Biological Frameworks for Engineers ME 411 / ME 511

ME 411 / ME 511

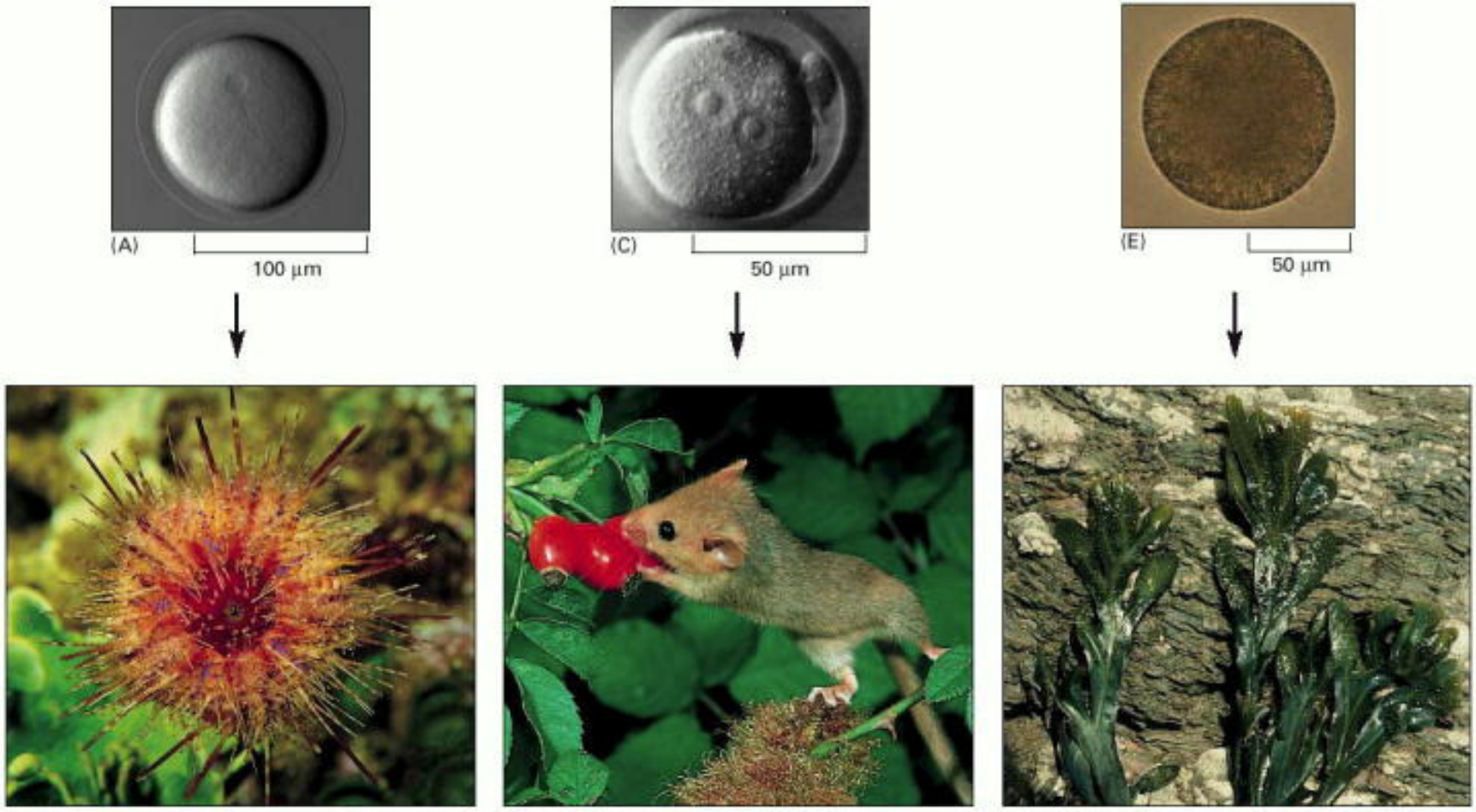
Biological Frameworks for Engineers

UNIVERSITY OF WASHINGTON

