

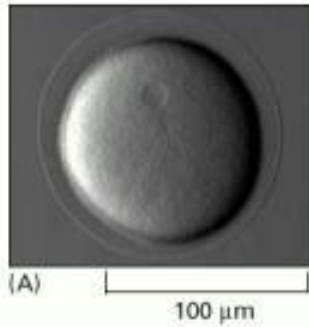
ME 411 / ME 511

# Biological Frameworks for Engineers

# Class Organization

- HW 1 due on Friday
- HW 2 available online
- Grad project available online

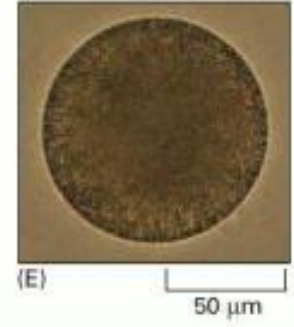
# What are Cells?



(B) Sea Urchin

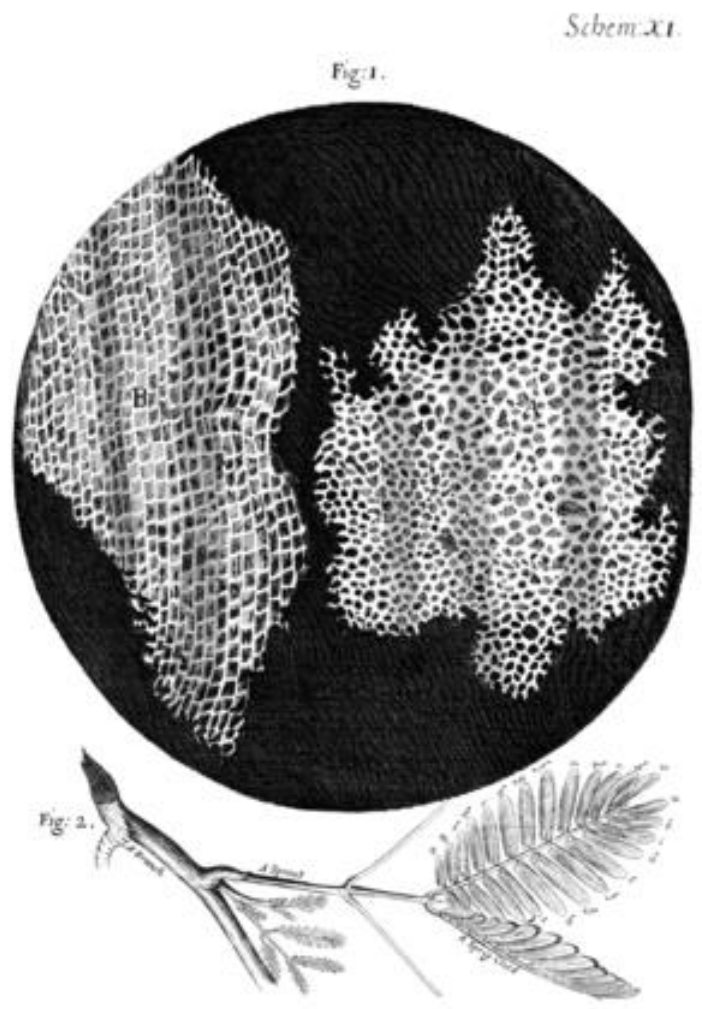
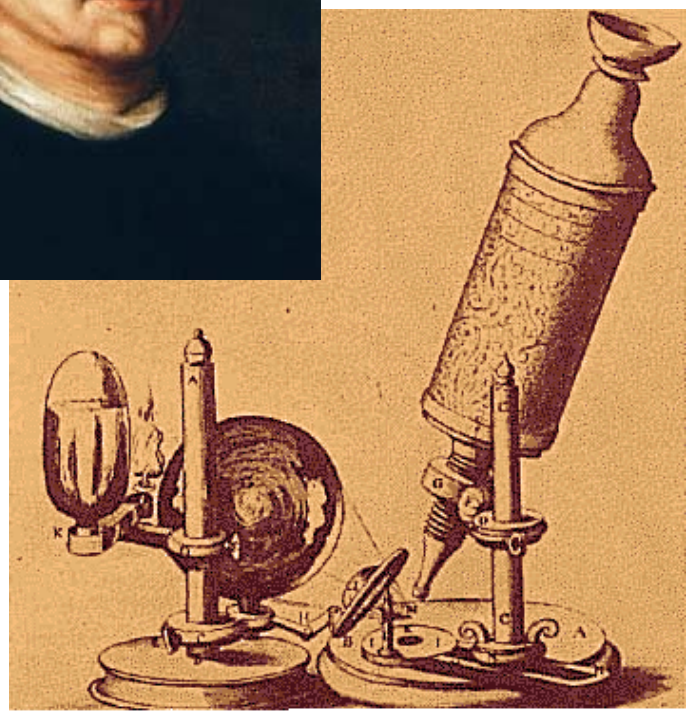


