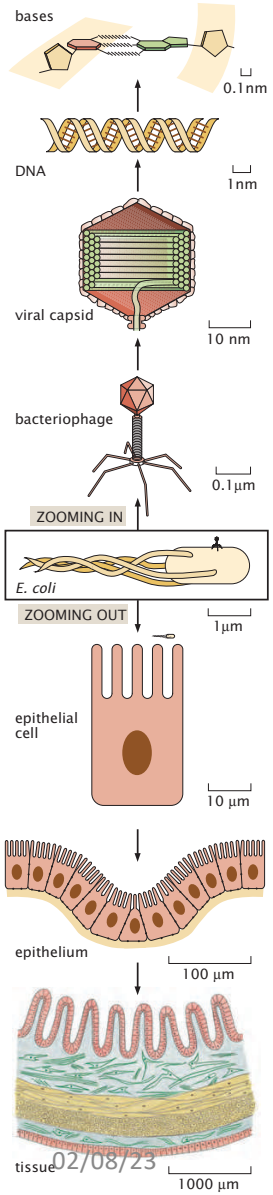


Figure 1.14 Physical Biology of the Cell, 2ed. (© Garland Science 2013)

Different sizes



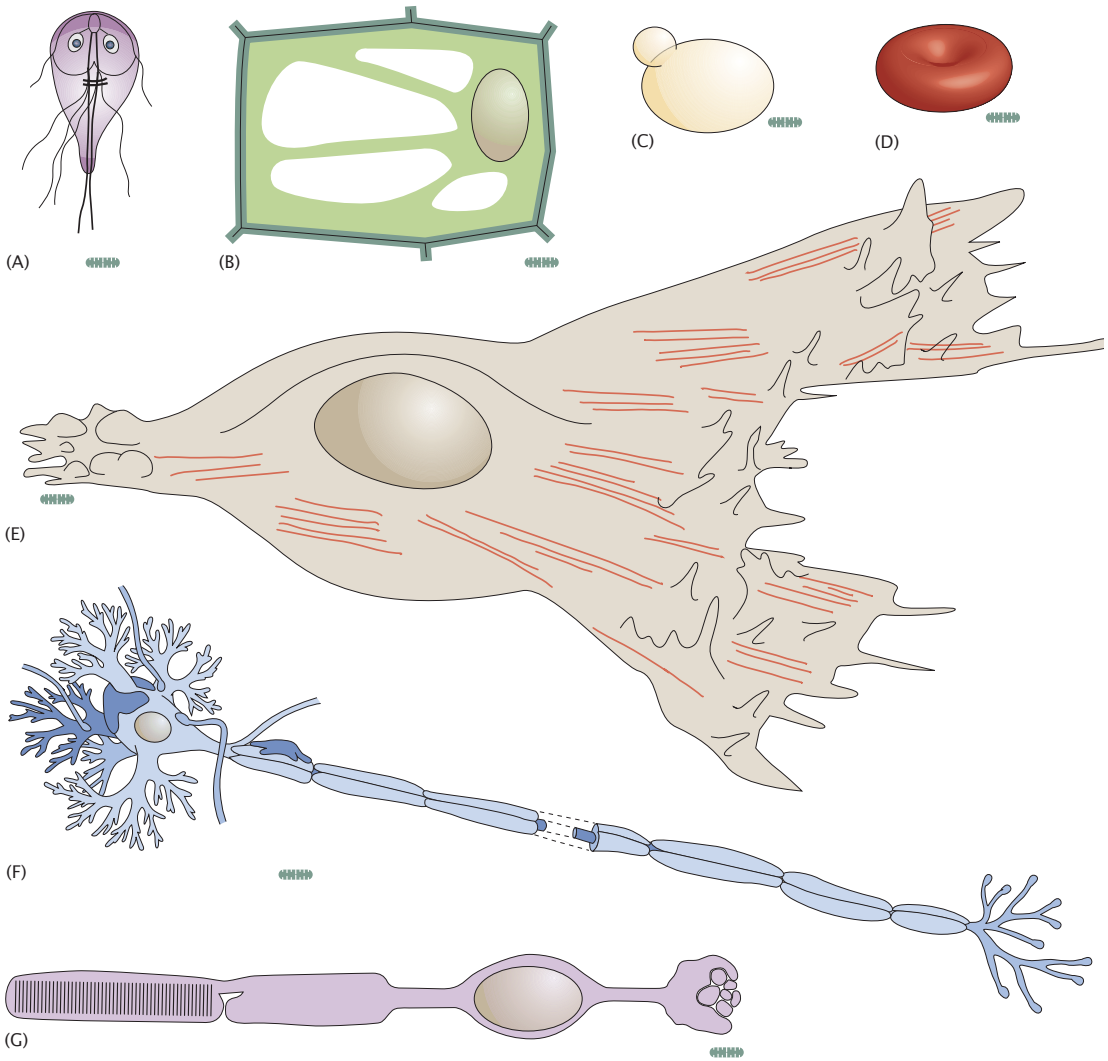


Figure 2.16: Cartoons of several different types of cells all referenced to the standard *E. coli* ruler. (A) The protist *Giardia lamblia*, (B) a plant cell, (C) a budding yeast cell, (D) a red blood cell, (E) a fibroblast cell, (F) a eukaryotic nerve cell, and (G) a retinal rod cell.