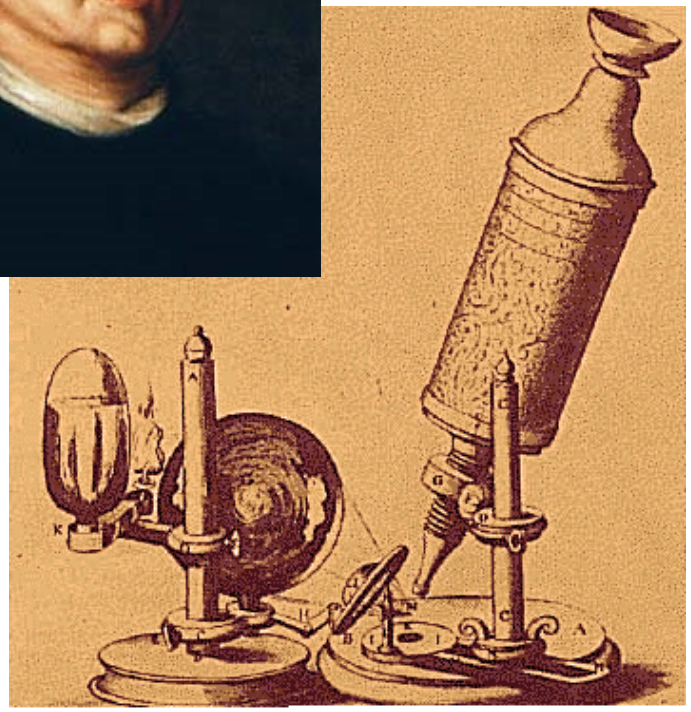
Class Organization

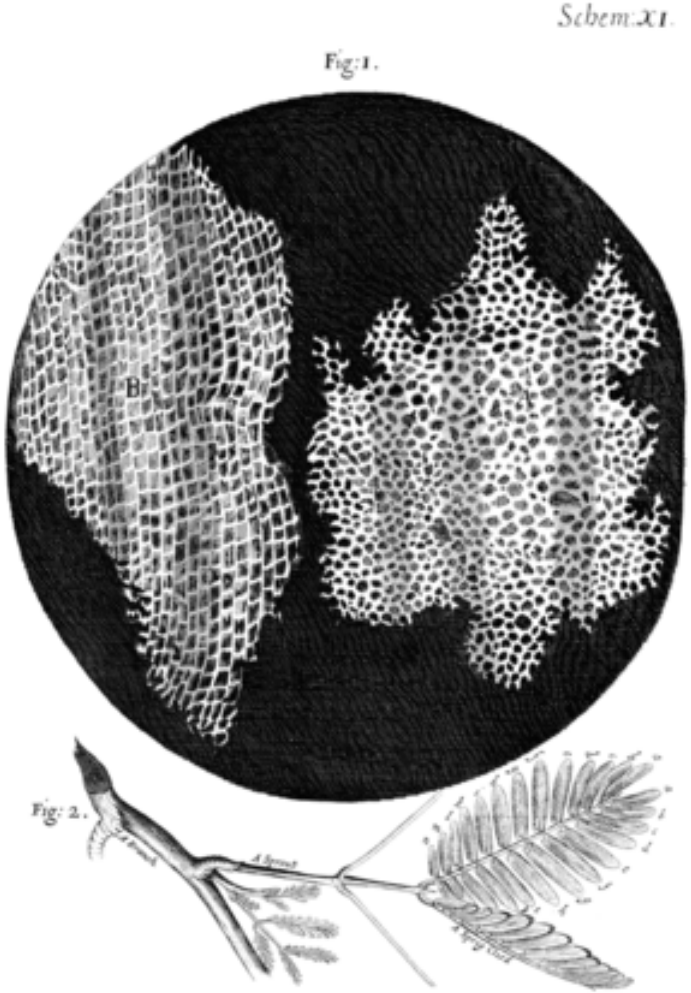
- Hw 1 due on Friday
- Grad project available online

What are Cells?

