As Mr. Weitz used to say….you’re doing the wrong kind of chemistry in here
2.1 Start with atoms (this should be review for you!!!!)

- **Atoms** = the building blocks of all substances
  - Made up of electrons, protons and neutrons

- **Electrons** ($e^-$) have a negative charge
  - Move around the nucleus

- The **nucleus** contains protons and neutrons
  - **Protons** ($p^+$) have a positive charge
  - **Neutrons** have no charge
How atoms interact

- **Chemical bond**
  - An attractive force existing between two atoms when their electrons interact

- **Molecule**
  - Two or more atoms joined in chemical bonds

- **Compounds**
  - Molecules consisting of two or more elements whose proportions do not vary
  - *Example*: Water (H₂O)

- **Mixture**
  - Two or more substances that intermingle but do not bond;
  - proportions of each can vary
Types of Bonding

- Ionic Bonding
  - A strong mutual attraction between two oppositely charged ions with a large difference in electronegativity (an electron is not usually transferred)
  - *Example:* NaCl (table salt)
Covalent bonding

- **Covalent bond**
  - Two atoms with similar electronegativity and unpaired electrons sharing a pair of electrons
  - Can be **stronger** than ionic bonds
  - Atoms can share one, two, or three pairs of electrons (single, double, or triple covalent bonds)
Hydrogen Bonds

- **Hydrogen bond**
  - A *weak* attraction between a highly electronegative atom and a hydrogen atom taking part in a separate polar covalent bond
  - Hydrogen bonds do not form molecules and are not “chemical bonds”
  - Hydrogen bonds stabilize the structures of large biological molecules
Chemical vs. Physical Reaction

- Physical – Changes states but can be changed back.
- Chemical – Can’t be changed back to the original substance.
2.2 Water’s Life Giving Properties

- Living organisms are mostly water
  - the chemical reactions of life are carried out in water
  - Water is essential to life because of its unique properties
Properties of Water

- The properties of water are a result of extensive hydrogen bonding with each other
  - Overall, water (H\textsubscript{2}O) has no charge
  - Slightly positive H attracted to slightly negative O end
  - Creates a “sticky” molecule
B Many hydrogen bonds (dashed lines) that form and break rapidly keep water molecules clustered together in liquid water.

C Below 0°C (32°F), the hydrogen bonds hold water molecules rigidly in the three-dimensional lattice of ice. The molecules are less densely packed in ice than in liquid water, so ice floats on water.
Adhesion and Cohesion

- **Cohesion** = hydrogen bonding between like molecules
  - Provides surface tension
  - Draws water up from roots of plants

- **Adhesion** = hydrogen bonding between water and other molecules
  - Capillary action
  - Meniscus
Water’s solvent properties

- **Solvents** dissolve **solute**s creating **solutions**
- Water dissolves ionic compounds and other polar molecules
pH is a measure of the number of hydrogen ions in a solution
- The more hydrogen ions, the lower the pH
- pH 7 is neutral (pure water)
- Most life chemistry occurs around pH 7
- Each number is a 10x increase in H+
Acids and Bases

- **Acids** donate hydrogen ions in a water solution
  - pH below 7

- **Bases** accept hydrogen ions in a water solution
  - pH above 7

- Chemical reactions involving acids and bases are important to homeostasis
2.3 Macromolecules

- Macromolecules
  - “giant molecules” – made of smaller molecules
  - Monomers = small units that are hooked together

- 4 Groups of Macromolecules
  - Carbohydrates
  - Lipids
  - Nucleic Acids
  - Proteins
Carbohydrates

- Monosaccharides = single sugars
  - Glucose, fructose
- Complex Carbohydrates
  - Starches, glycogen, cellulose
- Used in animals to store energy and in plants for structure and energy.

Twitchy consumes large amounts of carbs!
Lipids

- Lipids
  - Fats, oils and waxes
  - Used to store energy and make up membranes.

- Saturated vs. Unsaturated
  - Saturated Fats
    - Fat contains the maximum number of hydrogen atoms
  - Unsaturated
    - Fat w/fewer hydrogen atoms (have more double bonds – kinked)
Proteins

- Proteins
  - Chains of folded Amino Acids
- Jobs of Proteins
  - Chemical reactions, pump molecules in/out of cell, enable cells to move.
- Amino Acids
  - There are over 20 different amino acids
  - These form different combinations, each combo = a different protein
Nucleic Acids

- Chains of nucleotides

Types of Nucleic Acids

- DNA – deoxyribonucleic acid
  - Contains the sugar deoxyribose
  - Double Stranded

- RNA – ribonucleic acid
  - Contains the sugar ribose
  - Single Stranded

Image adapted from: National Human Genome Research Institute.
2.4 Activation Energy & Enzymes

- **Activation Energy**
  - The energy needed to start a chemical reaction

- **Enzymes**
  - Proteins that lower the activation energy (they speed up reactions)
Energy Substrate Complex

- Substrate – a molecule that an enzyme reacts with
- Enzyme–Substrate Complex – Certain enzymes (proteins) can only bind with specific substrates.
2 Types of Energy Changes

- **Endothermic** – Absorbs energy
- **Exothermic** – Releases Energy