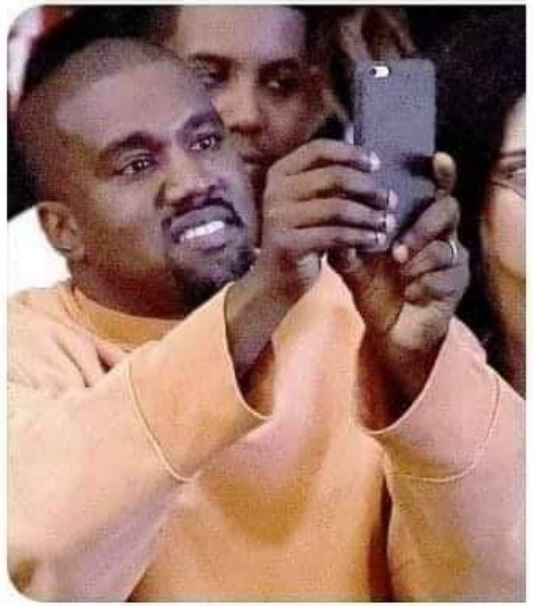
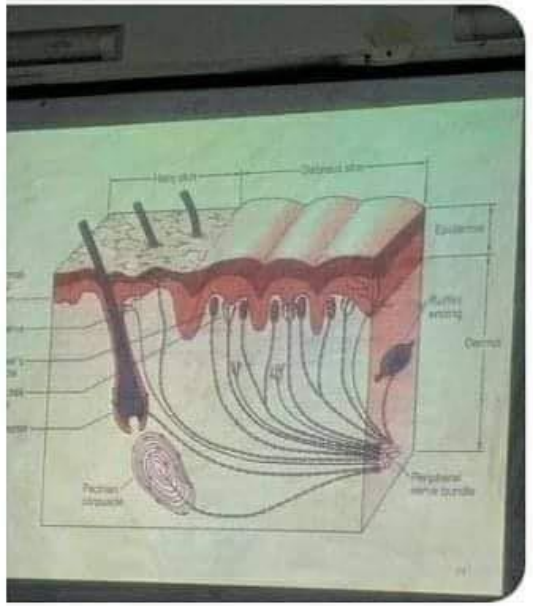
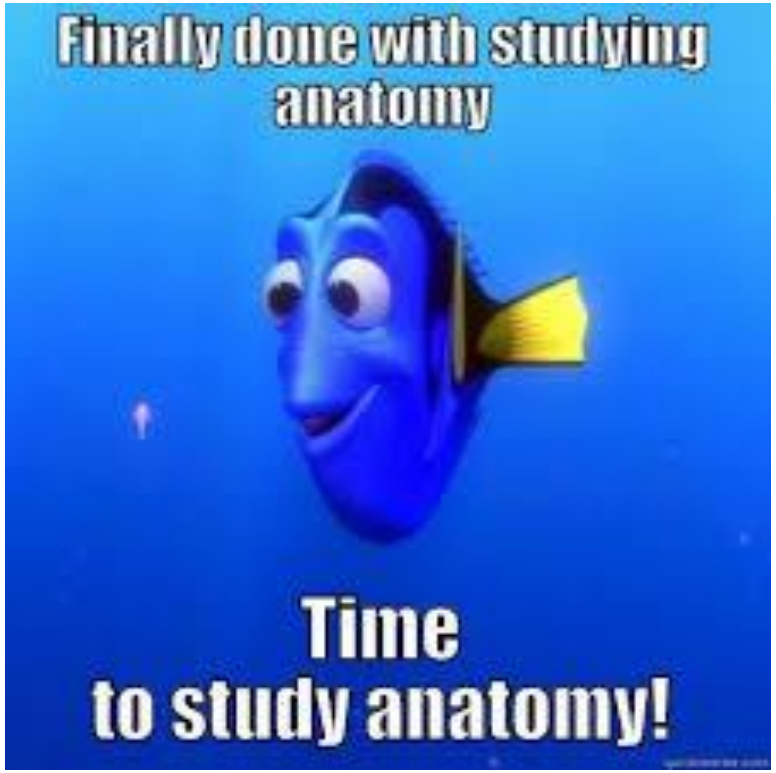
Me in class taking a picture of the board that I know I will never look at again.

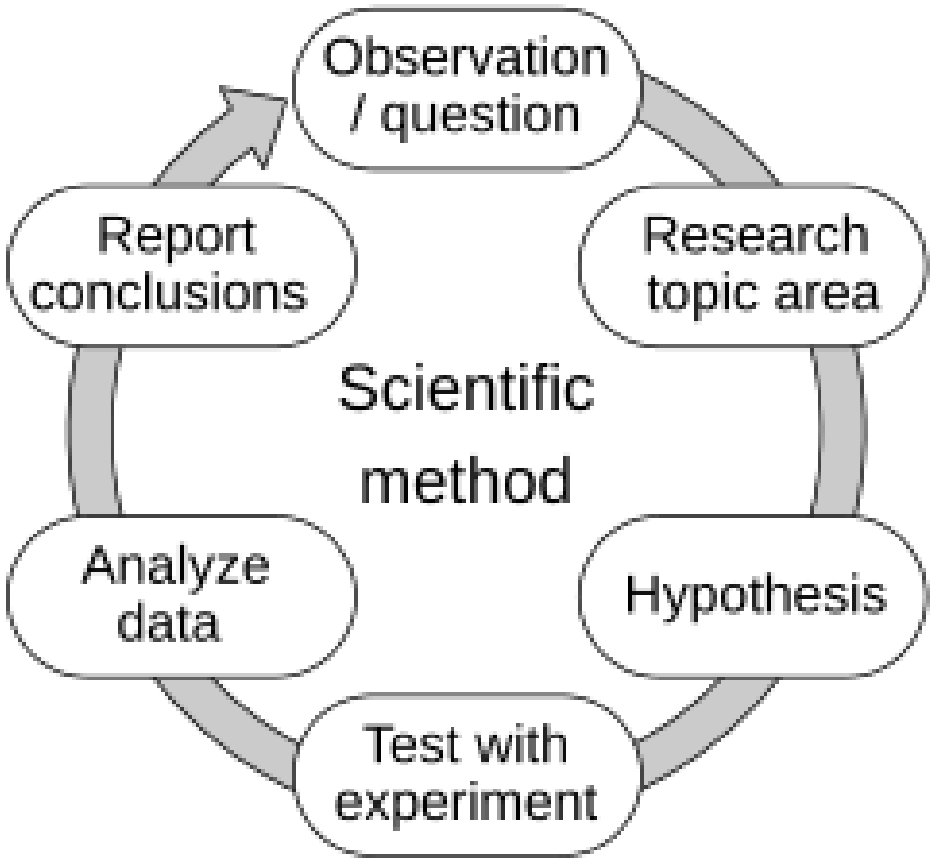






Ingredients for Life Notes (AKA Buckle Up)

Scientific Method



a method of procedure that has characterized natural science since the 17th century, consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses.

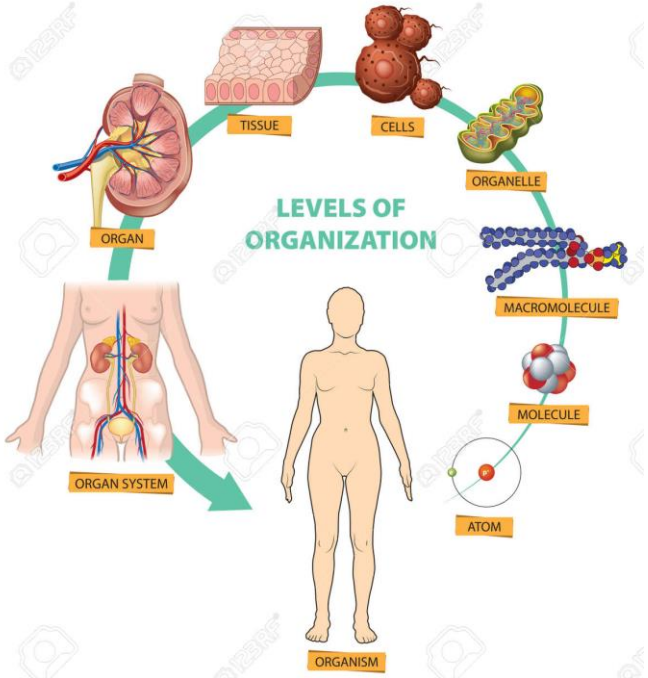
Control: an element that remains unchanged or unaffected by other variables, serving as a baseline for comparison to assess the impact of other factors

Experimental Group **Control Group**

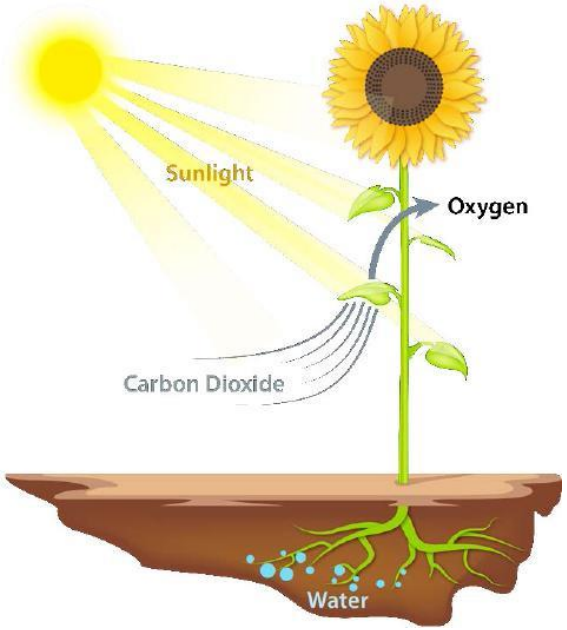
In experiments, scientists compare a control group and an experimental group that is identical in all respects. Unlike the experimental group, the control group is not exposed to the variable under investigation. It provides a baseline against which any changes in the experimental group can be compared.

Characteristics of Living Things

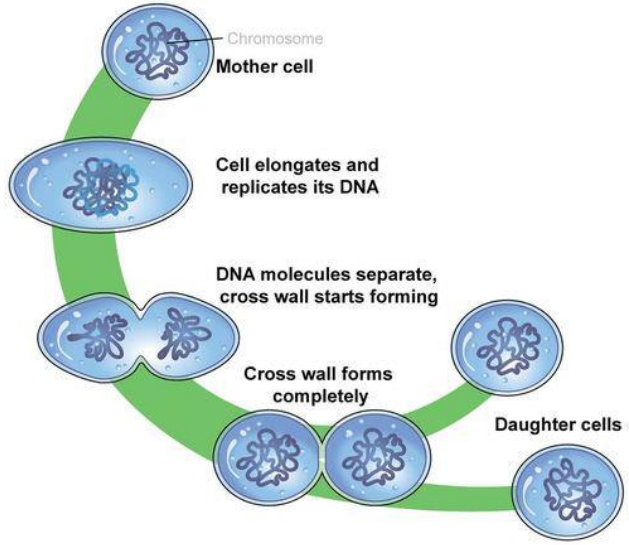
Are ORGANIZED in a hierarchy of levels



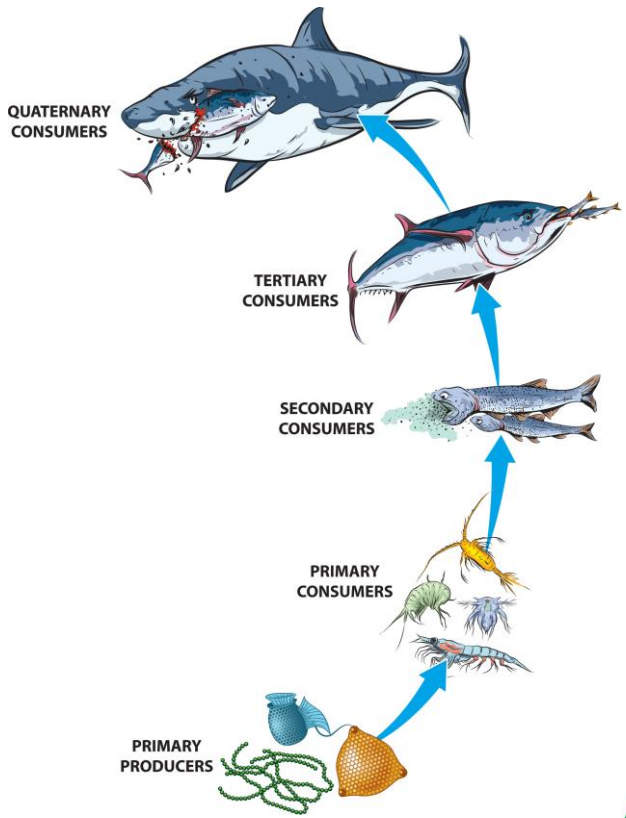
Acquire Materials and Energy

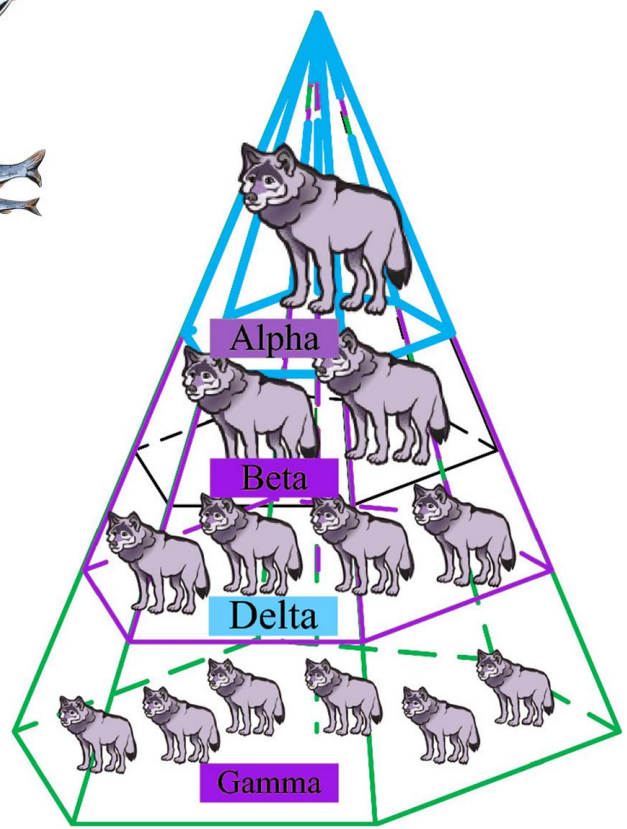


Reproduce



Are ORGANIZED in a hierarchy of levels

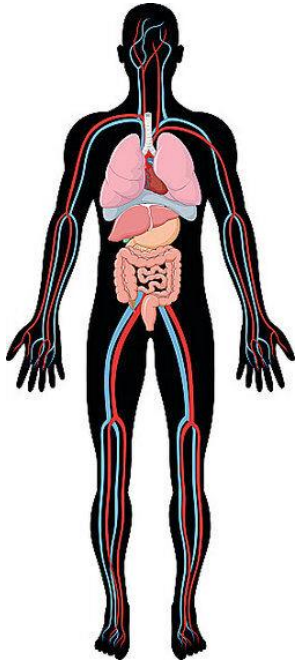




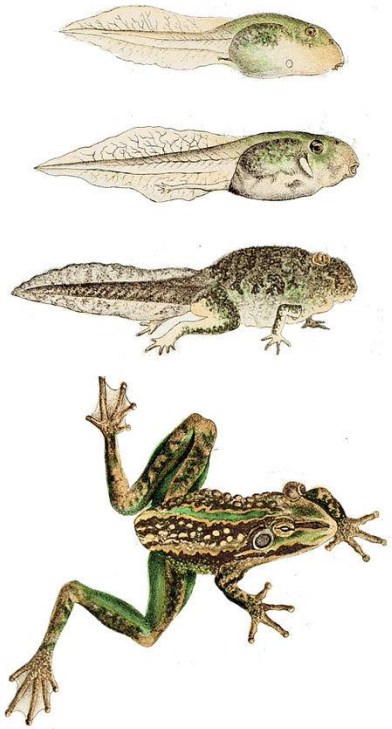
Characteristics of Living Things

Respond to Stimuli

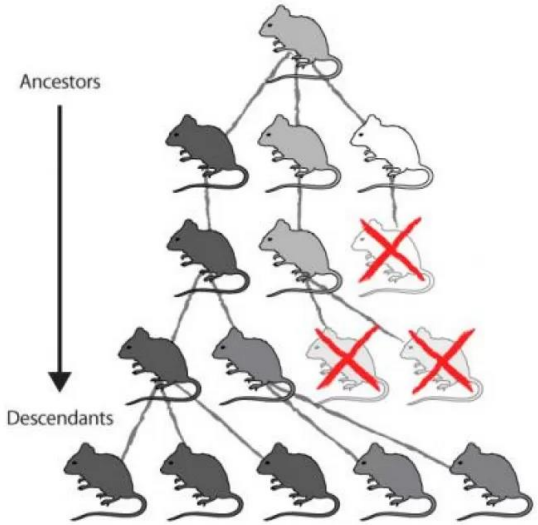
Methods for Homeostasis



Grow and Develop

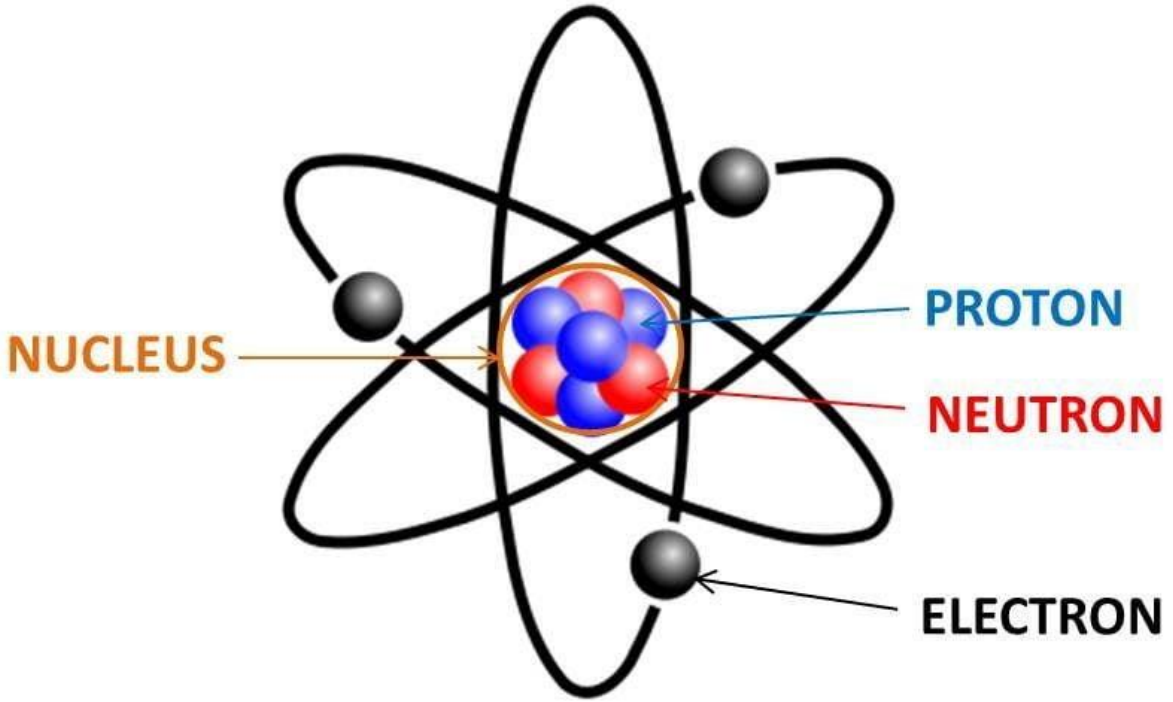


Adapt to Change



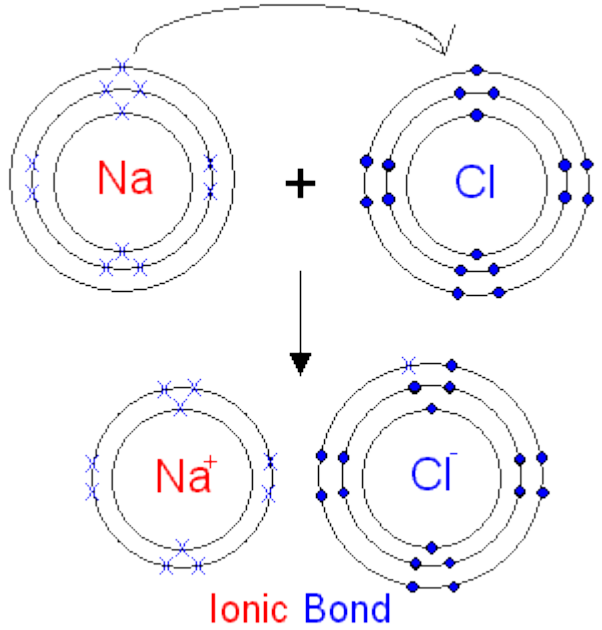
Atom

- Make sure you review on your own:
  - Electron, proton, neutron and their respective charges
  - Structure/model of the atom