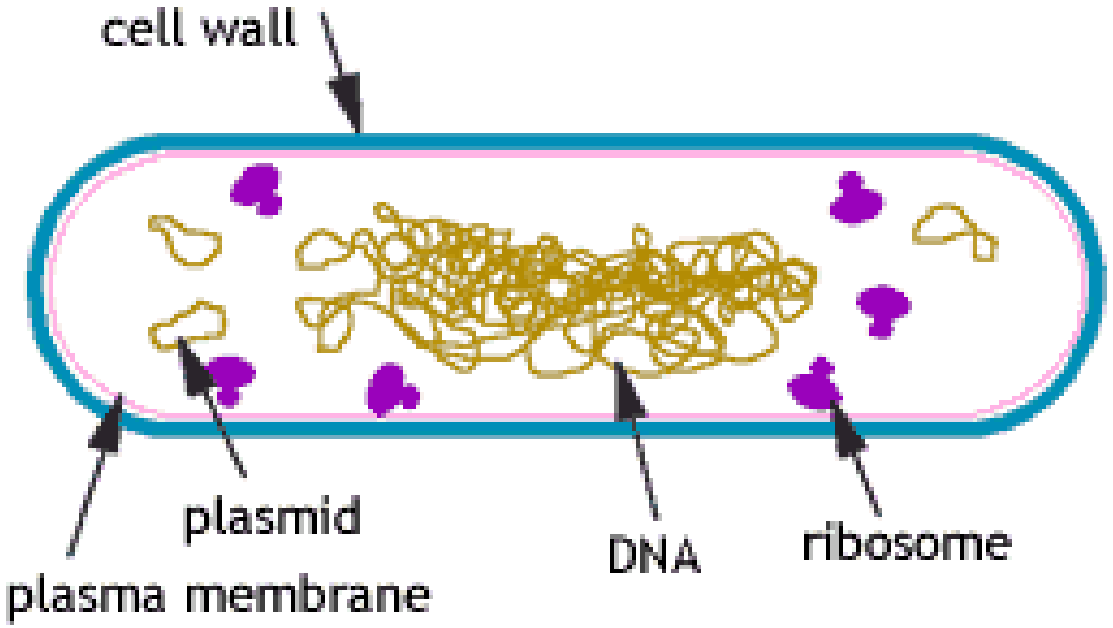


Robert Hooke

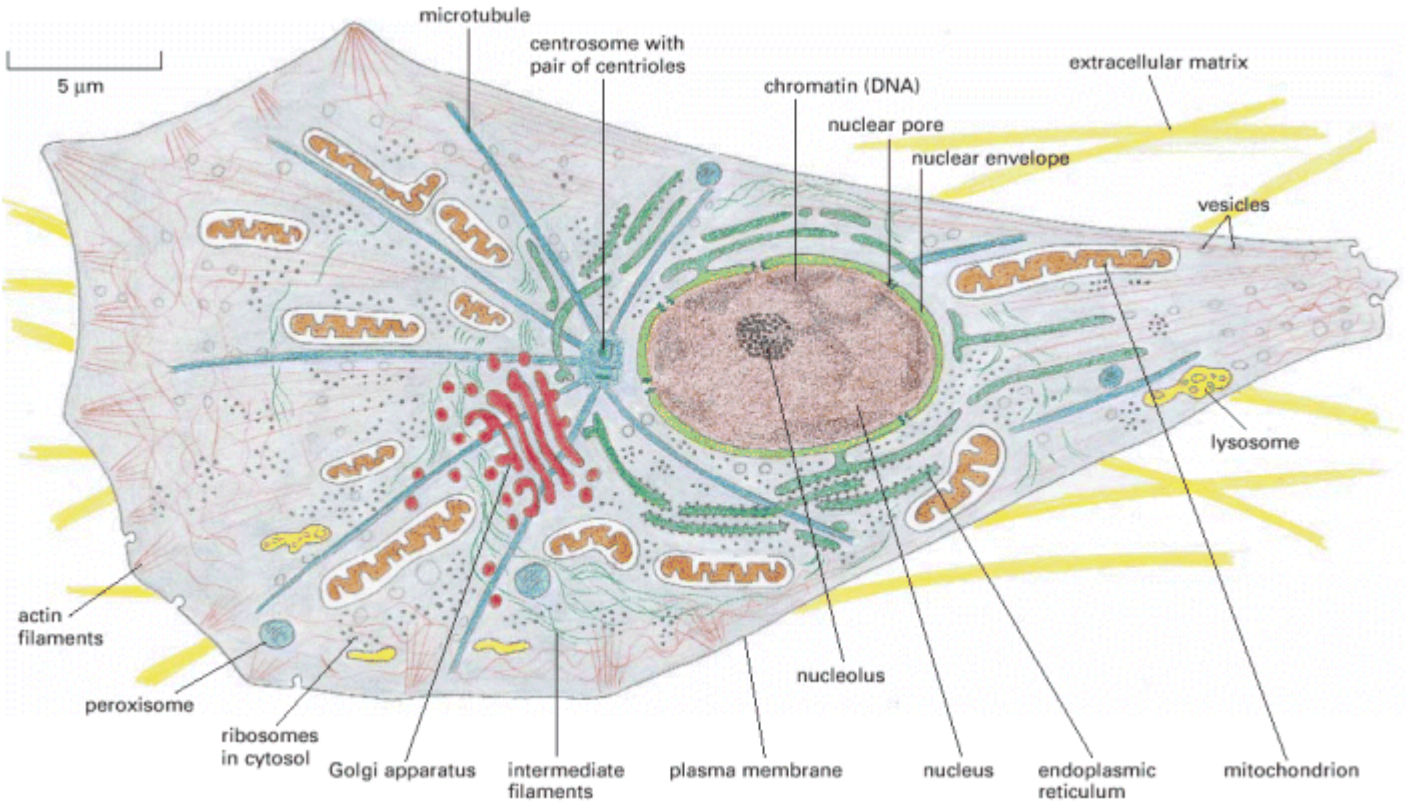




Prokaryotic Cells

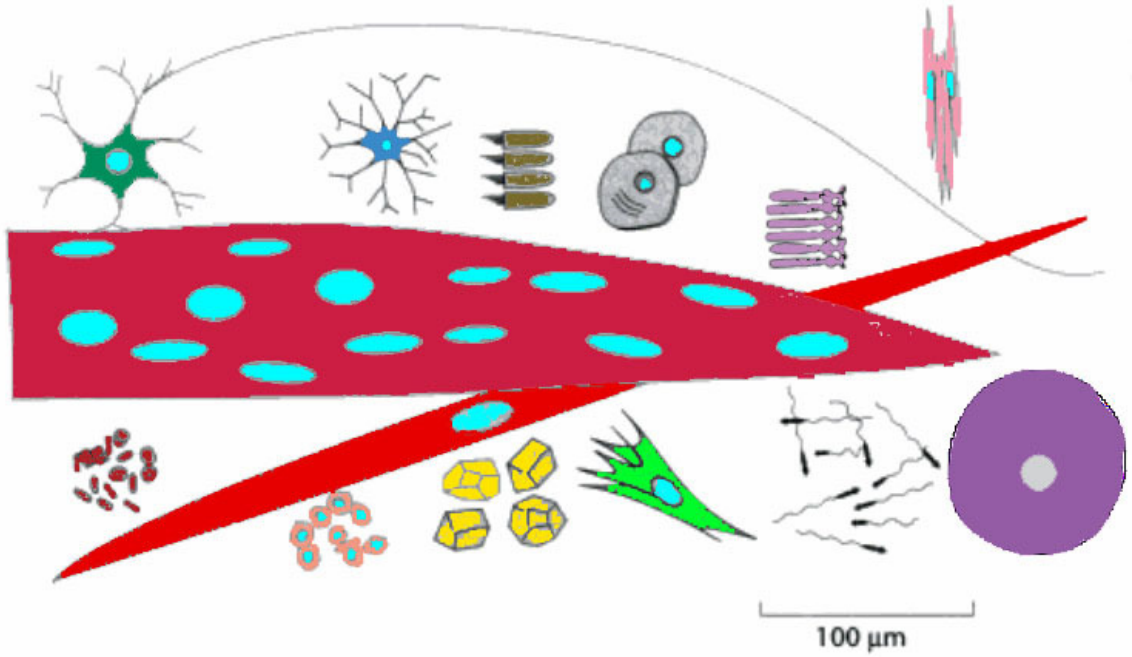


Eukaryotic Cells



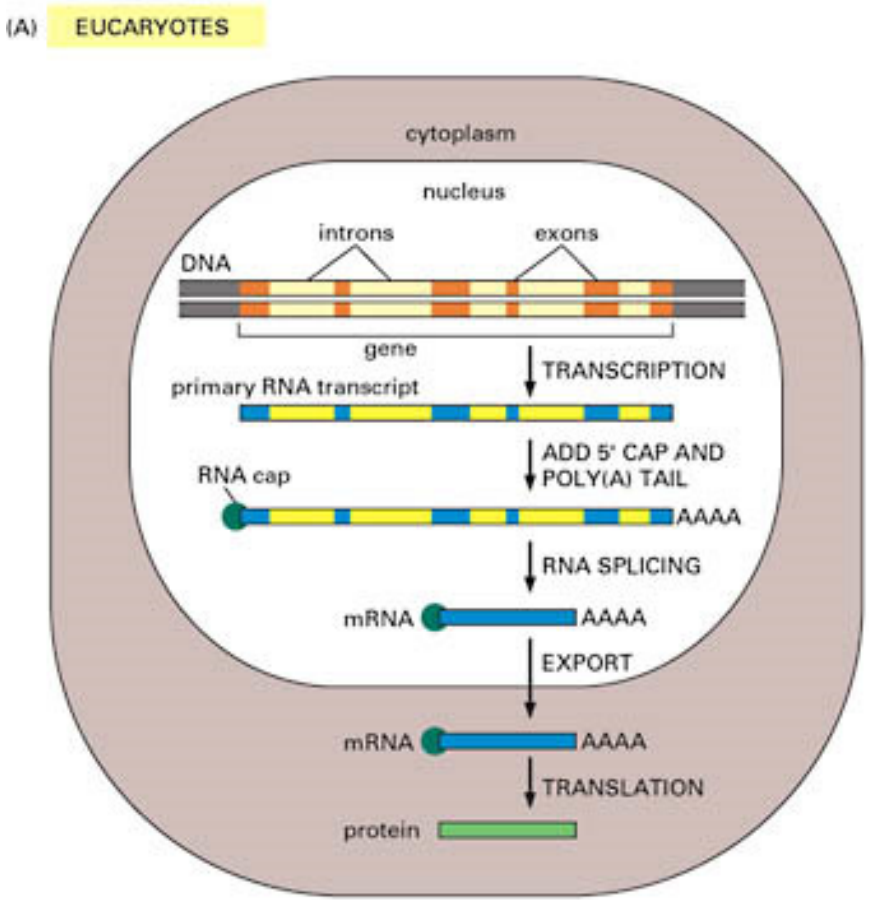
Cell Function Follows Form

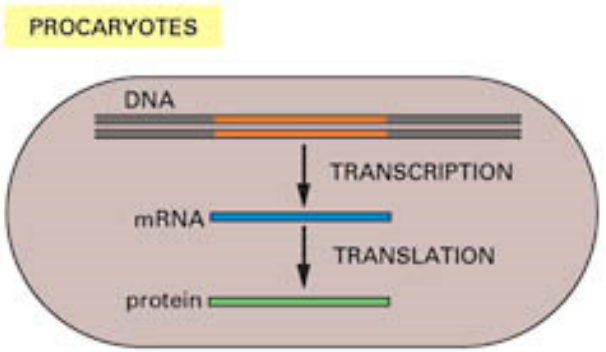
- Cell types:
  - motor neuron
  - osteocyte
  - hair cell
  - adipocyte
  - rods and cones
  - endothelials
  - skeletal muscle
  - smooth muscle
  - RBC
  - lymphocyte
  - epithelial (separated)
  - fibroblasts
  - sperm and egg cells



(Drawn to scale)

