Biochemistry Literacy for Kids, Daniel Fried

Lesson 4 outline

Preparation:
Hand out lesson worksheets.
Hand out molecular model kits.

Overview:

Octet rule (and duet rule)
Students learn about what elements other elements "dream about being".

Hydrogen-containing molecules
Students learn how to draw Lewis-structure-like diagrams for simple molecules that contain hydrogen. They also build these molecules with the model kits.

Single and multiple bonding for larger molecules.
Students draw and build larger molecules and learn how to rationalize and build double and triple bonds.

Lecture sequence:

Octet rule (and duet rule)
We know that electrons can and like to pair up—this is one of the two behaviors of electrons we know of, the other being that electrons like to spread out if there is "room". Since electrons like to pair up, certain elements must have elements that they "idolize" or dream about being. The configurations of these (nobel gas) elements are favored based on quantum mechanics. Hydrogen with 1 electron idolizes helium, because it has a happy electron pair (duet rule). C, N, O, and F idolize Ne because it has the complete octet (octet rule)—all its electrons are happy and paired.

Hydrogen-containing molecules
Slowly go through the electron pairing animations. Ask students, how can each atom achieves it's dream to become like one of the chosen (noble gas) elements. Most will say that the two unhappy, unpaired electrons of the two H atoms will like to pair up. Emphasize the concept of "shared pair" of electrons. Tell them that the gray bond in their model kits represents something —what is it?—a shared pair of electrons. The plastic bond piece represents something real, and is not just a means of connecting the atoms—it is a shared pair of electrons. I include an animation for boron, but attentive students may ask why the octet rule is not obeyed for boron. You can tell them that this is a simplification for the structure of borane (BH_3) but that there is a more complete story for borane, which can be addressed later. Bonding for the other elements should become logical for the students once they begin to see the patterns. Many students will ask why only hydrogens are bonding to the central atoms. Tell them that this is just the first lesson, and that many more kinds of covalent bonding will be seen. Throughout the lesson, ask students to reflect back on the 4, 3, 2, 1, 0 rule and tell them that this is a way of understanding

the origin of the rule. The periodic table is therefore designed to teach us how not only to draw atoms, but to draw molecules.

IMPORTANT: Beginning this class, and in all subsequent classes, make the class repeat after you as group the answer the question, what is a bond? The class should repeat back the following: “A bond is a shard pair of electrons.” It is extremely important that the students have this rote memorized definition at the tips of their tongues, since it will help them quickly describe the more in depth and complex learning about bonds.

Single and multiple bonding for larger molecules.
For multiple bonds, I have modified the Lewis-structure-like atoms so that the lone electrons will appear to pair nicely with each other when bonded. Emphasize that these drawings are simply a teaching tool to understand bonding, and that real molecules do not actually look like this. Most students will be able to predict double and triple bonding, based on how the structures are drawn in the animations. One aside you can make is to tell them that nitrogen is a very hard gas to break down, due to its triple bond. When the students build the N_2, ask them to try to pull it apart, and students will see that this is quite difficult, compared with double- and single-bonded molecules. While carbon, oxygen, and hydrogen easily enter the biosphere, nitrogen is difficult to obtain from the atmosphere, and only nitrogen fixing bacteria have the proper mechanism to break this very strong bond, freeing nitrogen to be used in the synthesis of biomolecules like DNA, RNA, and proteins.

As the students draw and build the larger gas molecules, have them notice that they are fulfilling the 4, 3, 2, 1, 0 rule. Have students notice that ethanol looks like a dog. We will use a related molecule to teach molecular handedness (chirality) in a future lesson.