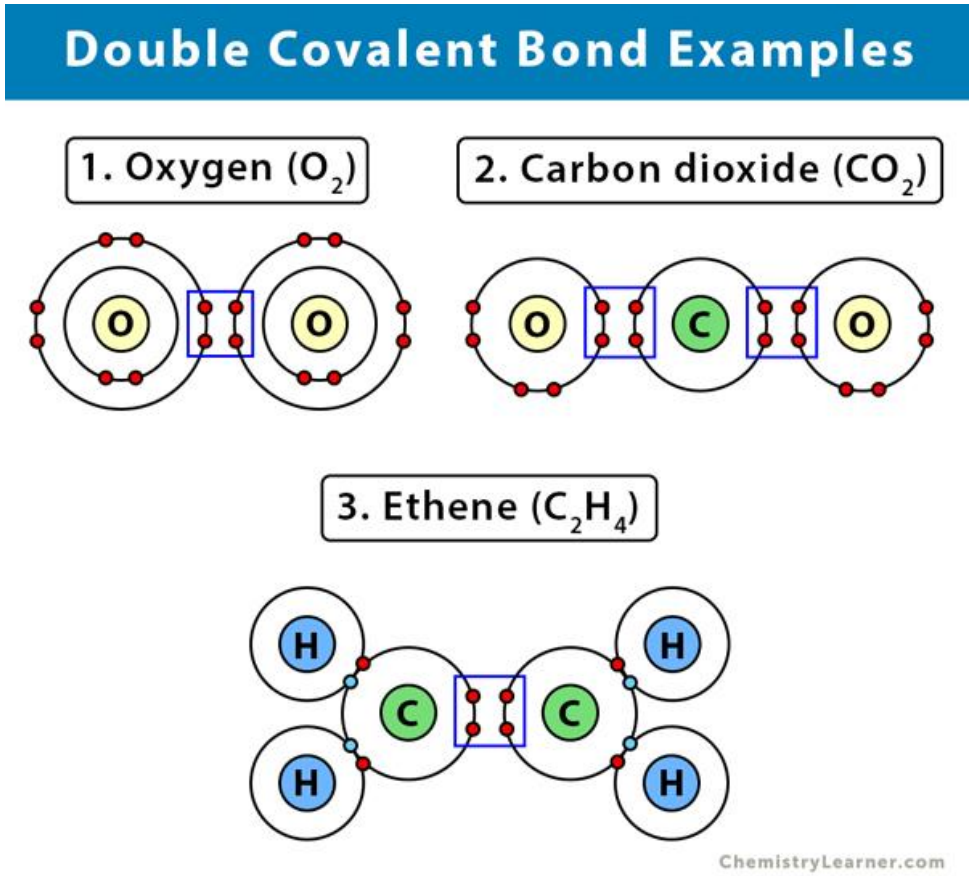
Ionic Bonds

- **Ion**: atom with a charge
- Atoms give up or take on electrons to achieve a complete outer shell.
- The reactions takes place between ions
- Metal and non-metal
- P. 27



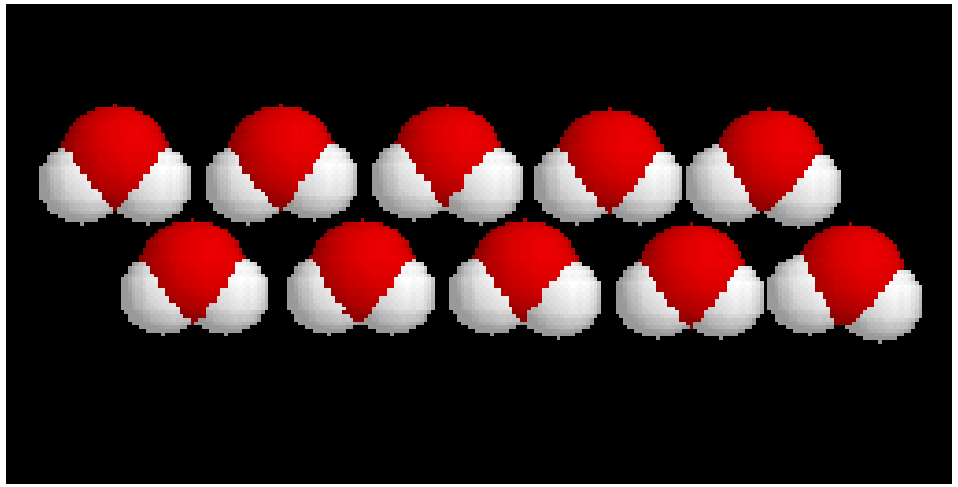
Covalent Bonds

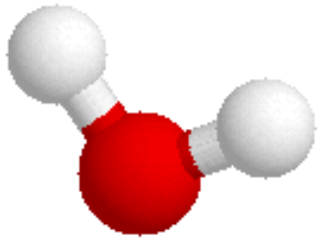
- Atoms sharing electron
- Non-metal and non-metal
- P. 28



Water

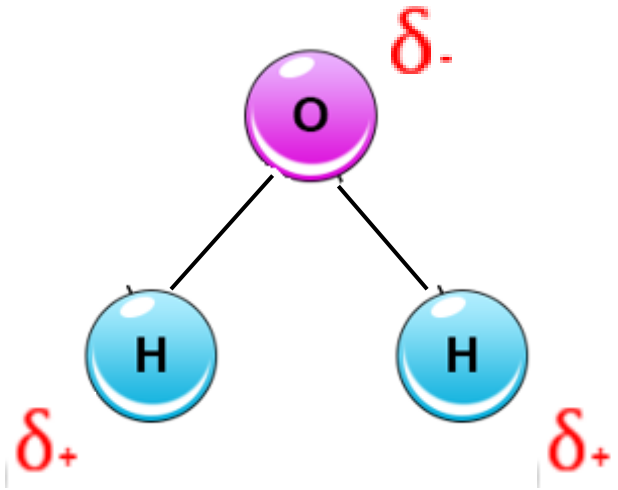
- A water molecule (H_2O), is made up of three atoms --- one oxygen and two hydrogen.

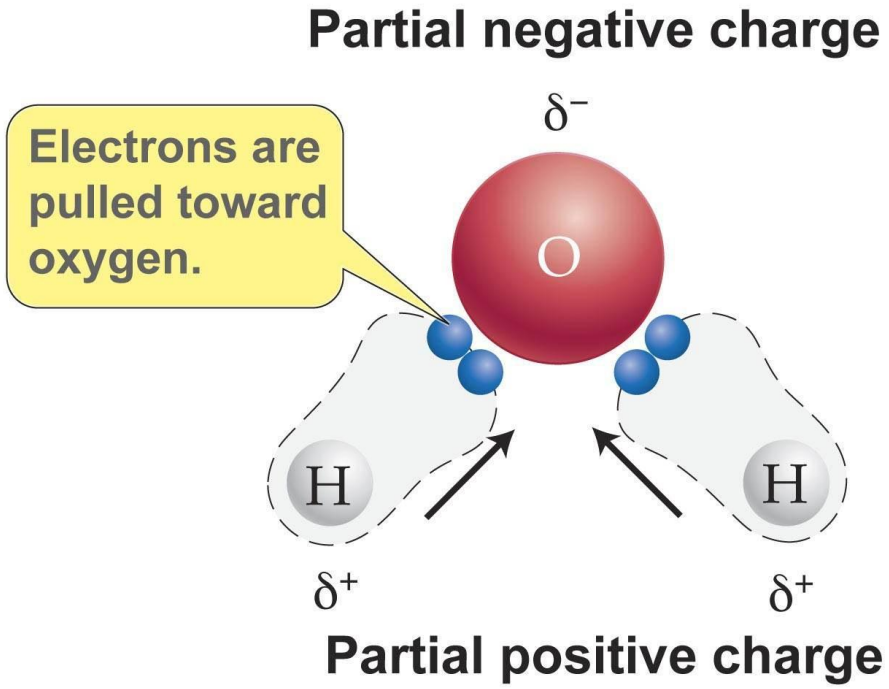




Water (H_2O)

- **Polar molecule**: the shared electrons prefer to spend time around the oxygen than the hydrogen thus causing the oxygen to have a slightly negative charge and hydrogen a slightly positive charge.
- Hydrogen bonds

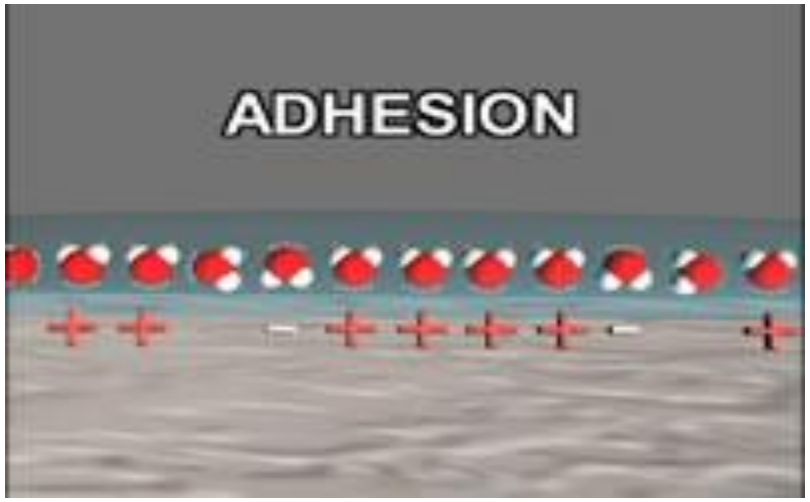




Properties of Water

- A **solvent** (p. 29) – good for chemical reactions
- A **transport** medium due to its cohesiveness (hydrogen bonding)
- **Cohesiveness** and **adhesiveness** (water can adhere to polar surfaces) allows it travel in tubular vessels (blood) and have a role as a lubricant in our joints.
- **High heat capacity** allows for slow rises and falls in our body temperature.

Adhesion Also Causes Water to …

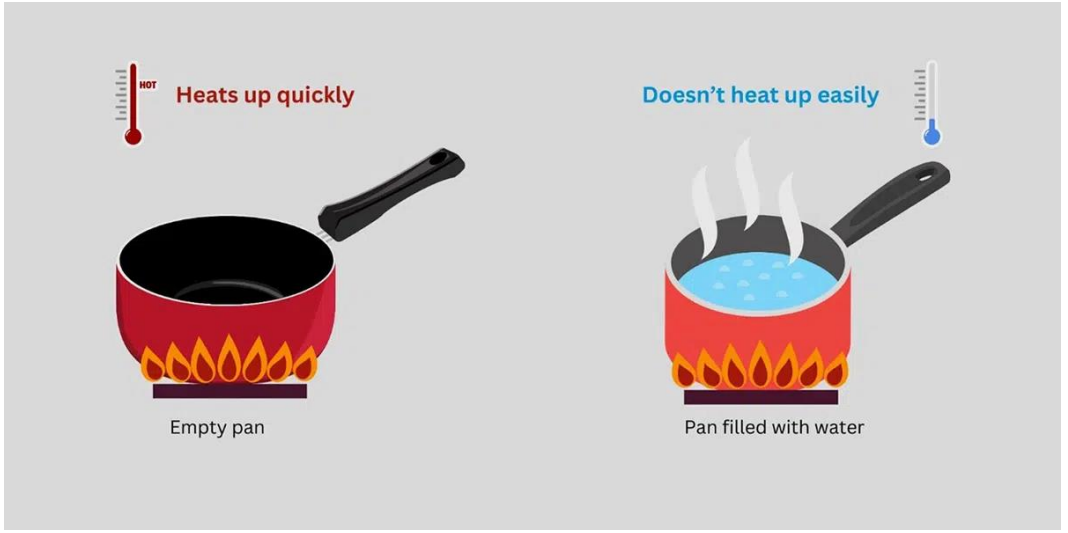


Attach to a silken spider web

Form spheres & hold onto plant leaves

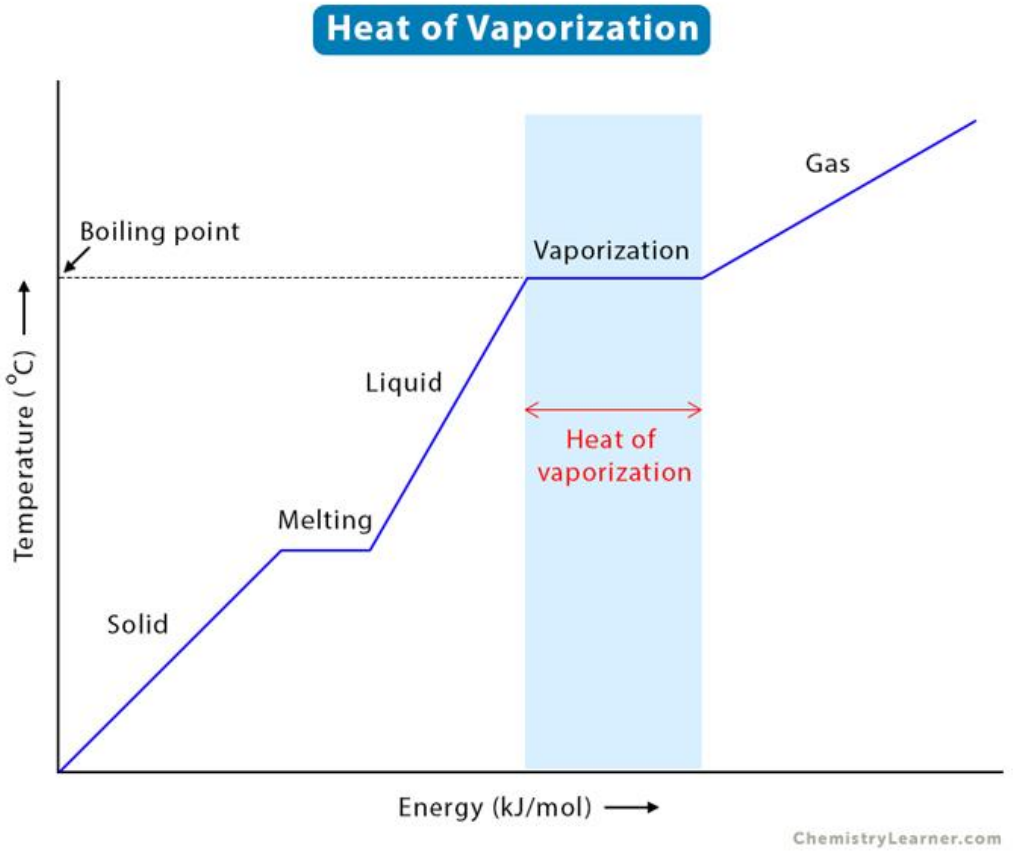
High Specific Heat

- Amount of heat needed to raise or lower 1g of a substance 1° C.
- Water resists temperature change, both for heating and cooling.
- Water can absorb or release large amounts of heat energy with little change in actual temperature.



High Heat of Vaporization

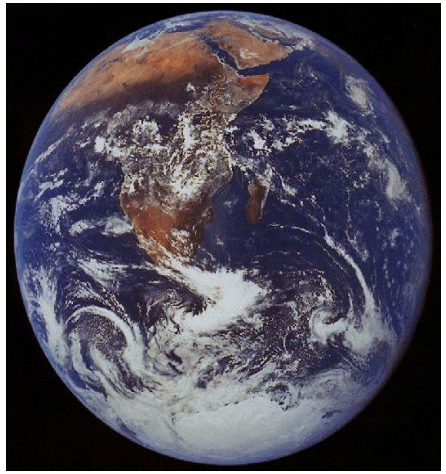
- Water's heat of vaporization is 540 cal/g.
- In order for water to evaporate, each gram must GAIN 540 calories (temperature doesn't change --- 100°C).
- As water evaporates, it removes a lot of heat with it (cooling effect).