Central Dogma





Biological Frameworks for Engineers

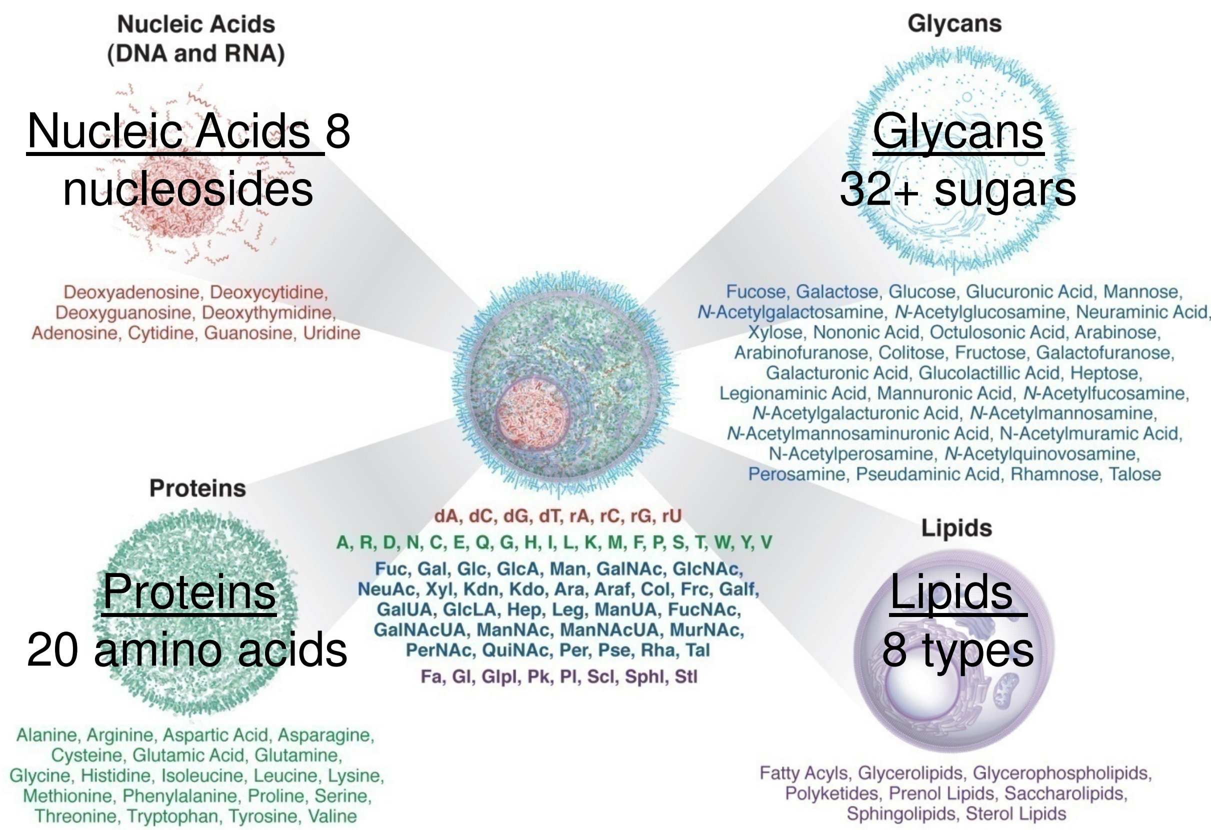
68 Basic Building Blocks

Nucleic Acids 8 nucleosides

Glycans 32+ sugars

Proteins 20 amino acids

Lipids 8 types



"From the construction, modification, and interaction of these components, the cell develops and functions." –James Marth

J. Marth *Nature Cell Biology*, 2008,10(9):1015-16

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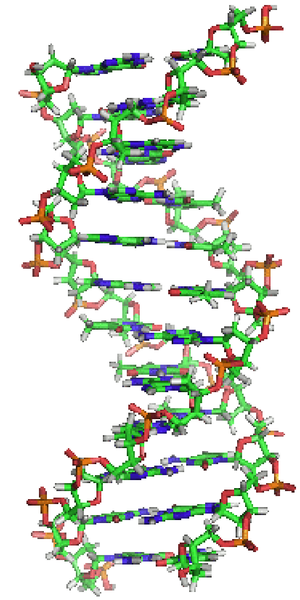
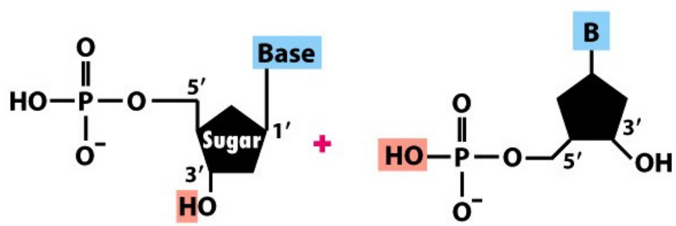
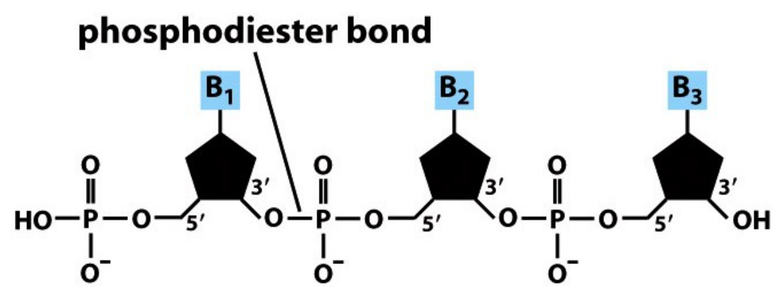
Nucleic Acids



- DNA (genetic storage)
- RNA (data transfer)
- ATP (energy unit)
- GTP (protein function)



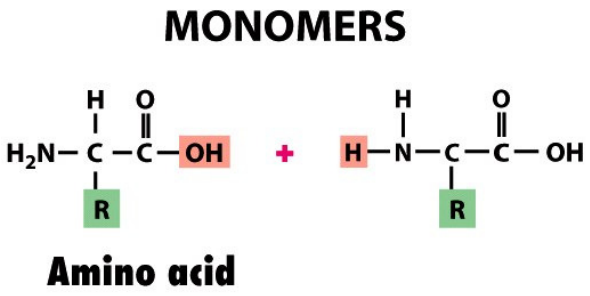
Nucleotide

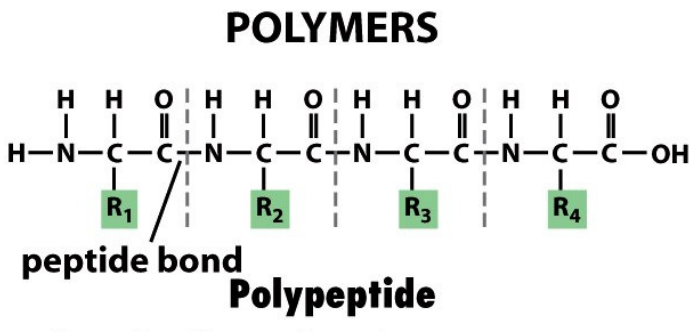


Nucleic acid

Proteins

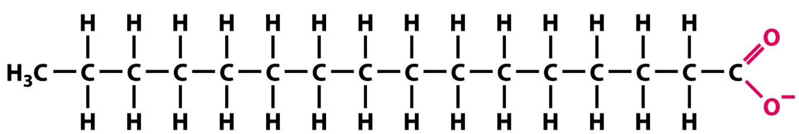
- Cytoskeletal proteins (structure)
- Enzymes (reactions)
- Surface receptors (function)
- Regulatory (activity maintenance)



