ME 411 / ME 511

Biological Frameworks for Engineers



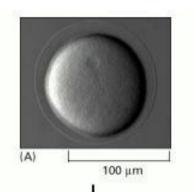
Class Organization

• HW 1 due on Friday

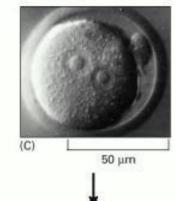
- HW 2 available online
- Grad project available online

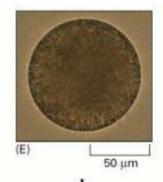


What are Cells?



Jogical Frameworks for Engineers







Sea Urchin

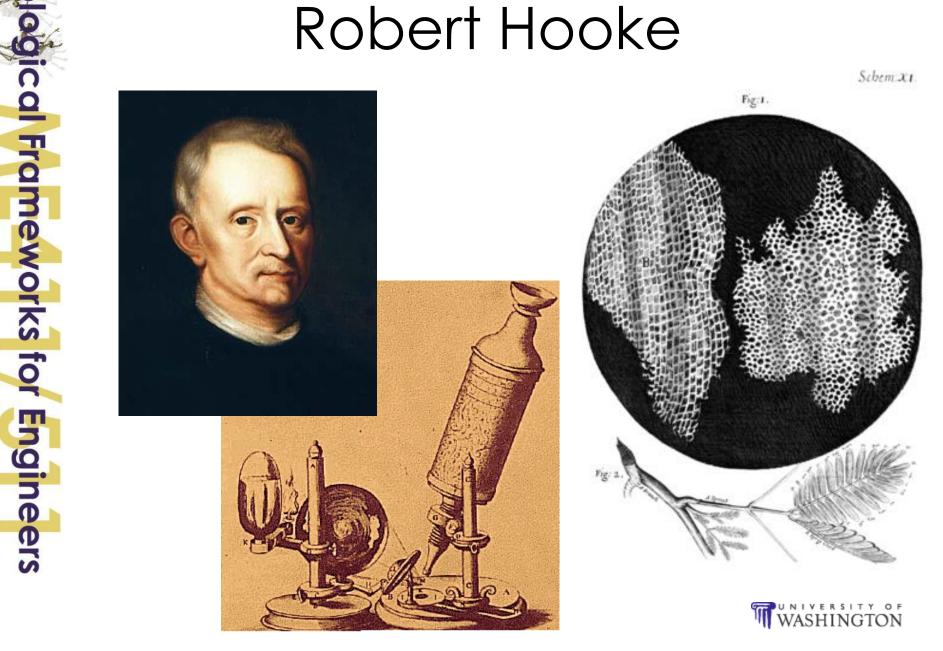


Mouse

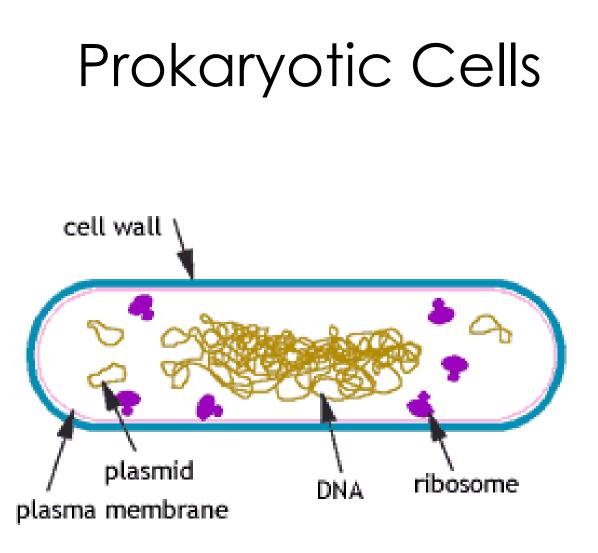


Seaweed WASHINGTON

Robert Hooke

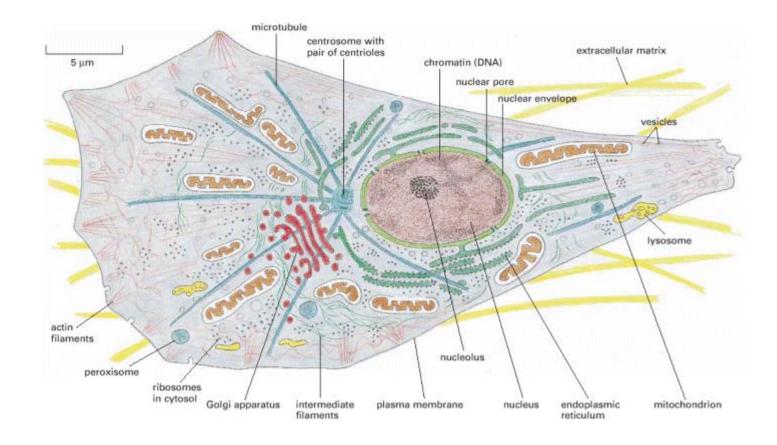








Eukaryotic Cells





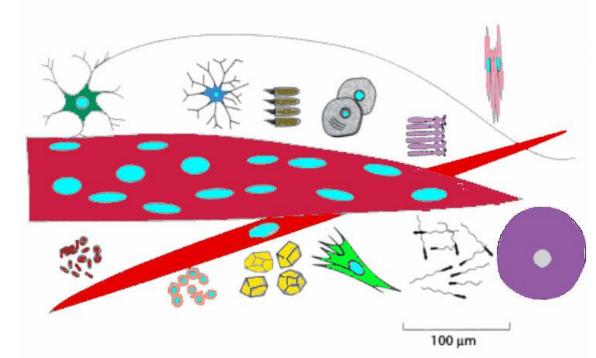
Cell Function Follows Form

- Cell types:
 - motor neuron
 - osteocyte
 - hair cell

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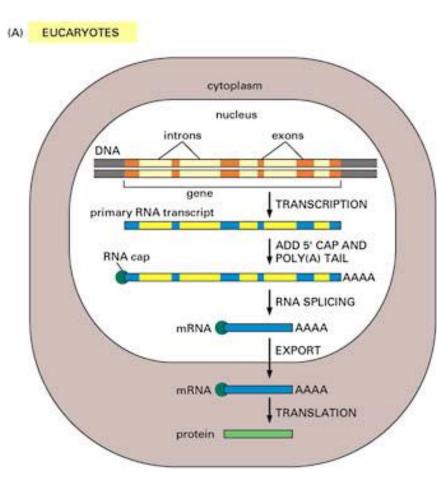
- adipocyte
- rods and cones
- endothelials
- skeletal muscle
- smooth muscle
- RBC
- lymphocyte
- epithelial (separated)
- fibroblasts
- sperm and egg cells



(Drawn to scale)

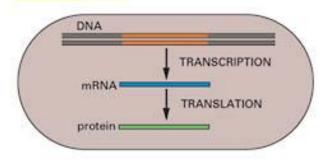


Central Dogma