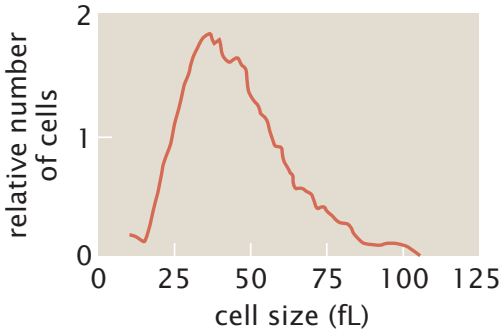
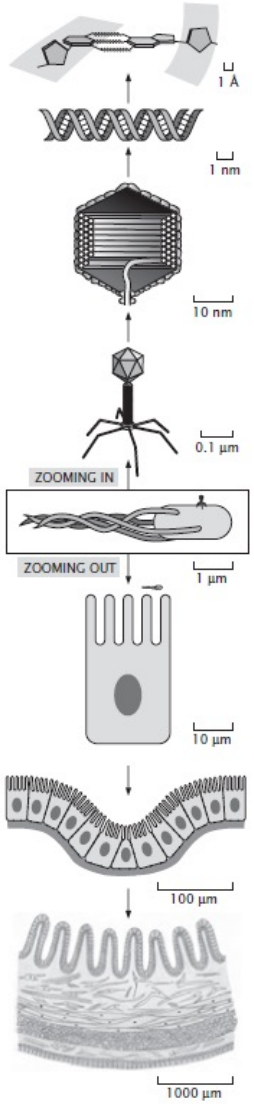


Figure 2.19: Yeast cell size distribution. Distribution of cell volumes measured for wild-type yeast cells. (Adapted from P. Jorgensen et al., *Science* 297:395, 2002.)



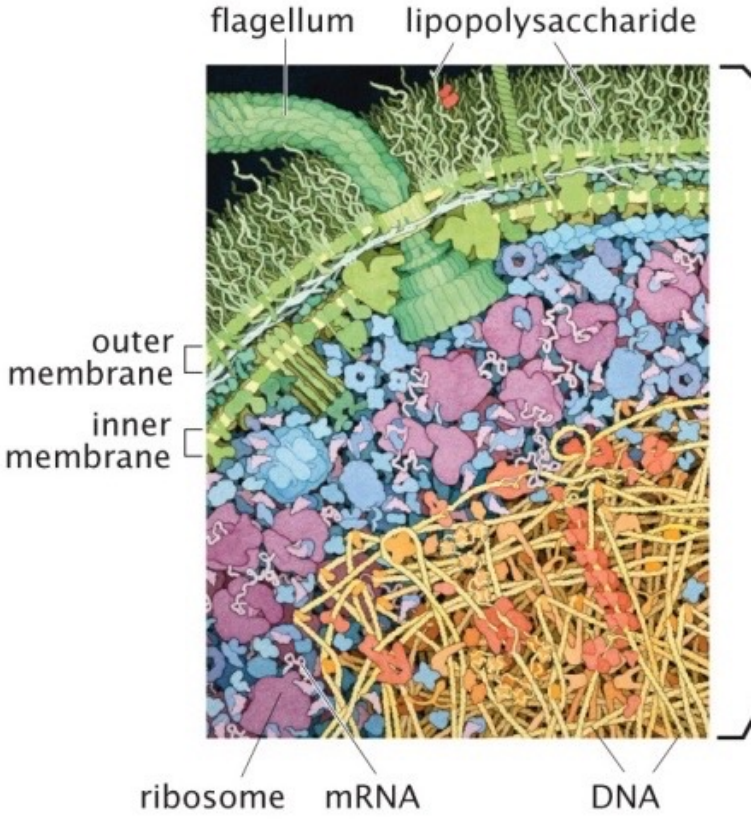


Figure 2.4 Physical Biology of the Cell, 2ed. (© Garland Science 2013)

Importance of Making ESTIMATES

A. Concentration, pH, interparticle distances

Most abundant molecule in us?

Approximate concentration of water (Molarity)?

Distance between water molecules?