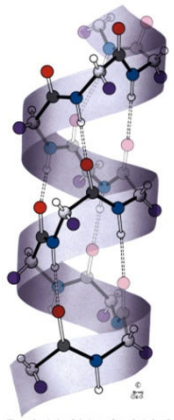
What is Biochemistry?

The chemistry of life! $\Rightarrow$ ***The study of biomolecules:***

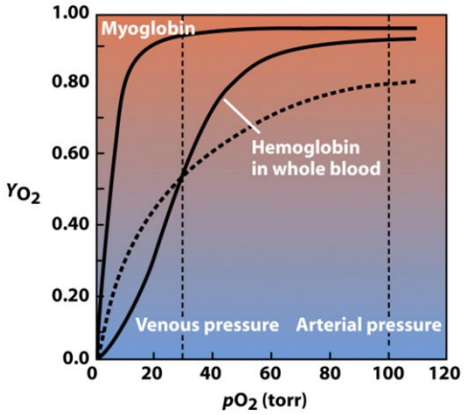
Components of an *E. coli* cell	Percentage of total cell weight	Number of different
Water	70	1
Proteins	15	3,000
Nucleic acids		
DNA	1	1
RNA	6	>3,000
Polysaccharides	3	5
Lipids	2	20
Subunits & intermediates	2	500
Inorganic ions	1	20

What is Biochemistry?

The chemistry of life! ⇒ ***The <u>study</u> of biomolecules:***

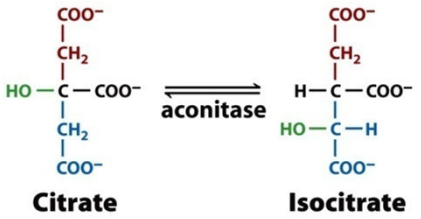


Structure



Properties

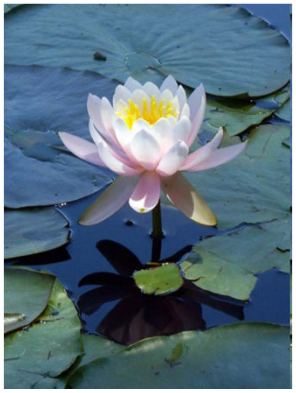
Interactions



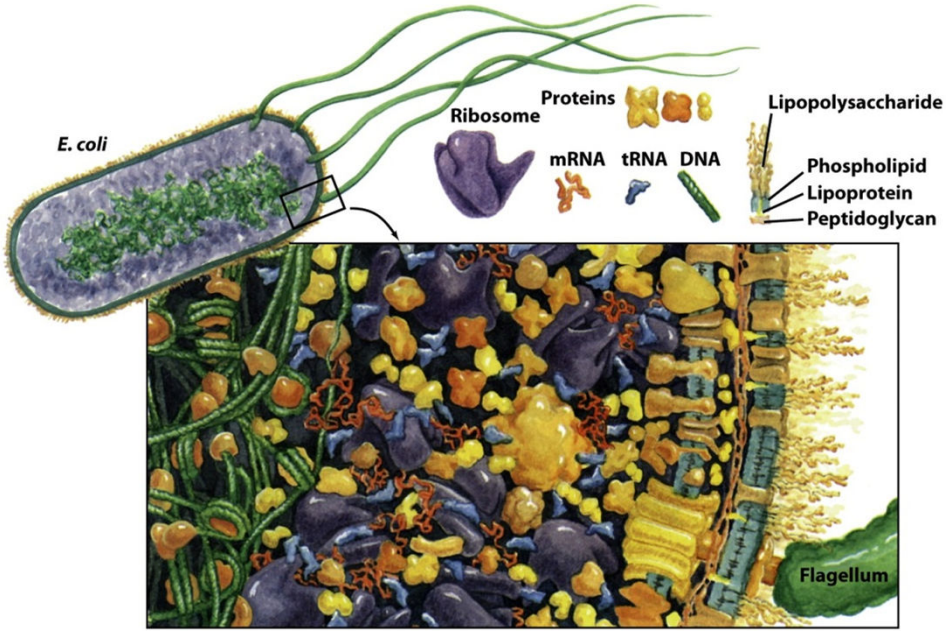
Reactions

Biochemists want to understand *everything* about *all* the molecules of life. This is a big job!

Life is diverse and complex!