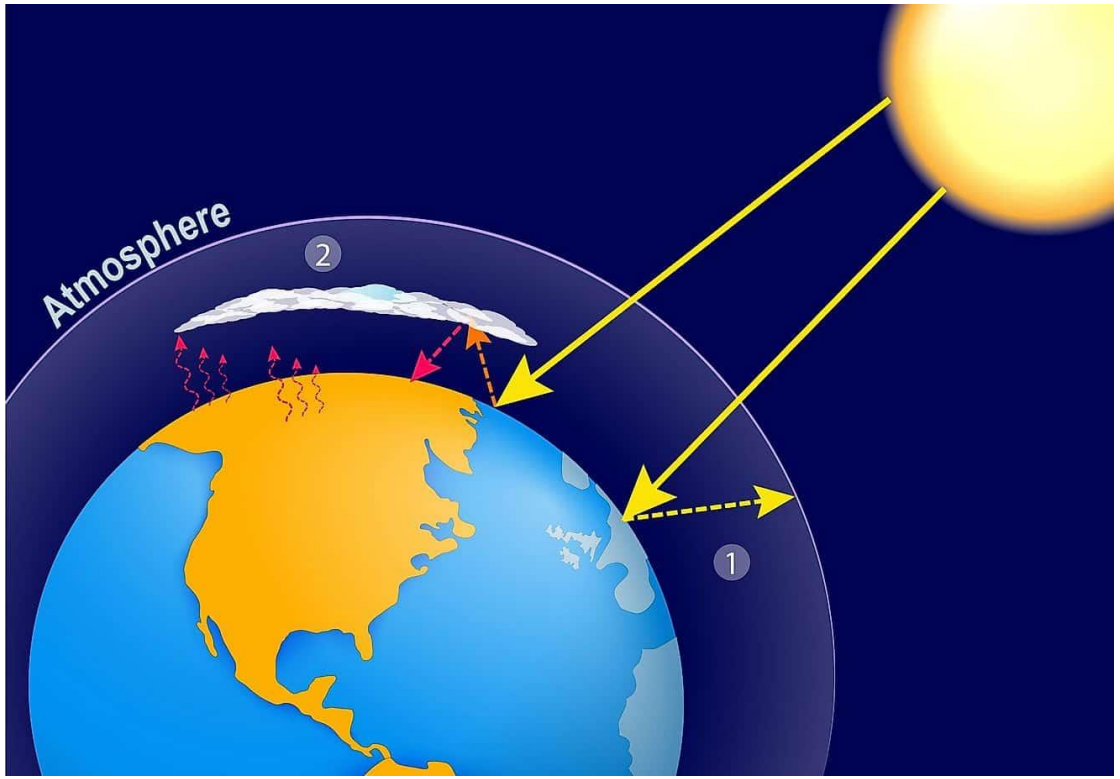


- Water vapor forms a kind of global ‘‘blanket” which helps to keep the Earth warm.
- Heat radiated from the sun warmed surface of the earth is

  absorbed and held

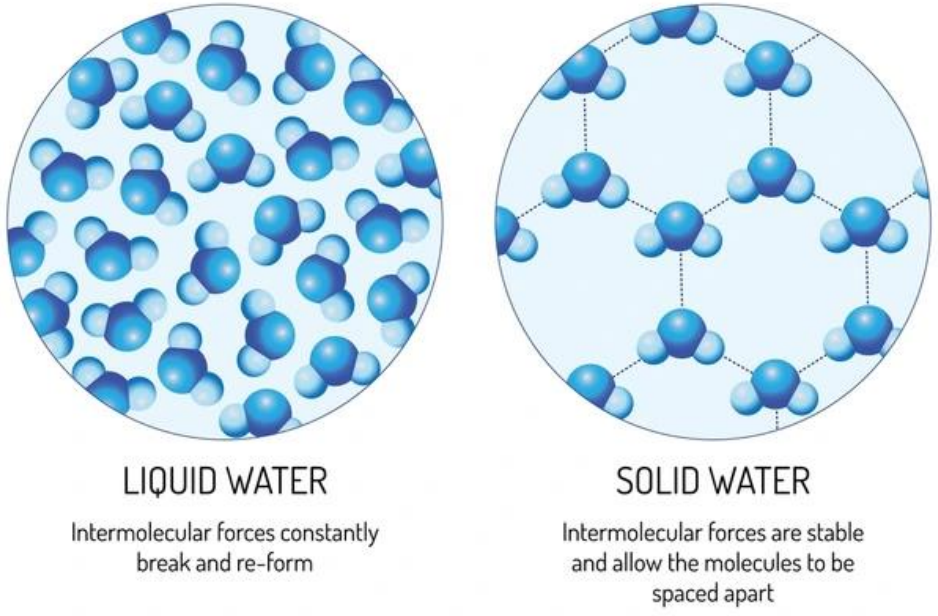
  by the vapor.





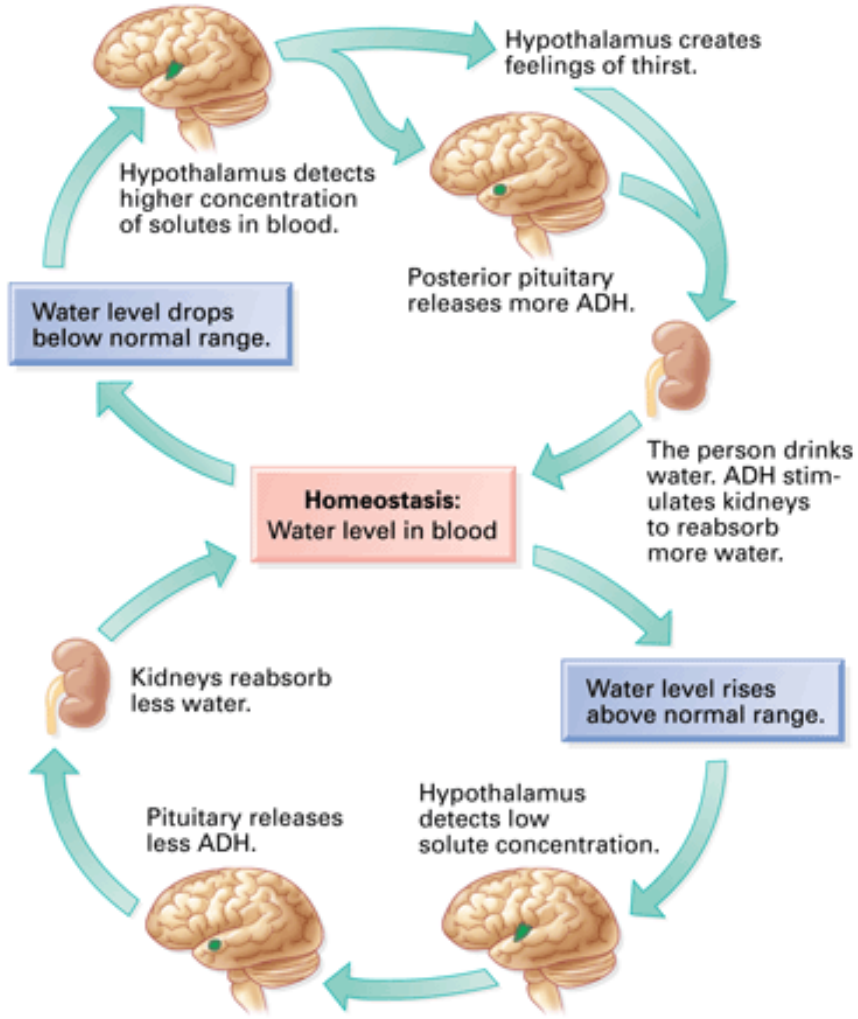
Water is Less Dense as a Solid

- Ice is less dense as a solid than as a liquid (ice floats)
- Liquid water has hydrogen bonds that are constantly being broken and reformed.
- Frozen water forms a crystal-like lattice whereby molecules are set at fixed distances.



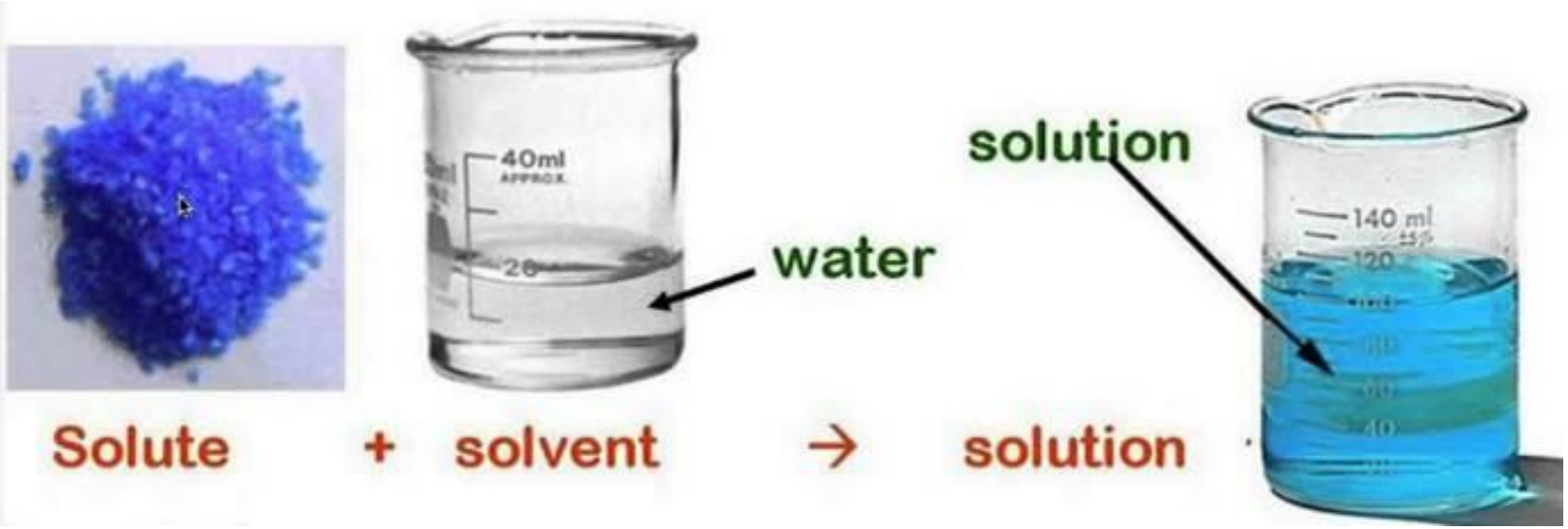
Homeostasis

- Ability to maintain a steady state despite changing conditions
- Water is important to this process because:
  a. Makes a good insulator
  b. Resists temperature change
  c. Universal solvent
  d. Coolant
  e. Ice protects against temperature extremes (insulates frozen lakes)



Solution

- Ionic compounds disperse as ions in water
- Evenly distributed
- SOLUTE
  - Substance that is being dissolved
- SOLVENT
  - Substance into which the solute dissolves

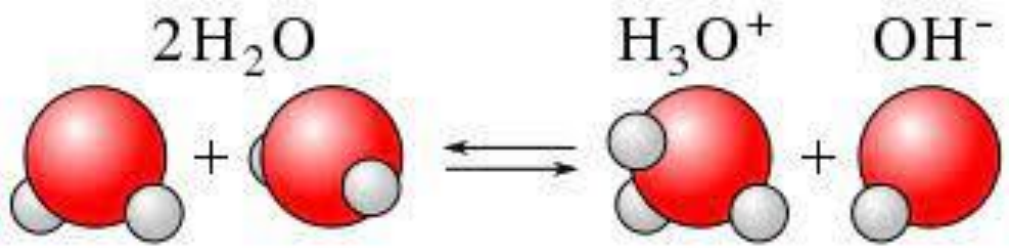


Suspensions

- Substances that don’t dissolve but separate into tiny pieces.
- Water keeps the pieces suspended so they don’t settle out.

Acids and Bases

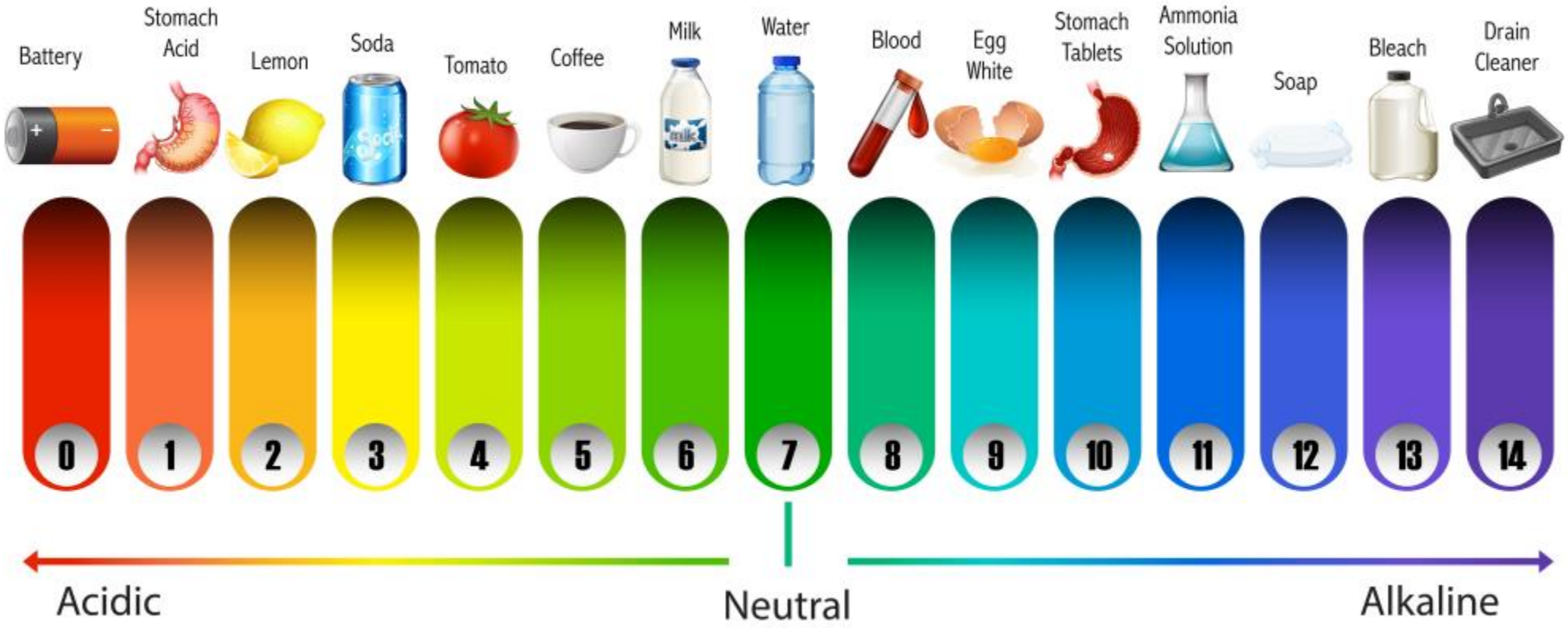
- **Dissociation**: “splitting” of water
- **Acids**: dissociation of H_2O to H^+
- **Base**: dissociation of H_2O to OH^-



Acid: $HCl \xrightarrow{H_2O} H_3O^+ + Cl^-$

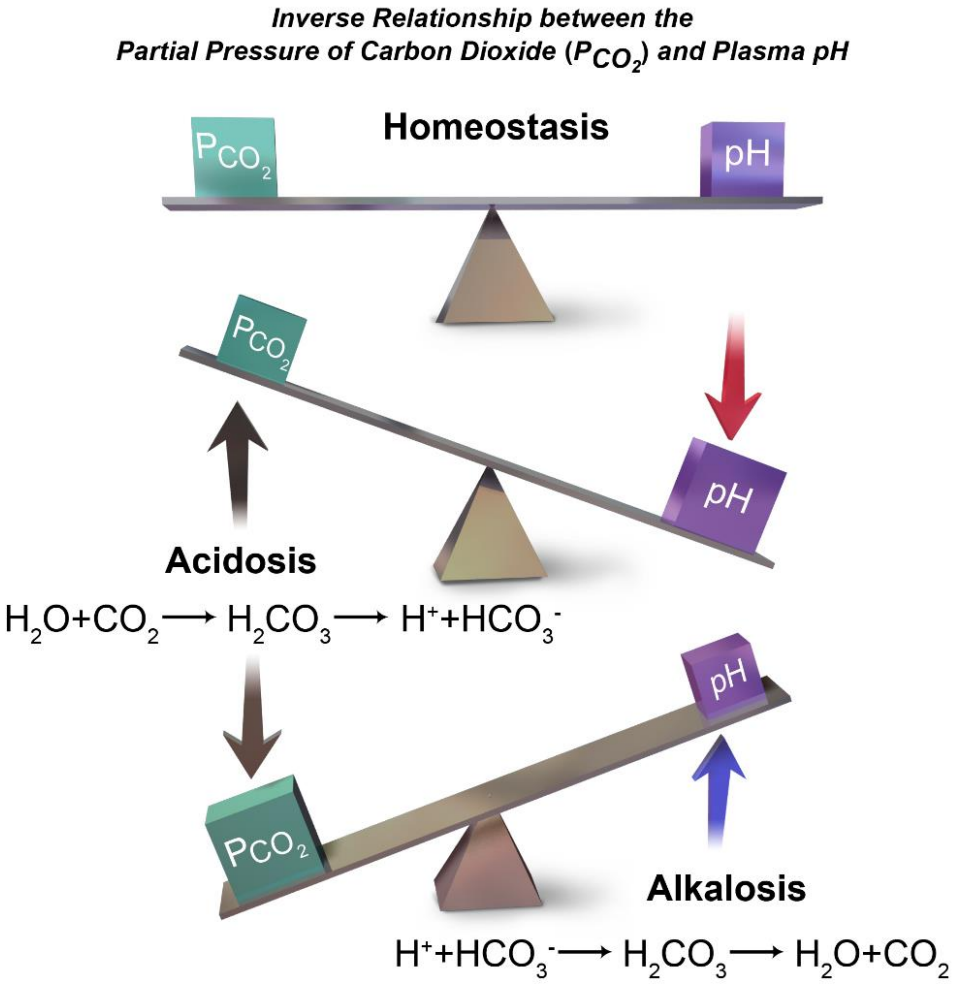
Base: $NaOH \xrightarrow{H_2O} Na^+ + OH^-$

