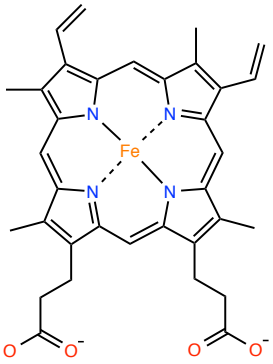
Biochemistry Literacy for Kids, Daniel Fried

Lesson 1 outline



Preparation:
Print the Periodic Table sheets (double sided).
Obtain colored pens or pencils.
Print the Day 1 worksheet.
Load PyMol onto the computer and ready the PyMol files.
If possible, build Heme B with an O_2 which includes the 3D lone pair electron pieces. (Use the structure to the right to build the heme.)
If possible, prepare a model structure of diamond using the models.
Prepare to distribute model kits to students.

Overview:

Atom Colors
In this lesson, students will learn the colors commonly used to represent the most biologically-relevant elements H, C, N, O as well as F.

Bonding Patters
Students will determine the number of bonds that H, C, N, O typically make, using the PyMol structure of hemoglobin.

Size of Atoms
Students will review the size differences between cells, molecules, and atoms.
If time allows, or for homework, have students watch this short, classic movie: Powers of 10.
https://www.youtube.com/watch?v=55Gpm1Q0abk

Model Building Basics (gasses)
Students will draw and build molecules of simple gasses.

Molecular Visualization of Air and Oxygen binding in the Blood
Students will get a mental picture of air, and how oxygen binds to the iron of hemoglobin.

Formulas
Students will learn how to read formulas and build/write molecular structures from a formula.

Model Building Basics (hydrogen containing molecules)
Students will learn how to build molecules that contain hydrogen atoms.

Lecture sequence:

Pre-test
It is important for the students to be aware of the progress they will make in even the first lesson. Ask them the questions on the first slide. If it is difficult for them to answer individually, have class brainstorming session to determine what students already know about atoms and molecules. Some students will have memorized responses like “the smallest piece of matter that cannot be broken down”.

Atom Colors
Have the students color C, N, O, and F on the periodic table with black, blue, red, and green pens or pencils. Use a gray pencil to color the hydrogen. These are the standard colors used in most textbooks and in the models.

Size of Atoms
Brainstorm which is bigger and smaller: cells, molecules, atoms. Have students fill in the worksheet with the different kind of blood cells. Explain that within every red blood cell are 270,000,000 oxygen-carrying molecules, called hemoglobin.

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Bonding Patters
Open the model of hemoglobin and use the mouse to explore the structure. Ask students to find patterns in what they see. Some will pick out geometrical patterns such as the aromatic rings or the tetrahedral nature of carbons, but focus them on the connectivity patterns. They will eventually realize that every hydrogen is bonded to only 1 other atom, carbons are always bonded to 4 other atoms, and oxygen and nitrogen are usually bonded to 2 and 3 other atoms, respectively. Try to avoid showing them 1-bonded oxygens and 4-bonded nitrogens—these are charged atoms—but if a student spots them, tell them that bonding rules are a little more elaborate, and they will learn about them later. The dotted bonds on the heme represent aromaticity, and you can mention that this also is a future topic. The orange atoms represent the irons of the hemes, and the yellow are sulfur. Point out the O_2 bonding on the hemes.

Have the students fill out the atom color chart. See if they can figure out the binding pattern and predict the number of bonds for fluorine and neon.

Model Building Basics (gasses)
For the molecular modeling sheet, have the students look at the formulas and try to first predict and draw what the molecules may be, based on the “bonding rules”. You may have to show them a couple of the drawings for them to understand what to do. At this point, you can hand out the model kits and have them build hydrogen, carbon dioxide, oxygen gas, etc.

Go through the slides and show them where the gasses may be found in everyday life an. Show them the diamond model so they can see how the bonding gives a very rigid structure. You can also use the PDB files for diamond and graphite, found in the dropbox PDB folder.

Optional: You can use the slides with the zeppelin and the space shuttle to preview the concept of a chemical reaction. Usually at least one student has already asked a question about fire or explosions by this time. The combustion of hydrogen reaction can be used to preview balancing. If anyone asks about the two solid rocket boosters, you can show them that ammonium perchlorate, 4 NH_4ClO_4, will combust to 4 HCl + 2 N_2 + 5O_2 + 6 H_2O. Going from a solid to a gas creates the thrust for the rocket. Ask the students if they see any "violations" of the 4,3,2,1, rule in that equation. This is an opportunity to tell them that while the 4,3,2,1 rule helps us understand simple molecules, there is even more to learn about how atoms bind, which they will learn in later classes. (Some students will have asked why the nitrogen atoms have 4 holes, so you can preview NH_4 here. If time allows, students can perform a hand held chemical reaction converting the hydrogen and oxygen molecules they built into water molecules.

Next, you can also show them the diagram of the atmosphere showing the proportions of the elements. The second picture shows that exhaled air only contains a small amount of CO_2.

Tell the students for homework to learn and memorize the structures of the gasses discussed in class. Tell them to remember the 4, 3, 2, 1, 0 rule.