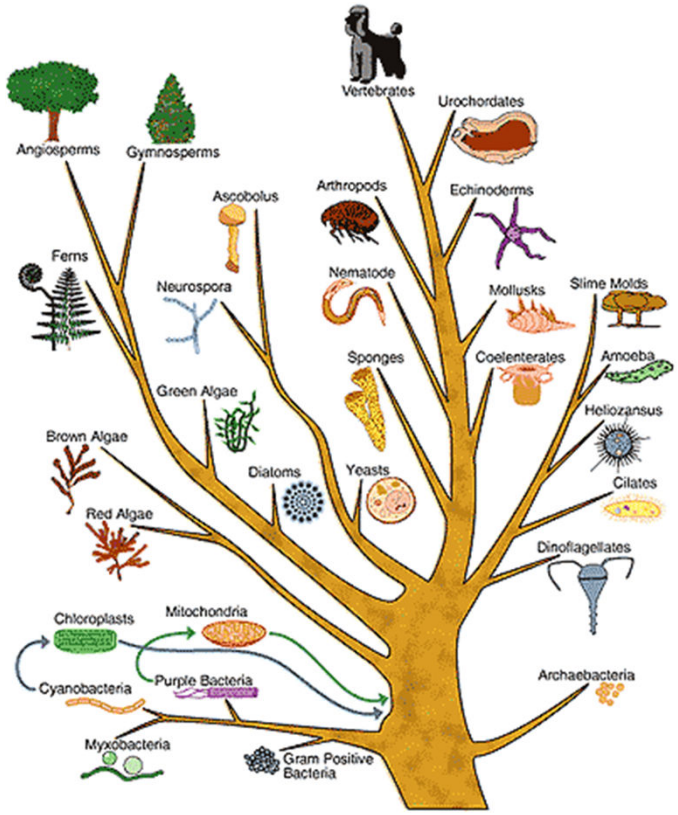


There are millions of different species on earth

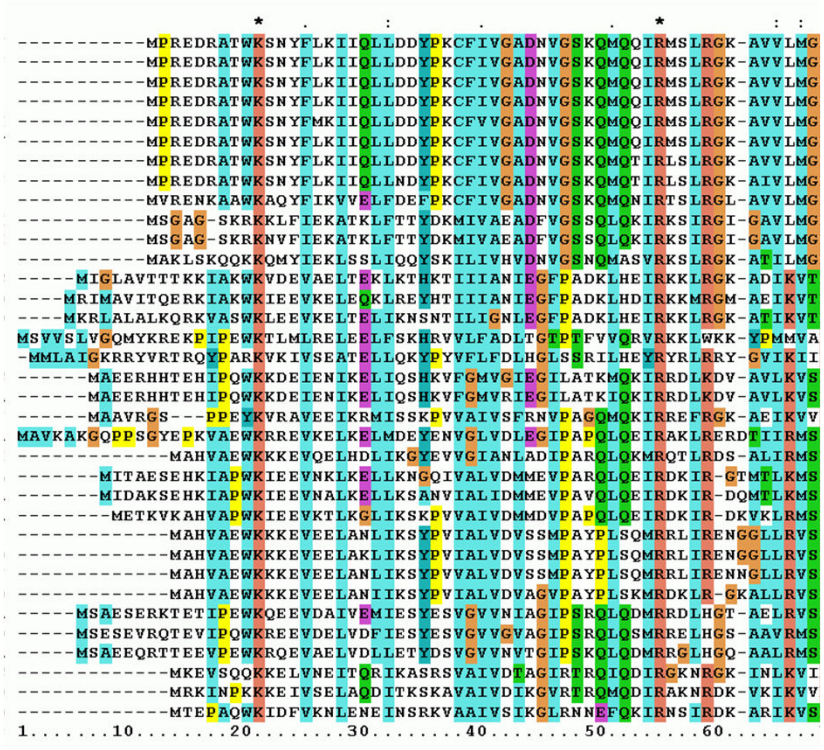


Each contains thousands of different types of molecules

Biochemists take advantage of similarities



Different species are related; they evolved from a common ancestor

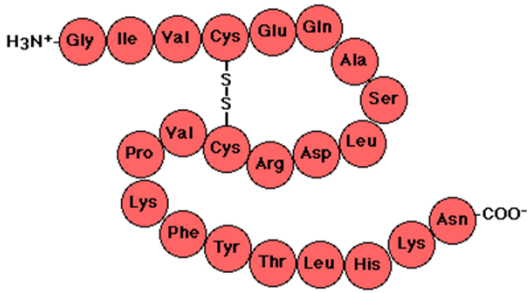


Biomolecules and biochemical systems from different species are related

Biochemists take advantage of similarities

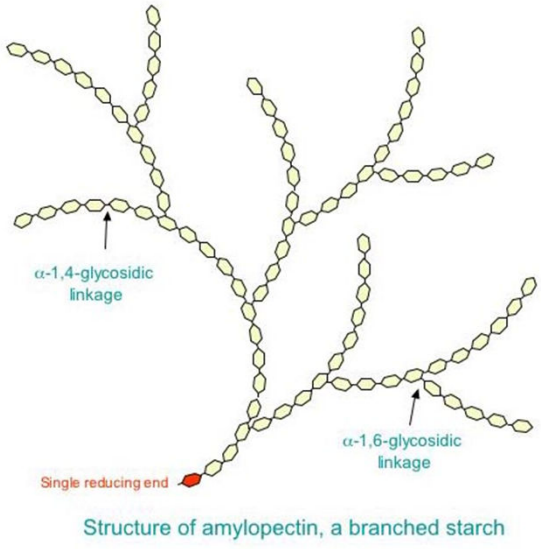
Many biomolecules are complex polymers of basic units

Protein (Polypeptide)



amino acid units

