Chapter 2:

The Chemical Basis of Life

To understand A&P it is essential to have a basic knowledge of chemistry…Why??

Chemicals compose the structures of the body & interactions of chemicals with 1 another are responsible for the fxns of the body!

Chapter 2 Outline

I. Basic Chemistry
   - A. Matter, Mass, and Weight
   - B. Elements & atoms
   - C. Electrons and Chemical Bonding
   - D. Molecules & Compounds
   - E. Intermolecular Forces

II. Chemical Rxns and E^+
   - A. Synthesis rxns
   - B. Decomposition rxns
   - C. Reversible rxns
   - D. Oxidation-Reduction rxns
   - E. Energy
   - F. Speed of Chemical rxns

III. Inorganic Chemistry
   - A. Water
   - B. Solution []'s
   - C. Acids and Bases
   - D. O_2 & CO_2

IV. Organic Chemistry
   - A. Carbohydrates
   - B. Lipids
   - C. Proteins
   - D. Nucleic Acids
   - E. Adenosine Triphosphate

I. Basic Chemistry

A. Matter, Mass and Weight
B. Elements & atoms
C. Electrons & Chemical Bonding
D. Molecules & Compounds
E. Intermolecular Forces

Basic Chemistry

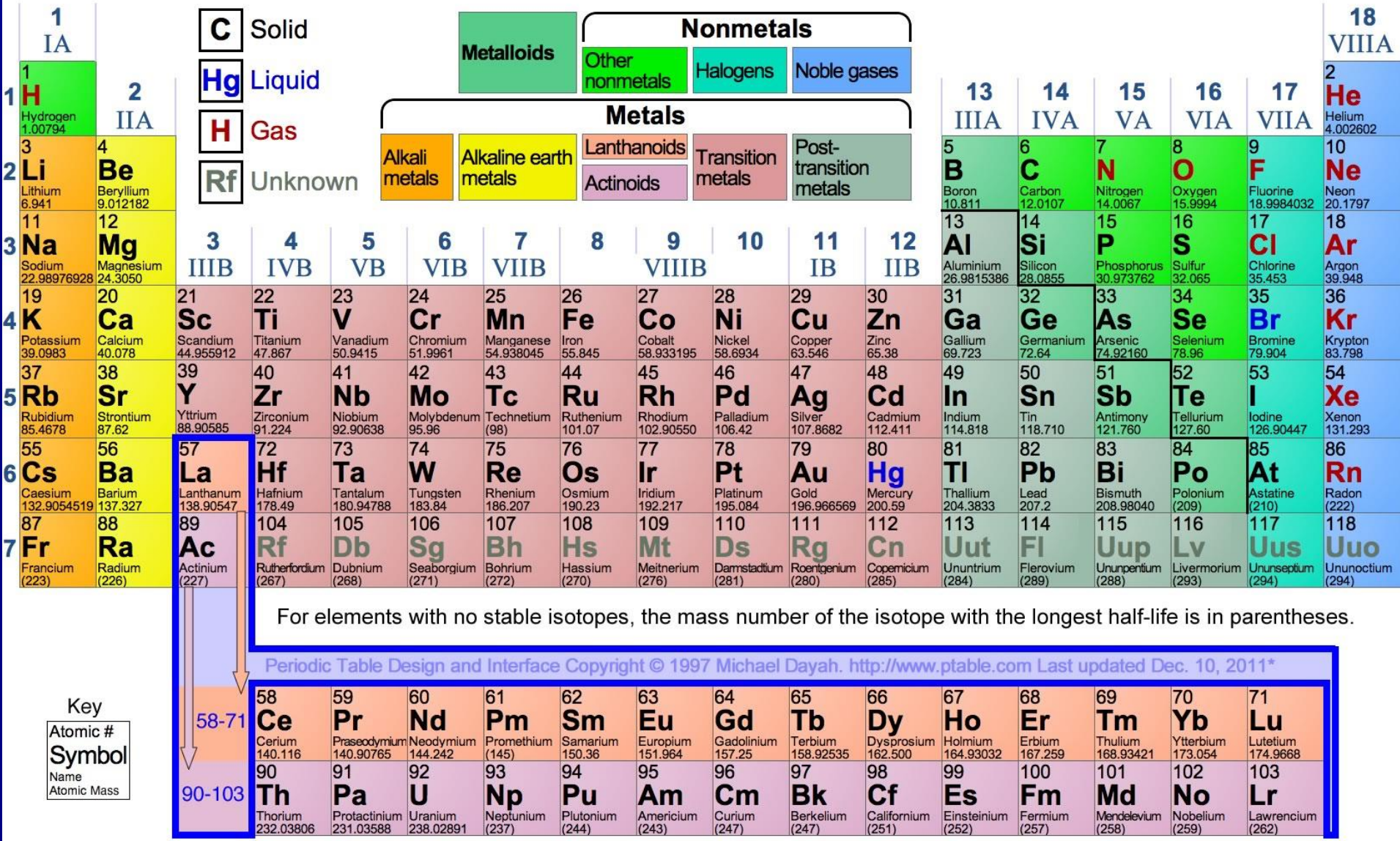
Matter, Mass, & Weight

- All living and non-living things are composed of **matter.**
  - Matter: anything that occupies space & has **Mass**
    - Mass: the amount of matter in an object
    - International units for mass kilograms (kg)
- Weight: gravitational force acting on an object of a given mass
  - Difference in weight between earth & space
  - It can Δ riding in a plane to being on the ground

Basic Chemistry
Elements and Atoms

- **Element** : the simplest type of matter w/unique chemical properties (multiple atoms of the same kind)
  - Most common in the human body:
    - O, C, H, N
  - Usually represented by a "symbol" (letter)
    - Ex/ Oxygen = O
    - Ex/ Sodium = Na???? B/c in Latin it is called **na**trium
- Atom: smallest particle of an element that still has the chemical characteristics of that element.

Periodic Table of Elements



For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

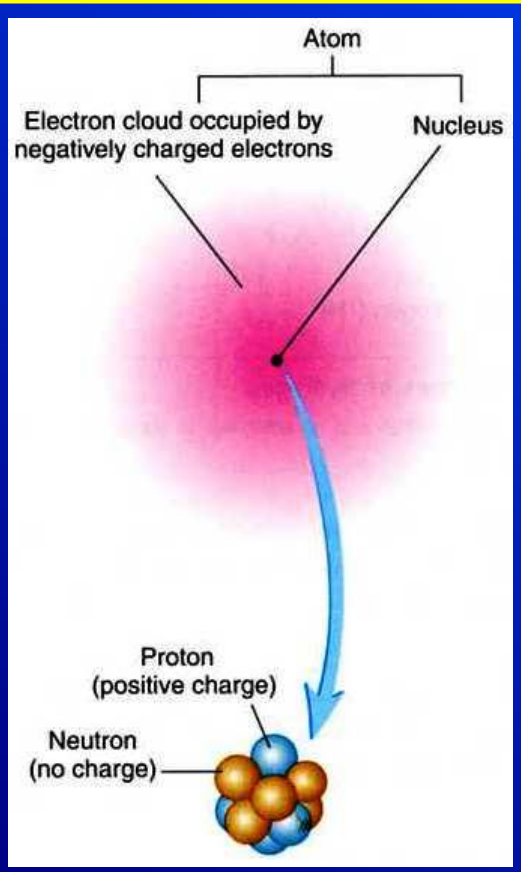
*Edited by Dr. Casagrande

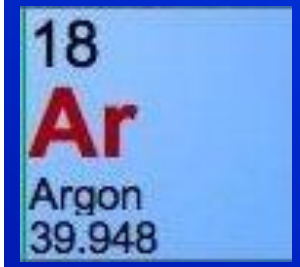
Basic Chemistry

Elements and Atoms: Atomic Structure

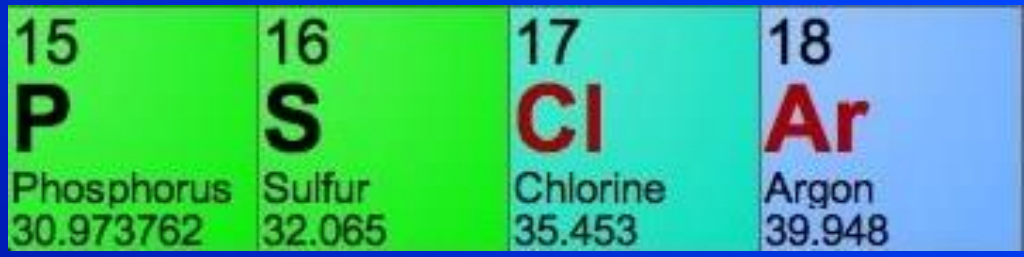
- Characteristics of matter result from structure, organization & behavior of atoms.
- Subatomic Particles:
  - A. Neutron(N^o)
    - No electrical Charge
    - w/in the nucleus
  - B. Proton (P^+)
    - 1 positive charge
    - w/in the nucleus
  - C. Electron (E^-)
    - 1 negative charge
    - In the e- cloud
    - 1-trillionth the volume of N^o or P^+
    - Most of the atom's vol is occupied by the E^- cloud

**In a perfect world: $\#E^- = \#P^+ = \#N^0$





Basic Chemistry
Elements and Atoms



Atomic Number

- The number of P^+ in each atom.
- This is literally the identity of the Atom.
- If you know the P^+ number you can tell me which element you have.

Mass Number

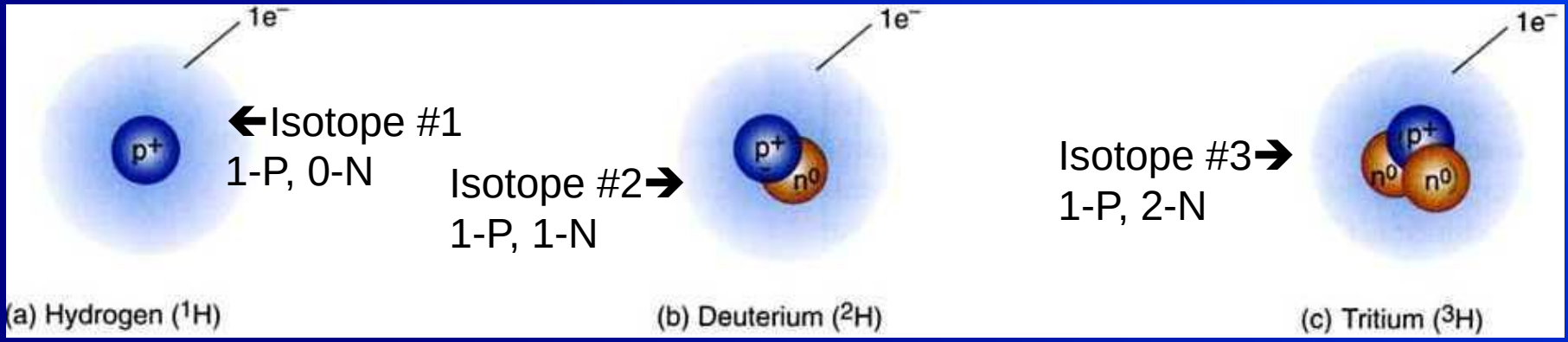
- The Number of P^+ plus the number of N^o inside of each atom.

Atomic Mass

- An average of mass because of isotopes
- **This changes because the numbers of N^o can vary**
- This is a variation of an atom called an **Isotope**

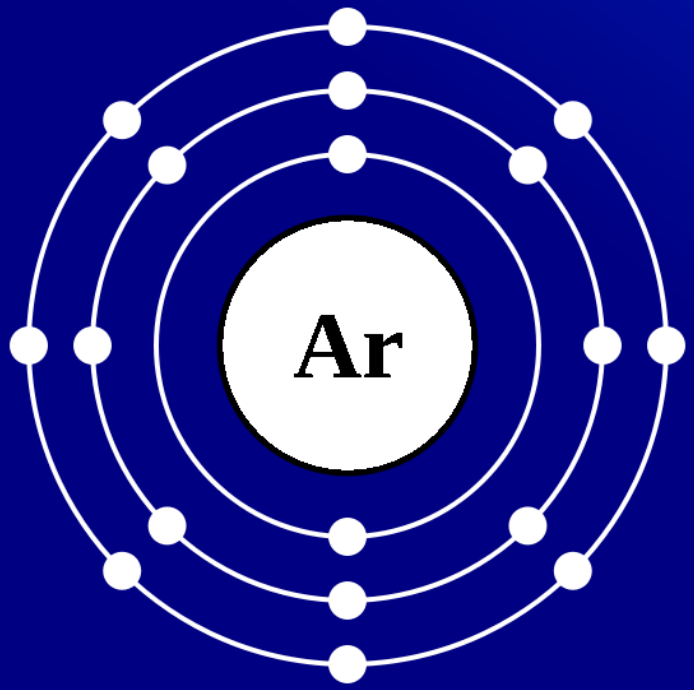
Basic Chemistry

Elements & Atoms: Isotopes & Atomic Mass



- Isotope: a variant of an element.
  - It has the same # of P^+ but different #'s of N^o
  - Therefore:
    - Isotopes have the same Atomic # but different Atomic Mass
- Periodic Table:
  - The atomic mass listed is an average of the elements naturally occurring isotopes
  - Avogadro's Number

Rules for Atoms

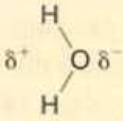
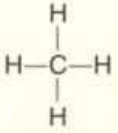
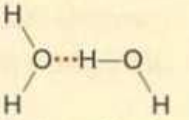


- The atomic number in a perfect world will be equal to the number of protons, electrons and neutrons in that atoms.
- *Problem there are also rules that must be followed when it comes to the valence “shells” that the electrons occupy.
- **Rules**:
  - 1st shell
    - Must have 2 electrons to be full
  - 2nd & 3rd Shell (Octet rule)
    - Must each have 8 electrons in each shell to be full

