# Science-1A Lab: Week 13, Wednesday, November 3, 2021

This lab is relatively short, but Friday's additional Lab about DNA is longer. Before COVID-19 restrictions, we would build some amino acids, oxytocin and a tiny segment of DNA using molecular models. This time, we must use our imagination.

## Amino Acids, Polypeptides and Proteins

When I was in High School, I read about how living creatures were just made of atoms like everything else. I wondered what it was that made life more than a simple mix of those chemicals. Now everyone can know that living things are collections of very remarkable molecules interacting with thousands of enzyme-mediated reactions to digest food, reproduce, defend, and repair themselves. All your ancestors have pondered the question "What is life", and you are lucky to be the first generation to be able to fully understand that – if you are sufficiently curious. Be curious!

The huge protein molecules in our body which perform a myriad of special functions are made from only 21 basic building blocks called amino acids. They are shown at blood pH levels in the handout at *https://yosemitefoothills.com/Science-1A/LabNotesAndLinks/AminoAcidsAndOxytocin/AminoAcidsInBody.png* .
You should observe that they all start in the same manner, a $–COO^-$ functional group and an $–NH_3^+$ functional group both connected to a C that is also attached to a variety of different tails.

The carbon between the $–COO^-$ and $–NH_3^+$ functional groups determines whether the amino acid is left- or right-handed depending on how it connects to the remainder of the amino acid. With very few exceptions, all life on Earth depends on left-handed amino acids. Only glycine has no handedness; its central carbon simply has hydrogens without any side chain tail

When amino acids are connected to each other to form short chains called polypeptides or long chains called proteins, they do so by connecting the negatively-charged $–COO^-$ group of one amino acid to the positively-charged $–NH_3^+$ group of the next. When this is done, the charges cancel and a water molecule is released. The result is called a peptide bond – CONH– .

There is no limit to how many amino acids can be connected together this way, but the resulting blob of amino acids will fold into a configuration determined by the precise location and characteristics of the 21 different types of amino acids. Those with positive and negative tails will tend to be attracted to each other and to surrounding water molecules (hydrophilic), and those with uncharged (hydrophobic) tails will try to hide from water molecules. Also, the amino acid cysteine, which has a sulfur atom at its tail, will often find another cysteine and make a cross-connection to it called a disulfide bridge. As a result, a huge variety of proteins can be constructed that have widely-varying shapes and therefore widely-varying properties. Some act as structural elements, some are enzymes which help join or cut other molecules, and some even form into rotating pumps or motors.

Amino acids are also used as precursor molecules in making many important biological molecules including the important brain chemicals dopamine, epinephrine and norepinephrine.

This is shown in a magnificent book entitled "The Machinery of Life" by David S. Goodsell (ISBN 978-0-387-84924-9). It contains precise drawings and explanations of how life functions using its many specialized proteins. A collection of images from the book are on the author's home page at *https://ccsb.scripps.edu/goodsell/machinery-of-life-reducedillustrations/* .
Be sure to look at the larger versions which can be seen by clicking on each image in that page. Even without the text, you can appreciate the amazing variety of molecules made by chaining amino acids together.

An important peptide called oxytocin is made from 9 amino acids, and has such interesting effects in humans (and dogs), I like to call it "Love Potion Number 9" after an old song. Biochemistry students like to have it printed on a T-shirt. Watch the following 16-minute TED Talk YouTube video entitled "Paul Zak: Trust, morality - and oxytocin" to learn more about this remarkable polypeptide molecule. It is at *https://www.youtube.com/watch?v=rFAdlU2ETjU*

For more about oxytocin with a picture of my 2013 Science-1A class holding their model of oxytocin see *https://yosemitefoothills.com/Science-1A/Handouts/Week-12/Oxytocin.pdf* .

**To earn credit for this lab, report that you have done the following:**

1. Read this handout.

2. Looked at some of the “The Machinery of Life” illustrations by David S. Goodsell at *https://ccsb.scripps.edu/goodsell/machinery-of-life-reducedillustrations/*

3. Watched the TED Talk YouTube video about oxytocin at https://www.youtube.com/watch?v=rFAdlU2ETjU