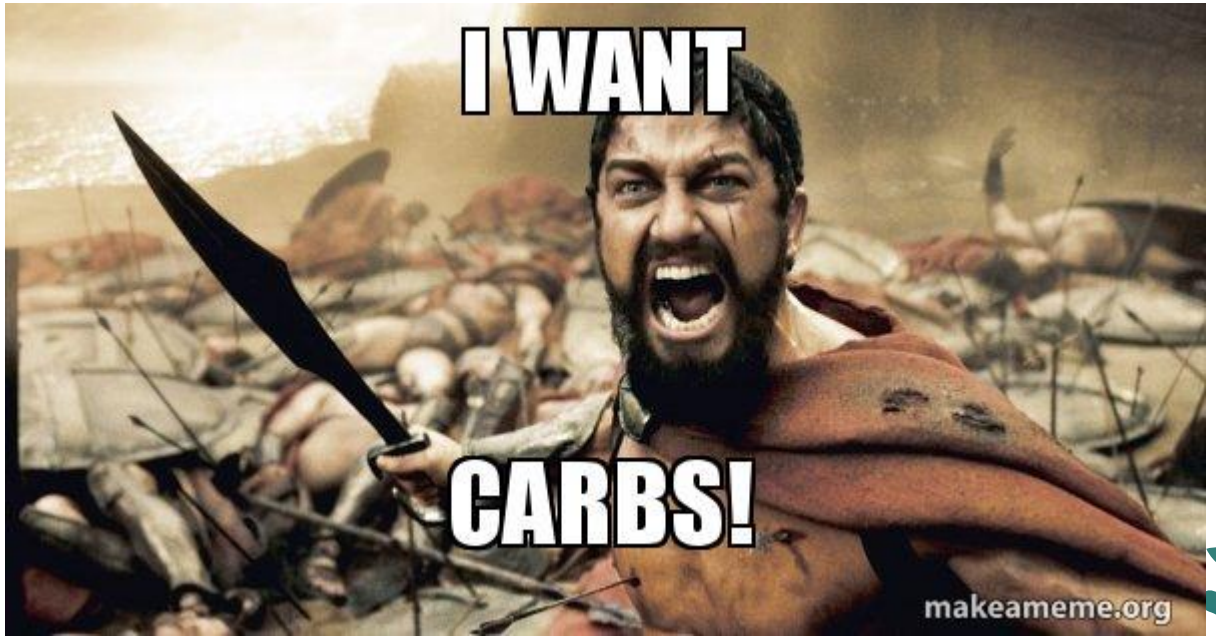
Acids and Bases – pH scale



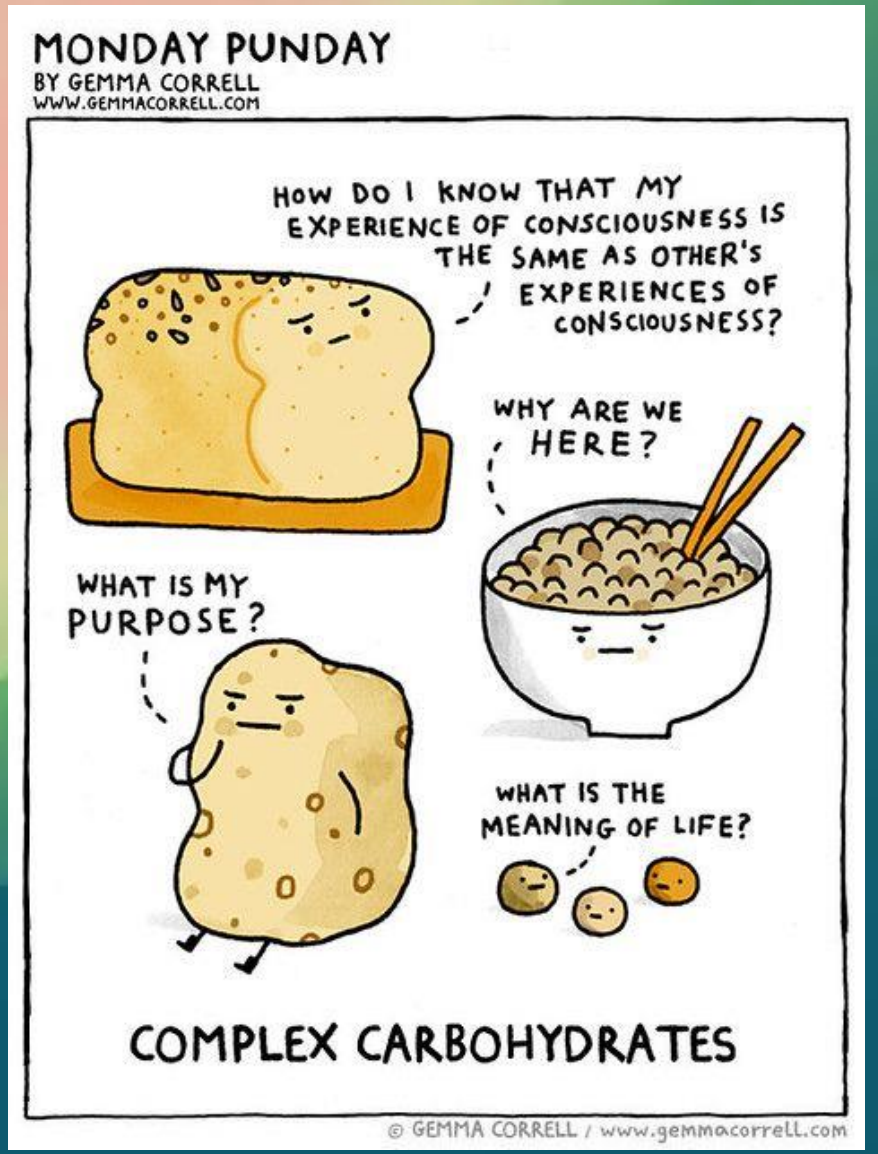
Acids and Bases: Buffers

- **Buffers**: a chemical that controls the acid and base levels.
- Your body needs to maintain a specific level of pH in each part of the body so it uses buffers to do this.
- Without buffers enzymes would not function properly and acidosis or alkalosis could occur.
- Normal pH for blood is around 7.4





Carbohydrates



Biological Molecules

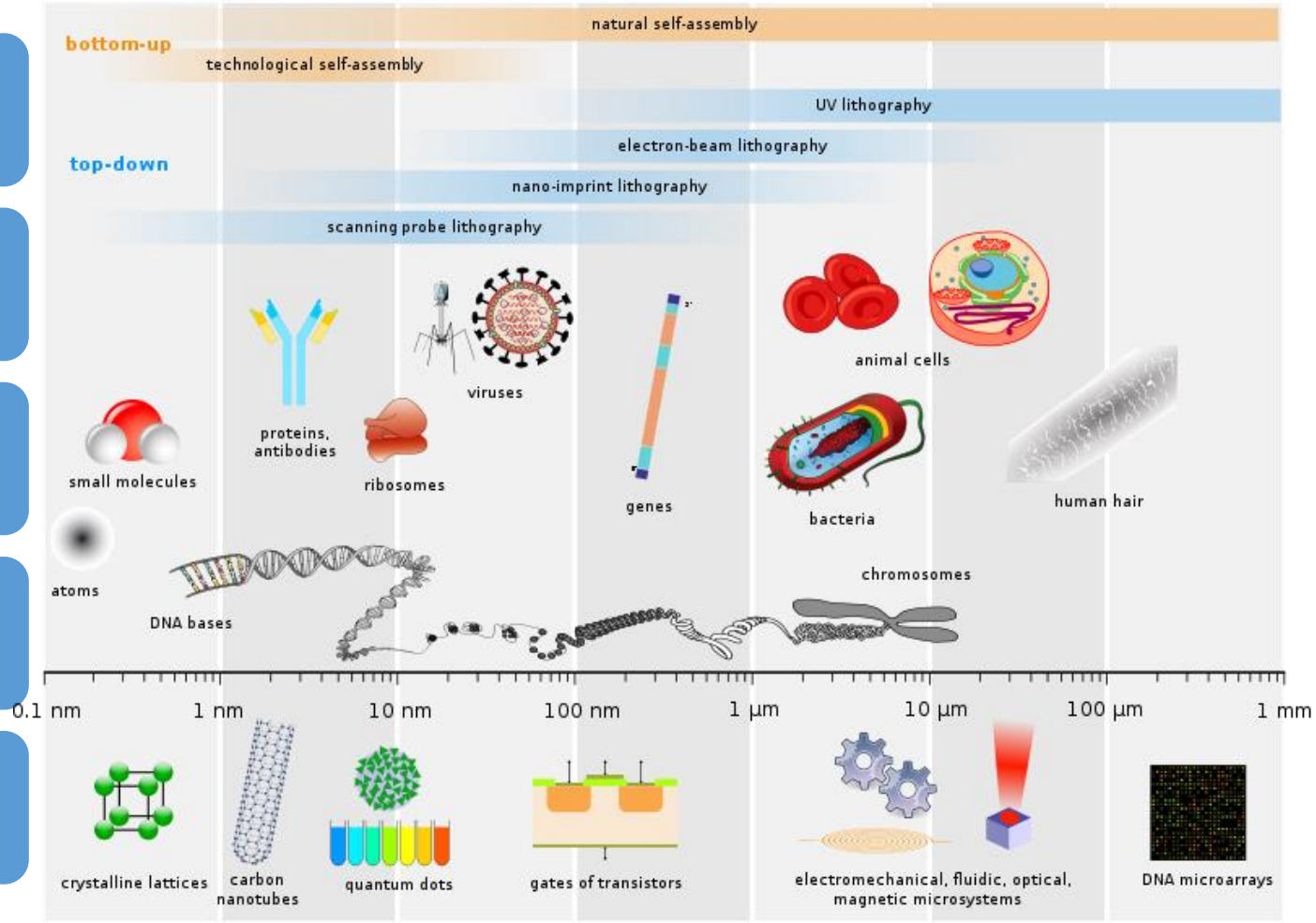
Four Main Organic Groups

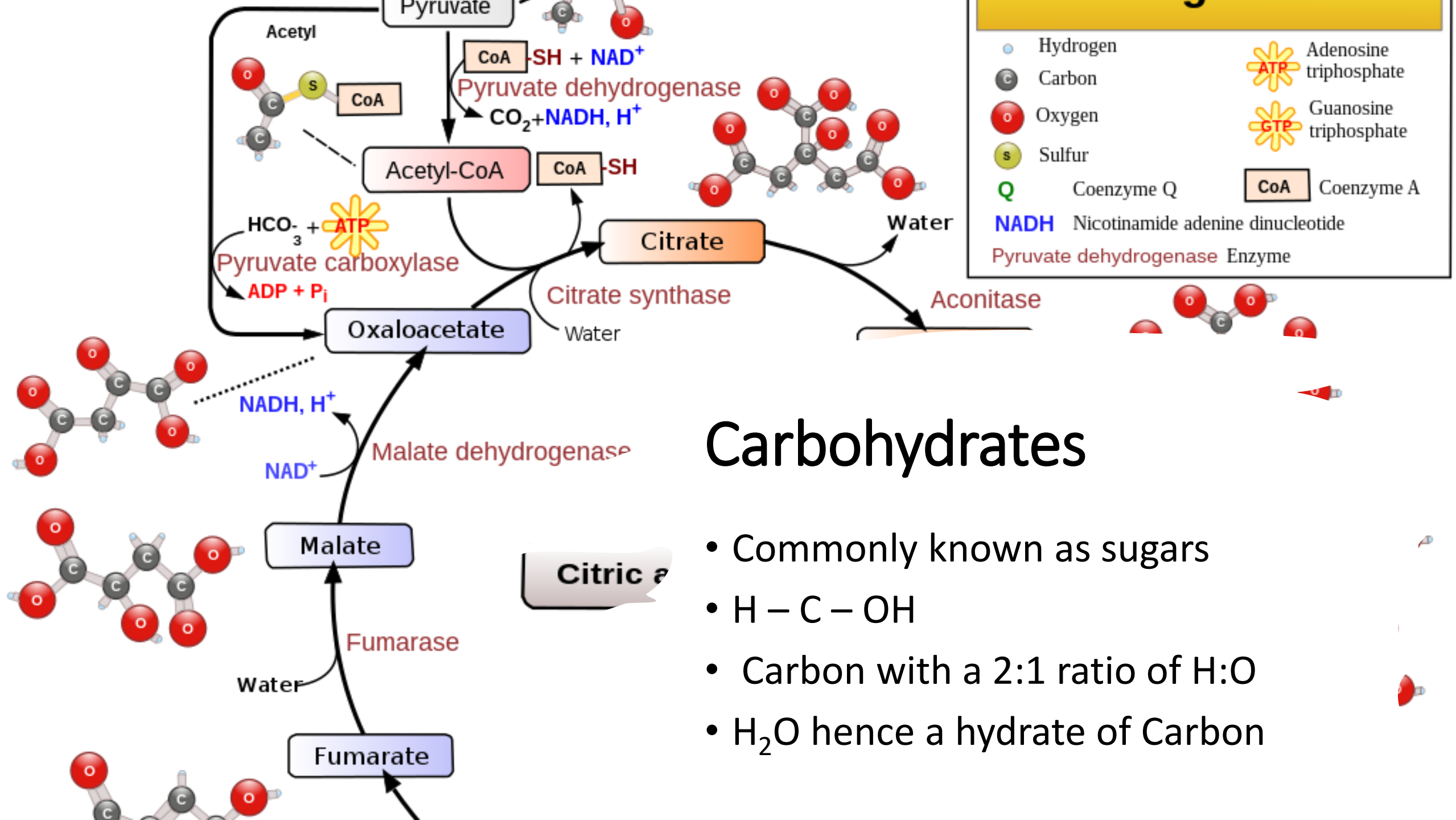
1) Carbohydrates

2) Proteins

3) Lipids

4) Nucleic Acids



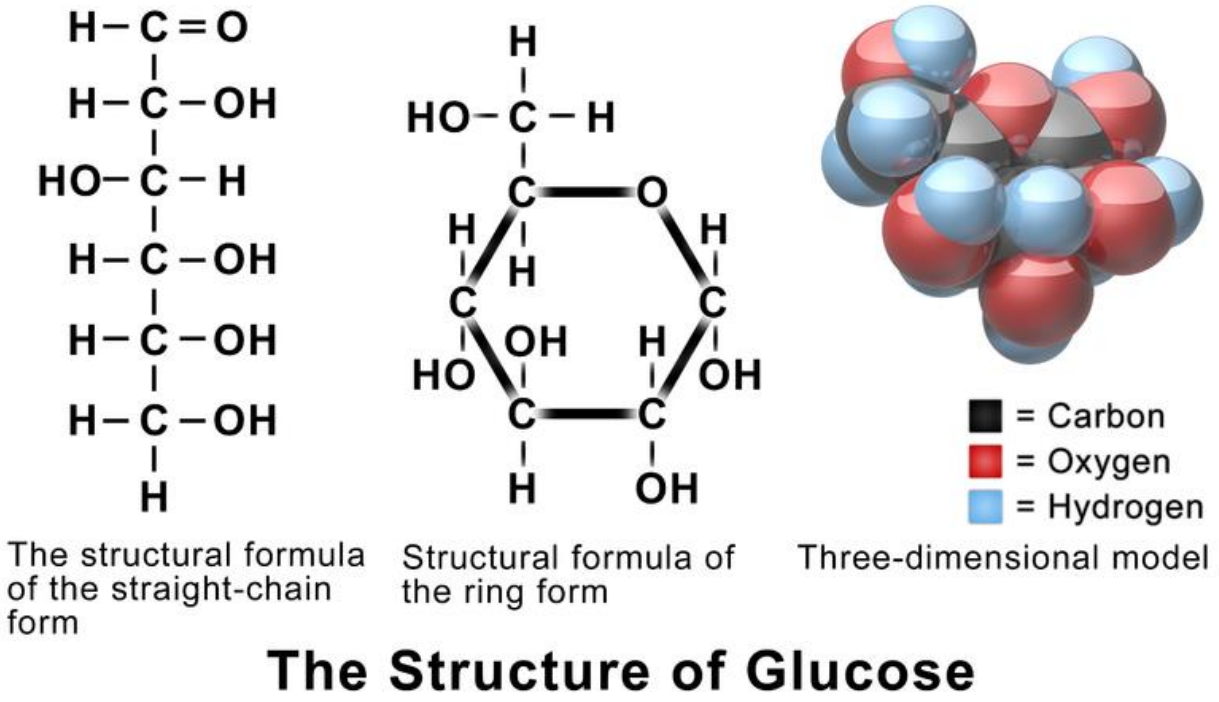


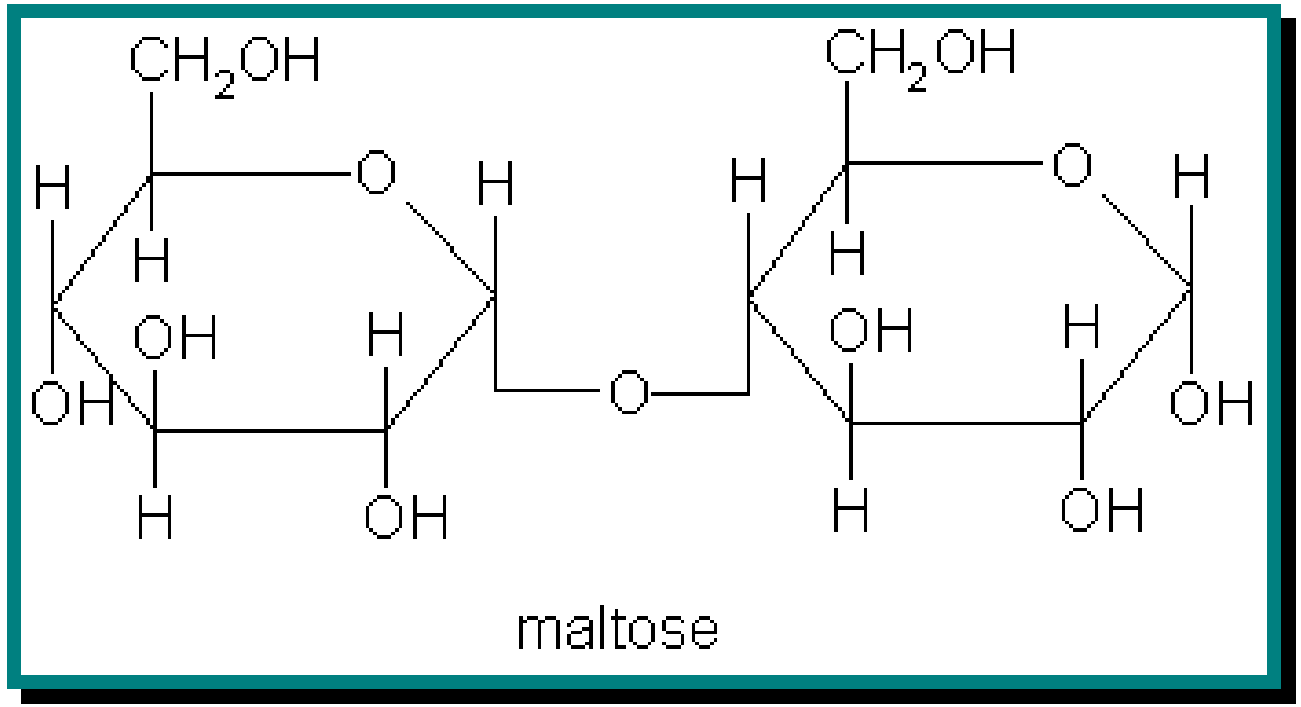
Carbohydrates

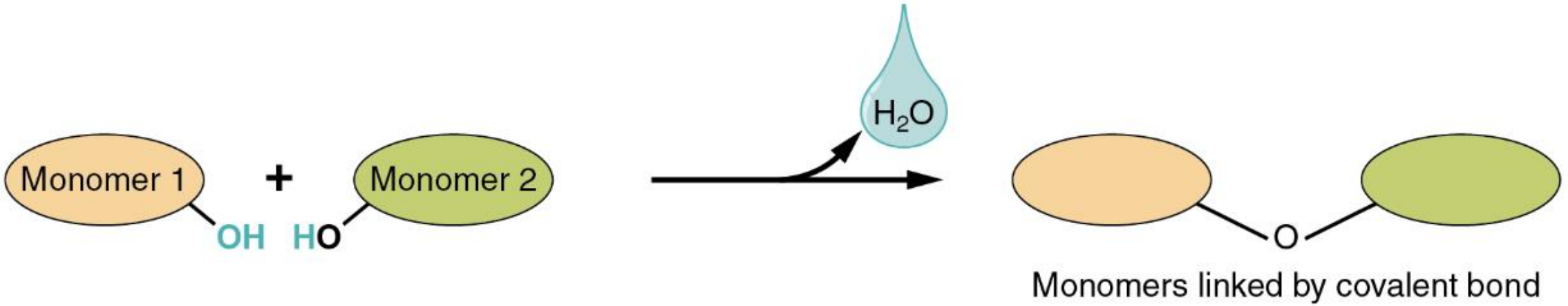
- Commonly known as sugars
- H – C – OH
- Carbon with a 2:1 ratio of H:O
- H_2O hence a hydrate of Carbon

Monosaccharide

- The basic building block (monomer) of carbohydrate
- **Monomer**: the simplest unit or building block
- Representative is **glucose** molecule $C_6H_{12}O_6$

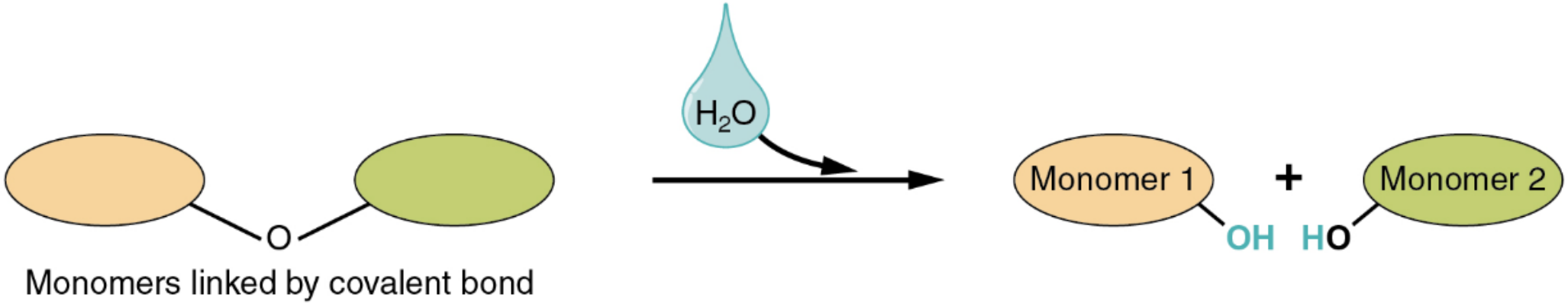



CH2OH
CH2OH
maltose



Dehydration Synthesis

- Monomers join together to form larger molecules called **polymers**.
- Proteins, carbohydrates, fats, and nucleic acids can all be polymers.
- To join the unit molecules (or building blocks) together, a molecule of water must be removed.
- H^+ is taken from 1 molecule and OH^- from the other molecule.
- This process is called **dehydration synthesis** and energy is required.