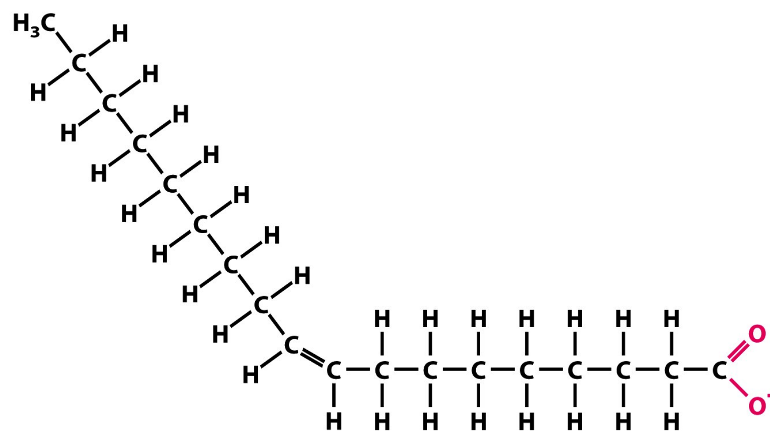


Lipids

- Fatty Acids (energy storage)
  - Hydrocarbon chain + carboxyl
  - Saturated (no C=C bonds)
  - Unsaturated (more than one C=C bond)



Palmitate
(ionized form of palmitic acid)



Oleate
(ionized form of oleic acid)

Biological Frameworks for Engineers

Lipids

- Fatty Acids (energy storage)
- Phospholipids (membranes)
  - 2 chains + glycerol + phosphate + polar group
  - Non-covalent bonding to form sheets

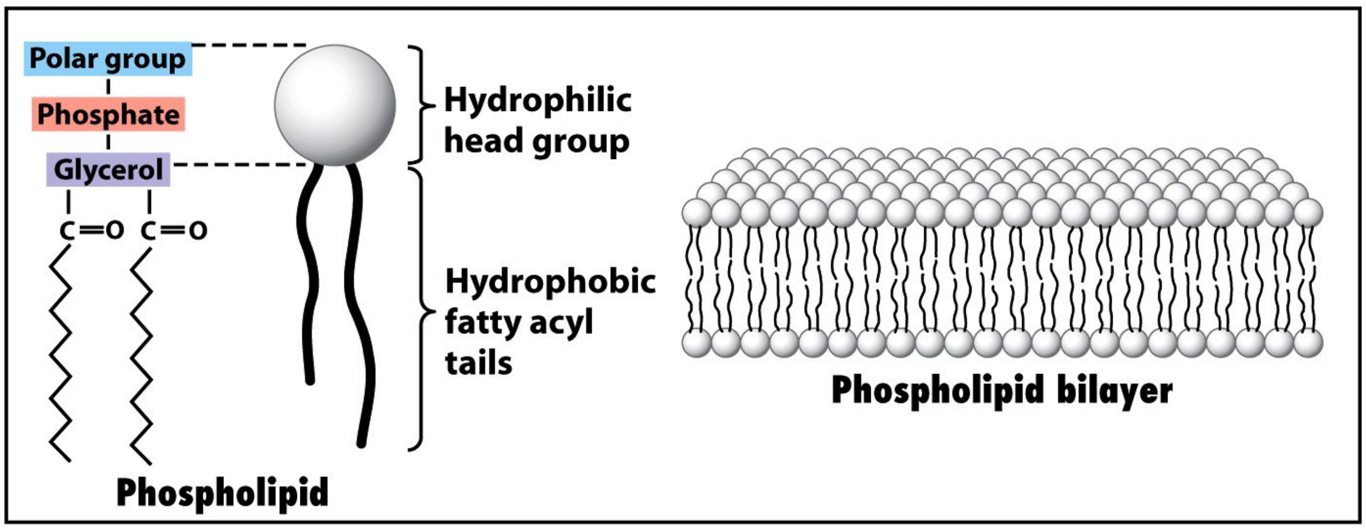


Figure 2-13 part 2
Molecular Cell Biology, Sixth Edition

Glycans

- Saccharides (energy)
  - Simple sugars
  - Hydrated carbons (C, H, O)