logical Frameworks for Engineers

(B) PROCARYOTES







68 Basic Building Blocks

Nucleic Acids (DNA and RNA)



Deoxyadenosine, Deoxycytidine, Deoxyguanosine, Deoxythymidine, Adenosine, Cytidine, Guanosine, Uridine



Fucose, Galactose, Glucose, Glucuronic Acid, Mannose,
N-Acetylgalactosamine, N-Acetylglucosamine, Neuraminic Acid,
Xylose, Nononic Acid, Octulosonic Acid, Arabinose,
Arabinofuranose, Colitose, Fructose, Galactofuranose,
Galacturonic Acid, Glucolactillic Acid, Heptose,
Legionaminic Acid, Mannuronic Acid, N-Acetylfucosamine,
N-Acetylgalacturonic Acid, N-Acetylmuramic Acid,
N-Acetylmannosaminuronic Acid, N-Acetylmuramic Acid,
N-Acetylperosamine, N-Acetylquinovosamine,
Perosamine, Pseudaminic Acid, Rhamnose, Talose

Proteins



Alanine, Arginine, Aspartic Acid, Asparagine, Cysteine, Glutamic Acid, Glutamine, Glycine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Proline, Serine, Threonine, Tryptophan, Tyrosine, Valine

dA, dC, dG, dT, rA, rC, rG, rU A, R, D, N, C, E, Q, G, H, I, L, K, M, F, P, S, T, W, Y, V

