What is Chemistry? (Study of Matter & Energy and the changes they go through. This study is usually at the levels between subatomic particles and supramolecular complexes.)

I. Matter (often not too hard to get a grip on)

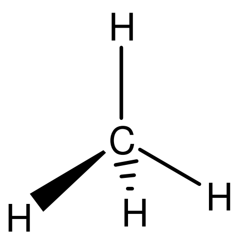
A. You can:
  1. see it (most of the time)
  2. feel/touch it
  3. sometimes (but clearly not always) smell or taste it

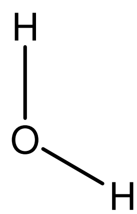
B. Matter has mass and occupies space.

C. We will be very interested in the structure of matter because:
  Structural properties can be used to make predictions about function.

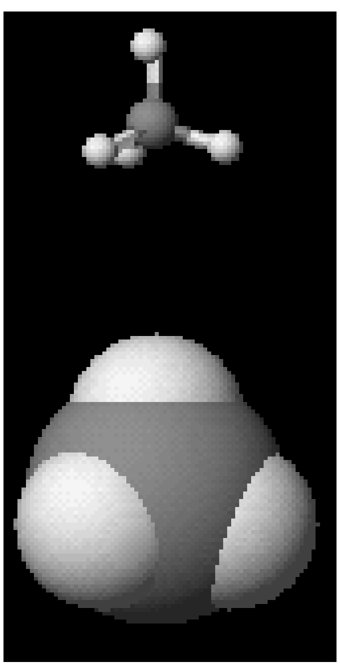
Examples:

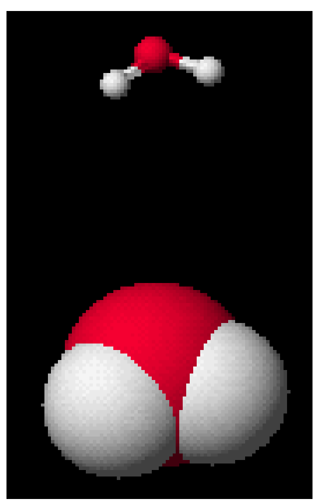
Methane, CH_4 **Water, H_2O** **Table salt, NaCl**

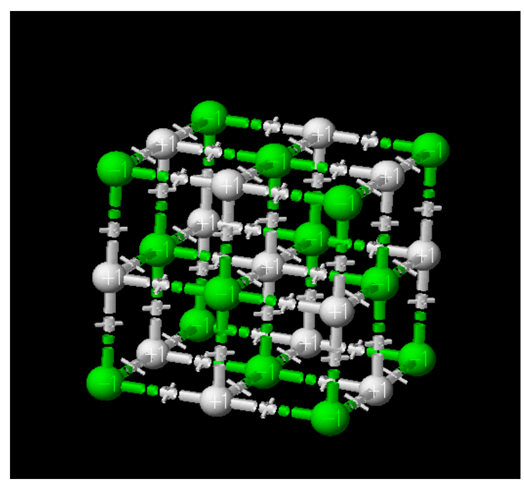




Structural representation of an individual formula unit is not so simple.







By the end of this semester you will be able to determine that methane is a gas, water is a liquid, and NaCl is a solid (at room temperature) and explain why this is so just by looking at their structures.

D. Chemists often organize matter into different groups, depending on their interests at the moment.

E. *Matter and energy are interconvertible!* Not easy to get a grip on because matter-energy interconversions are not part of your daily experience. (But what happens at a nuclear power plant or when a nuclear weapon explodes?)

II. Energy (sometimes not easy to get a grip on)

A. Types of energy familiar from your every day experience:

1. light
2. heat
3. kinetic

B. Some energy forms are harder to understand.

1. Mass & energy can be interconverted. (See above.)
2. Energy can be stored in a variety of forms. We often refer to this as *potential energy*.
    a) Example: a spring you have compressed (as in a mousetrap)
    b) Some chemicals have energy stored in their bonds. When we eat food we release and capture the energy stored in bonds of the food molecules.

C. If we can develop an understanding of energy, we will be able to make accurate, useful predictions about physical and chemical processes (changes) related to human health. This is the basis for much of pharmacology.

III. Chemical and Physical changes relative to life

A. All living things must increase the rates of specific chemical and physical changes to stay alive.

1. Can you name a chemical change that we have already discussed in some detail?

2. Physical changes?
   a) A genetic disease that relates to inability (loss-of-function) to perform a specific physical change at a fast enough rate is cystic fibrosis. The physical change that is not being performed fast enough in that case is chloride ion (Cl^-) transport across cellular membranes.
   b) Much of information biochemistry involves physical changes
      i) neurotransmitters
      ii) hormones
      iii) DNA double helix formation

B. If we assume the number of physical and chemical jobs that needs to be done is about the same as the number of genes present in an organism:
   1. The minimum number of jobs to be alive (currently) ~ 500 (very small bacteria)
   2. How many genes do you have? More than ______________
   3. Some (many?) human genes appear to do more than one job.

C. We will need to study 2 aspects of chemical & physical changes because they are central to understanding the chemistry of life.
   1. Kinetics: how fast changes occur
   2. Equilibrium: how far changes go
   3. Gibbs Free Energy Equation, $\Delta G = \Delta H - T\Delta S$
      a) Helps predict how far processes will go toward completion.
      b) Δ means , G = ,
         H = ,
         S = .
      c) If ΔG is negative, the process will proceed.
      d) At this point, know the equation and what the symbols mean
      e) We will return to it often.

Although you may be more comfortable thinking about matter (you can see it, feel it, *etc*.) understanding energy is actually the key to making useful predictions about III. C. 1 and 2.