- science is inquiry based on:
  - repeatable experiments
  - verifiable data (observations, measurements)

Chapter 2: Essential Chemistry for Biology
- matter: anything that has mass and occupies space
- element: cannot be chemically broken down into another substance
- how many elements naturally occur: 92
- trace elements: 14 trace elements make up .01% of the human body, but they're necessary to survive (e.g.: iodine)
- atoms: smallest units of an element
- compounds: molecules composed of 2 or more elements combined in a fixed ratio

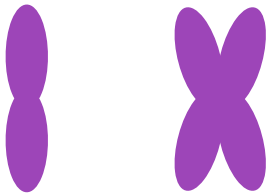
NOTE: While compounds are elements, not all elements are compounds. For example, single-atom molecules, diatomic molecules, or molecules composed only of 1 element are not compounds.

- atomic number: number of protons in a molecule
- mass number: the mass of a molecule, approximately equal to the number of protons + the number of neutrons
- number of elements in the human body: 25, namely hydrogen, carbon, nitrogen, and oxygen
- isotopes: forms of an atom of the same element (i.e.: same number of protons) which have different numbers of neutrons, and thus different mass numbers
- radioactive isotope: nucleus of the atom spontaneously decays, giving off particles and energy
- electron energy levels: electrons closer to the atomic nucleus have lower energy levels, while further-out atoms have higher energy levels
- valence electrons: The electrons in the outermost shell of an atom, which have the highest energy levels. Valence electrons determine the reactivity of the atom, because they are the electrons which exchange with other atoms.
- chemical bonds: bonds between atoms
  - covalent bonds: These are the strongest bonds. They hold together molecules, and their atoms share electrons. The number of possible covalent bonds an atom can make equals the number of empty spaces in the atom's outer shell.
  - ionic bonds: These are the mid-strength bonds. They hold together ions, which have positive or negative charges. One atom in an ionic bond gives its electrons to the other, so the "giver" atom has fewer electrons (and thus it is not neutrally charged) and the "receiver" atom obtains a complete shell of valence electrons
  - hydrogen bonds: These are the weakest bonds. They do not hold together individual molecules, but rather they make two polar molecules attract to one another. (Water molecules are a good example. The positive side of one water molecule is attracted to the negative side of another water molecule, but this attraction is so weak that it is generally fleeting.)
- chemical reactions: Rearrange the reactant matter into the product matter, breaking apart and then rejoining atoms. Chemical reactions only rearrange matter, and do not create or destroy it.
- heat: the amount of energy from molecular movement which arises in a body of matter
- temperature: the average speed of particles in a body of matter (i.e.: the intensity of the heat)
- evaporation and boiling as cooling processes: only the "hottest" atoms (i.e.: those with the most energy) have enough energy to escape the liquid, so only the "less hot" atoms are left behind

    - 2 cell membranes
    - stroma: thick fluid in chloroplasts
    - thylakoids: sacs suspended in the stroma
    - chlorophyll: light-absorbing pigment in the thylakoids
    - grana: stacks of thylakoids
- stomata: leaf pores which take in CO_2 and let out O_2
- why is chlorophyll green: chlorophyll absorbs all visible wavelengths except green, which is reflected
- photosynthesis equation: energy (sunlight) + $6H_2O + 6CO_2$ —> food ($C_6H_{12}O_6$) + $6O_2$ (waste)
- electron carrier for photosynthesis: NADP+, which accepts 2 electrons (and 1 hydrogen) to become NADPH when full
- photosystem 2: the water-splitting photosystem, which occurs first in the photosynthesis process
- photosystem 1: the NADPH-producing photosystem, which occurs second the photosynthesis process
- stages of photosynthesis:
    - light reactions: Light energy excite electrons in the chlorophyll, which get trapped in a primary electron acceptor of the photosystem 2. Photosystem 2 replaces those electrons by taking them from water molecules, thus producing oxygen as waste. Electrons from the primary electron acceptor go through an electron transport chain in the thylakoid membrane, down to photosystem 1, which moves hydrogen ions against its concentration gradient into the thylakoid. Hydrogen falls back into the stroma via an ATP synthase, producing ATP, and the electrons from the transport chain fill empty NADP+ acceptors to turn them into NADPH. The light reactions occurs in the thylakoids.
    - Calvin cycle: First, CO_2 gets added to a 5-carbon sugar, which is then broken into two 3-carbon sugars. The cell uses ATP and electrons from the NADPH to make the 3-carbon sugars into G3P sugars. For every three CO_2, we thus get 1 G3P. We need 2 G3P to make glucose, so the Calvin cycle must occur 6 times. The Calvin cycle occurs in the stroma.
- C3 plants: obtain CO_2 from air
- C4 plants (or CAM plants): obtain CO_2 alternatively
- why is photosynthesis so difficult in the desert: Stomata must be closed in dry environments to conserve water, and this limits the intake of CO_2.

Chapter 8: Cellular Reproduction

- cell division: cell divides into 2 genetically identical daughter cells
- chromosome: Chromosomes are structures that contain most of the cell's DNA. They only exist during cellular reproduction, or else the cell's DNA exists in a jumbled up soup in the nucleus. The word "chromosome" applies to both structures in this diagram



- chromatids: The chromosome shown at left consists of only one chromatid. Each vertical pair of ellipses in the chromosome shown at right are sister chromatids. While they do not contain the same alleles, each chromatid does contain the same genes in the same order as its sister.