(D) Mouse

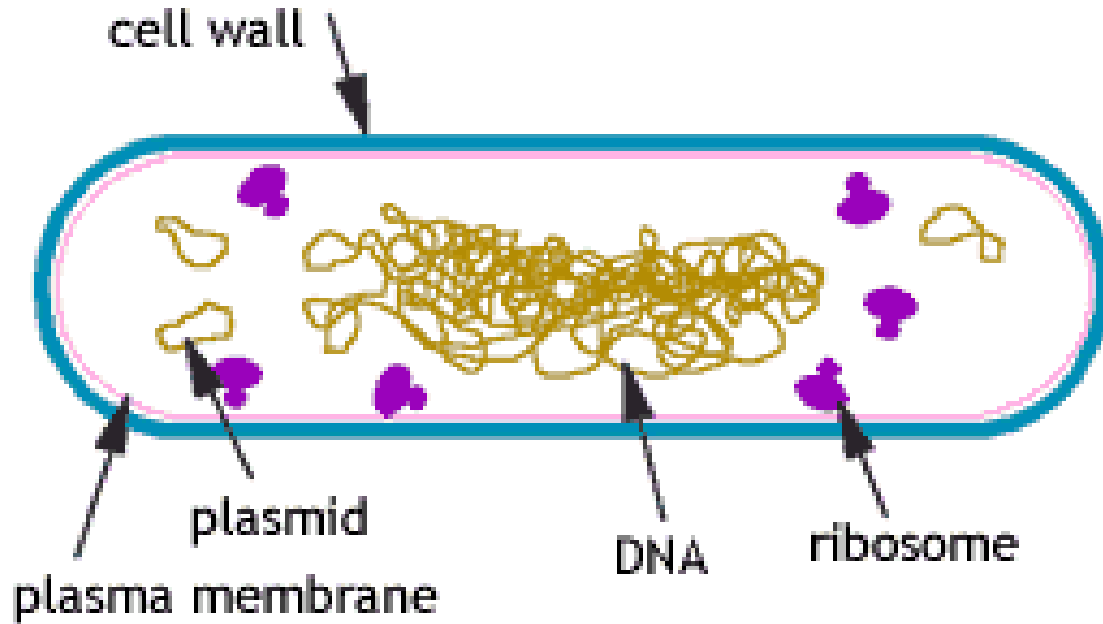


(F) Seaweed

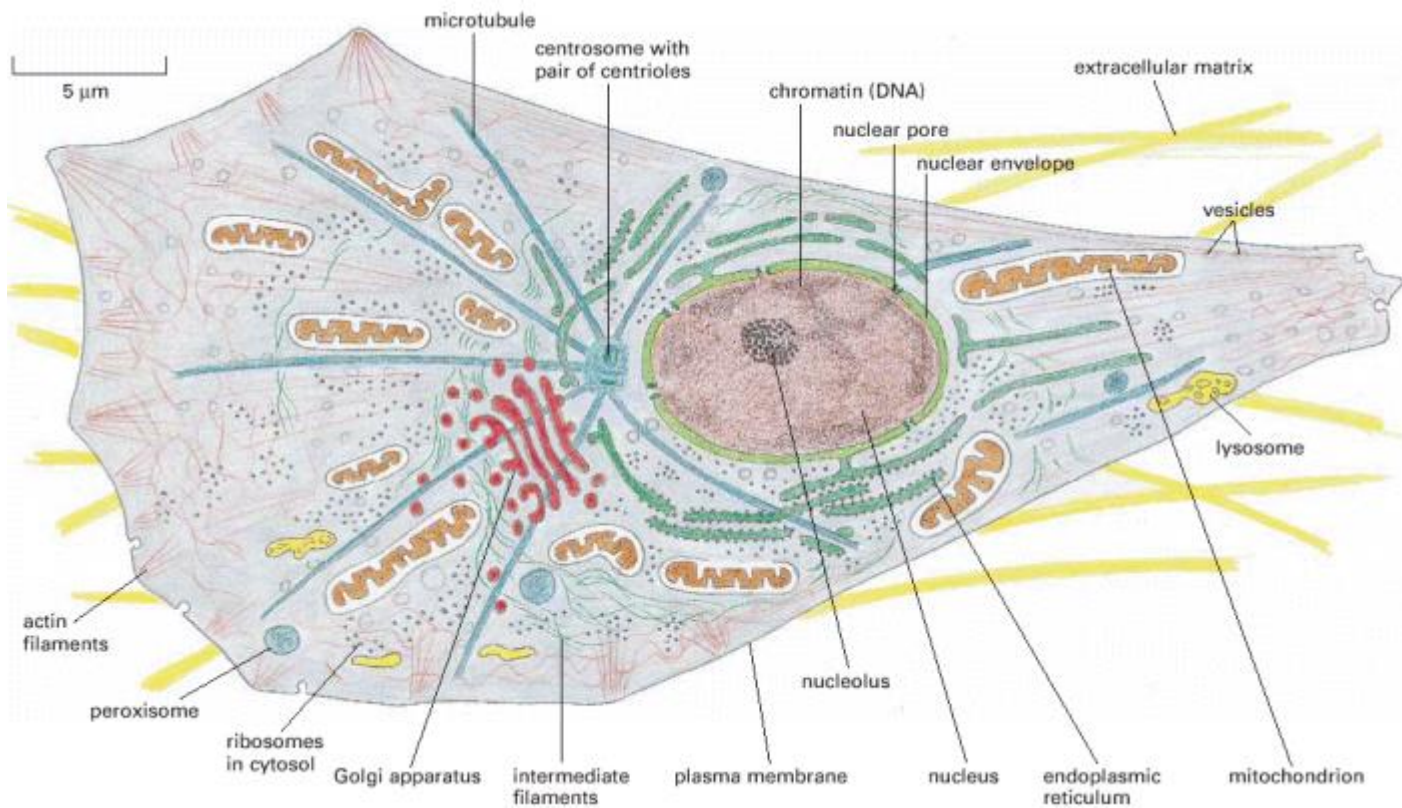
# Robert Hooke



# Prokaryotic Cells

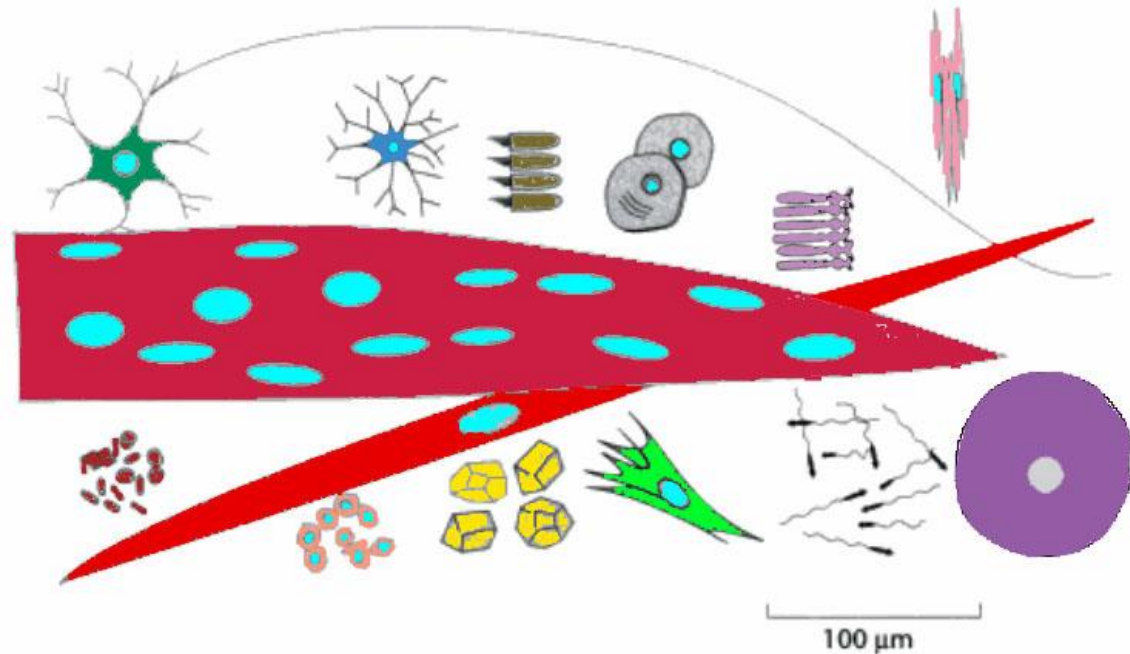