Fuc, Gal, Gic, GicA, Man, GalNAc, GicNAc, NeuAc, Xyl, Kdn, Kdo, Ara, Araf, Col, Frc, Galf, GalUA, GicLA, Hep, Leg, ManUA, FucNAc, GalNAcUA, ManNAc, ManNAcUA, MurNAc, PerNAc, QuiNAc, Per, Pse, Rha, Tal

Fa, Gl, Glpl, Pk, Pl, Scl, Sphl, Stl

Lipids

Lipids 8 types

Fatty Acyls, Glycerolipids, Glycerophospholipids, Polyketides, Prenol Lipids, Saccharolipids, Sphingolipids, Sterol Lipids

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

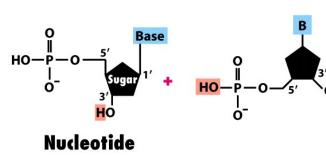
J. Marth Nature Cell Biology, 2008,10(9):1015-16

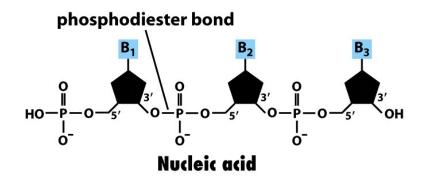




Nucleic Acids

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



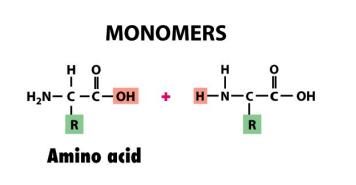


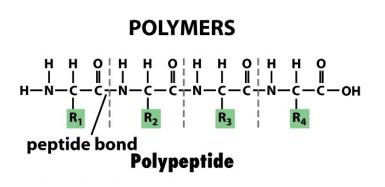


Proteins



- 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)

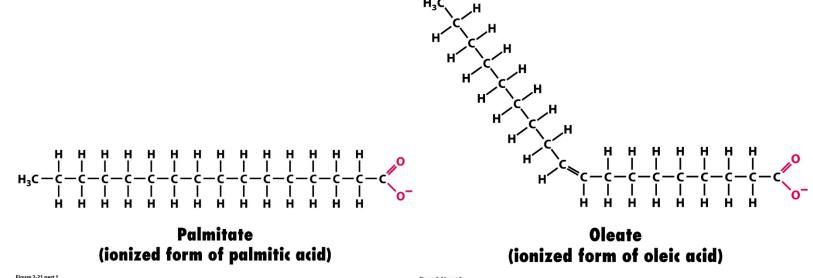


Figure 2-21 part 1 Molecular Cell Biology, Sixth Edition © 2008 W. H. Freeman and Company

Figure 2-21 part 2 Molecular Cell Biology, Sixth Edition © 2008 W. H. Freeman and Company



Lipids

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

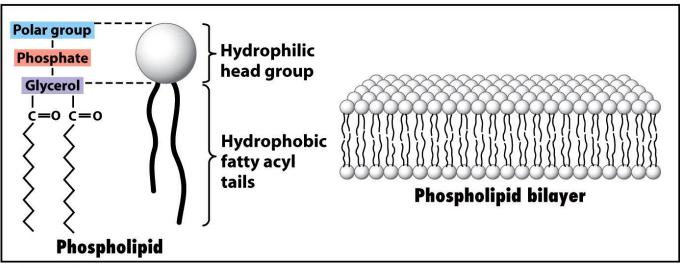


Figure 2-13 part 2 Molecular Cell Biology, Sixth Edition © 2008 W. H. Freeman and Company