Basic Chemistry

Electrons and Chemical Bonding

TABLE 2.4 Comparison of Bonds

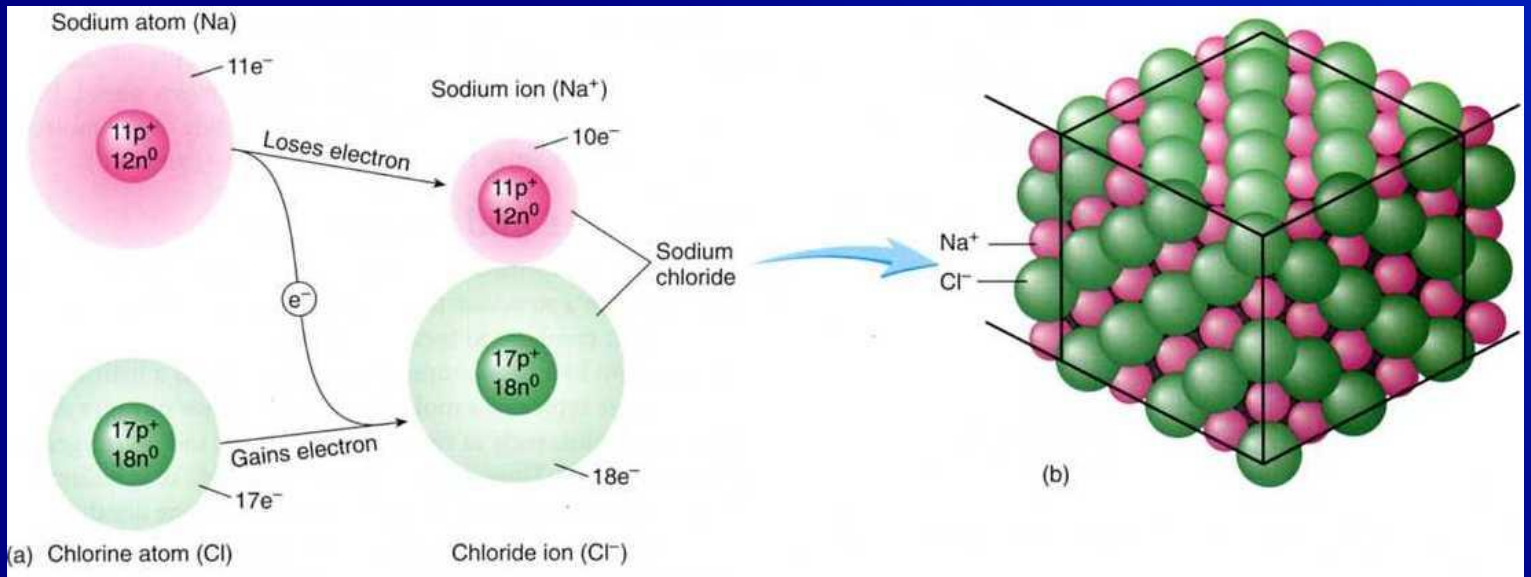
Bond	Example
Ionic Bond A complete transfer of electrons between two atoms results in separate positively charged and negatively charged ions.	Na^+Cl^- Sodium chloride
Polar Covalent Bond An unequal sharing of electrons between two atoms results in a slight positive charge (δ^+) on one side of the molecule and slight negative charge (δ^-) on the other side of the molecule.	 Water
Nonpolar Covalent Bond An equal sharing of electrons between two atoms results in an even charge distribution among the atoms of the molecule.	 Methane
Hydrogen Bond The attraction of oppositely charged ends of one polar molecule to another polar molecule holds molecules or parts of molecules together.	 Water molecules

- Outermost e- of an atom determine its chemical behavior.
- If these are transferred or shared btwn atoms it is called: **Chemical Bonding**
- **2 major types:**
  A. Ionic
  B. Covalent

Basic Chemistry

Electrons and Chemical Bonding: Ionic Bonding

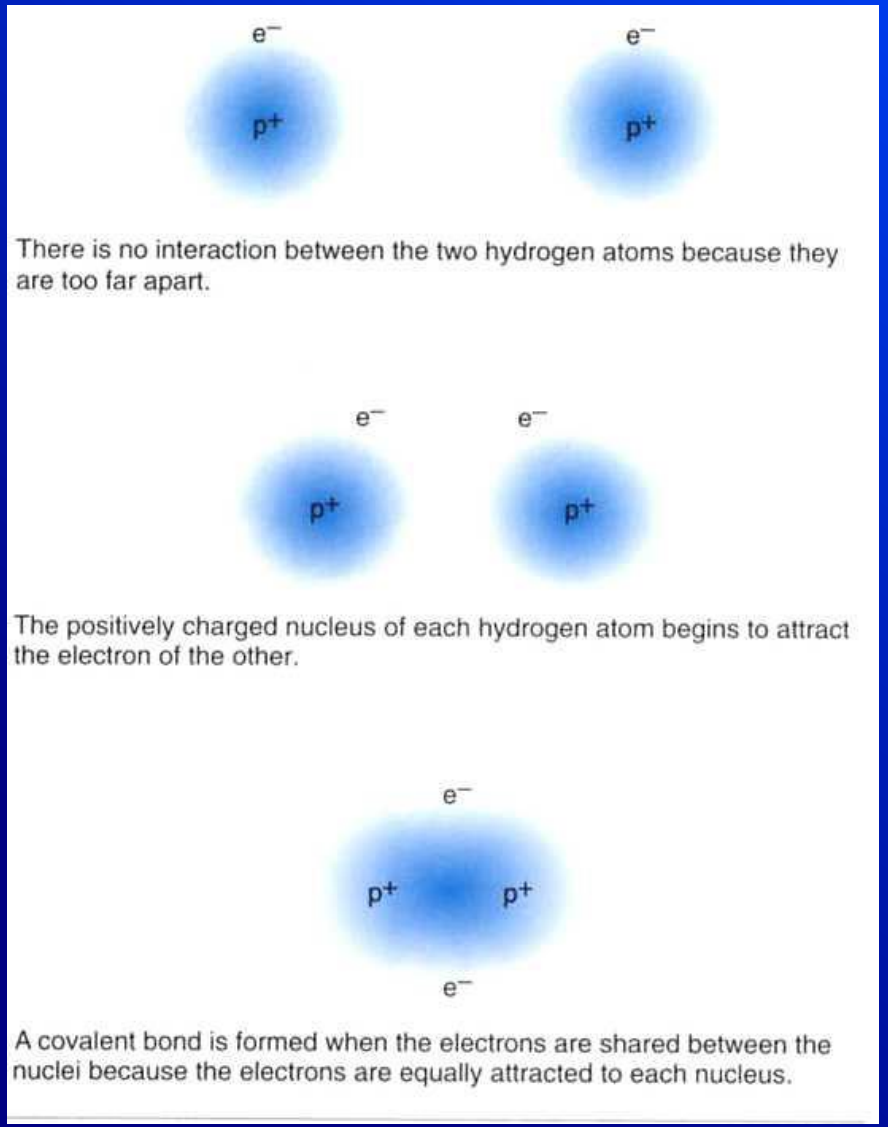
- Normally atoms are electrically neutral b/c $P^+ = E^-$
- If an atom looses or gains an E- then $P^+ \neq E^-$ thus the particle becomes charged
- An Ion is a Charged Particle.
  - + Charged = Cation
  - - Charged = Anion
- Ionic Bonding: when ions of opposite charges attract each other and remain close together



Basic Chemistry

Electrons & Chemical Bonding: Covalent Bonding

- Covalent Bonding: when atoms share 1 or more pairs of E^-
- Molecules = pairing of atoms
- E^- occupy shells outside of the atom's nucleus
  - 1st shell hold 2 E^-'s
  - 2nd & 3rd hold 8 E^-'s
- These bonds can be
  - Single➔ 1 pair shared
  - Double➔ 2 pairs shared
  - Triple➔ 3 pairs shared
  - Quadruple➔ 4 pairs shared
- These Bonds can also be
  - Polar
  - Non-polar



Basic Chemistry

Electrons & Chemical Bonding: Covalent Bonding

Polar Bonding vs. Non-polar Bonding

Polar

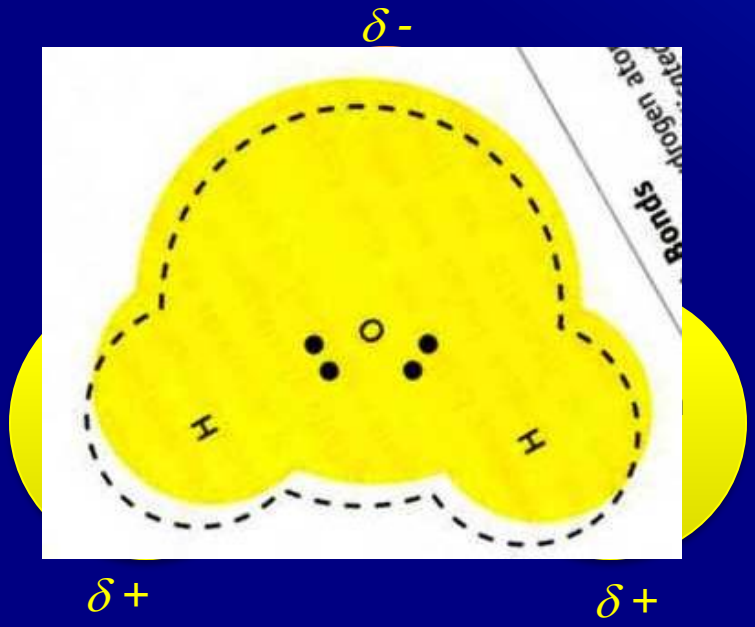
An unequal sharing of electrons because bound atoms have different numbers of protons

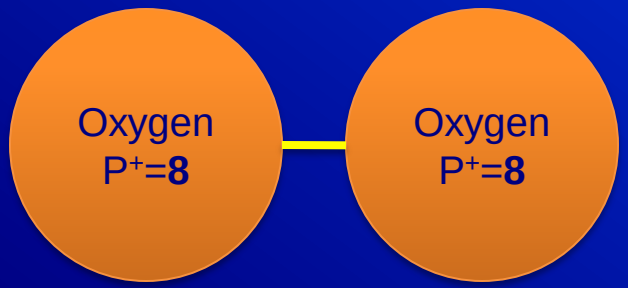
This leads to partial charge within the same molecule δ

Non-Polar

An equal sharing of electrons because bound atoms have the same numbers of protons

This means that there is no charge in the particle





Basic Chemistry

Molecules

- 2 or more atoms chemically combine to form a structure that behaves as an independent unit
  - This can be a combination of the same atom or various atoms
  - H_2 or H_2O

Compounds

- Substance composed of 2 or more **different** types of atoms that are chemically combined
- **Thus not all molecules are compounds**
- NaCl (Ionic Compund)
- $C_6H_{12}O_6$
- H_2O

- **Thus not all molecules are compounds**

- Kinds and #'s of atoms in a molecule or compound can be represented by a formula denoting chemicals by symbol & # subscript
- Glucose $C_6H_{12}O_6$ ➔ there are 6-C 12-H and 6-O
- Molecular Mass (MM): adding up the MM of all its atoms

Basic Chemistry

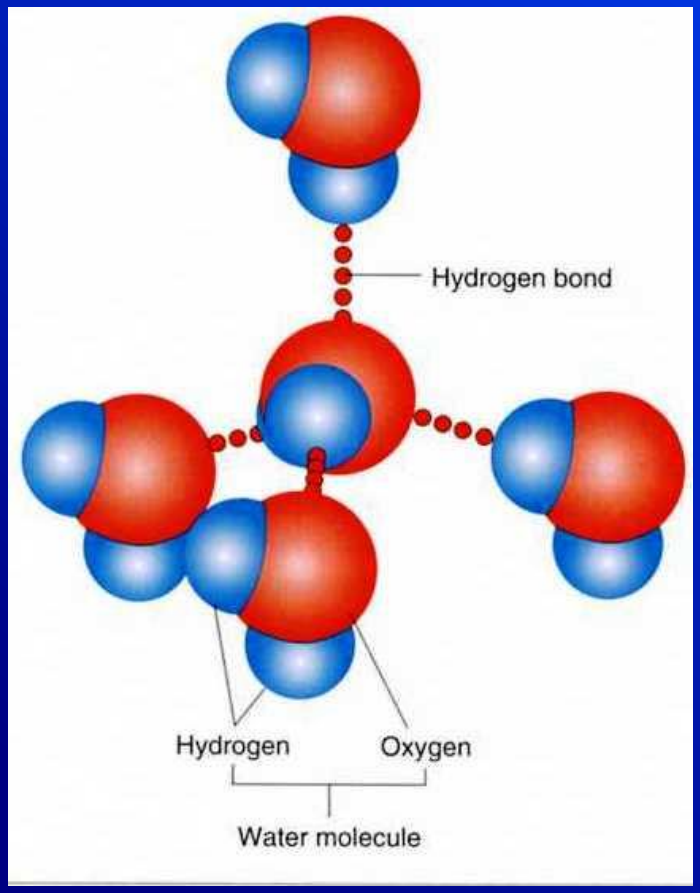
Intermolecular Forces

result from weak electrostatic attractions btwn oppositely charged parts of molecules or btwn ions and molecules

These are much weaker than chemical bonds*

Hydrogen Bonds

- Molecules w/ polar covalent bonds have + and – ends
- This results in the attraction of the + and – ends to each other.
  - Such as the H_2O example in the picture ➔
- These play an important role in determining the 3-D shape of complex molecules b/c H-bonds between different polar parts hold the molecule in its shape.