# Eukaryotic Cells



# Cell Function Follows Form

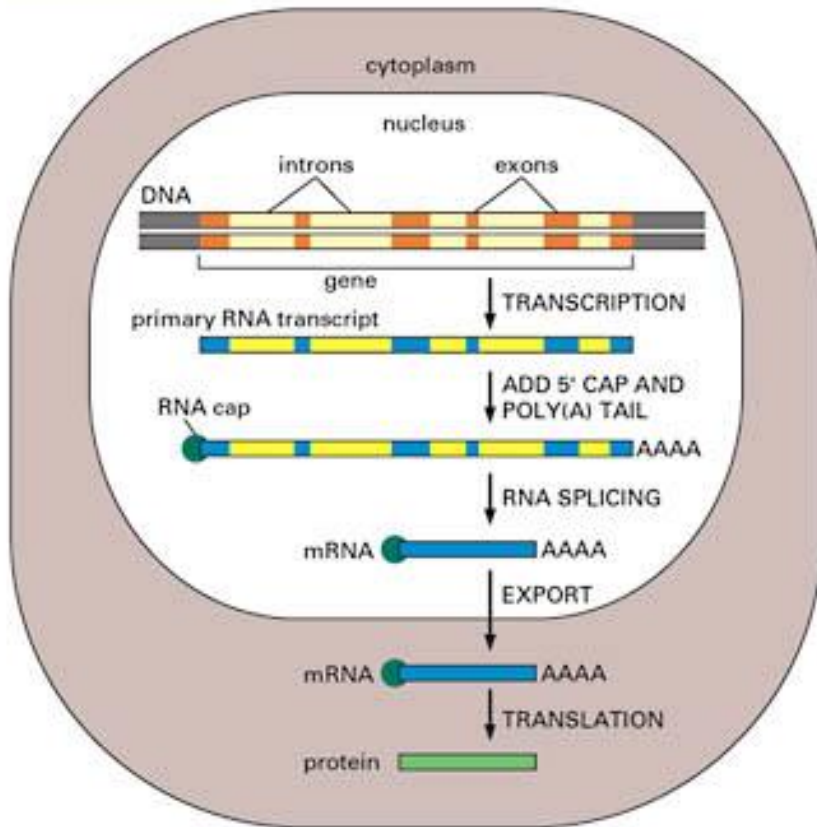
- Cell types:
  - motor neuron
  - osteocyte
  - hair cell
  - adipocyte
  - rods and cones
  - endothelials
  - skeletal muscle
  - smooth muscle
  - RBC
  - lymphocyte
  - epithelial (separated)
  - fibroblasts
  - sperm and egg cells



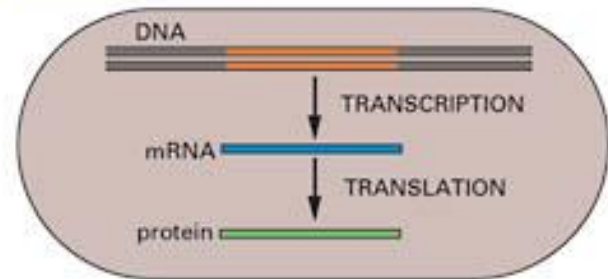
(Drawn to scale)