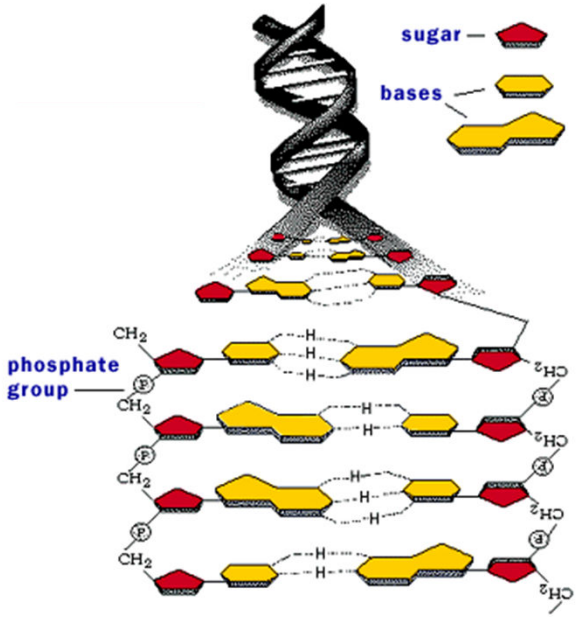
Carbohydrate (Polysaccharide)



Structure of amylopectin, a branched starch

monosaccharide (sugar) units

DNA molecule



nucleotide units (sugar + phosphate + base)

The world of biomolecules

Human cells are ~10 μm in length (~1000x shorter than your finger tip)

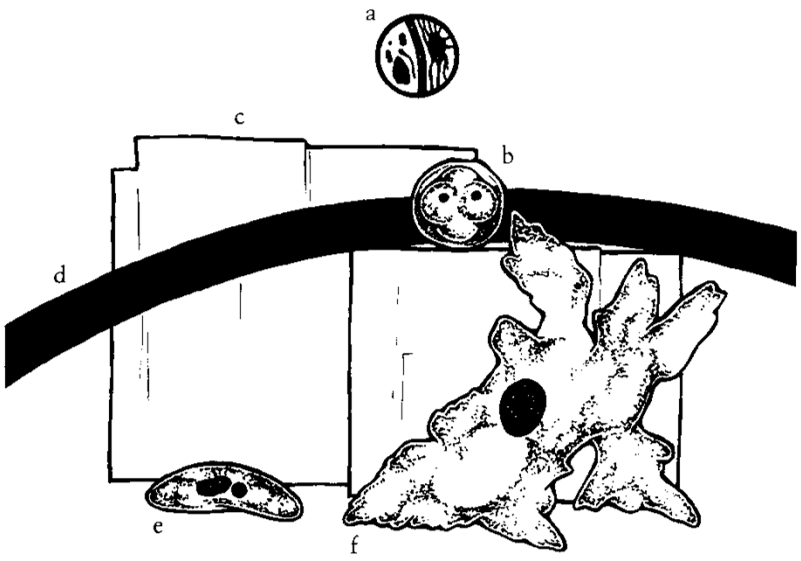


Figure 1.1 One Hundred Times Magnification

a. A collection of cells (enlarged in the next figure). b. Human egg—the largest human cell—at the four-cell stage. c. Grains of table salt. d. Human hair. e. The protozoan *Paramecium multimicronucleatum*. f. The protozoan *Amoeba proteus*.