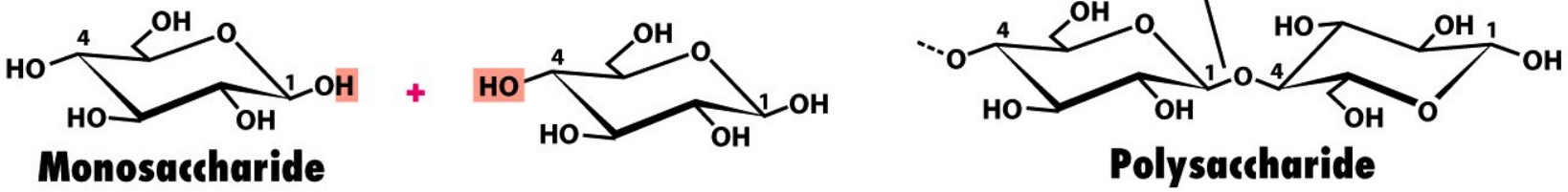
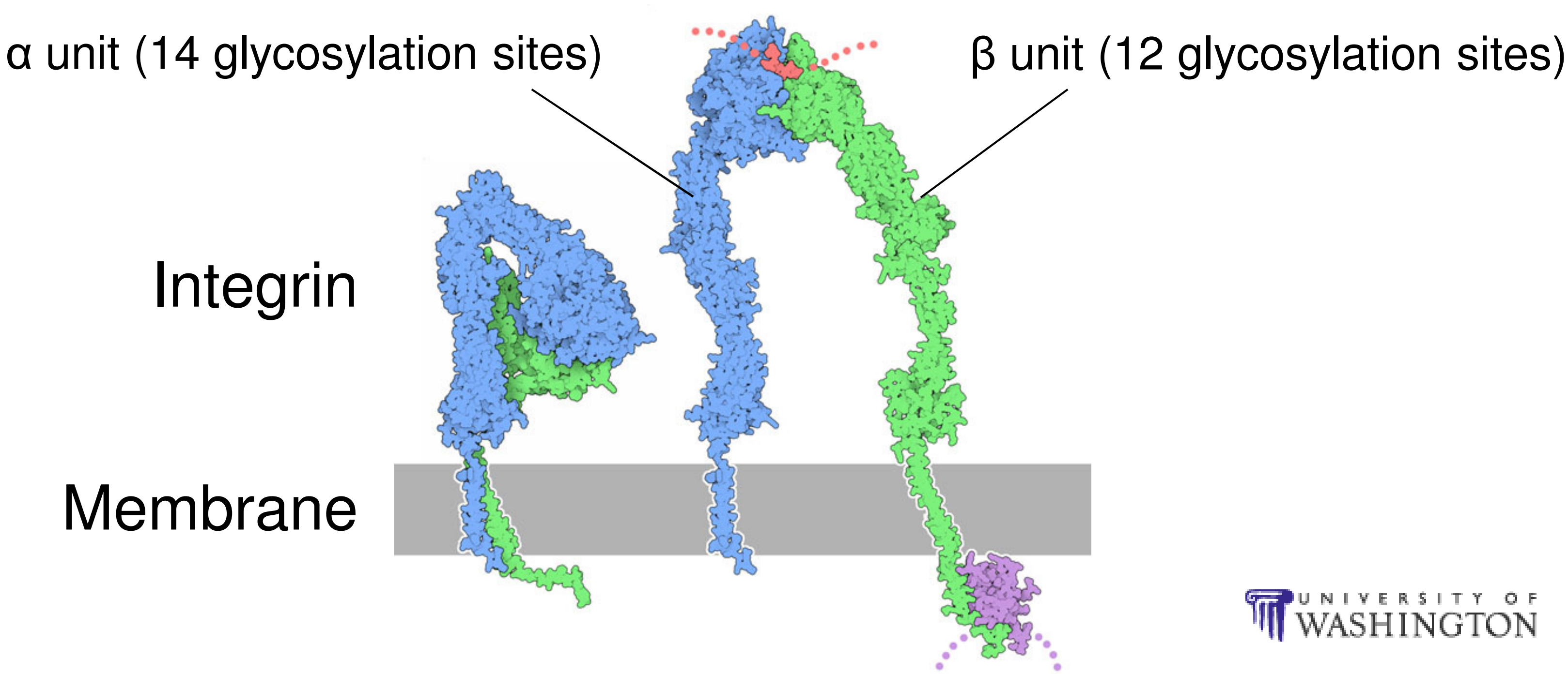


Figure 2-13 part 1
Molecular Cell Biology, Sixth Edition

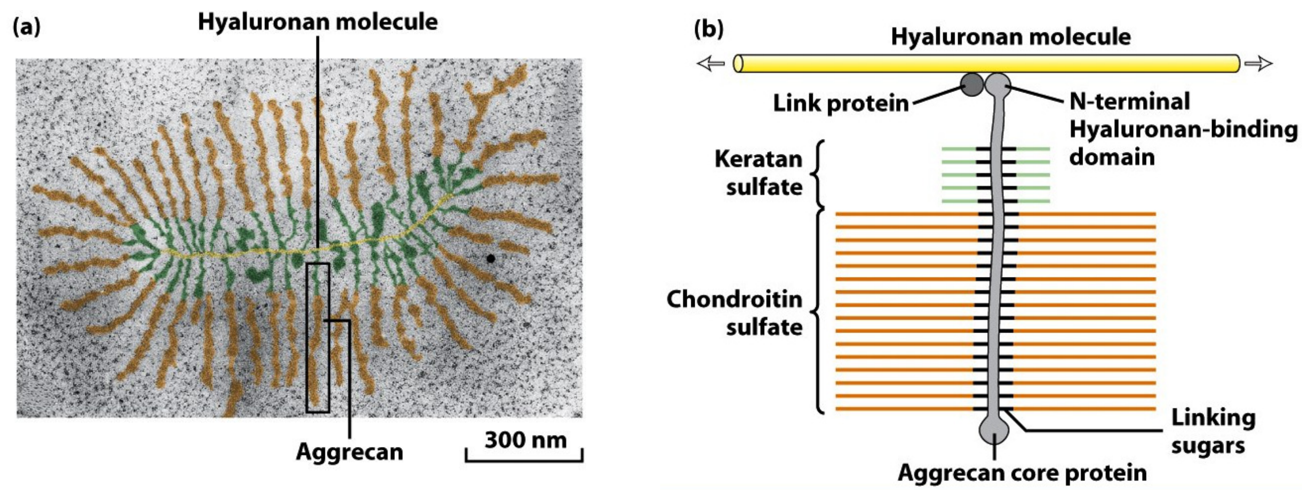
Glycans

- Saccharides (energy)
- Glycoprotein (receptors)
  - Protein with a covalently attached sugar