# Central Dogma

(A) EUCARYOTES

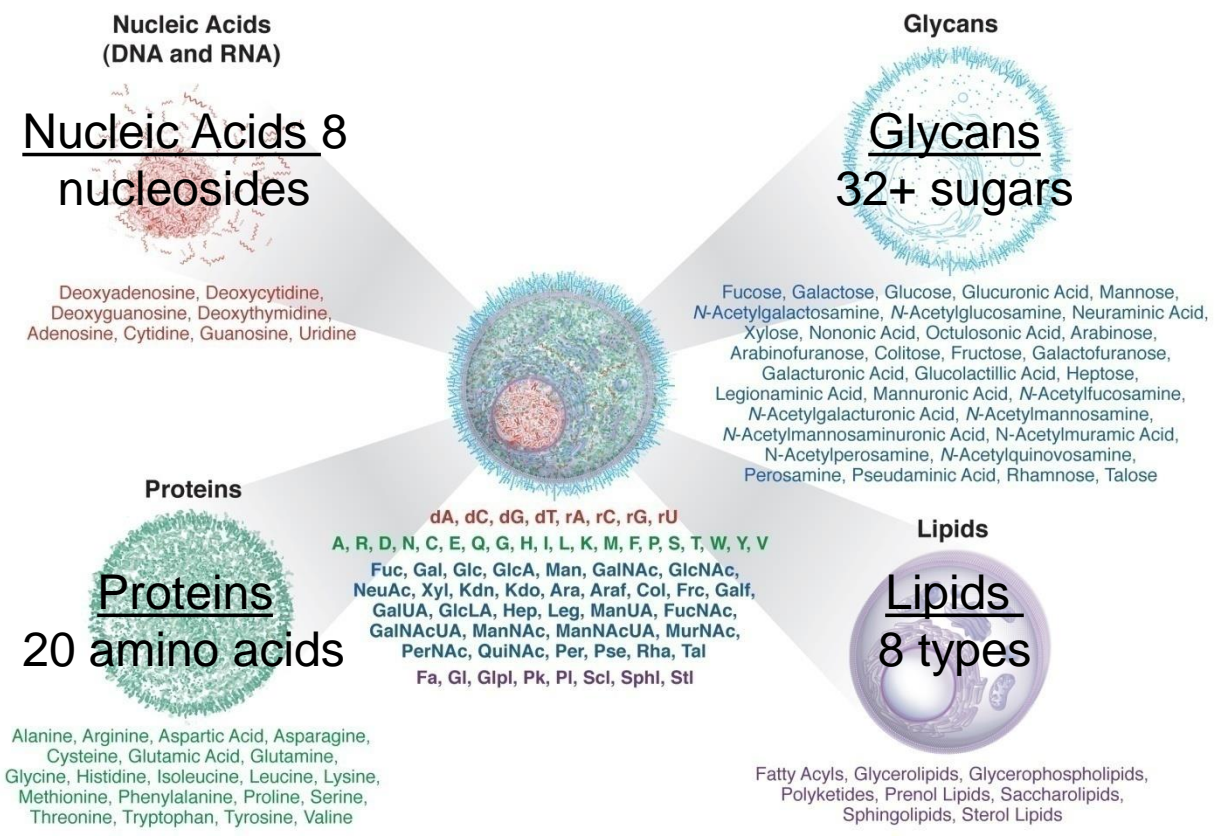


(B) PROCARYOTES





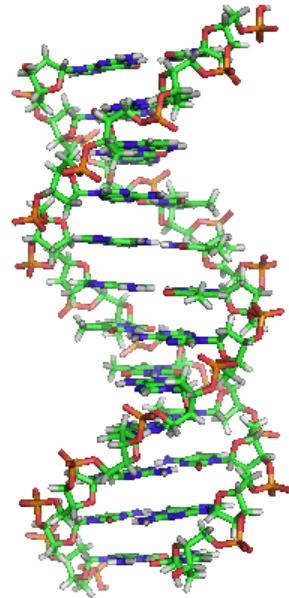
# 68 Basic Building Blocks



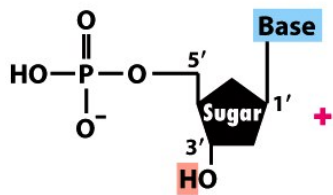
“From the construction, modification, and interaction of these components, the cell develops and functions.” –James Marth

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

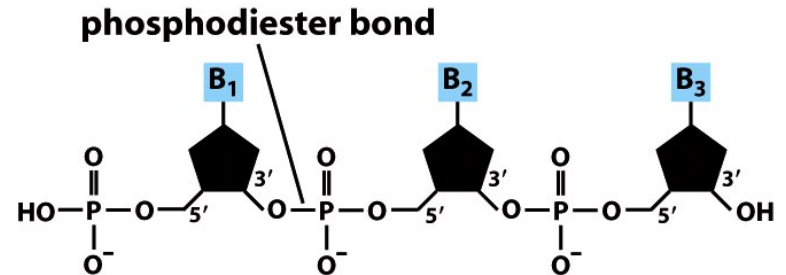
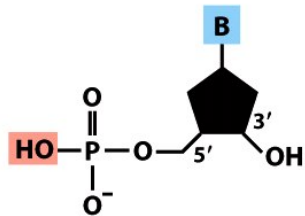
# Nucleic Acids



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



**Nucleotide**

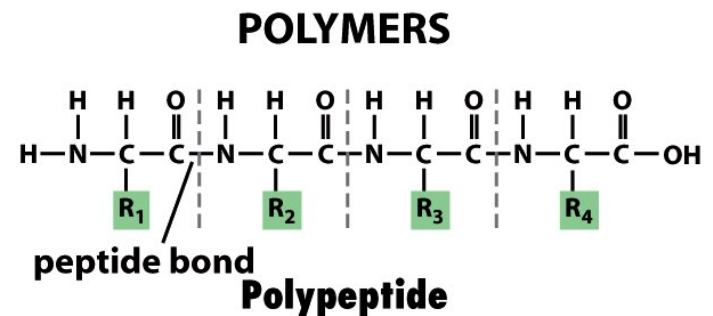
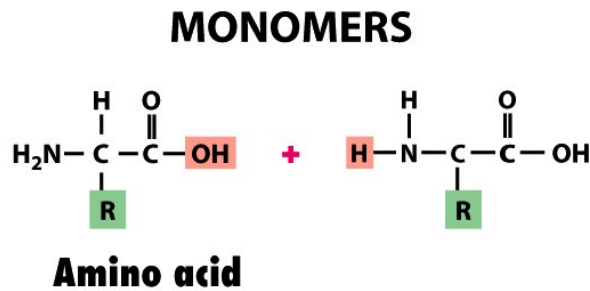