OH

1_OH

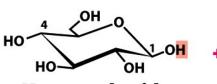
юн



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

HO

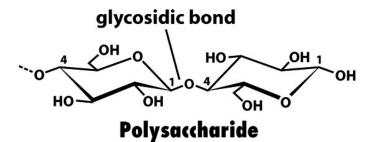
HO



Monosaccharide

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

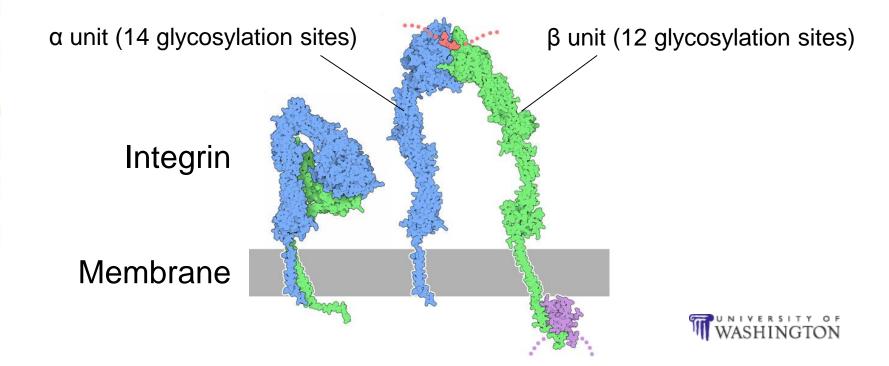






• Saccharides (energy)

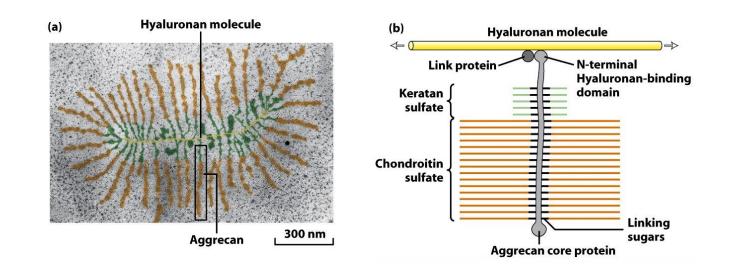
- Glycoprotein (receptors)
 - Protein with a covalently attached sugar





• Saccharides (energy)

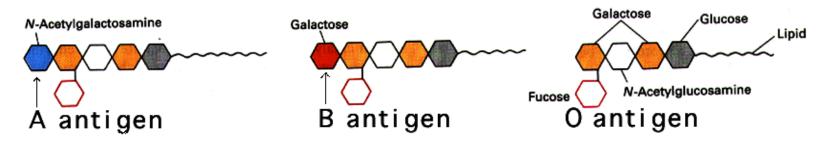
- Glycoprotein (receptors)
- Proteoglycan (extracellular matrix)
 - Protein with glycosaminoglycans (GAGs)





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

ical Frameworks for





Factory Parallels with Cells

- a. The building framework
- b. Doors

gical Frameworks for

- 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)



Factory Parallels with Cells

- a. The building framework cell wall, cytoskeleton, cell membrane
- b. Doors

gical Frameworks for

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Factory Parallels with Cells

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Engineers

cell membrane, organelle membranes

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Engineers

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enzymes, ribosomes

Factory Parallels with Cells

- a. The building framework cell wall, cytoskeleton, cell membrane
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- g. The combustion engine

gical Frameworks for

Engineers

h. Solar cells (photosynthetic organisms)



Factory Parallels with Cells

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- e. The central computer DNA/chromosomes/genome
- f. The central computer room (eukaryotic cells only) nucleus
- g. The combustion engine

ical Frameworks for

Engineers

h. Solar cells (photosynthetic organisms)



Factory Parallels with Cells

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- f. The central computer room (eukaryotic cells only) nucleus
- g. The combustion engine *mitochondria (cell membrane)*
- h. Solar cells (photosynthetic organisms)



Factory Parallels with Cells

cal Frameworks for

Engineers

- 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
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- f. The central computer room (eukaryotic cells only) nucleus
- g. The combustion engine *mitochondria (cell membrane)*
- h. Solar cells (photosynthetic organisms)



chloroplasts

- 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 =



- What do you get when you combine?
 - a. Glycan + Glycan = disaccharide
 - 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 =



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- e. Glycan + Glycan + ... + Glycan =
- f. (Part b) + (Part b) + ... + (Part b) =
- g. Protein + (Part f) =
- h. Lipid + Protein =



- 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 =



- 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 =
 - f. (Part b) + (Part b) + ... + (Part b) =
 - g. Protein + (Part f) =
 - h. Lipid + Protein =



- 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) =
 - g. Protein + (Part f) =
 - h. Lipid + Protein =



- 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 =



- 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 =



- 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 ?

