What is Biochemistry?
The chemistry of life! ⇒ *The study of biomolecules*:

<table>
<thead>
<tr>
<th>Components of an <em>E. coli</em> cell</th>
<th>Percentage of total cell weight</th>
<th>Number of different</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>70</td>
<td>1</td>
</tr>
<tr>
<td>Proteins</td>
<td>15</td>
<td>3,000</td>
</tr>
<tr>
<td>Nucleic acids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DNA</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>RNA</td>
<td>6</td>
<td>&gt;3,000</td>
</tr>
<tr>
<td>Polysaccharides</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Lipids</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>Subunits &amp; intermediates</td>
<td>2</td>
<td>500</td>
</tr>
<tr>
<td>Inorganic ions</td>
<td>1</td>
<td>20</td>
</tr>
</tbody>
</table>
What is Biochemistry?

The chemistry of life! ⇒ The study 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)**: monosaccharide (sugar) units
- **DNA molecule**: nucleotide units (sugar + phosphate + base)
The world of biomolecules
Human cells are \(~10 \, \mu m\) in length (\(~1000x\) shorter than your finger tip)

Figures from "The Machinery of Life" by David Goodsell

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

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

Figure 1.4  One Million Times Magnification

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×)

Figures from "The Machinery of Life" by David Goodsell