**Nucleic acid**

# Proteins



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





# Lipids



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

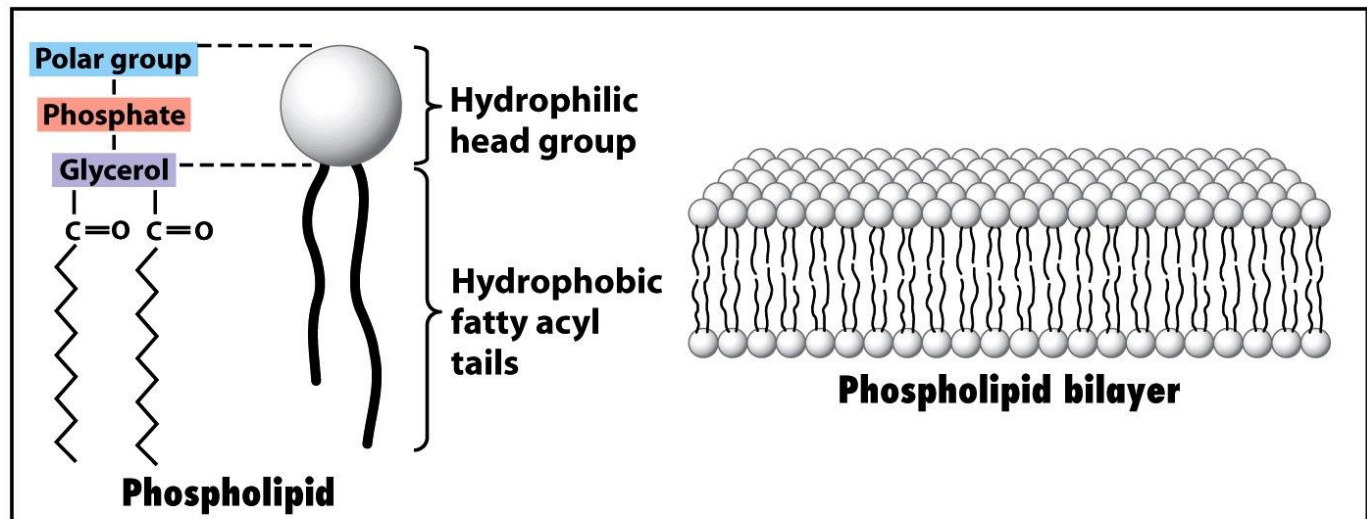
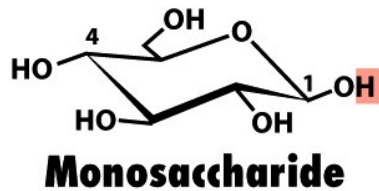


Figure 2-13 part 2  
*Molecular Cell Biology, Sixth Edition*  
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# Glycans



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



+

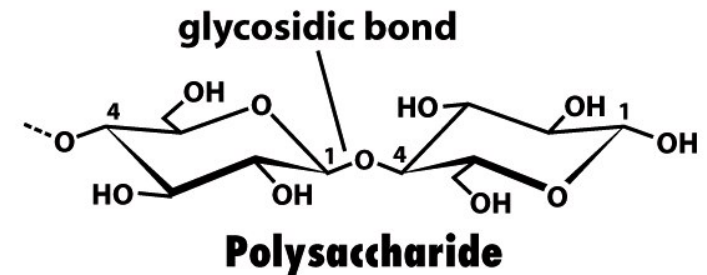
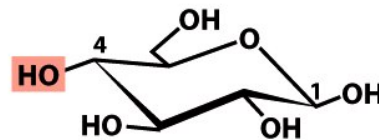