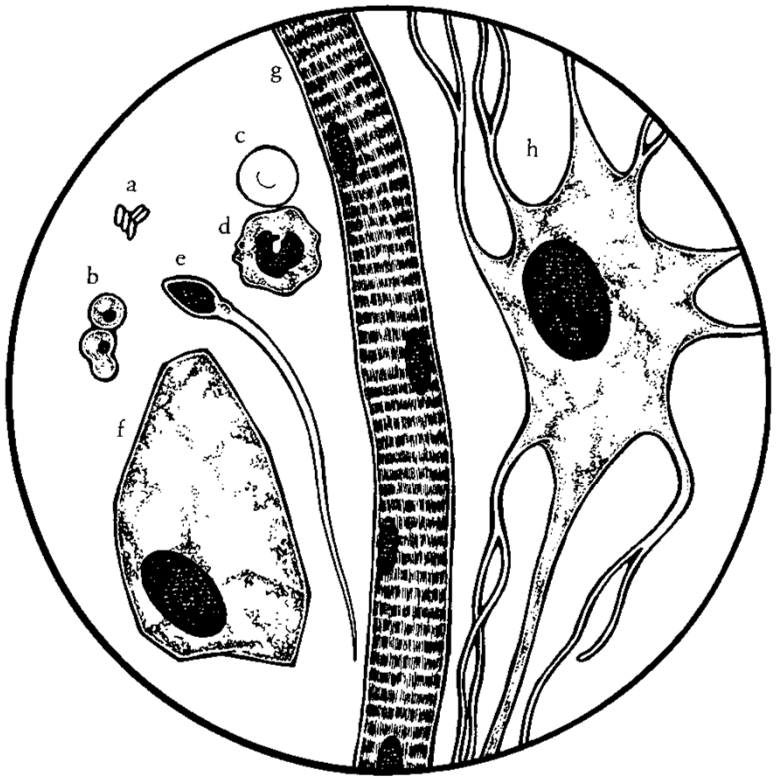


Figure 1.2 One Thousand Times Magnification

a. Five *Escherichia coli* bacteria cells. b. Two cells of baker's yeast, *Saccharomyces cerevisiae*, one in the process of budding. c. Human red blood cell. d. Human lymphocyte. e. Human sperm cell. f. Human epidermal cell. g. Human striated muscle cell. h. Human nerve cell.

Figures from "The Machinery of Life" by David Goodsell

Macromolecules are ~10 nm in length (~1000x shorter than the length of a cell)