Basic Chemistry

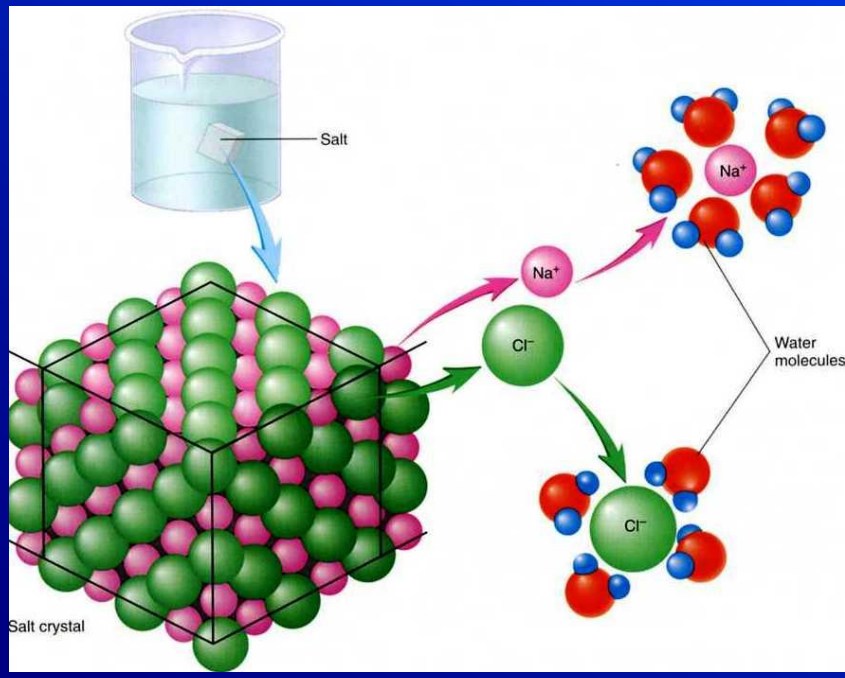
Intermolecular Forces

weak electrostatic attractions btwn oppositely charged parts of molecules/btwn ions and molecules

These are much weaker than chemical bonds

Solubility and Dissociation

- Solubility: ability of 1 substance to dissolve another
- *Charged* or *polar* substances easily dissolve in H_2O
- Non-polar substances DO NOT
- Ionic Compounds:
  - They will dissociate(separate) because the cations will be attracted to the – and anions will be attracted to the +
- Although molecules do not dissociate, 1 molecule can be surrounded and thus suspended in H_2O
- *Electrolytes*
  - Cations and anions can conduct current

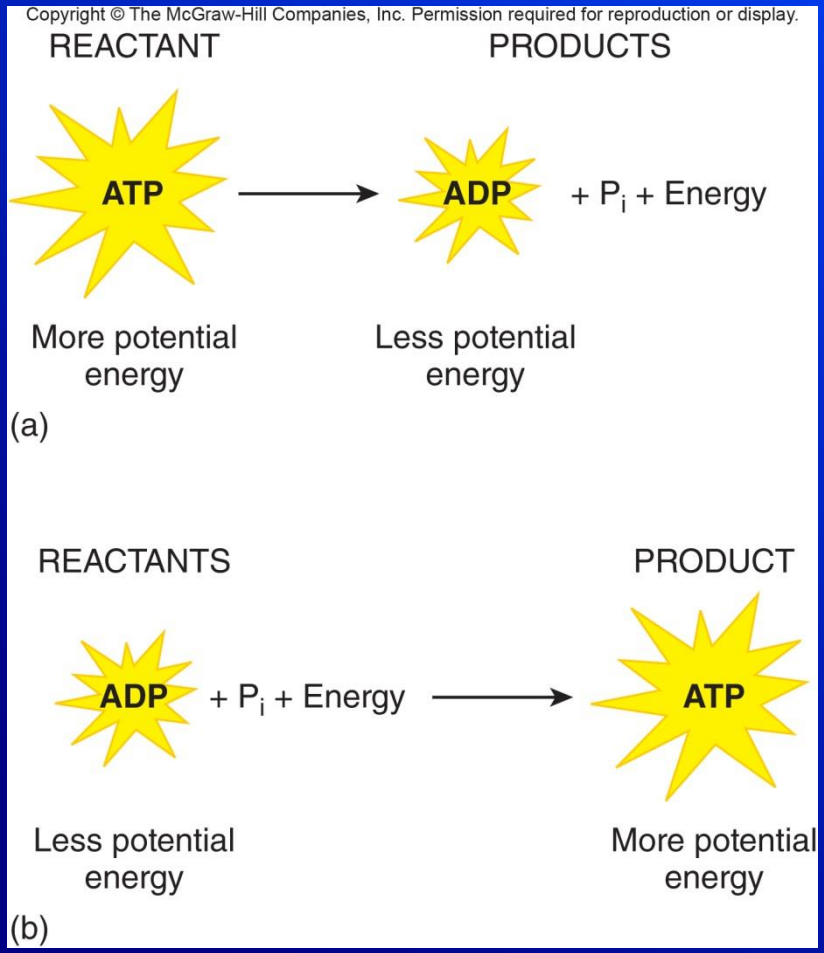


II. Chemical Rxns and Energy (E^+)

A. Synthesis Rxns
B. Decomposition Rxns
C. Reversible Rxns
D. Oxidation-reduction Rxns
E. Energy (E^+)

Chemical Rxns & E^+

- Atoms, ions, molecules, or compounds interact to form or break chemical bonds
- 2 players:
  A. Reactants: substances that enter a rxn
  B. Products: substances that result from a rxn

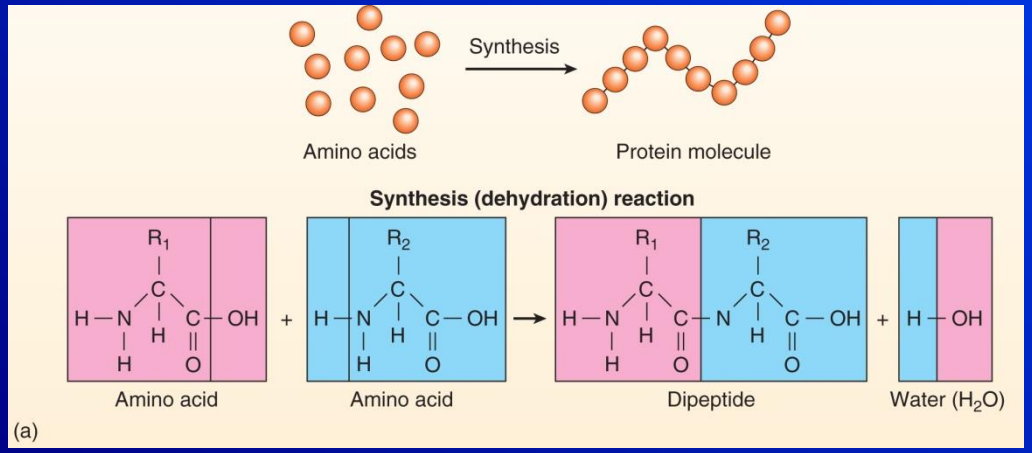


Chemical Rxns & E^+

3 Important points to chemical rxns

1. A less complex reactants are combined to form more complex products
   - AA➔ Proteins
2. Reactants can be broken-down(decomposed) into simpler less complex products
   - Food➔ basic building blocks for the body to use
3. Atoms are generally associated w/ other atoms through chemical bonding or intermolecular forces. Thus to synthesize or bkdwn products it is required to Δ relationships btwn atoms

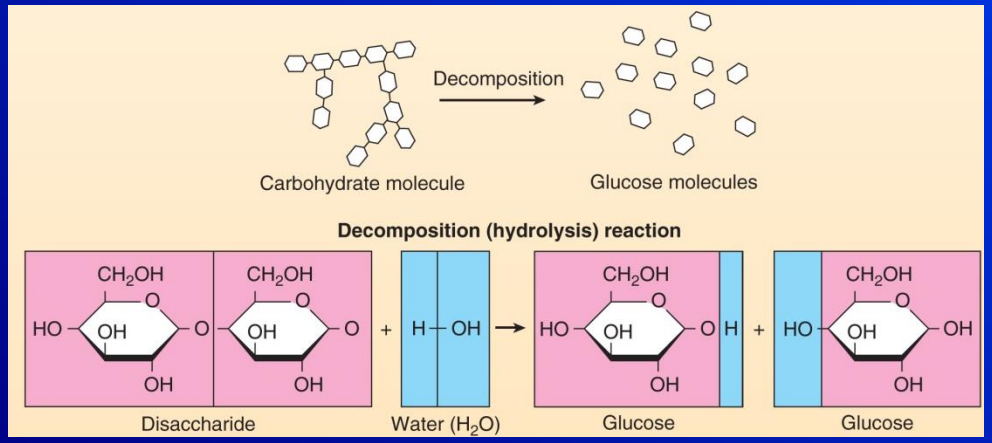
Chemical Rxns & E+



Synthesis Rxn

- When 2 or more reactants chemically combine to form a new and larger molecule.
- Dehydration: called "dehydration" when a H_2O molecule is the removed bi-product of the rxn(as shown above).
- Old chemical bonds are broken & new bonds are formed as atoms rearrange
- **Anabolism-** to build something
  - What Synthesis rxns are referred to that occur w/in the body
  - Growth, maintenance, & repair couldn't take place w/o anabolic rxns

Chemical Rxns & E+



Decomposition Rxn

- Reverse of a synthesis rxn
- Large reactant is chemically brkdwn into 2 or more smaller products
- Hydrolysis- is called a hydrolysis rxn when water is used to break apart the components.
  - Hydro – water Lysis- to break down
- **Catabolism-** to break something down

Metabolism ➔ (Catabolism + Anabolism)- defined as both anabolic and catabolic rxns in the body

Chemical Rxns & E^+

Reversible Rxn

- A chemical rxn in which the rxn can go forward or backward
- Equilibrium:
  - Rate of product formation is equal to rate of product breakdown
  - Ex. Body

$$H_2CO_3 \leftrightarrow H^+ + HCO_3^-$$

Oxidation-Reduction Rxn

- Chemical rxns that result from the XΔ of E- btwn reactants
- Oxidation: loss of an E^-
- Reduction: Gain of an E^-
- Ionic: complete loss or gain of E^-
- Covalent: partial loss or gain of E^-
- Because loss by one atom usually means the gain of another it is also referred to as a **Redox Rxn**
- *Synthesis/Decomposition* rxns can be redox rxns

Chemical Rxns & E^+

Energy

- E^+: the capacity to do work
  - 2 classifications:
  1. Potential E^+
     - Stored e+ that could do work but isn't doing it
     - Ex/ Ball being held
  2. Kinetic E^+
     - Form of e+ that does work and moves matter
     - Ex/ Ball falling

Chemical Rxns & E^+

Two types mentioned come in 3 ***forms***

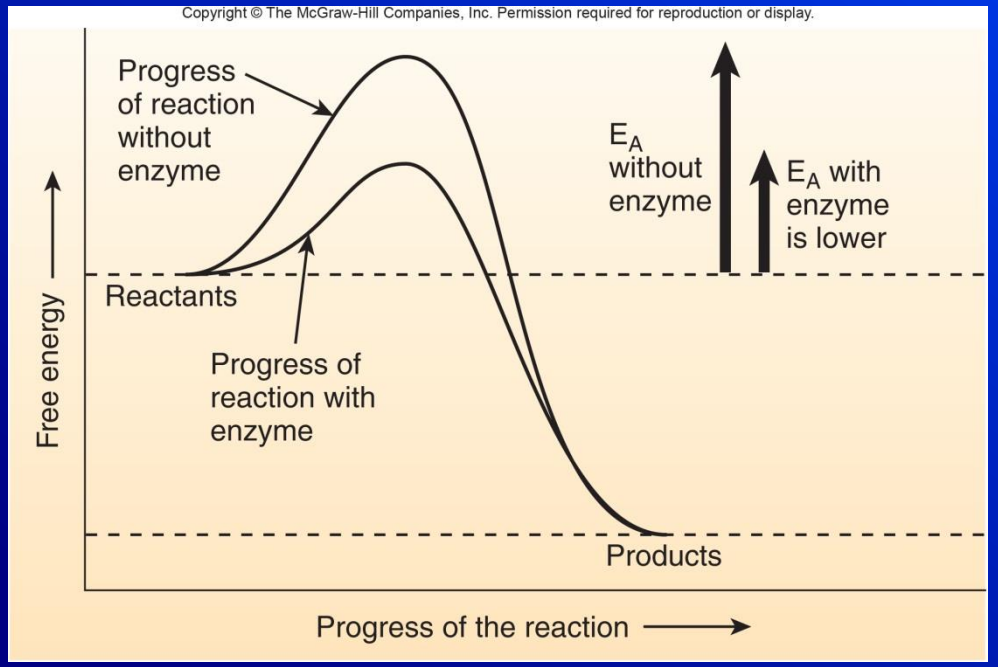
1. Mechanical E^+
   - E+ resulting from the position and movement of objects
   - Ex/ Moving a limb
2. Chemical E^+
   - A form of e+ in which a substance is a form of stored (potential) e+ w/in its chemical bonds
   - Ex/ **$ATP + H_2O \rightarrow ADP + H_2PO_4 + E^+$**
     - Potential e+ in chemical bonds of ATP **>** products thus e+ released by rxn
3. Heat E+
   - E+ that flows btwn objects that are different temperatures
   - Ex/ Human body's chemical rxns release heat as a by-product and this helps to maintain body temperature

Chemical Rxns & E+

Speed of Chemical Rxns

Reminder

- *Atoms are surrounded by e- clouds, each e- is negatively charged thus the repulsive forces of these "clouds" must be overcome before a chemical rxn can occur*
- ***It must have sufficient kinetic e+*
- Activation E+
  - Minimum e+ required for reactants to begin a chemical rxn
- Most chemical reactions required to sustain life are too slow to sustain life that is why we have **catalysts!!**



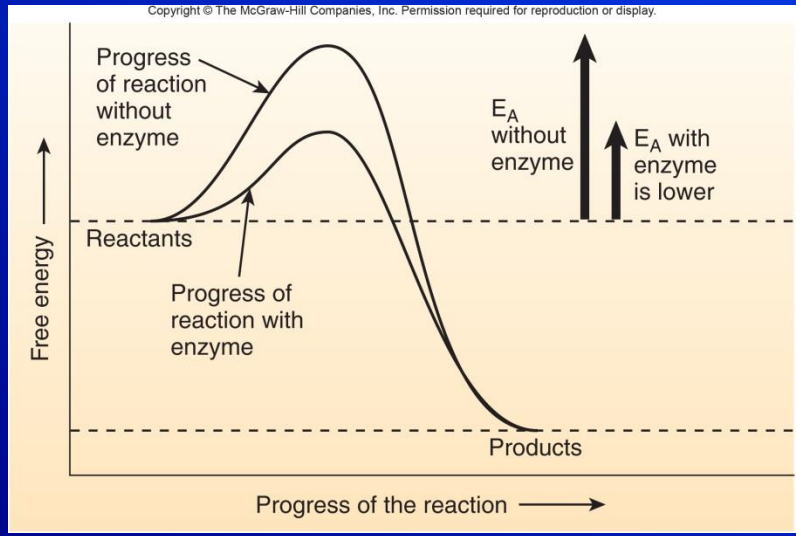
Chemical Rxns & E+

Speed of Chemical Rxns: **Things that Δ rate of rxns**

- **Catalyst:** Substance that ↑ the rate of a chem. rxn w/o being Δed or depleted

Change the rate of a chemical rxn

1. **Temperature**
   - as temp ↑ reactants kinetic e+ ↑ thus they move faster and collide w/ one another more frequently & w/greater force increasing the likelihood of chem. rxns
2. **Concentration-** greater concentration can ↑ rate of rxn b/c w/↑ concentration atoms more likely to come into contact w/ each other for chem. rxns.