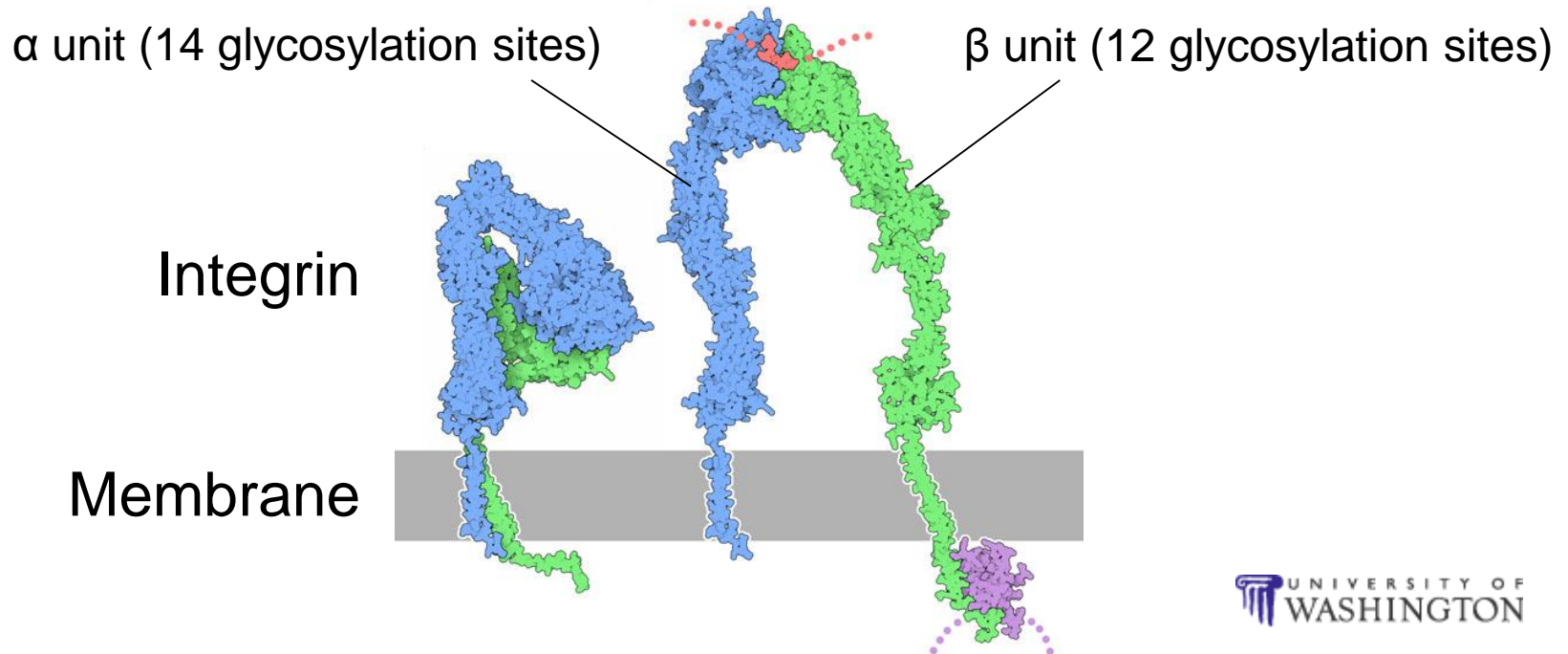
Figure 2-13 part 1  
*Molecular Cell Biology, Sixth Edition*  
 © 2008 W. H. Freeman and Company

# Glycans



wiseGEEK

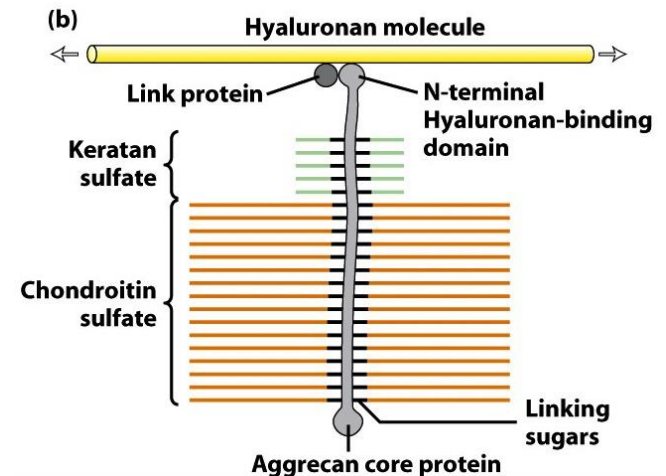
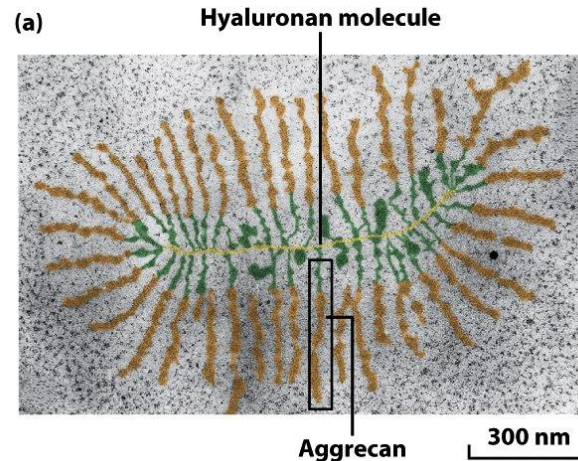
- Saccharides (energy)
- Glycoprotein (receptors)
  - Protein with a covalently attached sugar