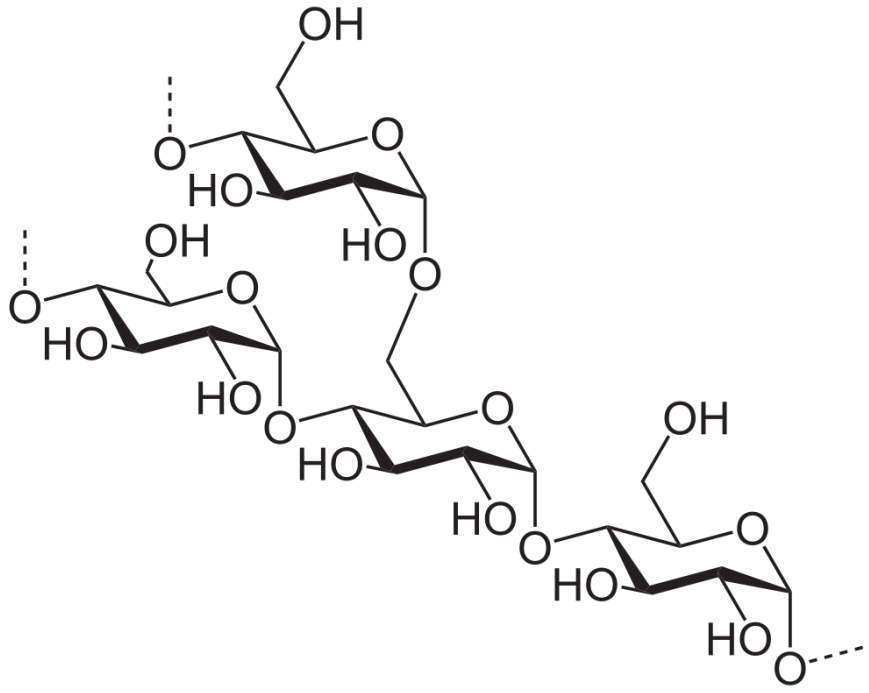


Hydrolysis

- To break down a polymer into its monomers a molecule of water must be added.
- This process is called **hydrolysis** and energy is released.
- H^+ is added to 1 molecule and OH^- to the other molecule.
- Hydro - refers to water and lysis means to break apart.

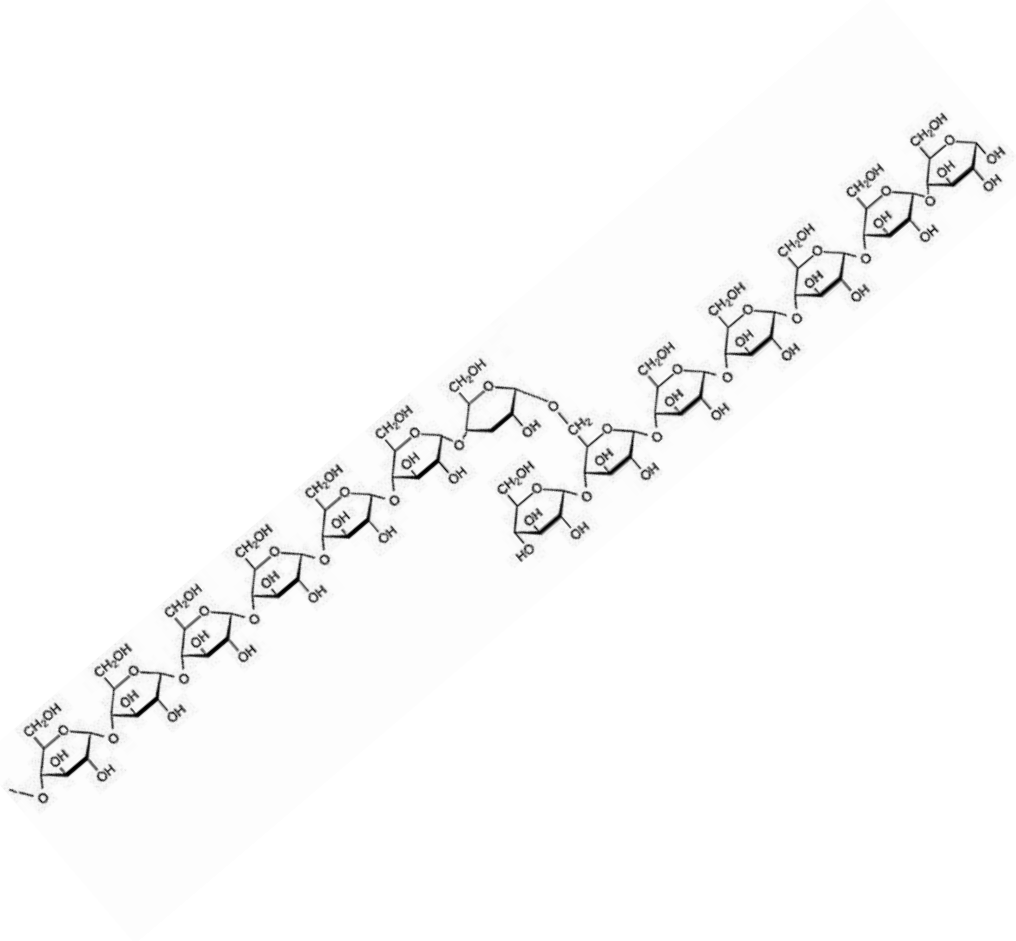
Polysaccharide

- Many monosaccharides joined together
- Covalent bonds
- 3 types
  - **Starch**:
    - A long chain of glucose molecules
    - A storage form of glucose in plants
    - Found in rice, potatoes, pasta and bread



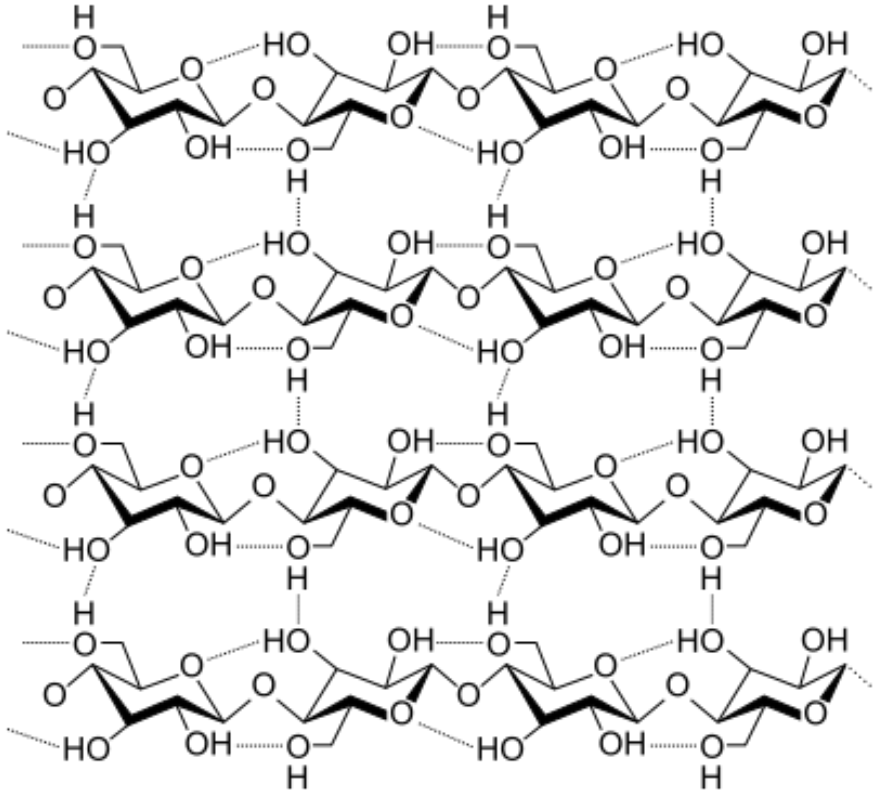
Polysaccharide

- **2) Glycogen**
  - Many side chains protruding off a main chain of glucose molecules.
  - Storage form of glucose in animals.
  - In humans, it is stored in the liver and muscle
  - It helps to maintain a 0.1% blood sugar level



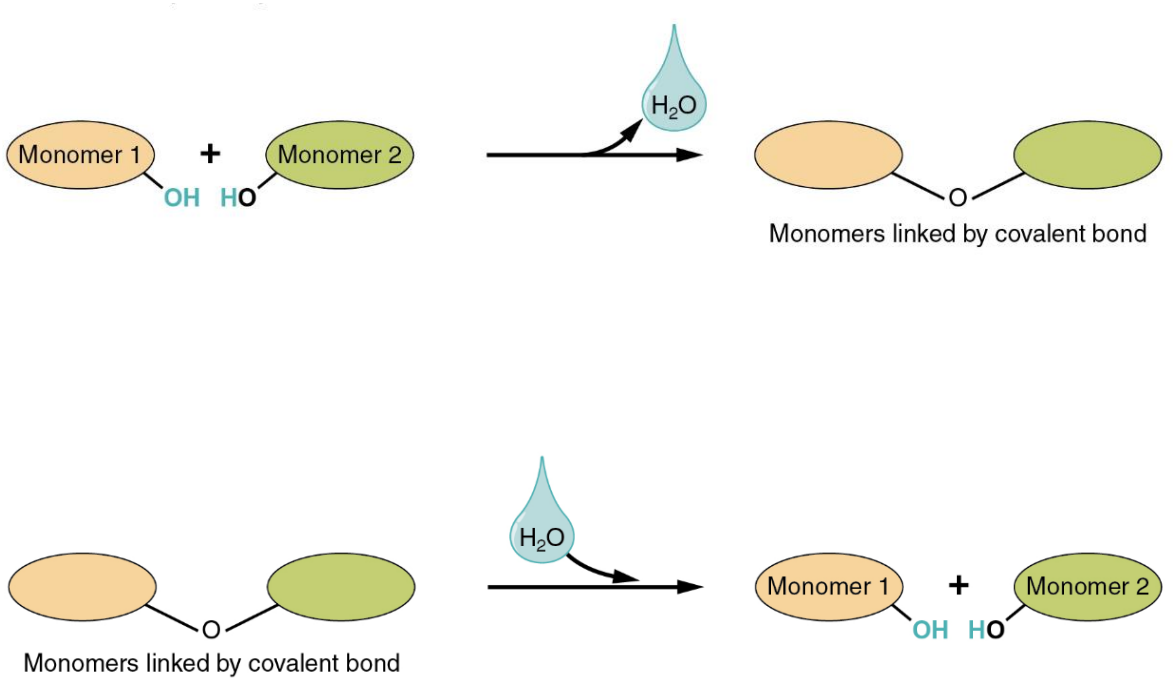
Polysaccharide

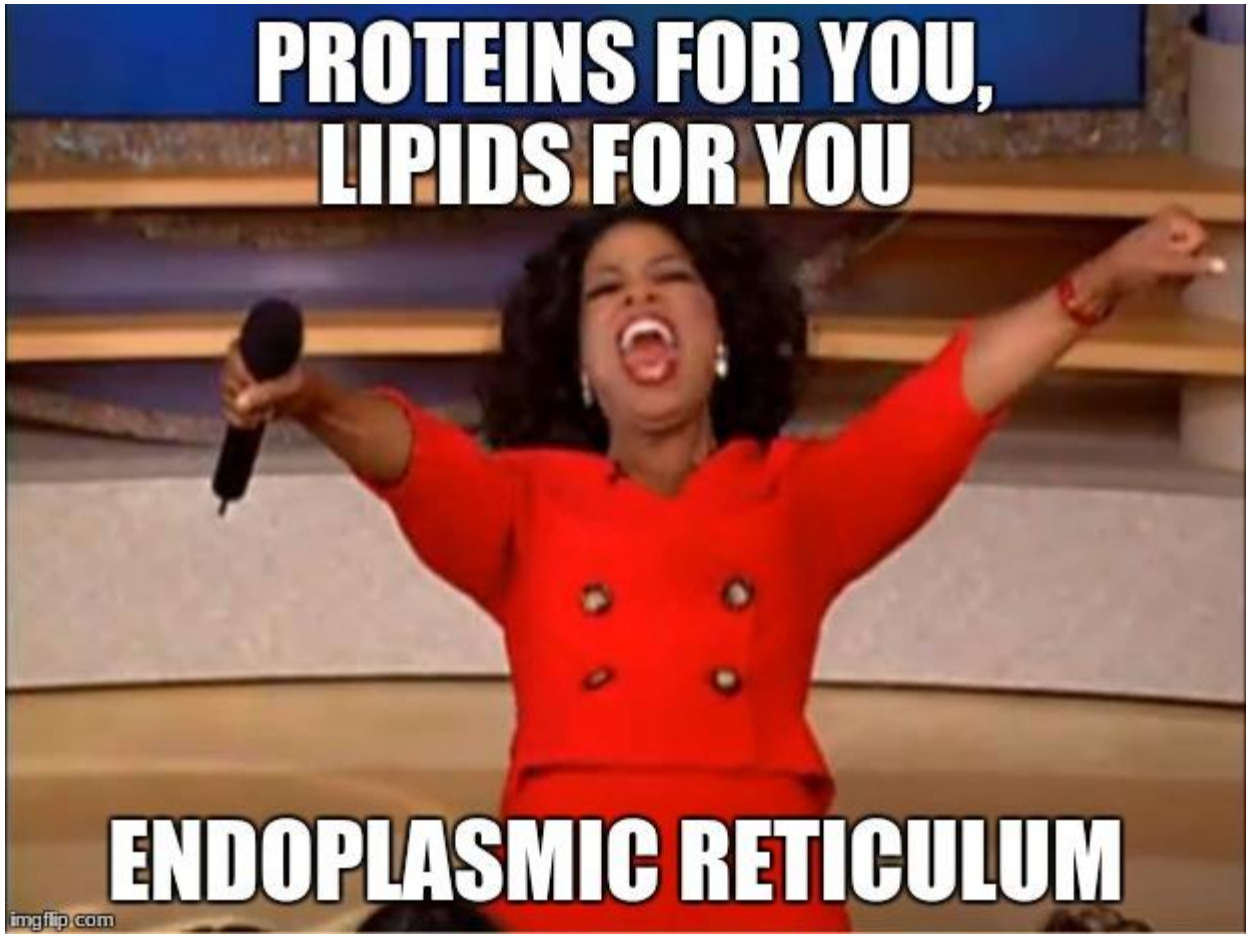
- **3) Cellulose**
  - A chain of glucose molecules that has bonding that our enzymes do not recognize. Therefore we cannot break down cellulose.
  - It is found in plant cell walls for strength
  - Good roughage for our digestive system



Important Terms to Know

- Carbohydrate
- Hydrolysis
- Dehydration Synthesis
- Monosaccharide
- Disaccharide
- Polysaccharide
  - Starch
  - Glycogen
  - Cellulose