III. Inorganic Chemistry

A. Water (H_2O)

B. Solution Concentrations ([ ]'s)

C. Acids and Bases

D. O_2

E. CO_2

Inorganic Chemistry

Understanding:

Inorganic Chemistry

- Generally deals with those substances that **do not** contain Carbon
- Another definition: lack of carbon-hydrogen bonds

Organic Chemistry

- Study of carbon containing substances

Exceptions to the rule:

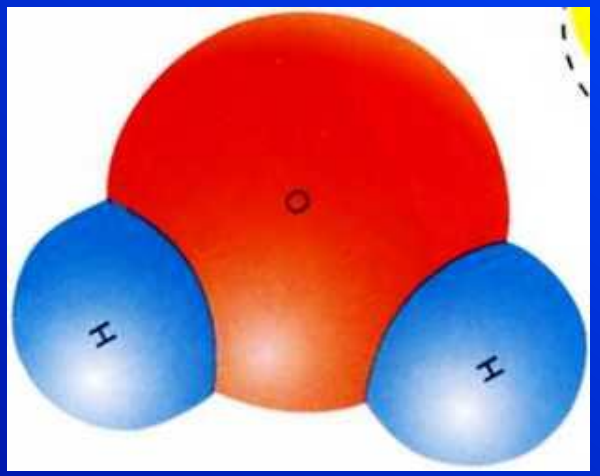
CO → Carbon Monoxide

CO_2 → Carbon Dioxide

HCO_3^- → Bicarbonate Ion

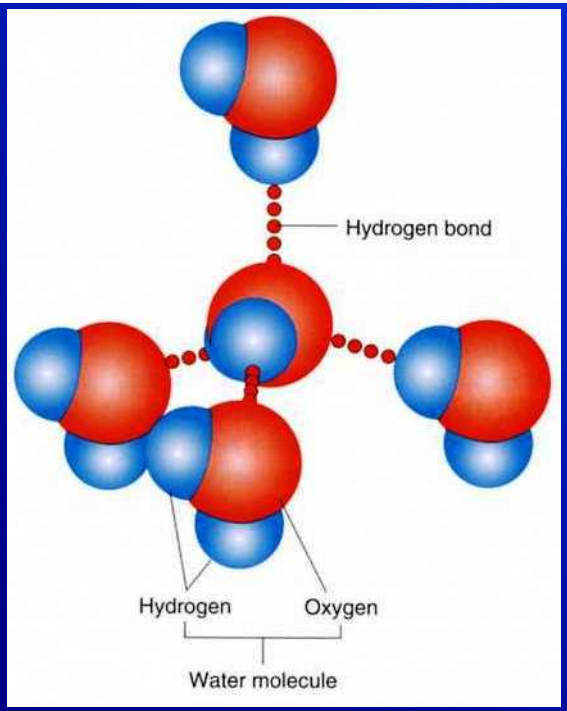
Inorganic Chemistry:

H_2O



Characteristics of H_2O

1. Polar molecule:
   - b/c it is polar it forms H+ bonds with other H2O molecules forming a lattice structure w/in the H2O
2. % of body's weight
   - 50% in ♀ (> body fat than ♂)
   - 60% in ♂
3. % of blood plasma
   - 92% H_2O



Inorganic Chemistry:

H_2O: Fxns in living organisms

1. Stabilizing Body Temp.
   - H2O has a high specific heat (meaning it takes a large amount of e+ to raise its temperature)
   - Thus it is resistant to temperature Δ's
   - H2O also evaporates (thus it can be sweat used to cool the body when it evaporates and takes the "heat" with it)
2. Protection
   - Acts as a lubricant to prevent damage from friction
   - It also forms a "fluid cushion" around the organs (ex/CSF)
3. Chemical Rxns
   - Reacting molecules must be dissolved in H2O for many of the bodies chemical rxns
   - **Hydrolysis
   - **Dehydration Synthesis
4. Mixing Medium
   - Mixture: combination of 2 or more substances blended together but not chemically combined

   a. Solution
   b. Suspension
   c. Colloid

Inorganic Chemistry:

H_2O: Fxns in living organisms cont…

a) Solution (Sol'n)
- Mixture of liquids, gases, or solids in which substances are uniformly distributed w/no clear boundary btwn substances
- **Solute** dissolves in **solvent**
- **Solvent** dissolves the **solute**
- Ex/ Salt Water

b) Suspension
- Mixture containing materials that separate unless they are continually, physically blended together
- Ex/ Penicillin

c) Colloid
- Mixture in wh/ dispersed (solute-like) substance is distributed throughout a Dispersing (solvent-like) substance
- The dispered particles are larger than simple molecules but small enough that they do not immediately settle out of solution
- Ex/ Blood (Plasma is made up of plasma + proteins

Inorganic Chemistry:
Sol'n Concentrations ([ ]'s)

- [ ] of solute particles dissolved in solvents can be expressed in several ways
  - Most Common ➔ grams/milliliter (g/ml)
  - 10% NaCl sol'n = 10 g of NaCl into enough water to make 100 mls (water will be displaced by NaCl's solid volume)

Inorganic Chemistry: Acids & Bases

Acid

- A proton (H^+) donor

Base

- A proton (H^+) acceptor
- OH^- is what is usually found in solution that will bind to free H^+'s

Strong Acid/Base

- Either will completely dissociate when put into H_2O, releasing all of the H^+ or OH^- in their make-up
- The rxn is not freely reversable
- Ex/
  - $HCl \rightarrow H^+ + Cl^-$
  - $NaOH \rightarrow Na^+ + OH^-$

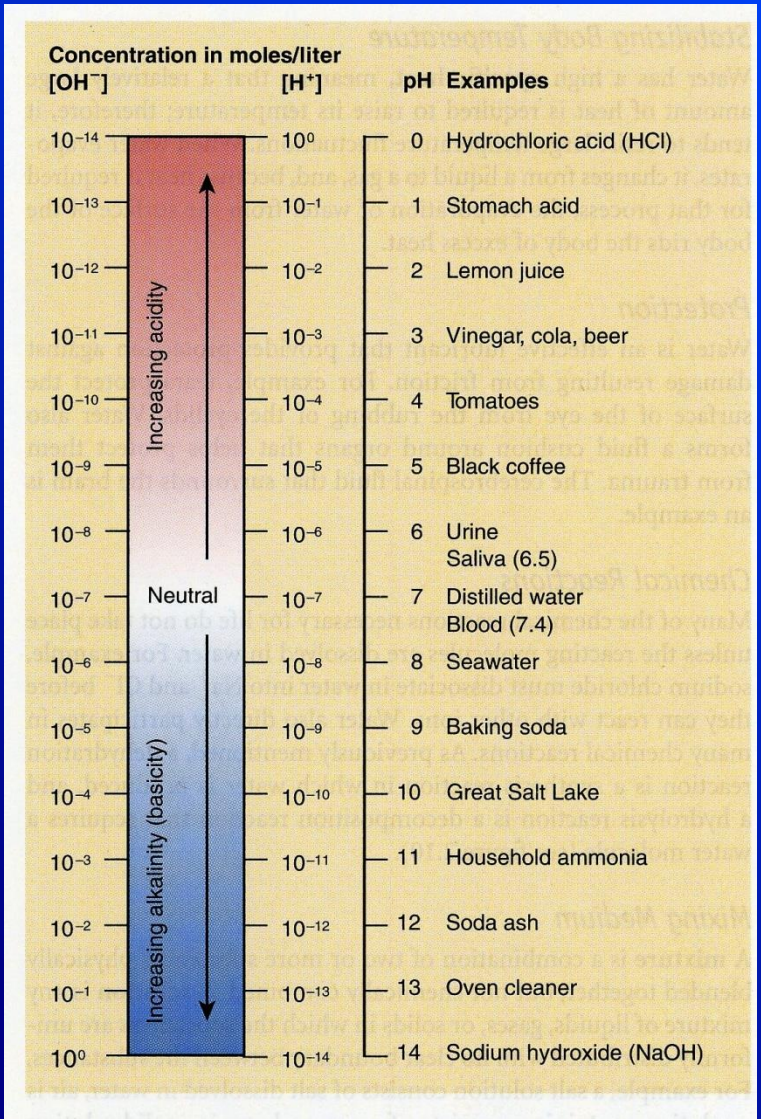
Weak Acid/Base

- A proton (H^+) acceptor
- OH- is what is usually found in solution that will bind to free H^+'s
- Rxn is reversible
- Ex/
  - $H_3COOH \leftrightarrow H_3COO^- + H^+$

Inorganic Chemistry: Acids & Bases

pH Scale

- Way to refer to the H+ [ ] in a sol'n
- H_2O is considered neutral
  - pH of H_2O = 7
  - pH < 7 ➔ Acidic
  - pH > 7 ➔ Basic
  - Δ of 1 pH "unit" is exponential
    - 10X Δ in $[H^+]$
    - pH 6 = 10X> [H+] than 7
    - pH 7= 10X> [H+] than 8



Inorganic Chemistry: **Acids & Bases**

Salts

- Compounds made of the combination of a cation and an anion
  - Except for H^+ and OH^-
- Formed by the interaction of an acid and a base
  - $HCl + NaOH \rightarrow H_2O + NaCl$

(acid) (base) (water) (salt)

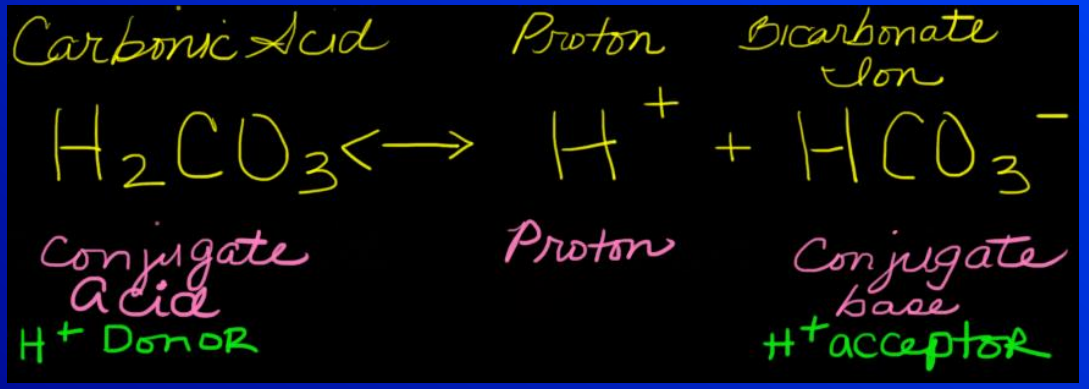
Buffers

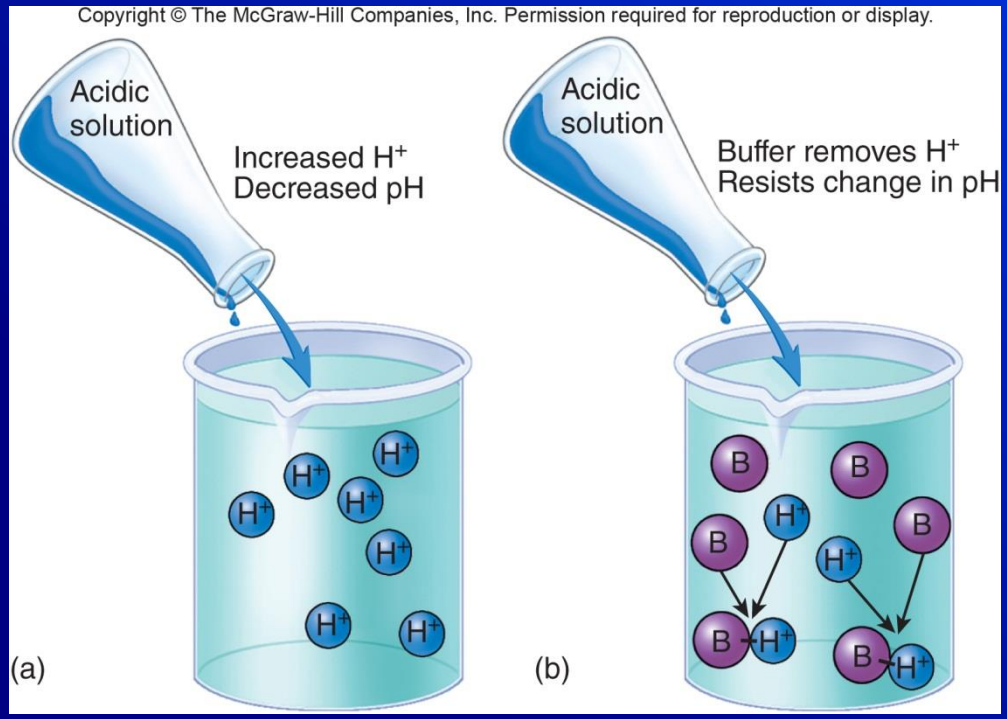
- Chemical behavior of a molecule can Δ as pH does (enz's wk in narrow range)
- ***Thus***: an organisms survival depends on its ability to regulate its pH
- A sol'n of a conjugate acid-base pair in which the acid and base components occur in similar [ ]'s

