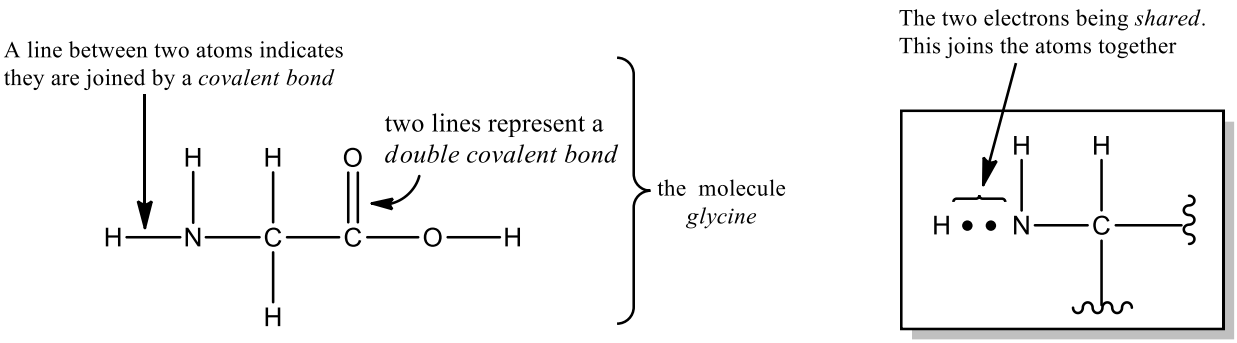
Bonding

Model 1. When at least two atoms are joined together by bonds, a *molecule* is formed. A compound is formed from the bonding of atoms from at least two different elements.



A *covalent bond* is formed by the sharing of **TWO *e*lectrons**. The straight line represents these electrons. Electrons are very tiny particles with *negative charge*. Every atom of each unique element has a specific number of electrons. For example, every hydrogen atom has one electron.

In some cases, the electrons are not shared. In the compound, NaCl or *sodium chloride*, the Cl anion has extra electrons - which give the Cl an overall *negative* charge. The Na cation has too few electrons, which give the Na an overall *positive* charge. The association between the Na^+ and Cl^- is called an *ionic bond*.

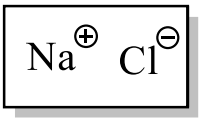


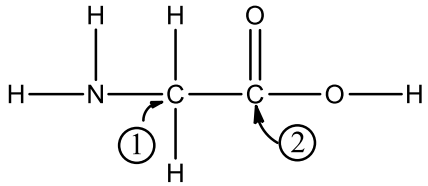
Figure 2.1. Covalent and ionic bonds.

In the compound sodium chloride, the sodium cation is always carrying a positive charge (Na^+) and the chloride anion is always carrying a negative charge (Cl^-), but sometimes the compound will be represented as NaCl – without the charges explicitly shown – see Activity 1 for a review of this concept.

1. Define the word *molecule* using the words atoms and bond.

2. How many electrons would you expect between the C and O atoms joined with a *double covalent bond* (also called a "double bond") in Figure 2.1?

3. In the molecule *glycine* shown in figure 2.1, there are two different carbon atoms. The structure has been re-drawn below and the carbons labeled.



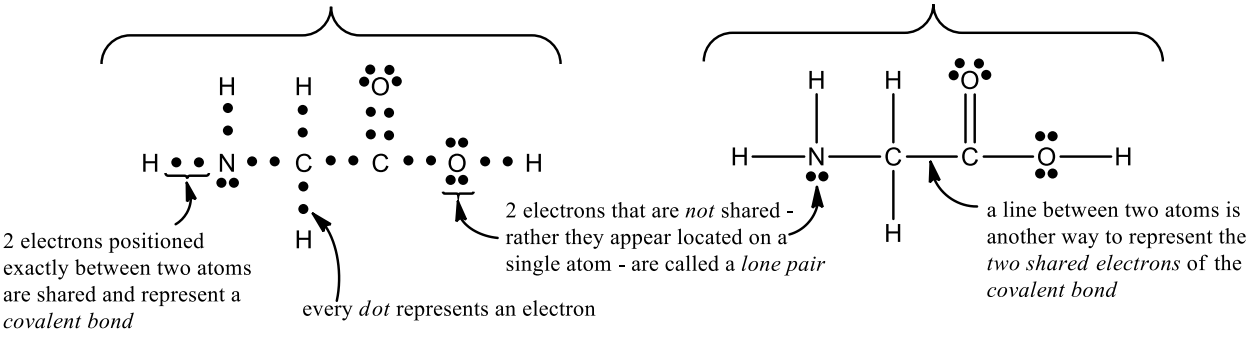
   a. How many *bonds* are being made with each of the two carbon atoms? i.e. How many bonds are being made with carbon 1; with carbon 2?

   b. How many electrons are represented by the bonds surrounding each individual carbon atom?

4. The NaCl does *not* have a *covalent bond* – i.e. there is no *sharing* of electrons. – rather it has an *ionic bond*. What seems to be holding the NaCl (i.e. table salt) molecule together?

Model 2.

Two representations of the molecule glycine



Every atom brings a certain number of electrons with it when it engages in bonding. Hydrogen brings one electron, carbon brings 4, nitrogen brings 5, oxygen brings 6. For the elements most often found in food molecules (carbon, oxygen, nitrogen, hydrogen), you can tell how many electrons that atom will bring with it by checking that atom's position within its row on the Periodic Table.

Figure 2.2. Two representations of glycine

Since food molecules are most often going to contain carbon, oxygen, nitrogen and hydrogen. The top rows of the periodic table are the most important when thinking about food. To determine the number of electrons that an atoms *brings along* when engaging in bonding, simply count from left to right. Starting on the left, count to the right along a single row – the position of the element on the P.T. within its row is equivalent to the number of electrons it *brings along* to bonding. This "counting" strategy is synonymous with the *Group Number* for the column. For example, in the image of the Periodic table shown below, carbon is in Group IVB. The important number here being IV or "4". Carbon is in *group 4*; carbon is also *four* spaces in from the left in row 2 (also called *period 2*).

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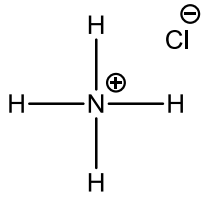
5. Study Figure 2.5 and categorize the molecules according to whether or not they are held together with covalent bonds, ionic bonds or both. For the molecules that have both covalent and ionic bonds, circle and label the different types. Then, label each molecule as *organic* or *inorganic.*

6. Calcium citrate is made with two citrate molecules and three Calcium *ions*. (An *ion* is an element that has *too many* or *too few* electrons, and is therefore carrying a charge). Why is this? (Hint: the overall molecule must be neutral)

7. In Figure 2.6, the *extra* electron present on the oxygen gives it a negative charge.
    a. Why are 6 electrons ok for an oxygen atom, but 7 is too many?
    b. How many electrons would be *too many* for a nitrogen atom?
    c. How many electrons would be *too few* for a nitrogen atom?
    d. How does your answer to (c) explain the structure of ammonium chloride below? Why is the nitrogen carrying a positive charge?



8. Table *salt* is an ionic compound – *sodium chloride.* Why might calcium citrate also be called the calcium *salt* of citric acid?