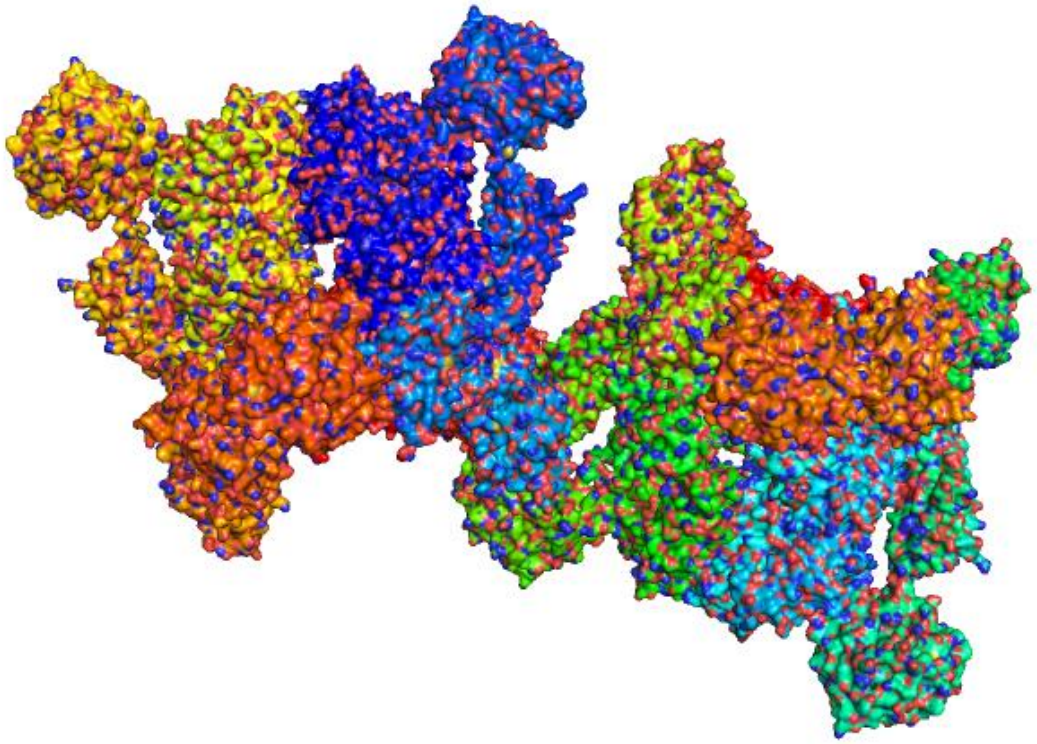




Proteins and Lipids

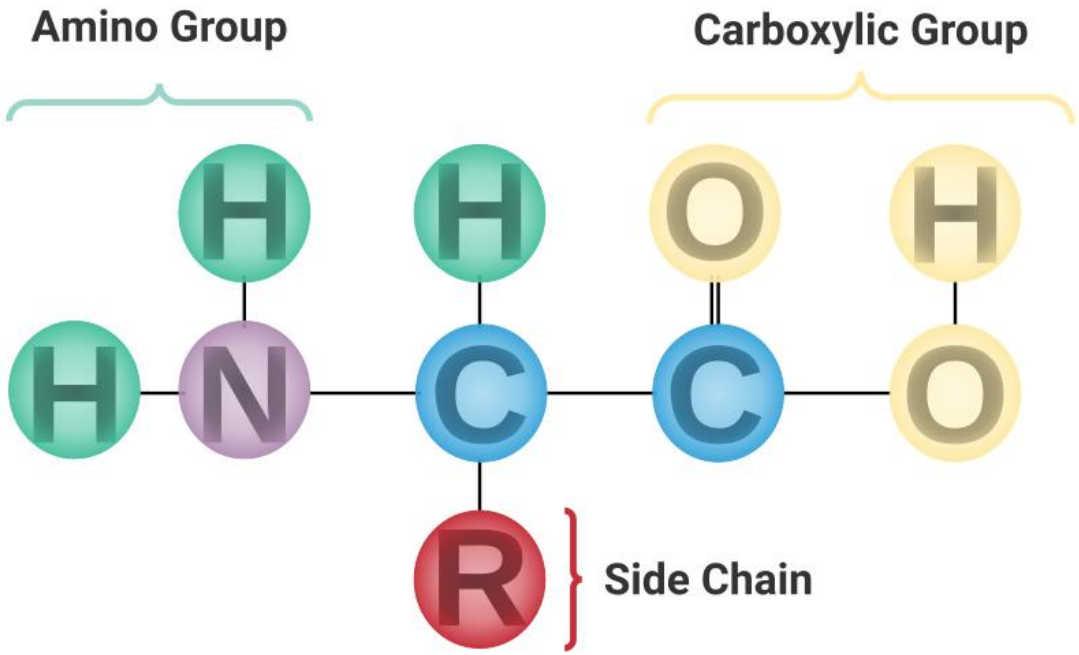
Proteins

- Very large macromolecules with a structural function at times.
- Many locations in body bone, tendons, ligaments, hair, cell membranes, nails.
- Some function as enzymes.

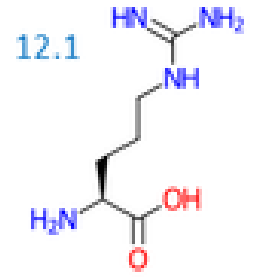


Proteins

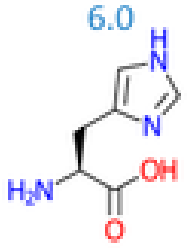
- The basic building block of proteins is the **amino acid**.
- There are 22 amino acids used to form proteins.
- The only difference is the R group.
- The 21st and 22nd are recent discoveries so most things still say 20 amino acids.
- The 22nd is only found in archaea



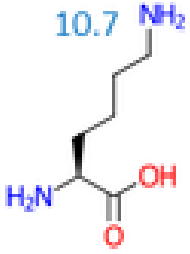
Positively charged



Arginine
Arg **R**

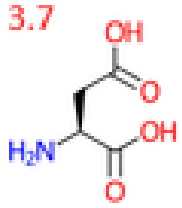


Histidine
His **H**

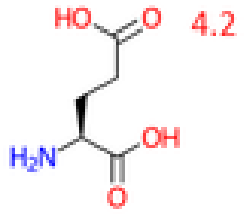


Lysine
Lys **K**

Negatively charged



Aspartic Acid
Asp **D**

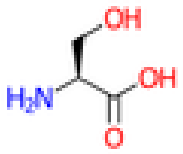


Glutamic Acid
Glu **E**

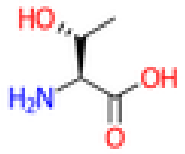
12.1 or 6.0: pKa of side chain

Sulfur or Selenium

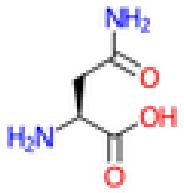
Polar uncharged



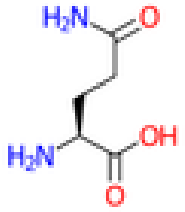
Serine
Ser **S**



Threonine
Thr **T**

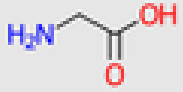


Asparagine
Asn **N**

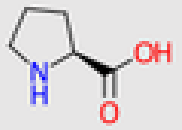


Glutamine
Gln **Q**

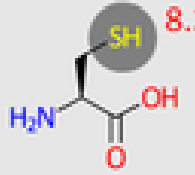
Special cases



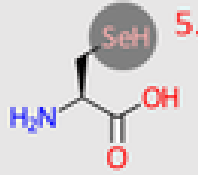
Glycine
Gly **G**



Proline
Pro **P**

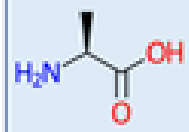


Cysteine
Cys **C**

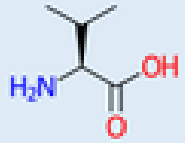


Selenocysteine
Sec **U**

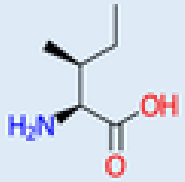
Hydrophobic



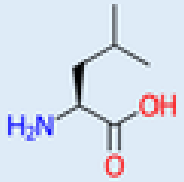
Alanine
Ala **A**



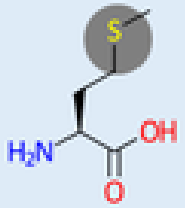
Valine
Val **V**



Isoleucine
Ile **I**

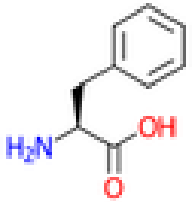


Leucine
Leu **L**

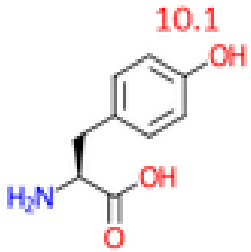


Methionine
Met **M**

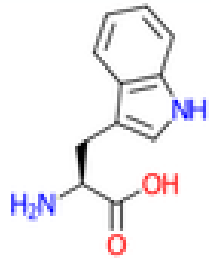
Hydrophobic



Phenylalanine
Phe **F**



Tyrosine
Tyr **Y**

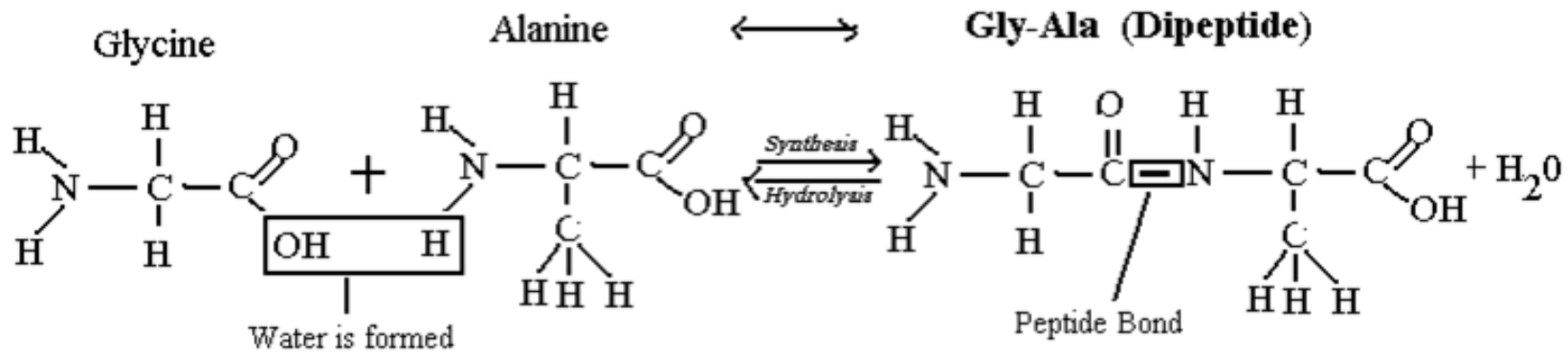


Tryptophan
Trp **W**

Thomas Ryckmans 2021

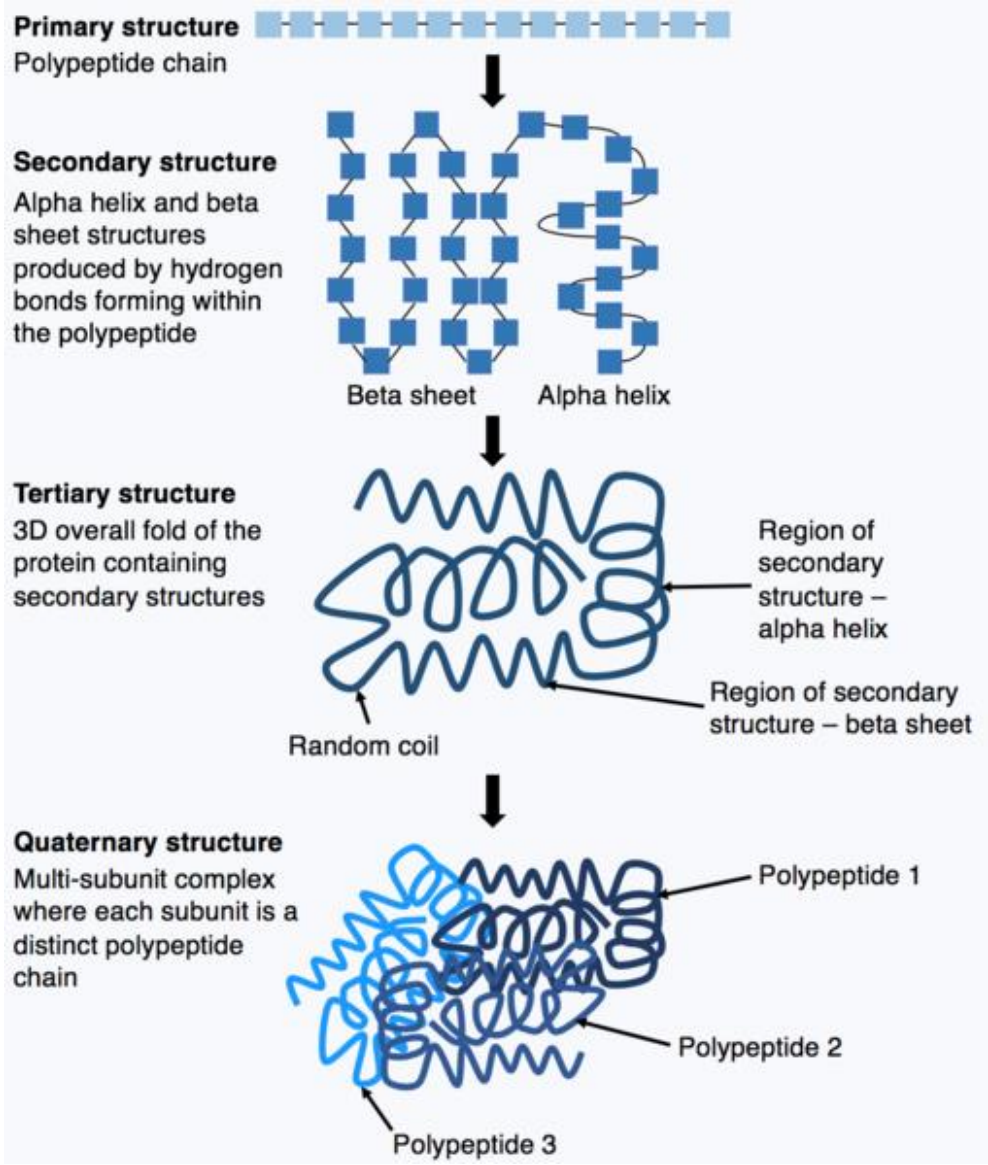
Dehydration Synthesis of Proteins

- **Peptide bond**: the specific bond that joins amino acids together
- 2 amino acids = **dipeptide**
- 3 amino acids = **tripeptide**
- 4 – 75 amino acids = **polypeptide**
- More than 75 amino acids = **protein**



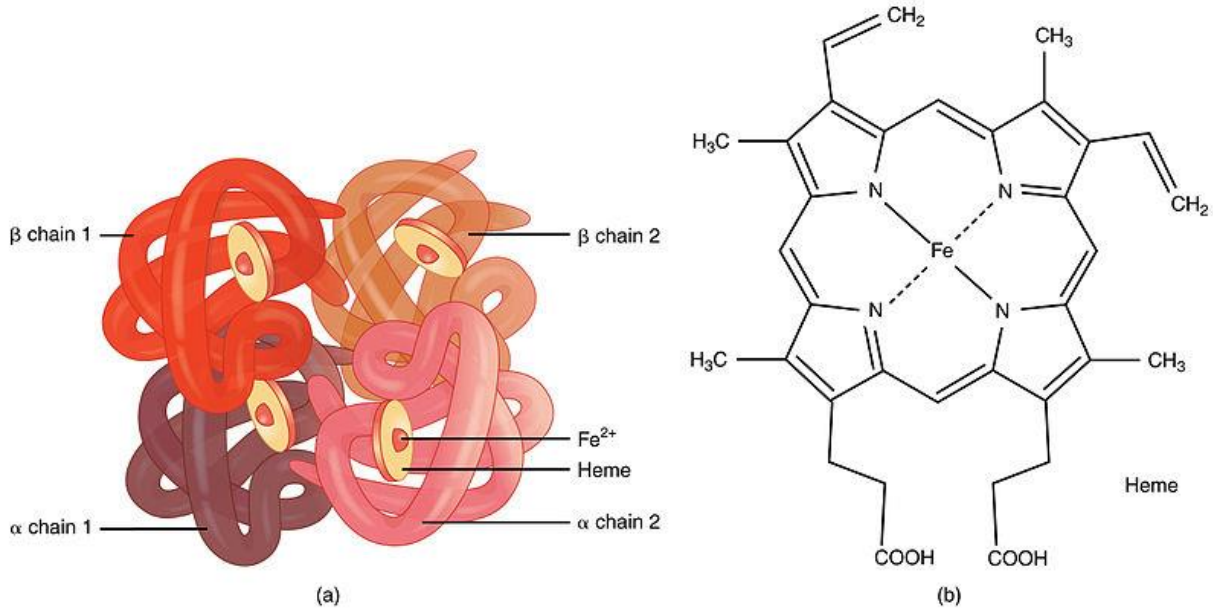
Structural Levels of Protein

- 1) **primary structure**: a chain of amino acids joined together by peptide bonds.
- 2) **secondary structure**: building upon the primary and involves hydrogen bonding
  - a) **alpha helix** – a chain that is wound.
  - b) **beta-pleated sheet** – accordion-like.



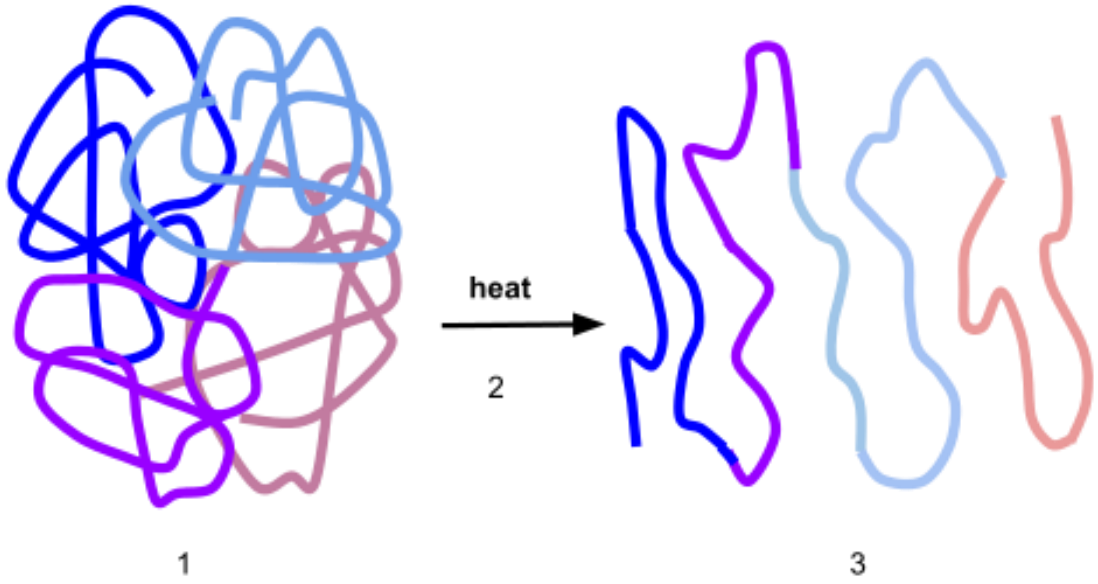
Structural Levels of Protein

- 3) **tertiary structure**: a 3 dimensional shape that builds from the secondary. It has hydrogen, covalent and ionic bonding
- 4) **quaternary structure**: a protein that utilizes a combination of the above 3 structures. I.e. hemoglobin – 4 primary structures



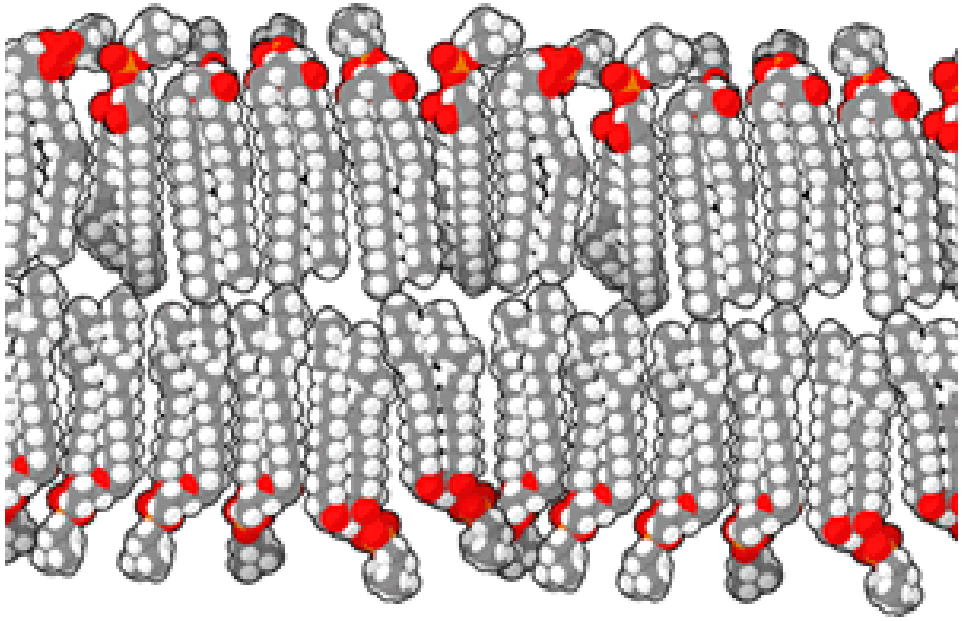
Denaturation

- **Denaturation:** the destruction of a protein so that it no longer functions due to the breaking of the bonds.
- Hot temperatures and pH changes will cause this.
- Other everyday examples: cooking an egg (white egg protein).