Inorganic Chemistry: Acids & Bases

Buffers cont…

- Examples of buffers used by living systems include:
  - Bicarbonate, Phosphates, Amino Acids, Proteins as Components
- The greater the buffer concentration the more resistant to Δ, but pH may still Δ just not as drastically as seen w/o the buffer





Inorganic Chemistry

Oxygen

- 21% of earth's atmosphere is O2
- Essential to lives of most animals
- Humans use it in the final step in a series of rxns in which e+ is extracted from food molecules

Carbon Dioxide

- Bi-product of organic molecule metabolism
- A small % is eliminated via exhalation
- Accumulation of high amounts is toxic to cells

IV. Organic Chemistry

A. Carbohydrates

B. Lipids

C. Proteins

D. Nucleic Acids: DNA & RNA

E. Adenosine Triphosphate

IV. Organic Chemistry

- **Carbon**:
  - Unique in that it can form covalent bonds w/ up to 4 other atoms.
  - 2 mechanisms that allow the formation of a wide variety of molecules are:
    1. Variation in length of the carbon chains
    2. Combination of atoms involved
- **Carbon containing molecules essential to living organisms are**:
  1. Carbohydrates
  2. Lipids
  3. Proteins
  4. Nucleic Acids
  5. Adenosine triphosphate

Organic Chemistry: Carbohydrates

- Carbo: Atom Hydrates: Hydrated
- Range from small to large in size
  1. Monosaccharide- Mono➔ 1 Simple Sugar
  2. Disaccharide- Di➔ 2
  3. Polysaccharide- Complex Sugar
- Made up of C, H, O in a 1:2:1 ratio
  – Glucose: $C_6H_{12}O_6$

Organic Chemistry:
Carbohydrates Functions

A. Structural: ribose and deoxyribose are component of DNA, RNA, ATP

B. Energy: simple sugars(monosaccharides) can be used as an immediate e^+ source, complex sugars must be processed before use
   - Glycogen (polysaccharide) important e^+ storage molecule

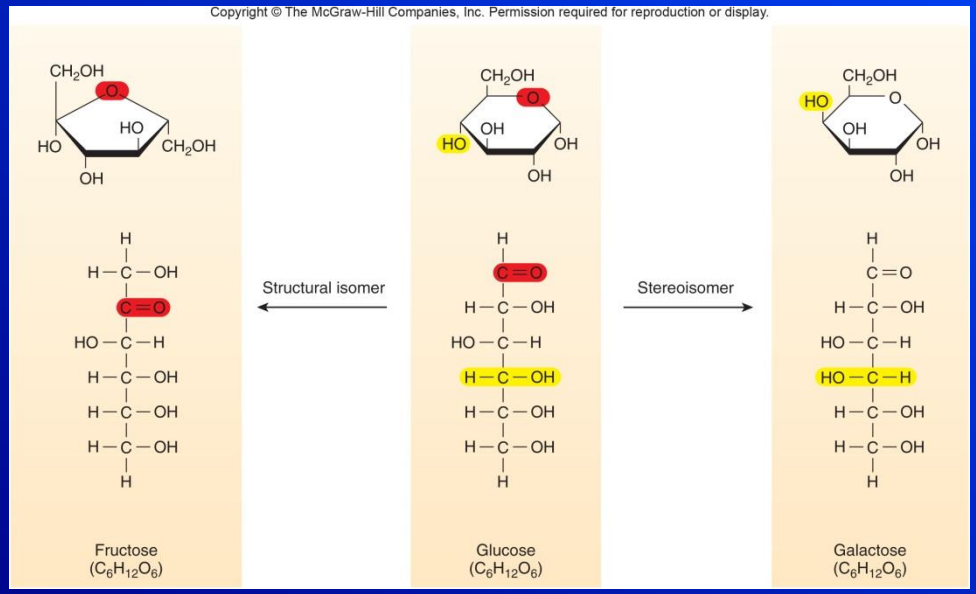
C. Bulk: cellulose (polysaccharide) forms the bulk of feces

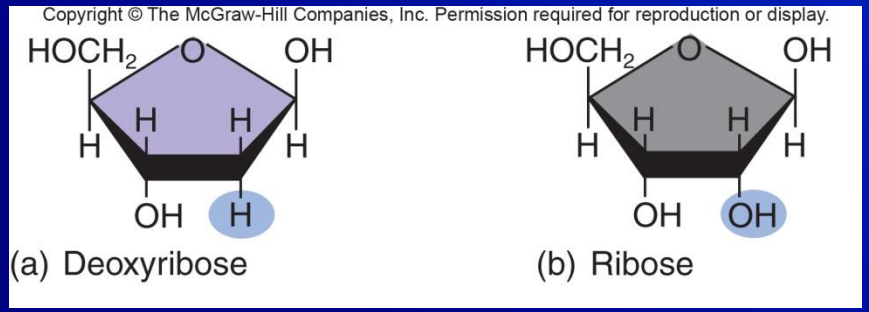
Organic Chemistry: Carbohydrates

Monosaccharides

Mono=1 Saccharide=Sugar

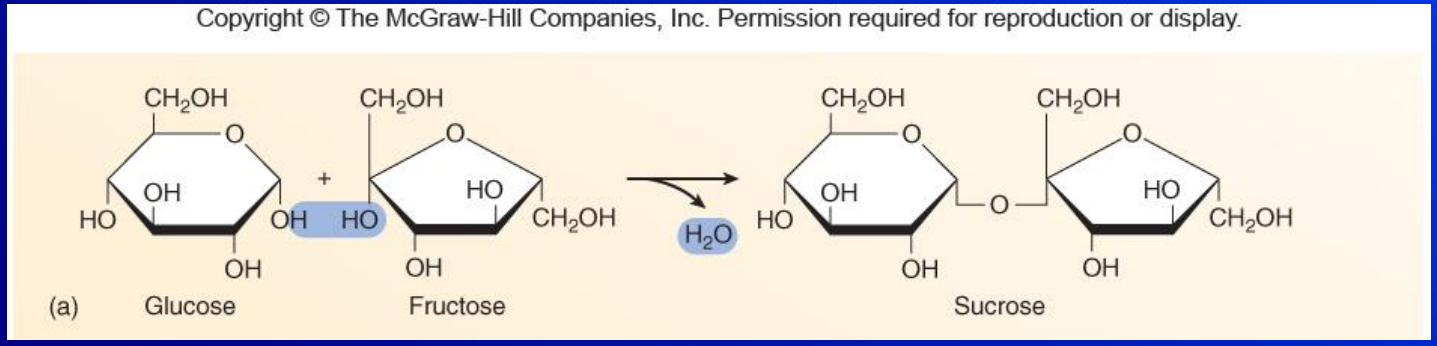
- MS's usually have from 3 to 6 C's in their make-up.
- Those w/6 are the most essential to humans
  - ➢ These include:
  - – Glucose, fructose & galactose
    - *These are isomers of each other*
- *2 important 5-carbon monosaccharides include:*
  - – *Ribose & deoxyribose*
  - – *Structural components of DNA*





Organic Chemistry: Carbohydrates

Disaccharides



Di➔ 2

Saccharide ➔ Sugar

- 2 MS's bound together
  1. Sucrose ➔ Glucose + Fructose
  2. Lactose ➔ Glucose + Galactose
  3. Maltose ➔ 2 Glucose

Organic Chemistry: Carbohydrates

Polysaccharides

Poly➔ many

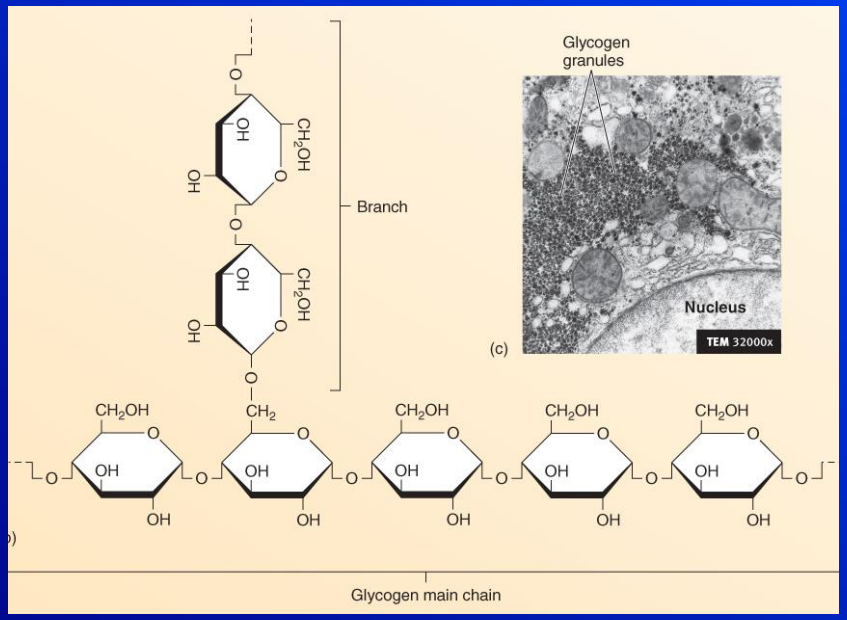
Saccharide ➔ Sugar

- Many MS's bound together to form long chains (can be straight or branched)
- **3 Fxns/major types:**
  - In animals you find 1 type in plants 2 types

a) Glycogen: "animal starch"; used as an e+ storage molecule. When quickly metabolized it results in e+ for cells

b) Starch: long chains of glucose used for e+ storage in plants
   - Humans can break it down & use it for e+

c) Cellulose
   - Long chains of glucose that fxn as a structural molecule in plants
   - Humans can't break it down & use it for e+, thus it b/comes bulk of feces



Organic Chemistry: Lipids (a.k.a. fats)

- Major components: C, H, & O
- Minor components: P & N
- Compared to carb's, lipids have a lower ratio of O to C, this makes them less polar thus they can be dissolved in non-polar organic solvents (acetone, alcohol)
- 4 major groups:
  - Triglycerides
  - Phospholipids
  - Steroids
  - "Other"

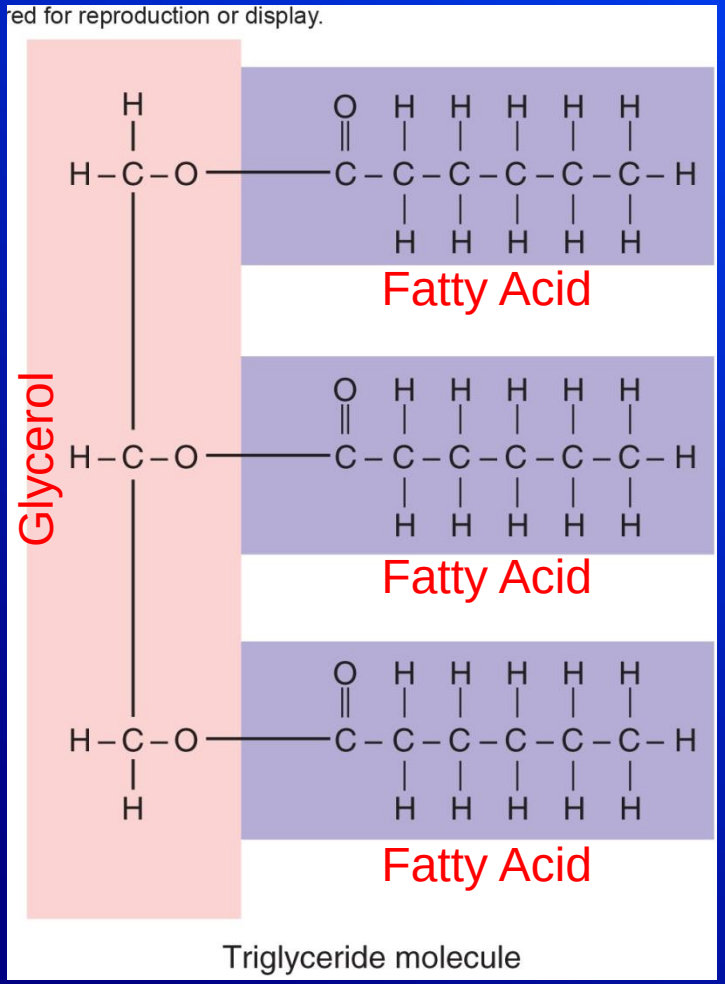
Organic Chemistry:
Lipid Functions

A. Protection: surrounds and protects organs
B. Insulation: fat under the skin prevents heat loss; myelin sheaths electrically insulate axons of neurons
C. Regulation: steroids→ regulates physiological processes prostaglandins→ regulate inflammation
D. Vitamins: "fat soluble" vitamins do many things
   - Vit A→ forms retinol req'd for night vision
   - Vit D→ Promotes Ca^{2+} uptake in bone tissue
   - Vit E→ Promotes healing
   - Vit K → necessary to form clotting factors
E. Structure- form the phospholipids and choleterol in the cell's membrane
F. Energy: can be broken down to yield more e+ than either carb's or proteins