# Glycans



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

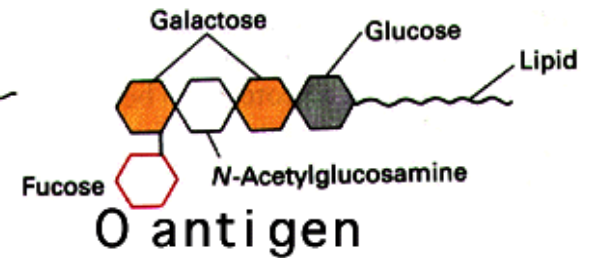
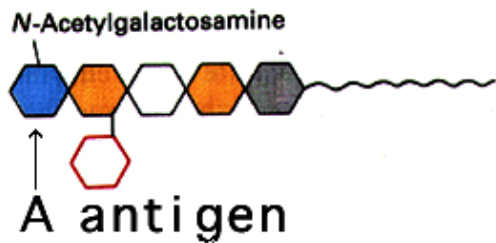




# Glycans



- 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. Solar cells (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
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- f. The central computer room (eukaryotic cells only)
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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
- d. The machines that make products
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# Cells

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- a. The building framework *cell wall, cytoskeleton, cell membrane*
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# Cells

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- 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)
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# Cells

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- 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. Solar cells (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. Solar cells (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. Solar cells (photosynthetic organisms) *chloroplasts*

# Building Blocks

- What do you get when you combine?
  - a. Glycan + Glycan =
  - b. Glycan + an amino Glycan =
  - c. Protein + Glycan =
  - d. Lipid + Glycan =
  - e. Glycan + Glycan + ... + Glycan =
  - f. (Part b) + (Part b) + ... + (Part b) =
  - g. Protein + (Part f) =
  - h. Lipid + Protein =

# Building Blocks

- What do you get when you combine?
  - a. Glycan + Glycan = **disaccharide**
  - b. Glycan + an amino Glycan =
  - c. Protein + Glycan =
  - d. Lipid + Glycan =
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# Building Blocks

- What do you get when you combine?
  - a. Glycan + Glycan = **disaccharide**
  - b. Glycan + an amino Glycan = **disaccharide**
  - c. Protein + Glycan = **glycoprotein**
  - d. Lipid + Glycan =
  - e. Glycan + Glycan + ... + Glycan =
  - f. (Part b) + (Part b) + ... + (Part b) =
  - g. Protein + (Part f) =
  - h. Lipid + Protein =

# Building Blocks

- What do you get when you combine?
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  - d. Lipid + Glycan = **glycolipid**
  - e. Glycan + Glycan + ... + Glycan = **polysaccharide**
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  - g. Protein + (Part f) =
  - h. Lipid + Protein =



# Building Blocks

- What do you get when you combine?
  - a. Glycan + Glycan = **disaccharide**
  - b. Glycan + an amino Glycan = **disaccharide**
  - c. Protein + Glycan = **glycoprotein**
  - d. Lipid + Glycan = **glycolipid**
  - e. Glycan + Glycan + ... + Glycan = **polysaccharide**
  - f. (Part b) + (Part b) + ... + (Part b) = **glycoaminoglycan, GAG**
  - g. Protein + (Part f) =
  - h. Lipid + Protein =

# Building Blocks

- What do you get when you combine?
  - a. Glycan + Glycan = **disaccharide**
  - b. Glycan + an amino Glycan = **disaccharide**
  - c. Protein + Glycan = **glycoprotein**
  - d. Lipid + Glycan = **glycolipid**
  - e. Glycan + Glycan + ... + Glycan = **polysaccharide**
  - f. (Part b) + (Part b) + ... + (Part b) = **glycoaminoglycan, GAG**
  - g. Protein + (Part f) = **proteoglycan**
  - h. Lipid + Protein =

# Building Blocks

- What do you get when you combine?
  - a. Glycan + Glycan = **disaccharide**
  - b. Glycan + an amino Glycan = **disaccharide**
  - c. Protein + Glycan = **glycoprotein**
  - d. Lipid + Glycan = **glycolipid**
  - e. Glycan + Glycan + ... + Glycan = **polysaccharide**
  - f. (Part b) + (Part b) + ... + (Part b) = **glycoaminoglycan, GAG**
  - g. Protein + (Part f) = **proteoglycan**
  - h. Lipid + Protein = **lipid-anchored protein (prenylation)**

Questions ?