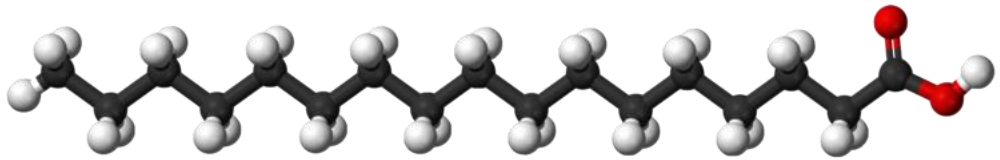


Lipids

- Organic compounds that are insoluble in water i.e. lard, fats, butter, and oil.
- Body fat is known as **adipose tissue**.
- 4 groups:
  - Neutral fats
  - Soaps
  - Phospholipids
  - Steroids



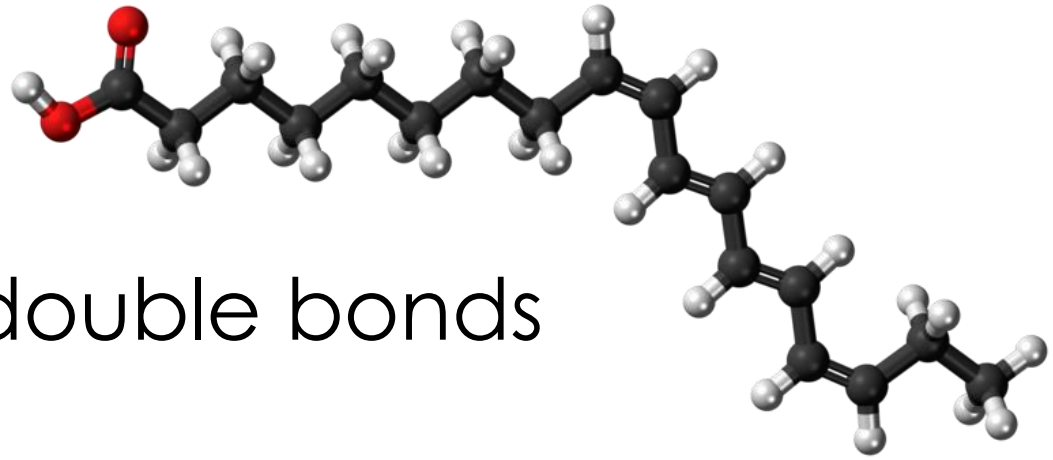
Neutral fats



- building blocks are 1 glycerol & 3 fatty acids.

a) **Fatty acids:** A long chain of C's, with H's attached, all ending with an acid group (COOH).
   - **Saturated fatty acid:** have no double bonds between the C'S so it is holding as many H's as it possibly can.
   - It is commonly associated with heart disease.

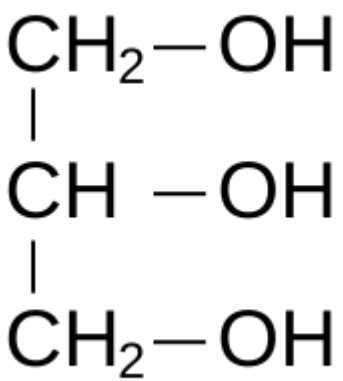
Neutral fats

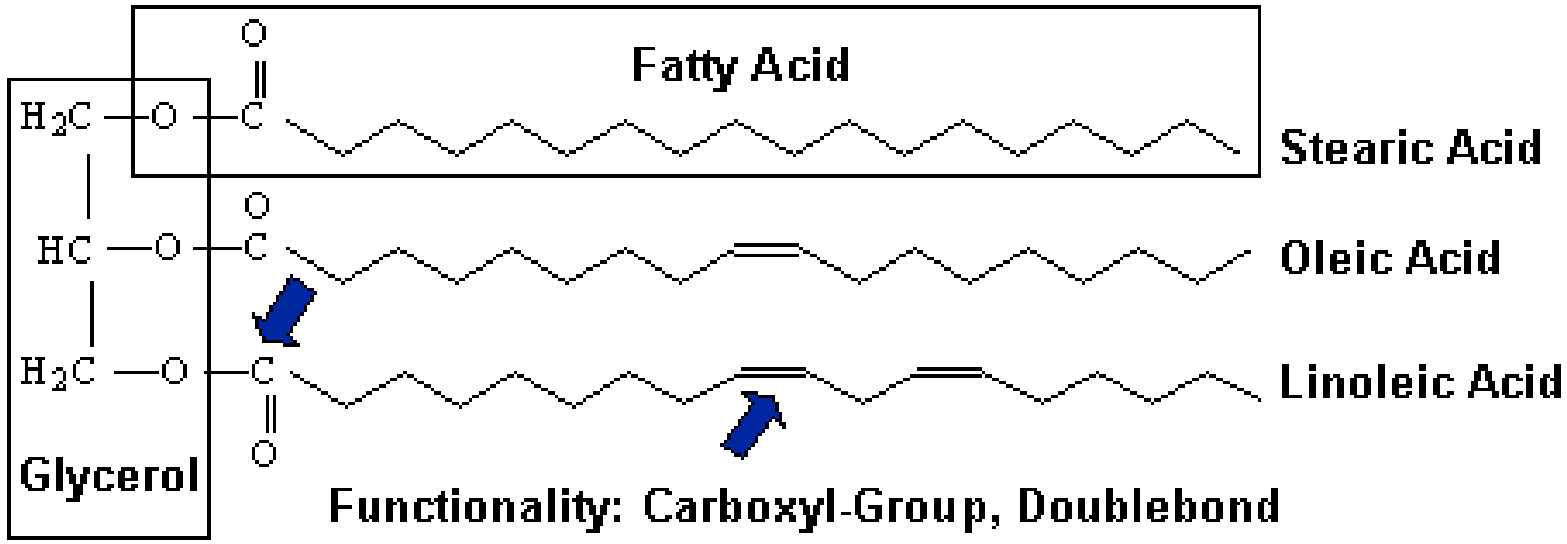


- **Unsaturated fatty acid:** has double bonds between the C'S.
- Note that the double bonds cause the chain to have bends in it.
- This lets the fat pack less solidly together and these fats are generally liquids rather than solids so are better for your health (they will not build up in your arteries).

Neutral fats

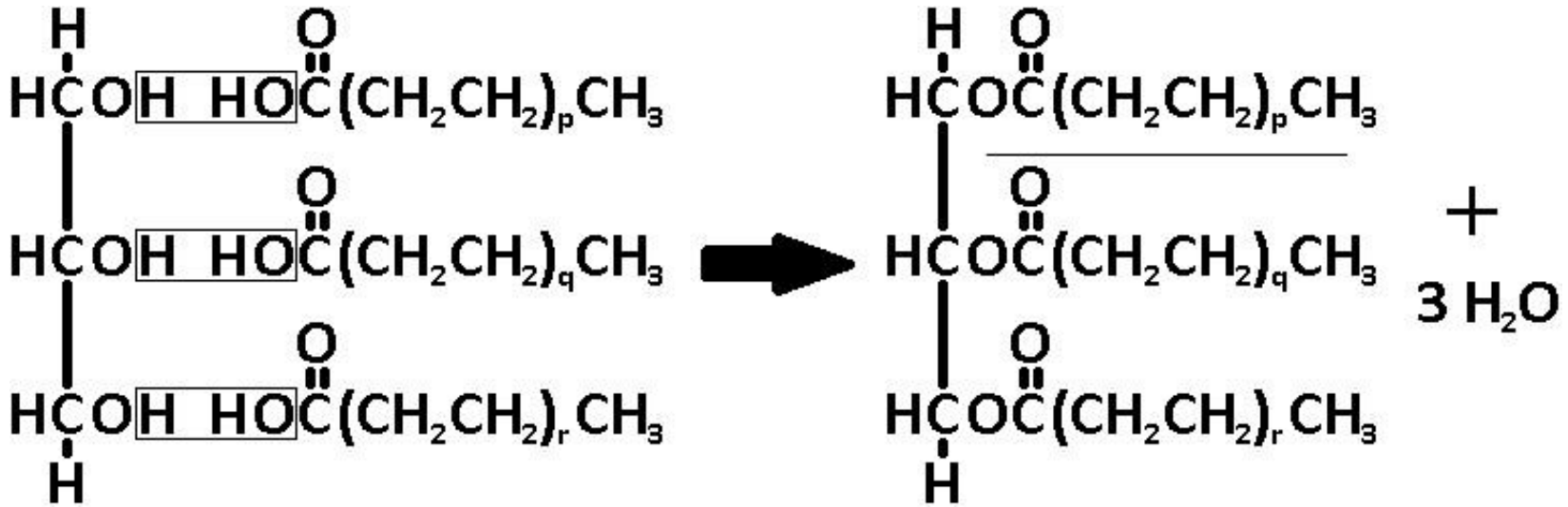
- **b) glycerol**: a compound of Carbon with 3 hydrates (H_2O)





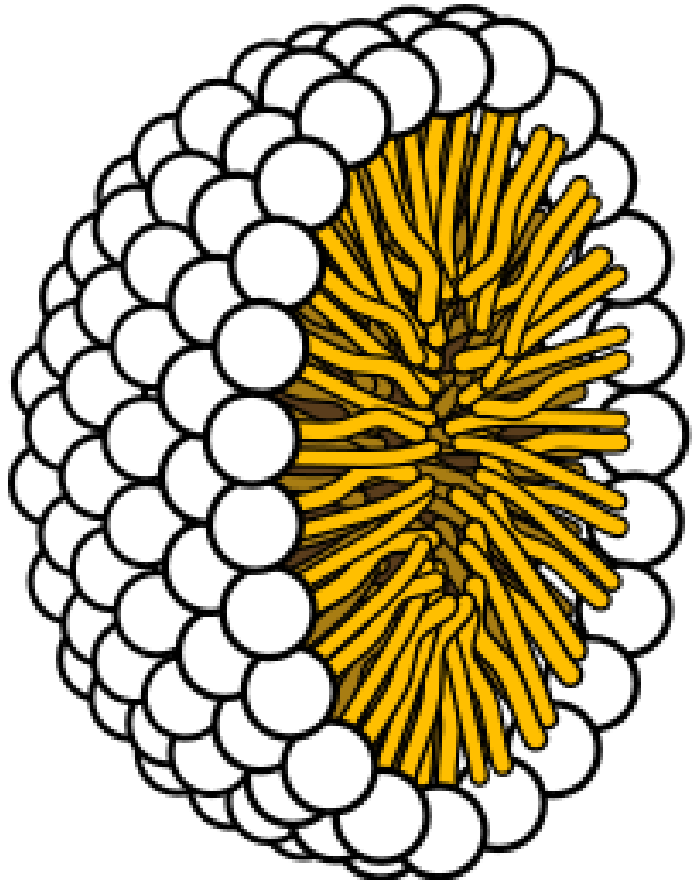
Formation of Lipids

- Glycerol backbone is joined to the 3 fatty acids through dehydration synthesis.
- Water is released as the H on the glycerol joins with the OH from the fatty acid.



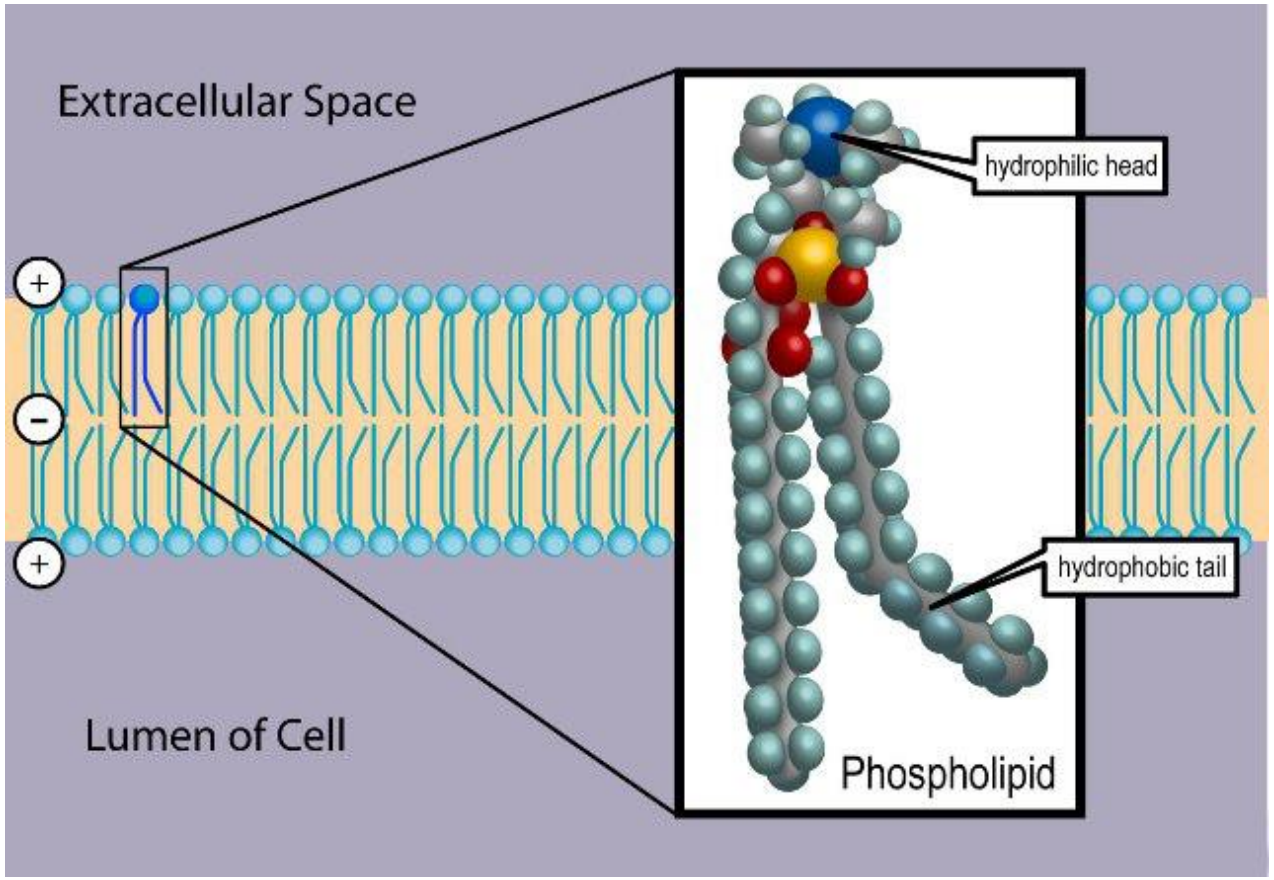
Soaps

- A salt formed by a fatty acid and an inorganic base.
- A soap is polar
- **Emulsifier**: something that breaks down fat i.e. soap
- **Emulsification**: act of breaking down the fat



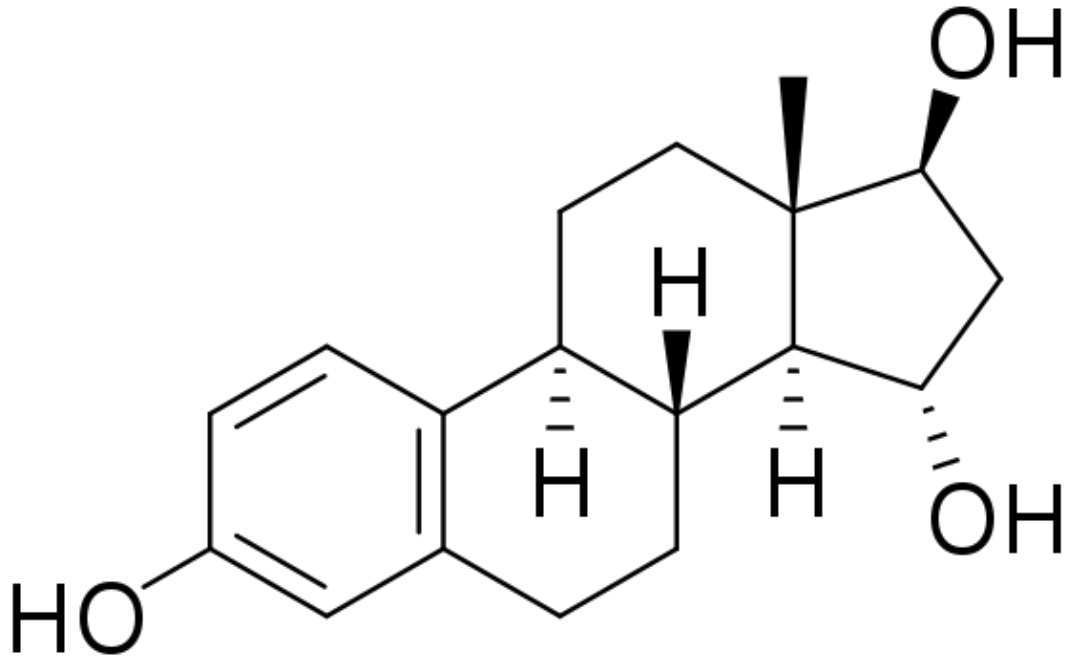
Phospholipids

- A lipid with a phosphate group
- Found in all cell membranes
- Critically important for living things since they form the outer layer of all cells and are part of all living things.