Organic Chemistry: Lipids

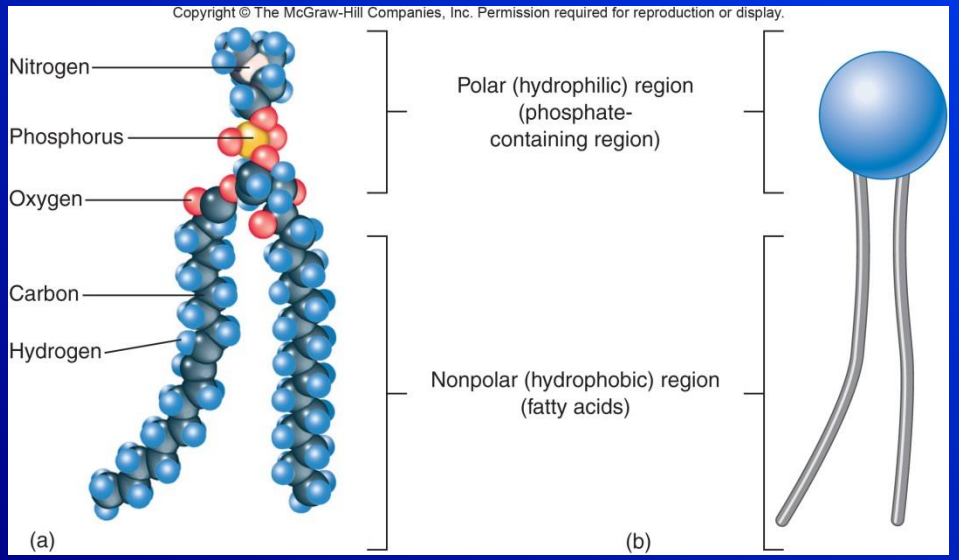
Trigycerides

- Make-up 95% of fats in the human body
- 1- glycerol + 3 Fatty Acids (FA's)
- FA's differ from each other by # of C's and degree of saturation
  - 2 types:
  1. Saturated
     - Only single covalent bond btwn C's in the carbon backbone
  2. Unsaturated
     - 1 or more double covalent bond btwn C's in the carbon backbone
       a) Monounsaturated
       b) Polyunsaturated
     - *Trans* fats: chemically altered UF, that is more of a risk of cardiovascular disease development than even the SF



Organic Chemistry: Lipids
Phospholipids

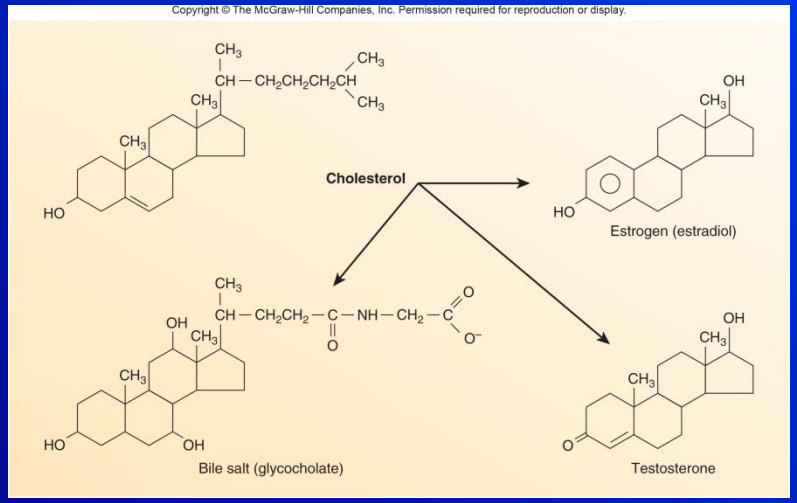
- Glycerol + 2 FA's + phosphate containing molecule
  - Notice structurally similar to TG's
- Polar Molecule:
  - Hydrophilic Head (Polar)
  - Hydrophobic Tails (Non-polar)
- Essential in the cell membrane's structure



Organic Chemistry: Lipids

Steroids

- Structurally they are a unique lipid, but their solubility characteristics are similar
- All composed of C's bound together in a 4-ring-like structure
- Important Ex/
  - Cholesterol (building blocks for other steroids)
    - Ingest too much ➔ heart disease, but it is still essential to diet
  - Bile Salts
  - Estrogen
  - Progesterone
  - Testosterone



Organic Chemistry: Lipids
Other

- Eicosanoids
  - Group of important molecules derived from FA's
  - Made in most cells
  - Important regulatory molecules
  - Ex/
  a) Prostaglandins: implicated in regulation of hormones for blood clotting, some reproductive fxns, and more (*Asprin*
  b) Thromboxanes
  c) Leukotrienes

- Fat Soluble Vitamins
  - Structurally not similar to one another but they are non-polar molecules essential to normal body fxn

Organic Chemistry: Proteins

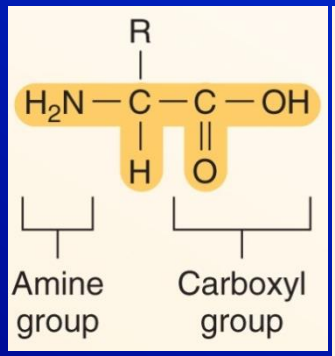
- Major components: C, H, O, & N
- Minor components: S, P, Fe, and I
- Protein's molecular mass can be huge:
  - NaCl= 58
  - Glucose= 108
  - Proteins ➔ 1000 to several million

Organic Chemistry:
Protein Functions

1. Regulation
   - Enz's control chem rxns and hormones regulate many physiological processes
2. Transport
   - Can help to transport things in the watery environment of the blood & can control mvmt in & out of cell
3. Protection
   - Antibodies and complement system proteins protect against foreign invaders
4. Contraction
   - Actin and Myosin and proteins involved in muscle movement
5. Structure
   - Collagen fibers give structural framework
   - Keratin lends strength to hair, skin, nails
6. Energy
   - Can be broken down to produce e+ equals the same yield as carb's

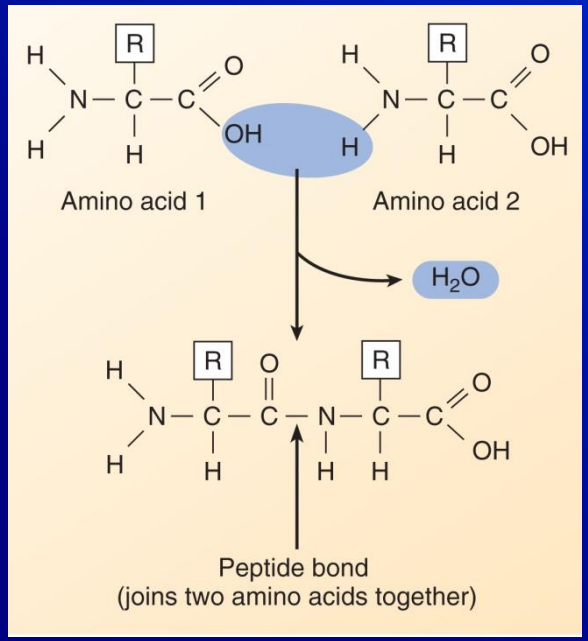
Organic Chemistry:
Protein Structure

- The building blocks of proteins are amino acids(AA):
  - These are made up of a central C with an Amine group at one end and a carboxyl group at the other
  - The R-Group varies from AA to AA

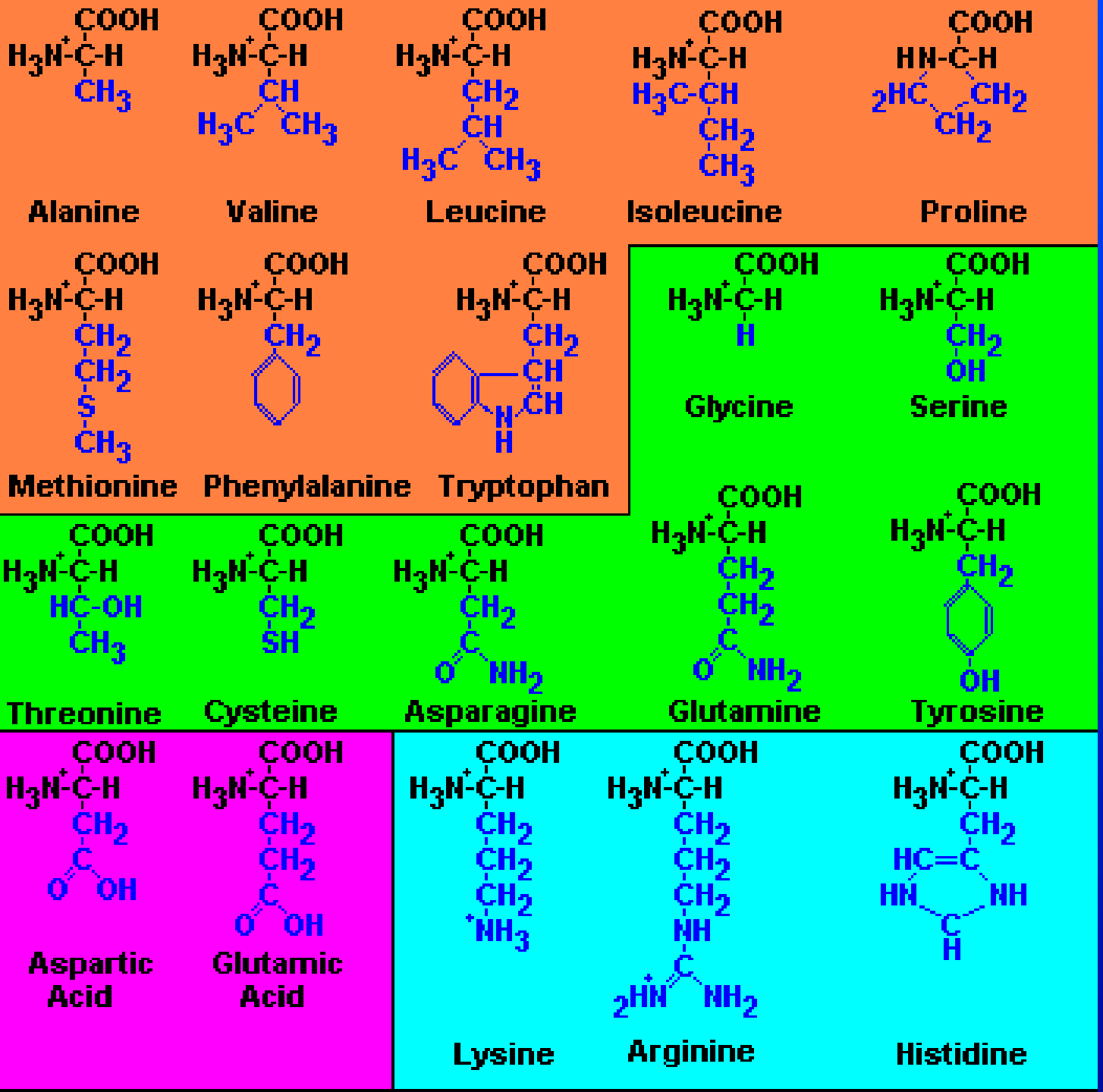


The general structure of an amino acid showing the amine group (—NH_2), carboxyl group (—COOH), and hydrogen atom highlighted in yellow. The R side chain is the part of an amino acid that makes it different from other amino acids.

- **Peptide Bonds**
  - Btwn each AA the Amine and Carboxyl groups bind to each other and form Peptide Bonds. Thus the reason proteins are often referred to as polypeptides.



All 20 Amino Acid Structures



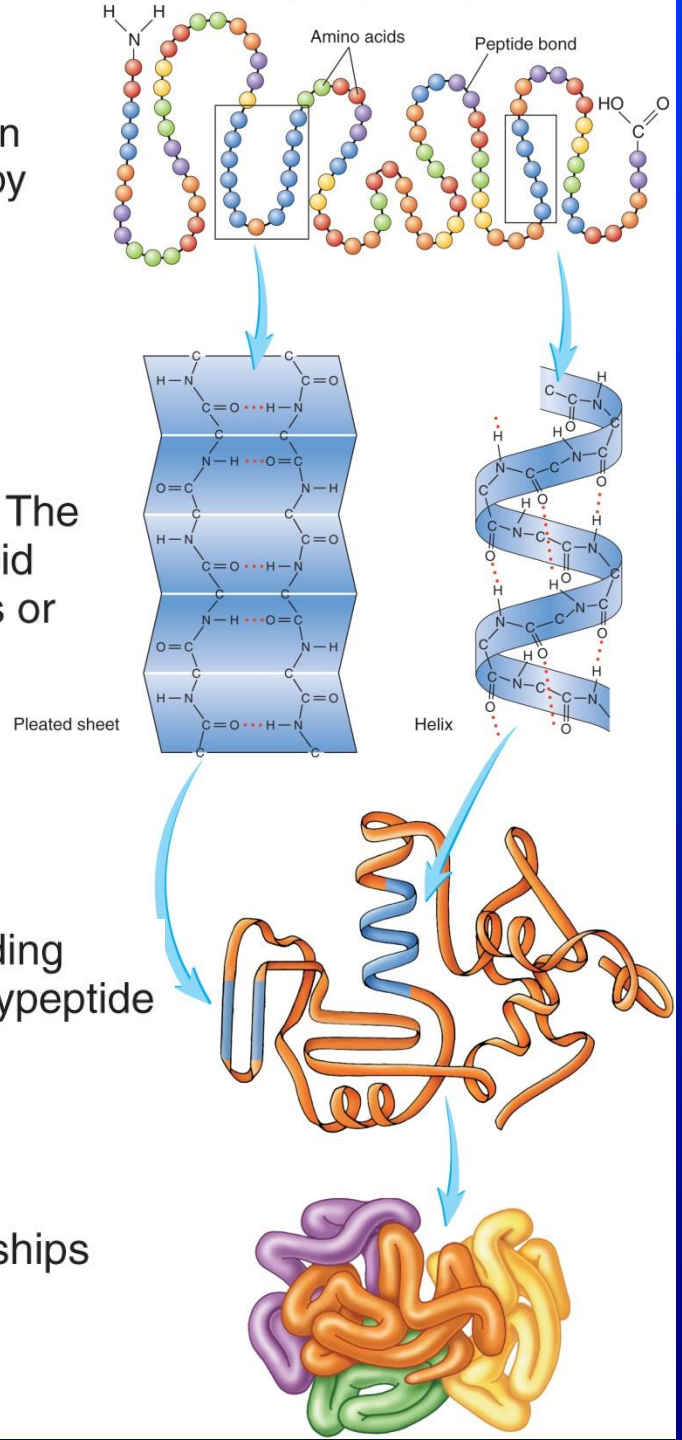
4 Levels of Protein Structure

(a) Primary structure—the amino acid sequence. A protein consists of a chain of different amino acids (represented by different colored spheres).

(b) Secondary structure results from hydrogen bonding (*dotted red lines*). The hydrogen bonds cause the amino acid chain to form pleated (folded) sheets or helices (coils).