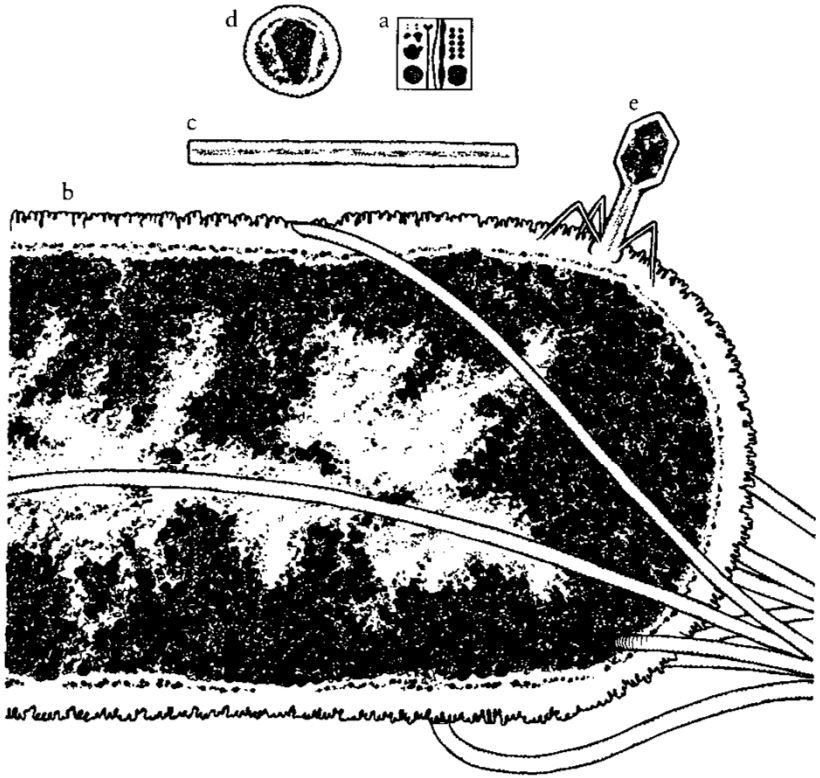


Figure 1.3 One Hundred Thousand Times Magnification

a. A collection of molecules (enlarged in the next figure). b. A bacterial cell (*a* in the previous figure). c. Tobacco mosaic virus. d. Human immunodeficiency virus. e. A bacterial virus.

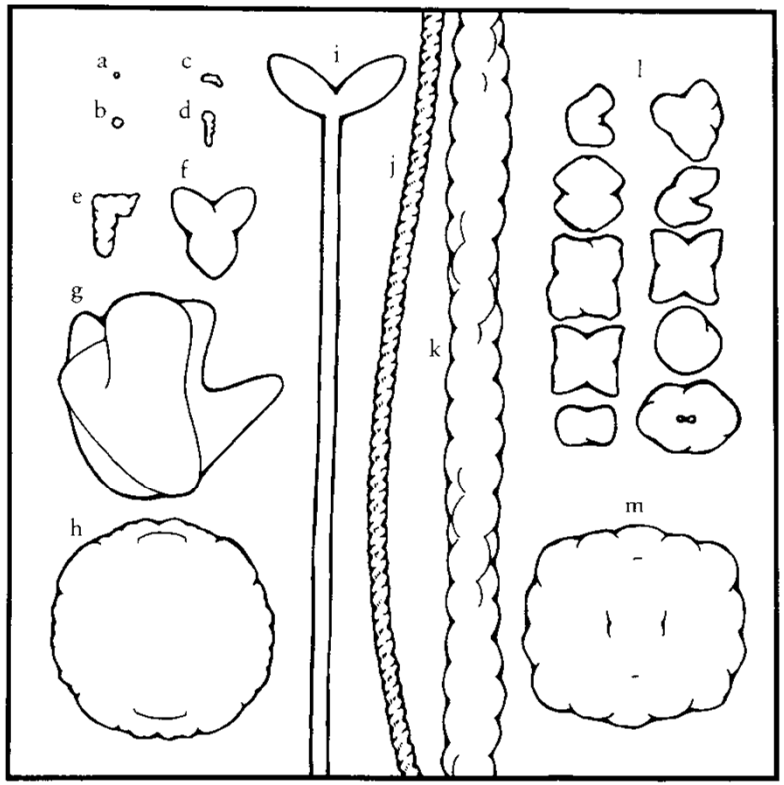


Figure 1.4 One Million Times Magnification

a. Carbon atom. b. Glucose. c. Adenosine triphosphate (ATP). d. Chlorophyll. e. Transfer RNA. f. Antibody. g. Ribosome. h. Poliovirus. i. Myosin. j. Deoxyribonucleic acid (DNA). k. Actin. l. The ten enzymes of glycolysis. m. Pyruvate dehydrogenase complex.

Figures from “The Machinery of Life” by David Goodsell

Organic molecules are ~10Å (1nm) in length (~10x shorter than macromolecules)