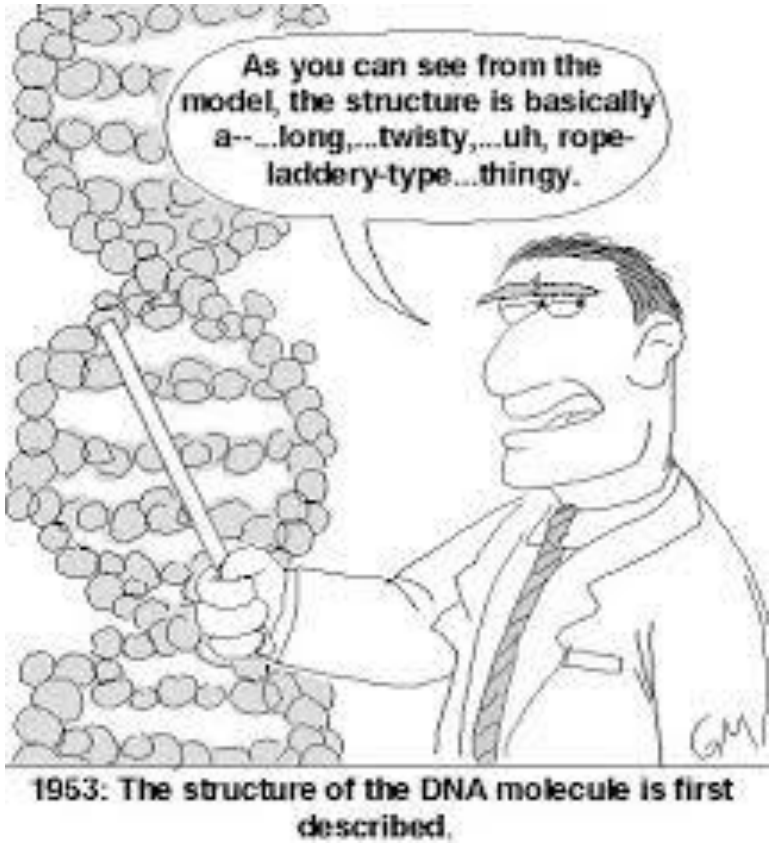


Steroids

- Made of lipids (hormones)
- Examples include estrogen, testosterone, and cholesterol
- Typically have a structure of 4 linked carbon rings.



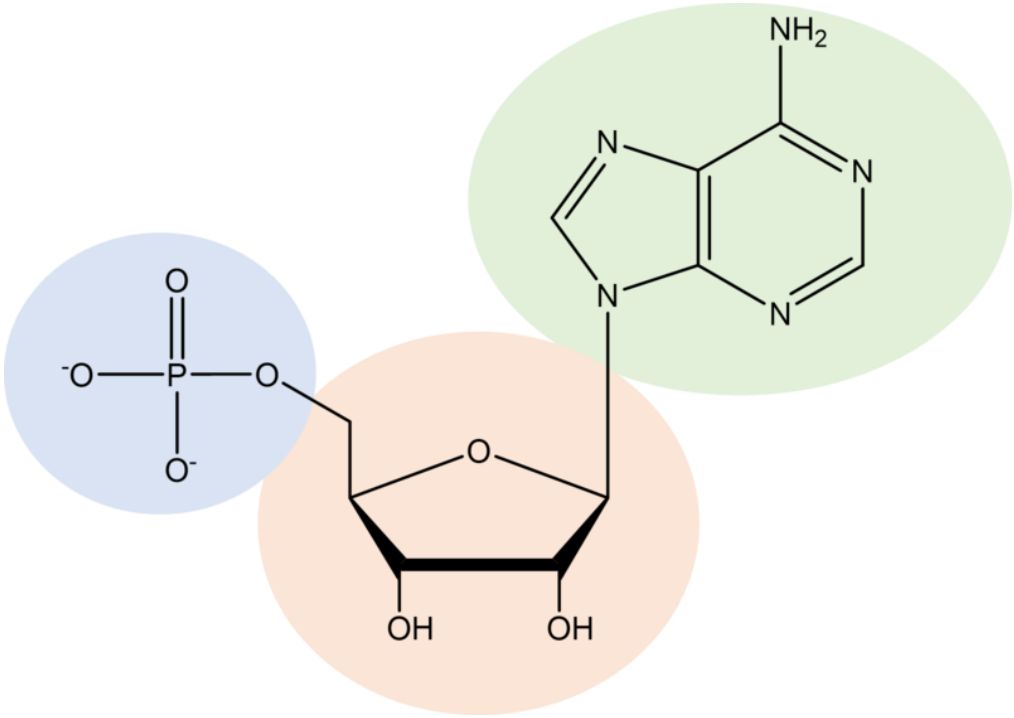
This is estradiol, a form of estrogen.



Nucleic Acids

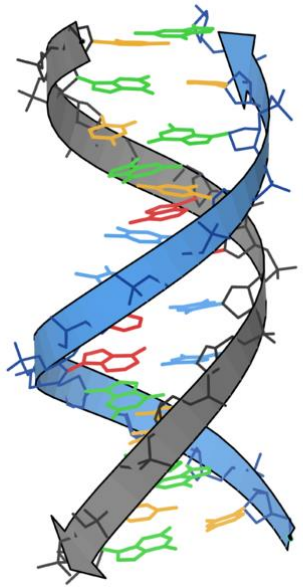
Nucleic Acids

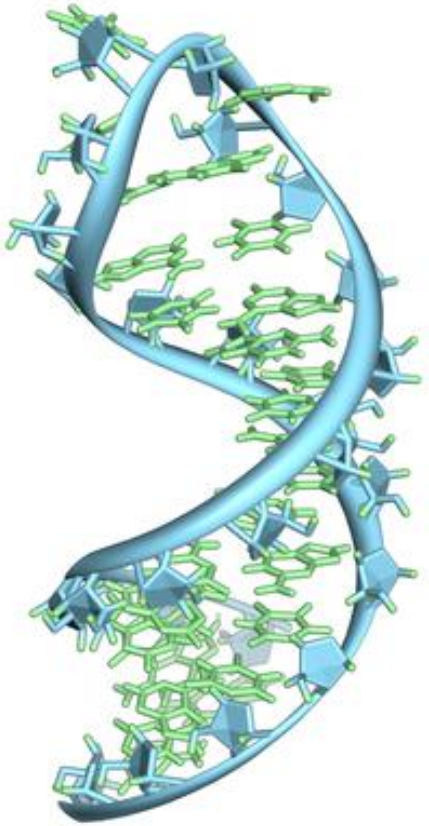
- 3 main kinds:
- **DNA: deoxyribonucleic acid**
- **RNA: ribonucleic acid**
- Building block is the **nucleotide**
- Each nucleotide is made of 3 parts
  - **1**. sugar
  - **2**. phosphate
  - **3**. base



Nucleic Acids

- **DNA:**
- Double stranded
- Helix
- Deoxyribose sugar
- Thymine base
- In nucleus only

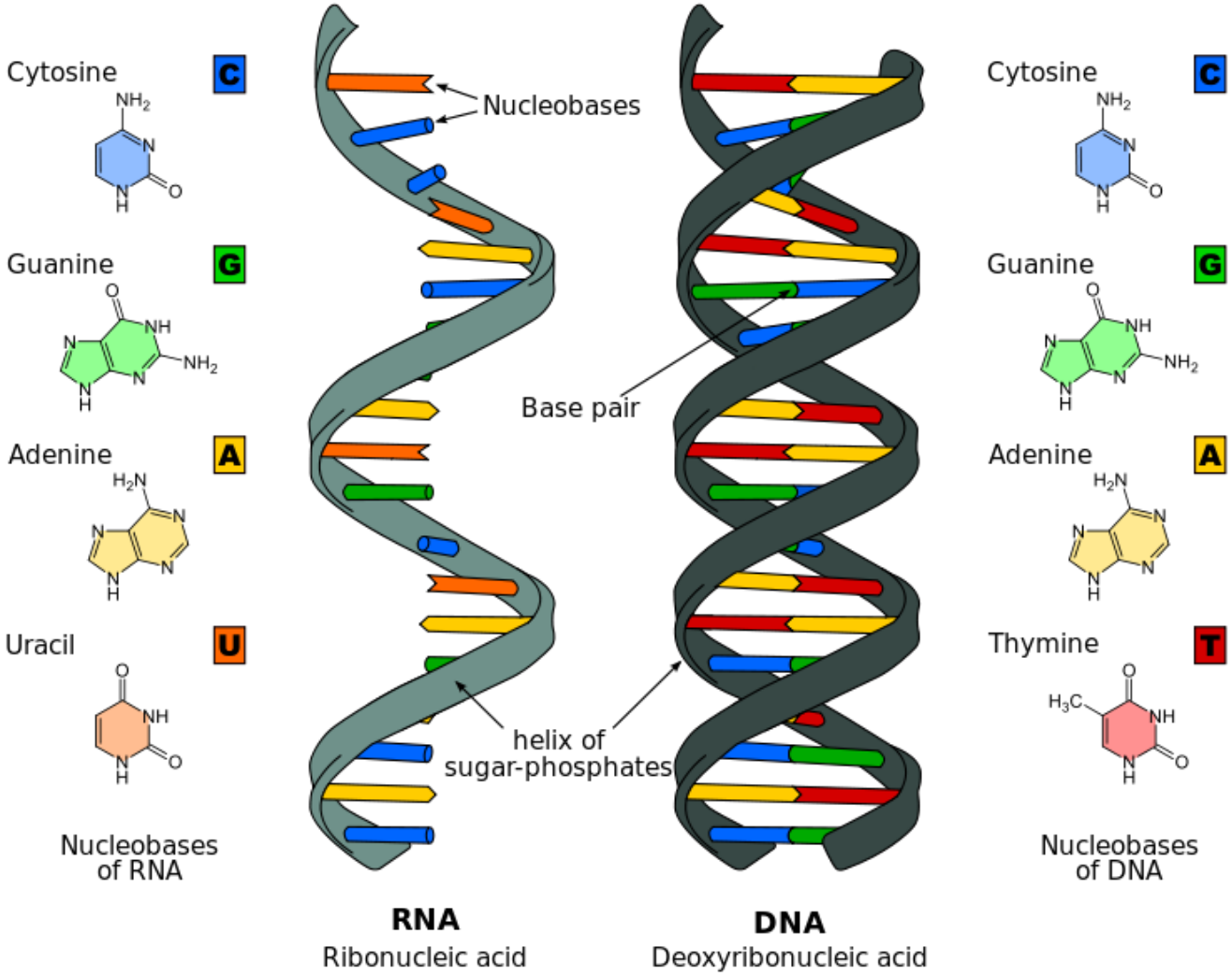




- **RNA:**
- Single stranded
- No helix
- Ribose sugar
- Uracil base
- Found in nucleus and cytoplasm

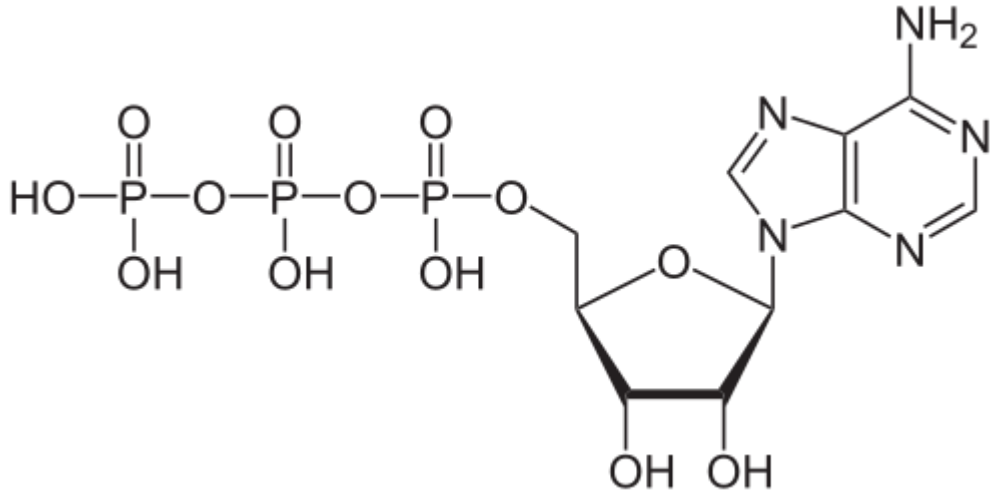
Nucleic Acids – Base Pairing

	Purines (double rings)	Pyrimidines (single ring)
DNA	Adenine (A) →	Thymine (T)
	Guanine (G) →	Cytosine (C)
RNA	Adenine (A) →	Uracil (U)
	Guanine (G) →	Cytosine (C)



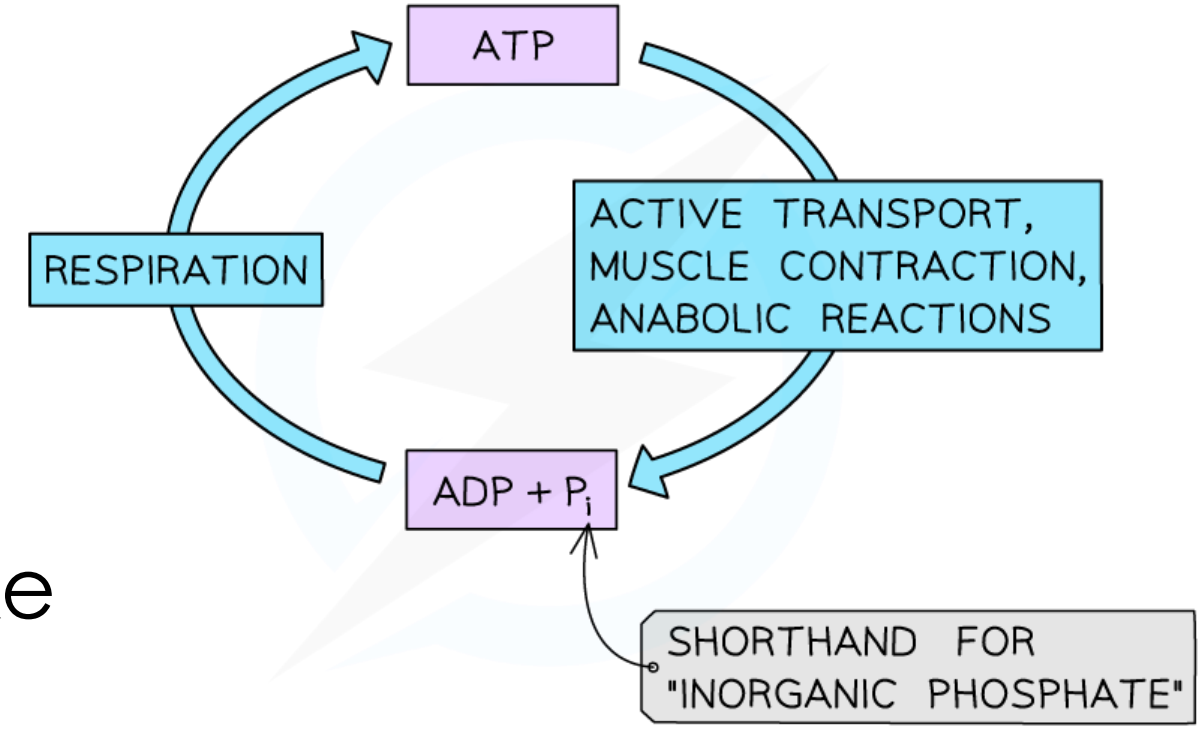
ATP

- **ATP: adenosine triphosphate** is the 3rd type of nucleic acid.
- ATP = Adenine base with ribose sugar and 3 phosphate groups attached.
- Used for energy transport in our cells - without this we would be dead.



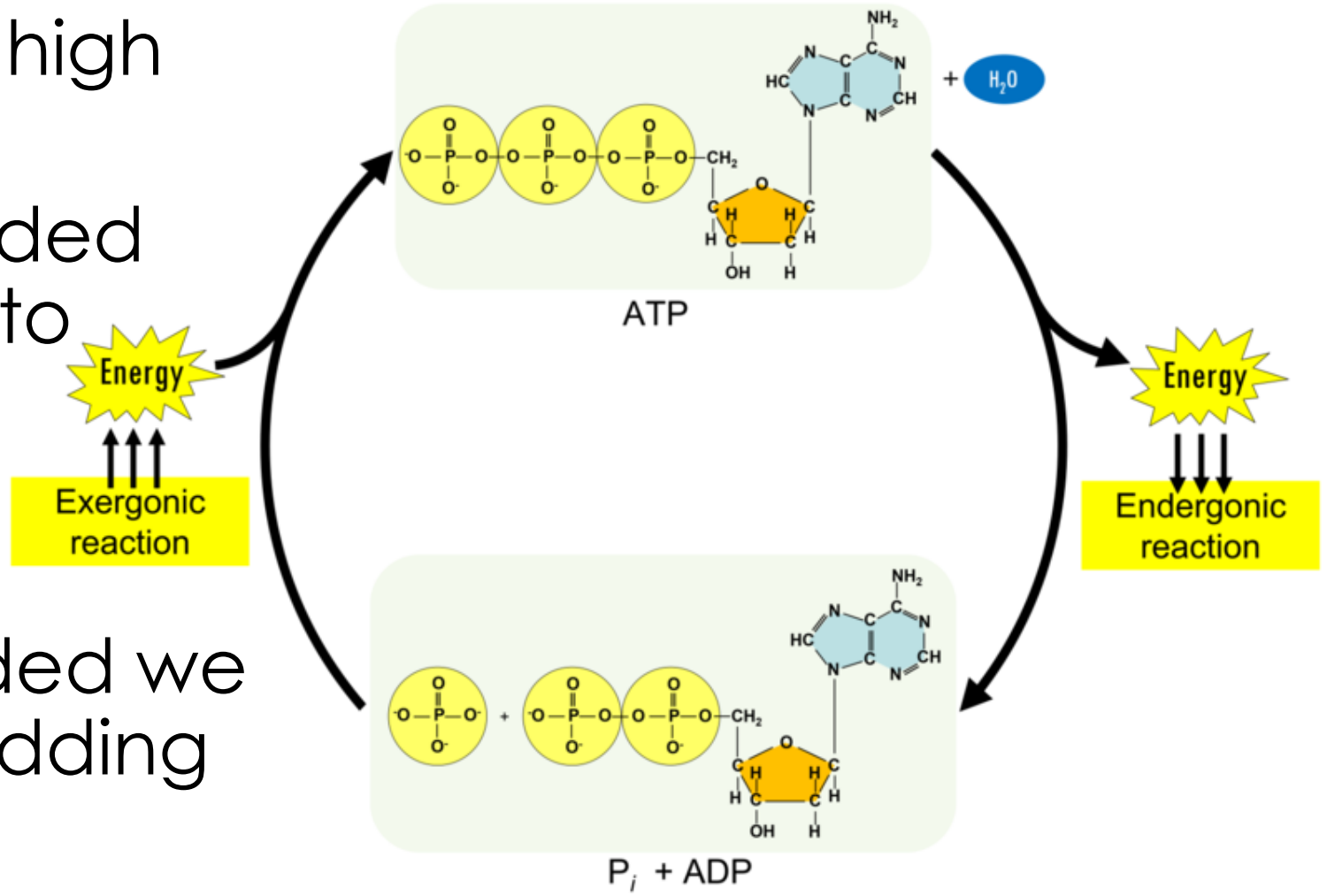
ATP Uses

- Chemical Work – make energy to make things
- Transport Work – make energy to move things around the cell
- Mechanical Work – make energy to contract muscles for movement



ATP

- The bond between the phosphates are the high energy bonds.
- When energy is needed we break the bond to create adenosine diphosphate
- When adenosine triphosphate is needed we create a bond by adding energy.



ATP and Energy

- Other polymers are broken down through chemical reactions like cellular respiration to release energy from food and storage in the body to be used by cells.
- ADP is converted into ATP and then into sugar and then into other molecules to store energy for later use by the body as well.