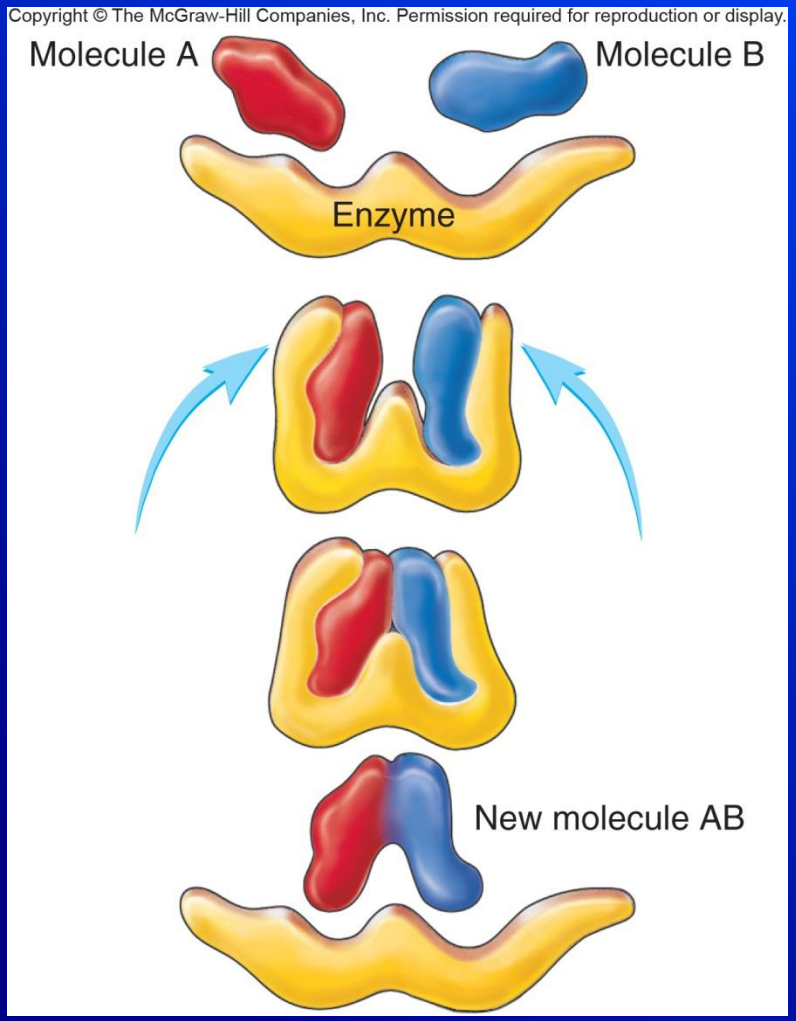
(c) Tertiary structure with secondary folding caused by interactions within the polypeptide and its immediate environment

(d) Quaternary structure—the relationships between individual subunits



Organic Chemistry:
Protein- Enzymes

- Protein catalyst that increases the rate of chemical rxn w/o being changed itself
- An enzymes 3-demisional shape is essential to its function
- Induced fit model
  - The enzyme can change its shape significantly to fit its reactants.
- Enzymes lower activation e^+ b/c they orient the reactant in such a way that chemical reaction is more likely to occur

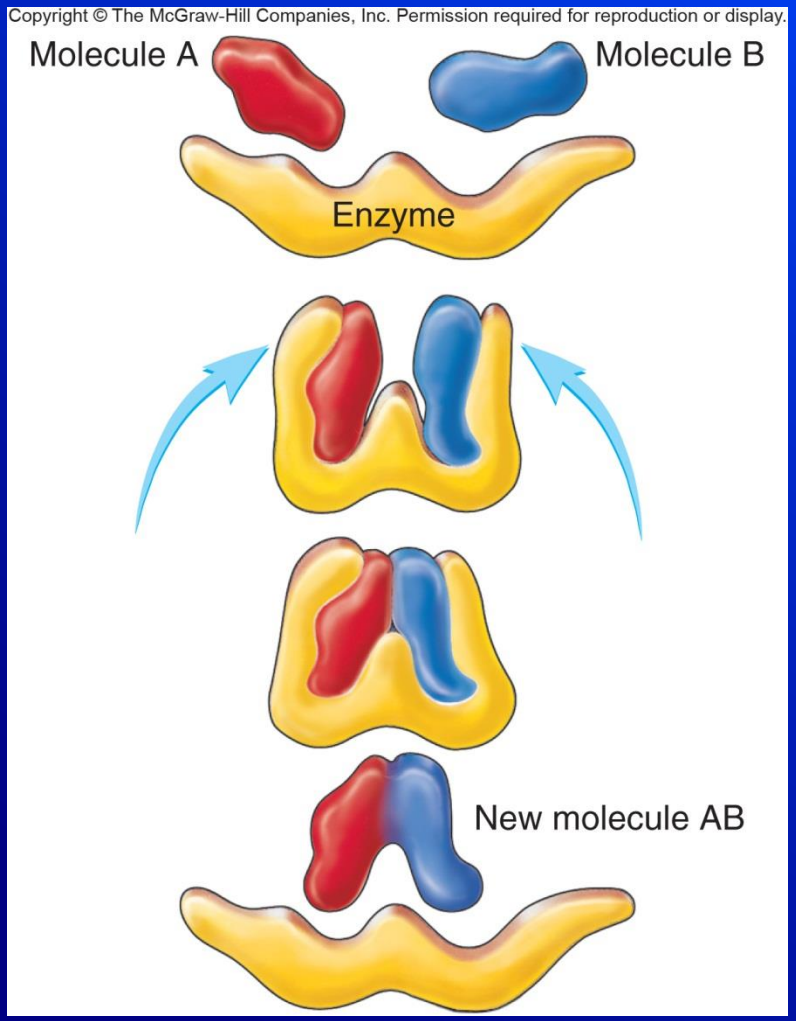


Organic Chemistry:
Protein- Enzymes

1. Enzymes binds reactants
2. Combines reactants
3. Releases reactant so that it can do it all occur again
4. It is capable of catalyzing multiple reactions

- Some enzymes require co-factors to function or an organic molecule
  - Co-factors: ions
    - Usually finalize the shape of the active site
  - Organic Molecule: co-enzymes

- -***ase***
  - this suffix means enzyme



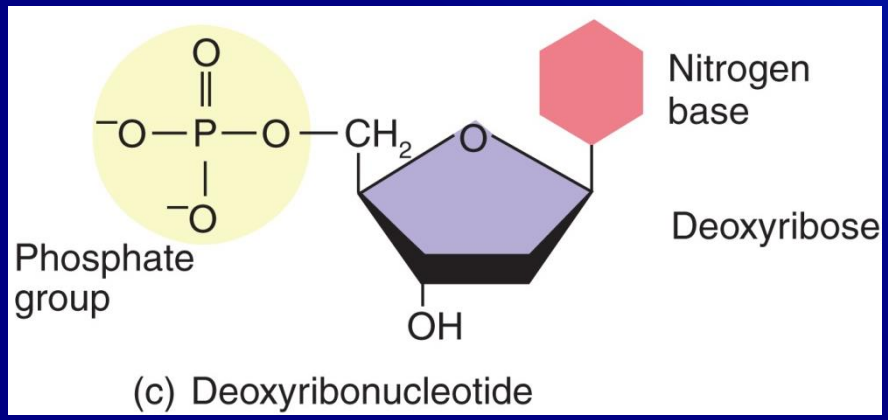
Organic Chemistry: Nucleic Acids

- Made-up of C,H,O,N & P
- DNA: carry genes
- RNA- encode amino acid sequences of proteins
- building blocks are called nucleotides

2 types

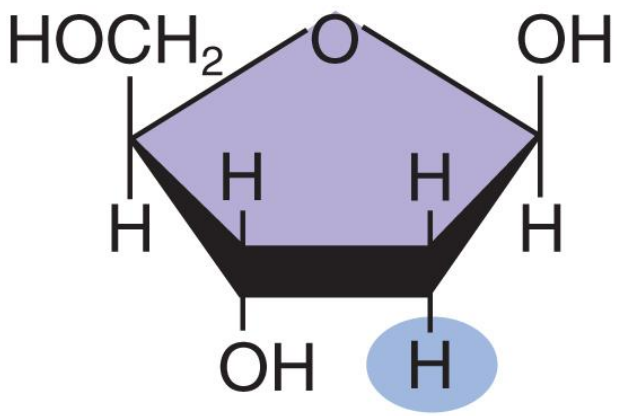
DNA	RNA
Deoxyribonucleic Acid	Ribonucleic Acid
Double Helix	Single stranded

Basic Nucleotide

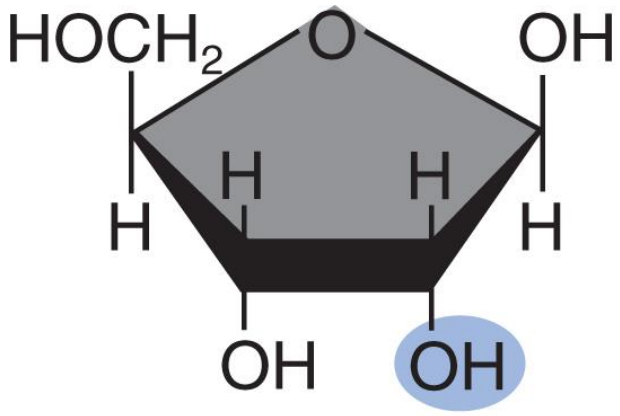


Organic Chemistry: Nucleic Acids DNA & RNA

Nucleotide: Sugars



(a) Deoxyribose



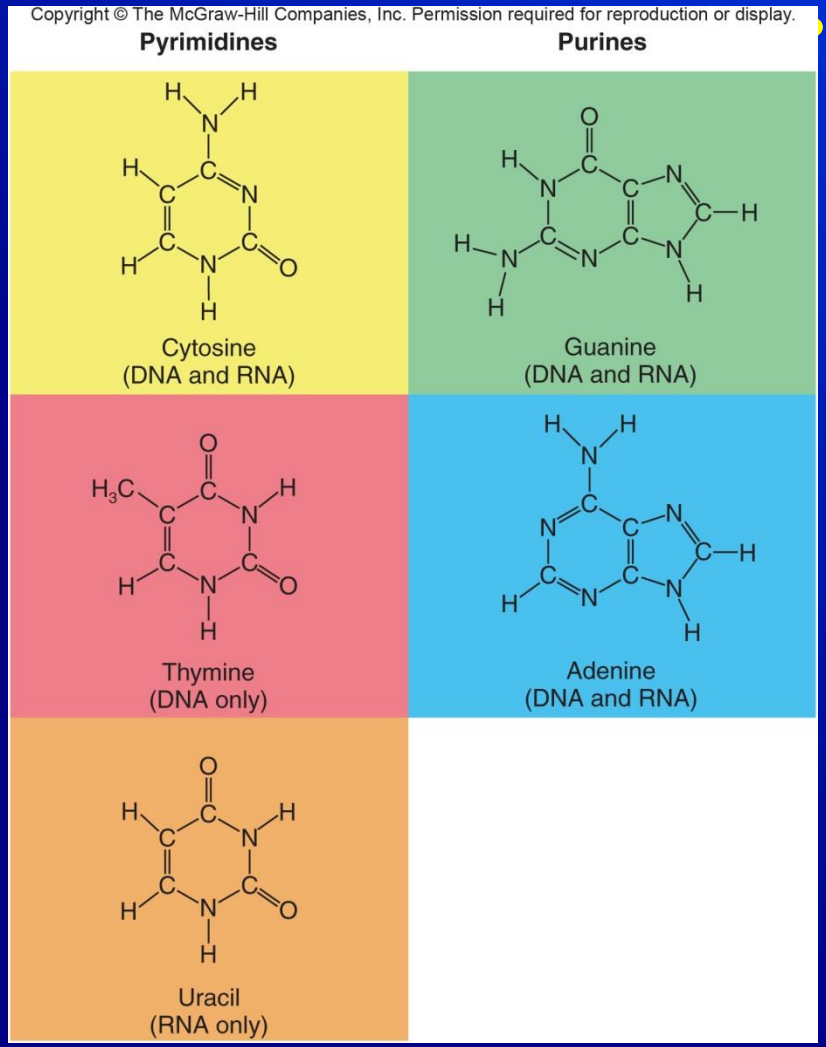
(b) Ribose

Nitrogenous Organic Bases

2 types

Pyrimidines

- Cytosine
- Thymine
- Uracil



Purines

- Guanine
- Adenine

DNA's bases

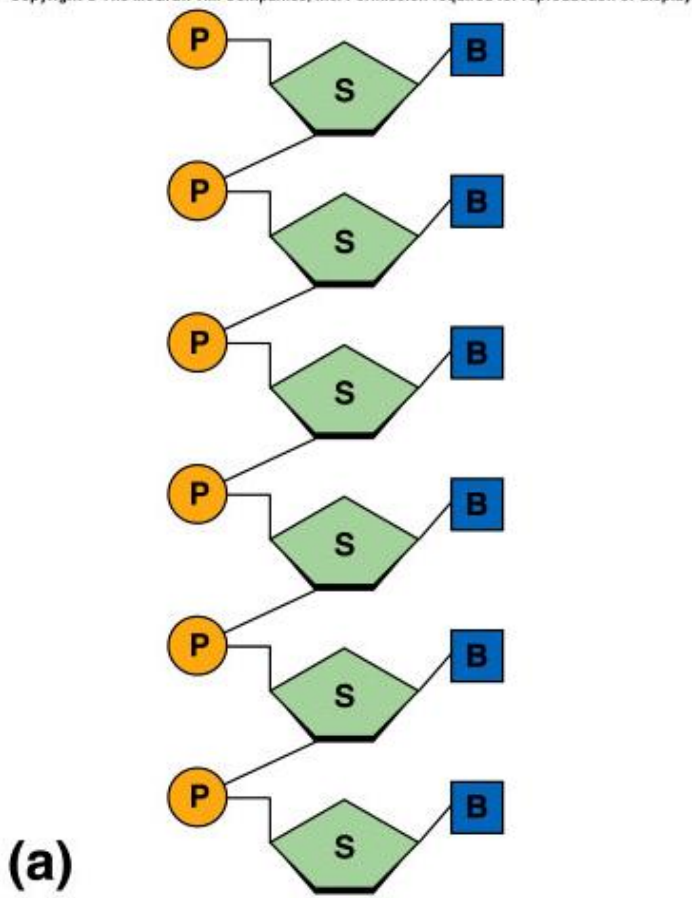
- Adenine
- Guanine
- Cytosine
- Thymine