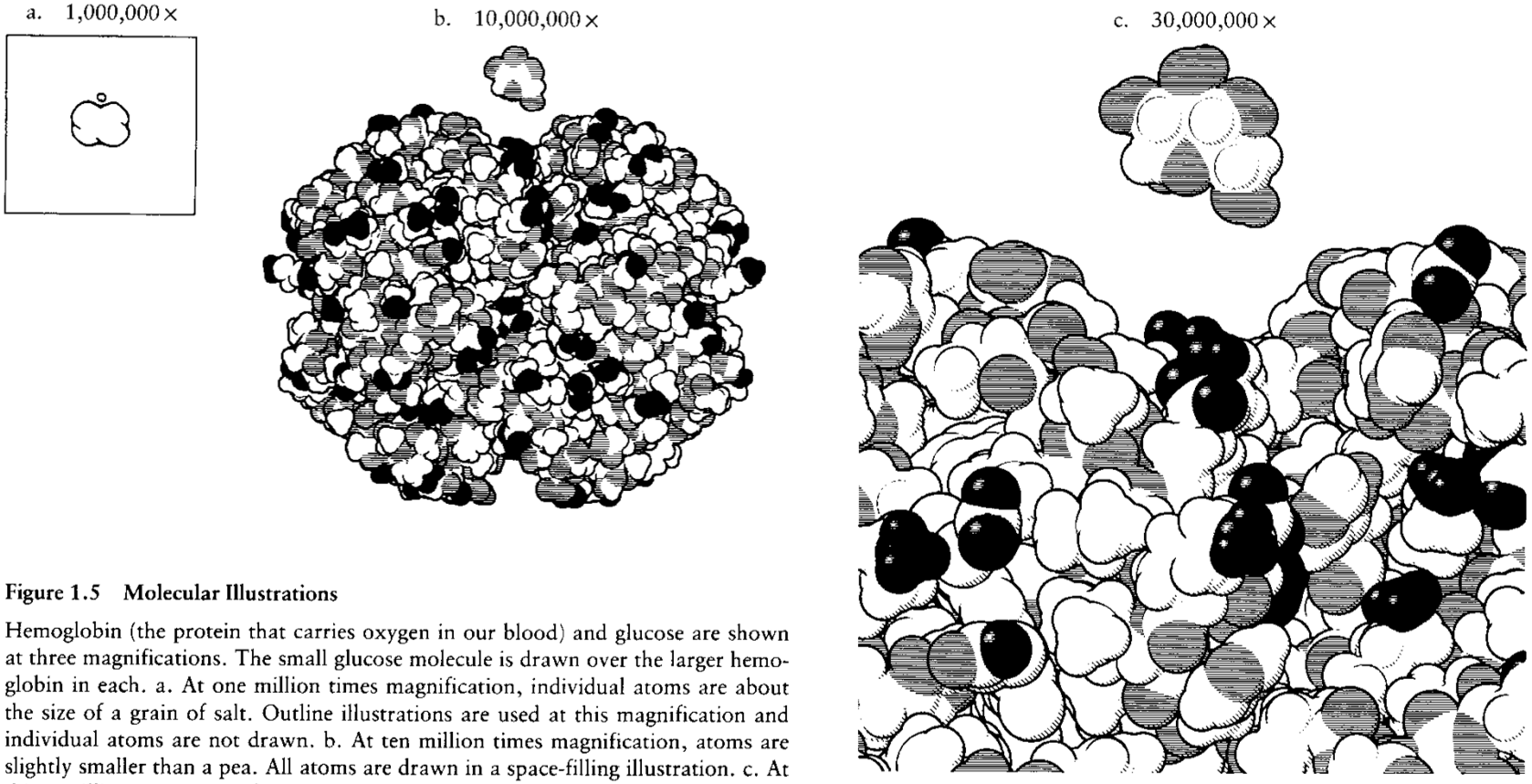


Figure 1.5 Molecular Illustrations

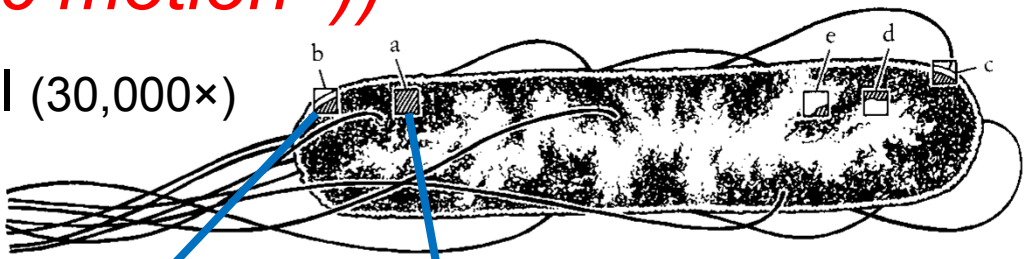
Hemoglobin (the protein that carries oxygen in our blood) and glucose are shown at three magnifications. The small glucose molecule is drawn over the larger hemoglobin in each. a. At one million times magnification, individual atoms are about the size of a grain of salt. Outline illustrations are used at this magnification and individual atoms are not drawn. b. At ten million times magnification, atoms are slightly smaller than a pea. All atoms are drawn in a space-filling illustration. c. At thirty million times magnification, an entire hemoglobin molecule is too large to fit on the page, but the arrangement of atoms in the glucose molecule is easily seen. Again, all atoms are drawn in a space-filling illustration.