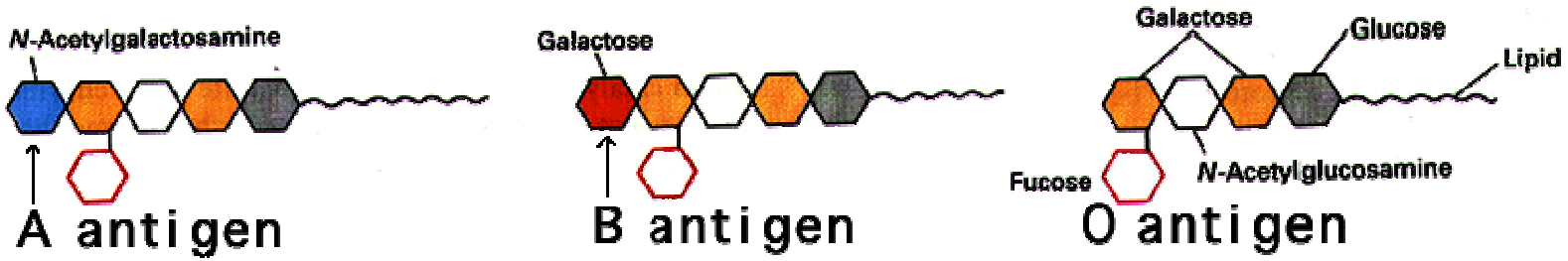
Glycans

- Saccharides (energy)
- Glycoprotein (receptors)
- Proteoglycan (extracellular matrix)
  - Protein with glycosaminoglycans (GAGs)



Glycans

- Saccharides (energy)
- Glycoprotein (receptors)
- Proteoglycan (extracellular matrix)
- Glycolipid (identification)
  - Sugar + lipid



Cells

Factory Parallels with Cells

a. The building framework
b. Doors
c. Internal walls
d. The machines that make products
e. The central computer
f. The central computer room (eukaryotic cells only)
g. The combustion engine
h. The solar cell (photosynthetic organisms)

Cells

Factory Parallels with Cells

a. The building framework *cell wall, cytoskeleton, cell membrane*

b. Doors

c. Internal walls

d. The machines that make products

e. The central computer

f. The central computer room (eukaryotic cells only)

g. The combustion engine

h. The solar cell (photosynthetic organisms)

Cells

Factory Parallels with Cells

a. The building framework *cell wall, cytoskeleton, cell membrane*

b. Doors *pumps, transporters, vesicles, pores*

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Cells

Factory Parallels with Cells

a. The building framework *cell wall, cytoskeleton, cell membrane*

b. Doors *pumps, transporters, vesicles, pores*

c. Internal walls *cell membrane, organelle membranes*

d. The machines that make products

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Cells

Factory Parallels with Cells

a. The building framework *cell wall, cytoskeleton, cell membrane*
b. Doors *pumps, transporters, vesicles, pores*
c. Internal walls *cell membrane, organelle membranes*
d. The machines that make products *enzymes, ribosomes*
e. The central computer
f. The central computer room (eukaryotic cells only)
g. The combustion engine
h. The solar cell (photosynthetic organisms)

Cells

Factory Parallels with Cells

a. The building framework *cell wall, cytoskeleton, cell membrane*
b. Doors *pumps, transporters, vesicles, pores*
c. Internal walls *cell membrane, organelle membranes*
d. The machines that make products *enzymes, ribosomes*
e. The central computer *DNA/chromosomes/genome*
f. The central computer room (eukaryotic cells only)
g. The combustion engine
h. The solar cell (photosynthetic organisms)

Cells

Factory Parallels with Cells

a. The building framework — *cell wall, cytoskeleton, cell membrane*
b. Doors — *pumps, transporters, vesicles, pores*
c. Internal walls — *cell membrane, organelle membranes*
d. The machines that make products — *enzymes, ribosomes*
e. The central computer — *DNA/chromosomes/genome*
f. The central computer room (eukaryotic cells only) — *nucleus*
g. The combustion engine
h. The solar cell (photosynthetic organisms)

Cells

Factory Parallels with Cells

a. The building framework *cell wall, cytoskeleton, cell membrane*

b. Doors *pumps, transporters, vesicles, pores*

c. Internal walls *cell membrane, organelle membranes*

d. The machines that make products *enzymes, ribosomes*

e. The central computer *DNA/chromosomes/genome*

f. The central computer room (eukaryotic cells only) *nucleus*

g. The combustion engine *mitochondria (cell membrane)*

h. The solar cell (photosynthetic organisms)

Cells

Factory Parallels with Cells

a. The building framework *cell wall, cytoskeleton, cell membrane*

b. Doors *pumps, transporters, vesicles, pores*

c. Internal walls *cell membrane, organelle membranes*

d. The machines that make products *enzymes, ribosomes*

e. The central computer *DNA/chromosomes/genome*

f. The central computer room (eukaryotic cells only) *nucleus*

g. The combustion engine *mitochondria (cell membrane)*

h. The solar cell (photosynthetic organisms) *chloroplasts*

Questions ?