RNA's bases

- Uracil
- Guanine
- Cytosine
- Adenine

Organic Substances
Nucleic Acids

- **RNA** (single stranded)
- **DNA** (Double Stranded)



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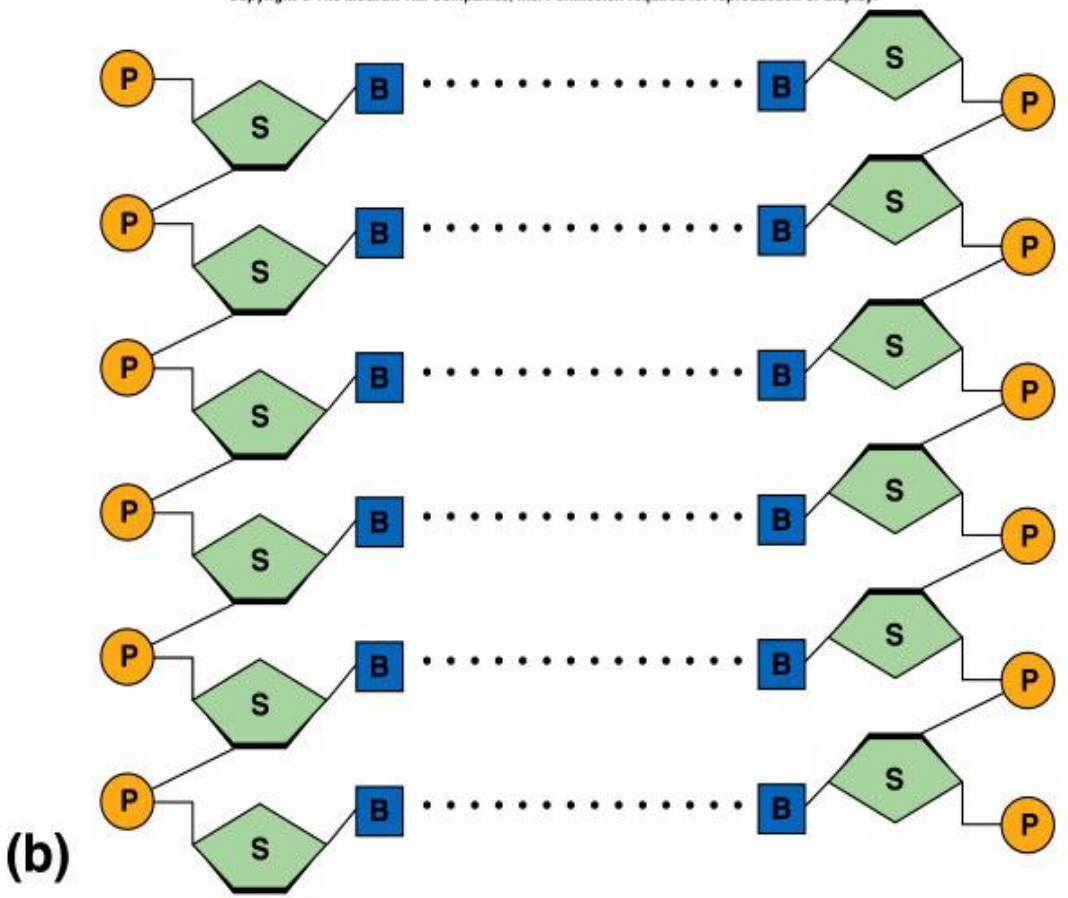
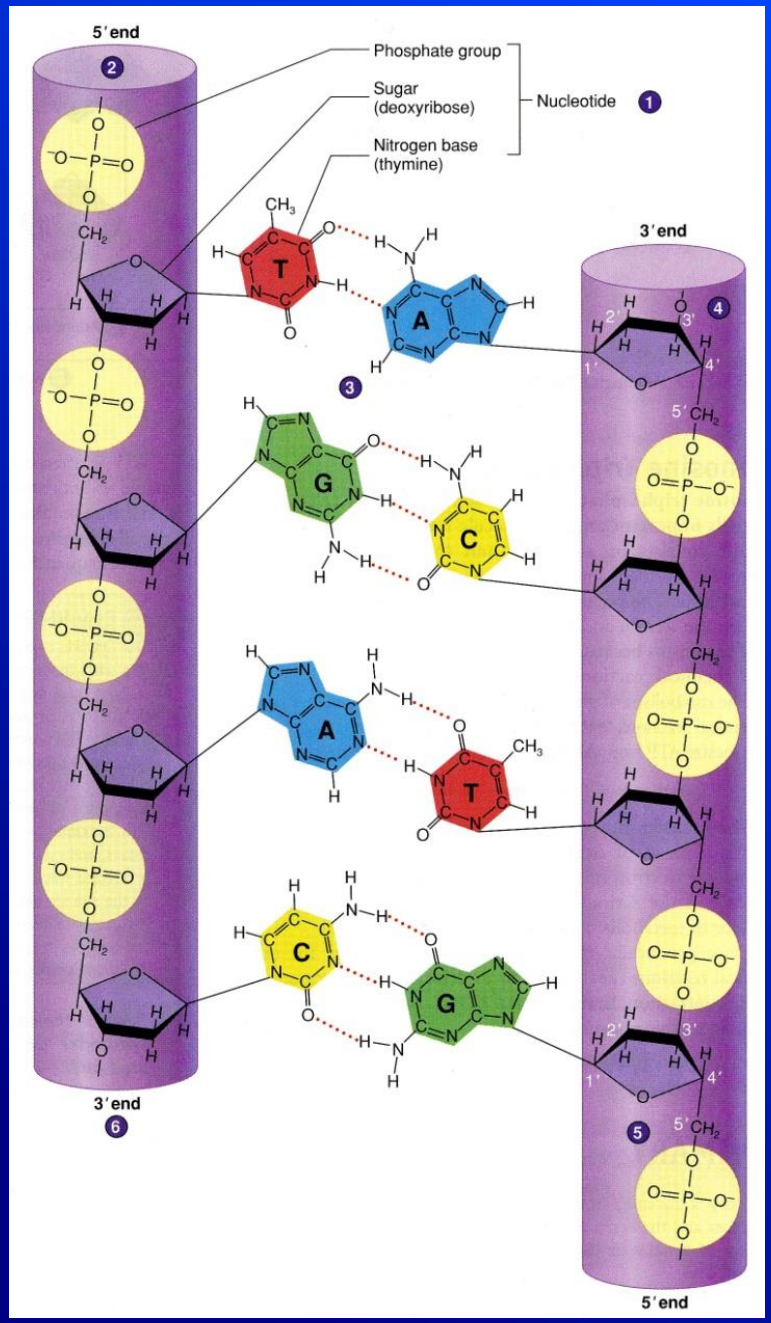


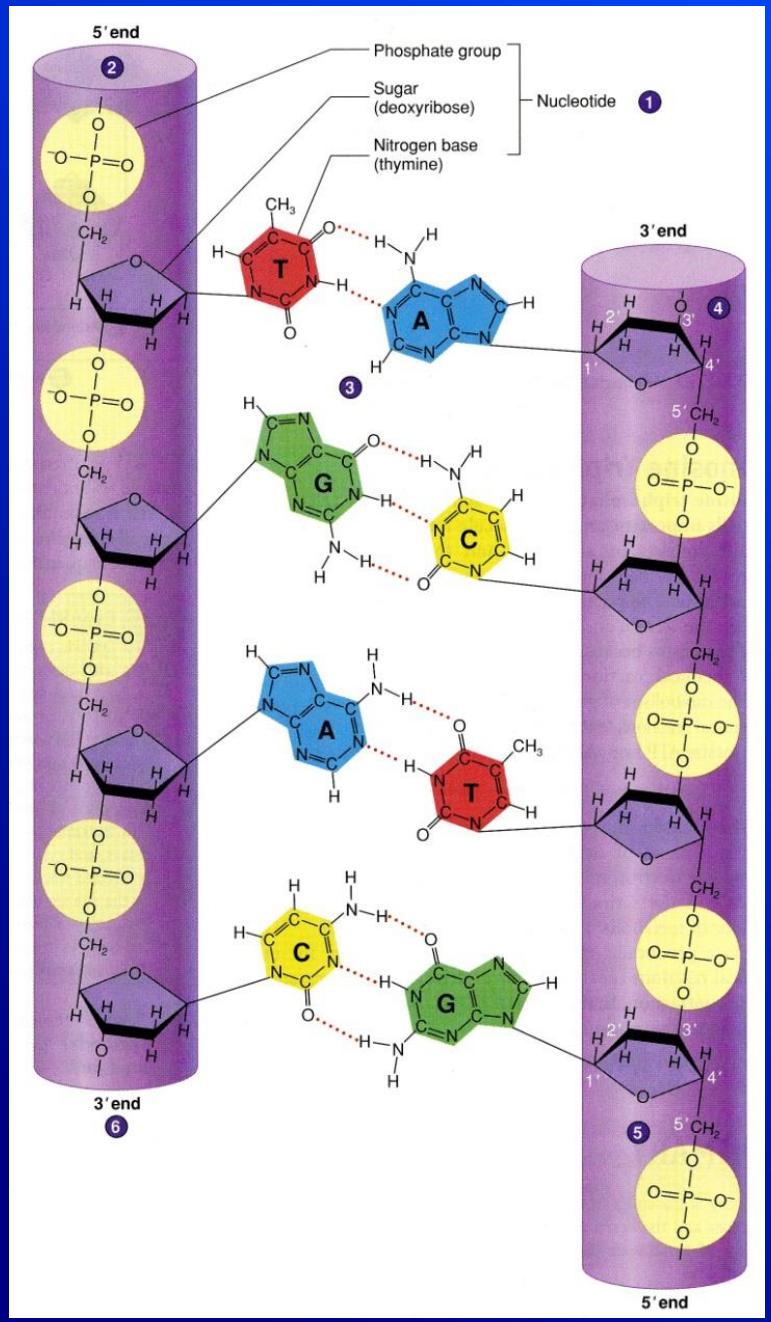
Nucleic Acids: DNA

- DNA is a double helix
  - "twisted ladder"
- Vertically nucleotides are held together via a covalent bond between
  - The phosphate group of 1 NA and the next
- Horizontally nucleotides are held together via a H bond between
  - Nitrogenous bases next to each other
  - **NB's must have to correct partner to bind to** this is called <u>complementary base pairing</u>
  - DNA :T=A G=C
  - RNA: U=A G=C



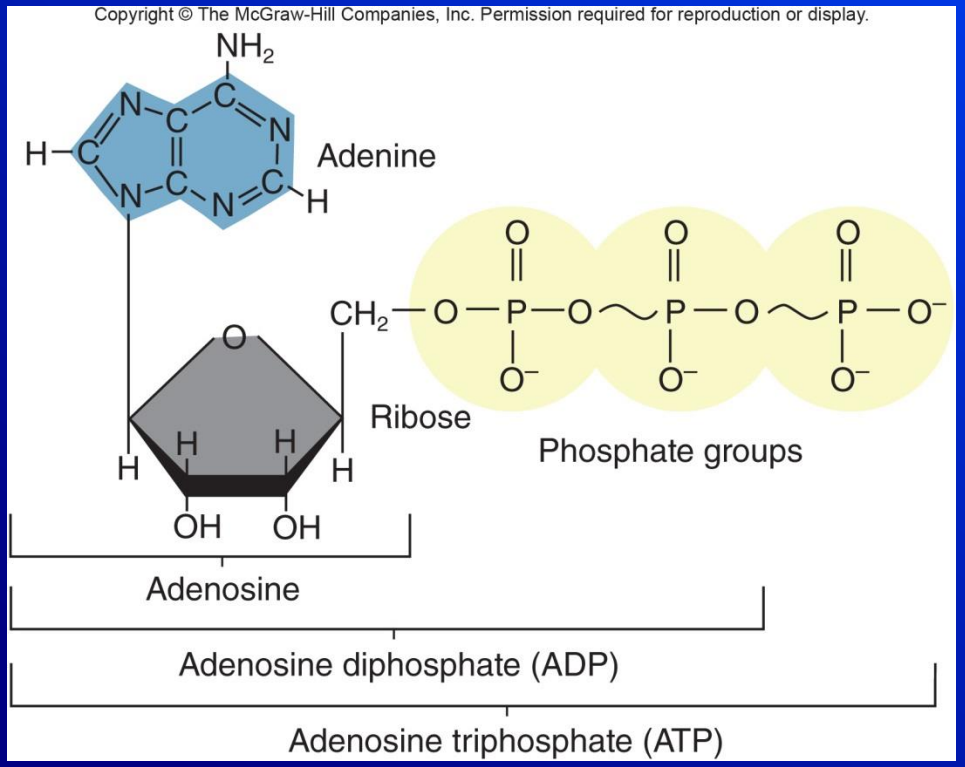
Nucleic Acids: DNA

- The two opposing strands of DNA also run ***antiparallel*** to each other.
  - Meaning the sugar phosphate backbone of 1 strand runs the opposite direction of it's partner
    - 5' ➔ 3'
    - 3' ➔ 5'
- Within DNA the sequence of bases is a "code" that stores information used to determine the structure and fxn of cells
- Gene: sequence of DNA that directs the synthesis of an RNA molecule that will become a protein



Adenosine Triphosphate (ATP)

- There is potential e+ stored in the 3rd (last) phosphate group that is essential to living organisms because it provides the e+ used in nearly all of the chemical rxns within the cells of the body



How to Make ATP

ADP + P_i + Energy ➔ ATP

- Catabolism of glucose, fat, or protein releases e+ and that is transferred via a series of Oxidation-reduction rxns.
- ATP is used to provide e+ for other chemical rxns (anabolism) or to drive cell processes.
  - Ex/ muscle contraction
- ATP is called the "Energy Currency" because it is both capable of giving or taking e+