Figures from “The Machinery of Life” by David Goodsell

Cells are crowded full of biomolecules

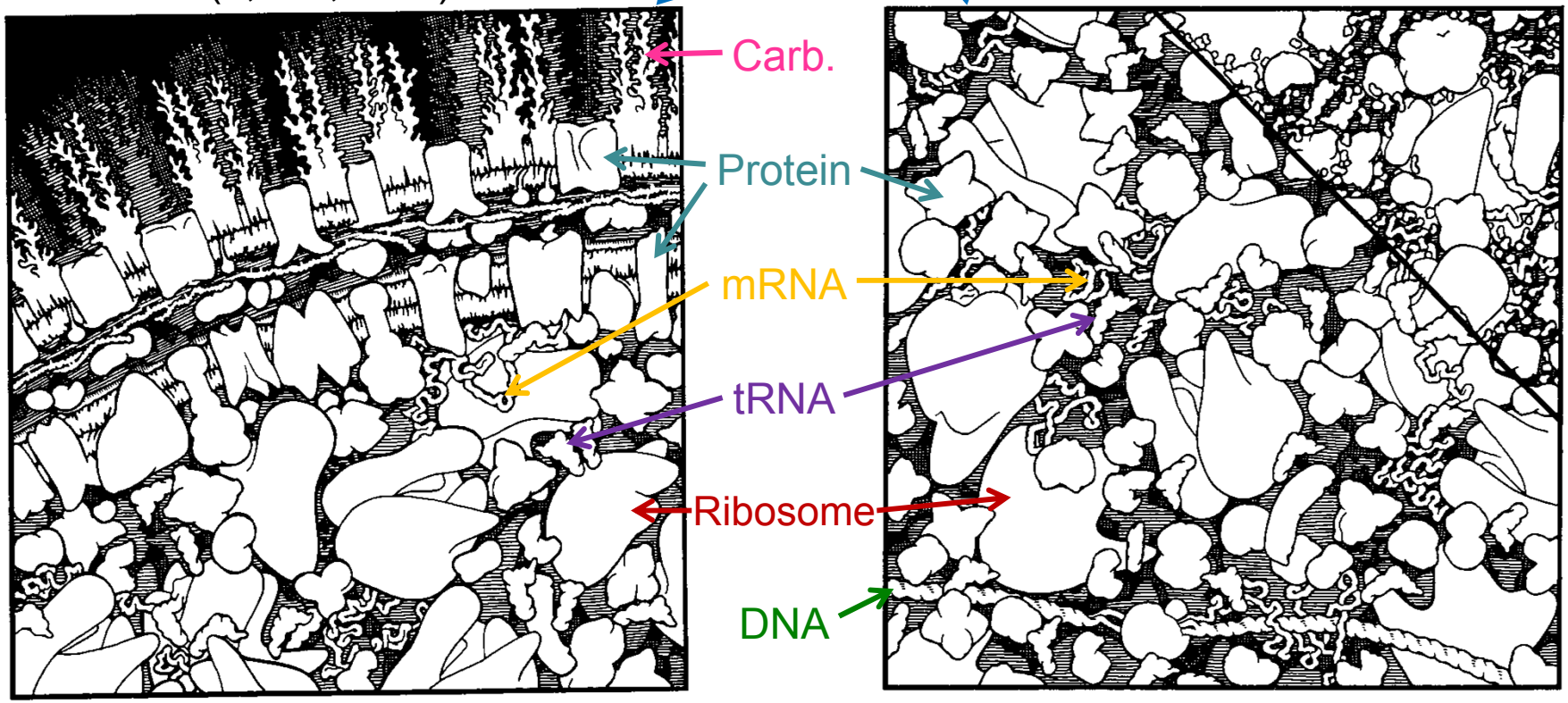
((in rapid, chaotic motion))

E. coli cell (30,000×)



Cell Wall (1,000,000×)

Cytoplasm (1,000,000×)



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