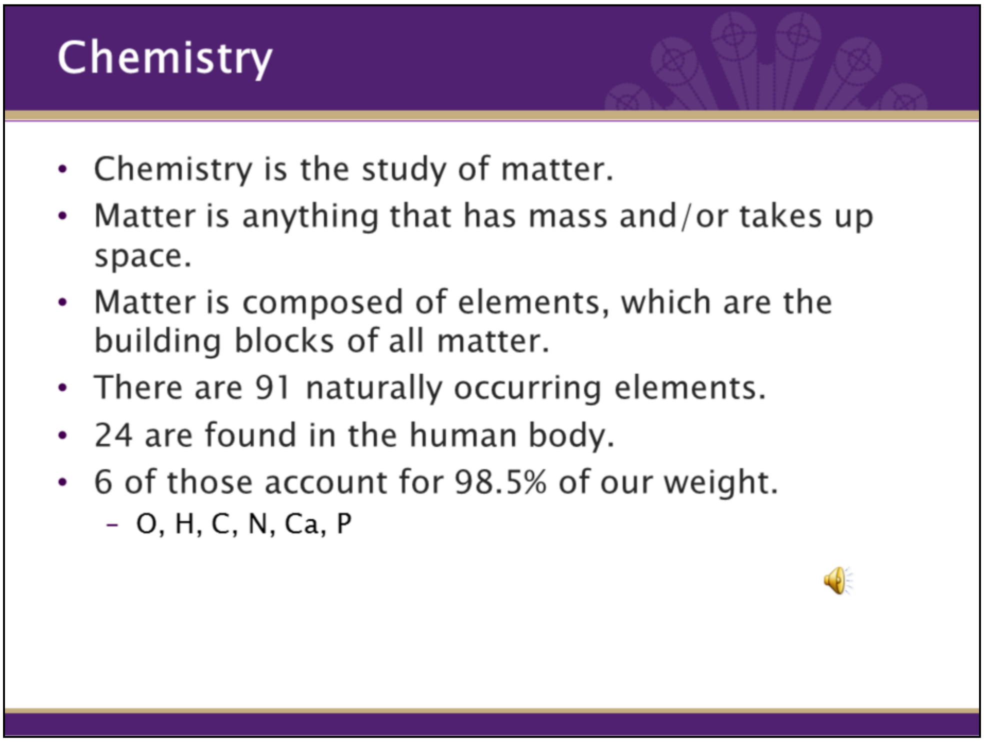
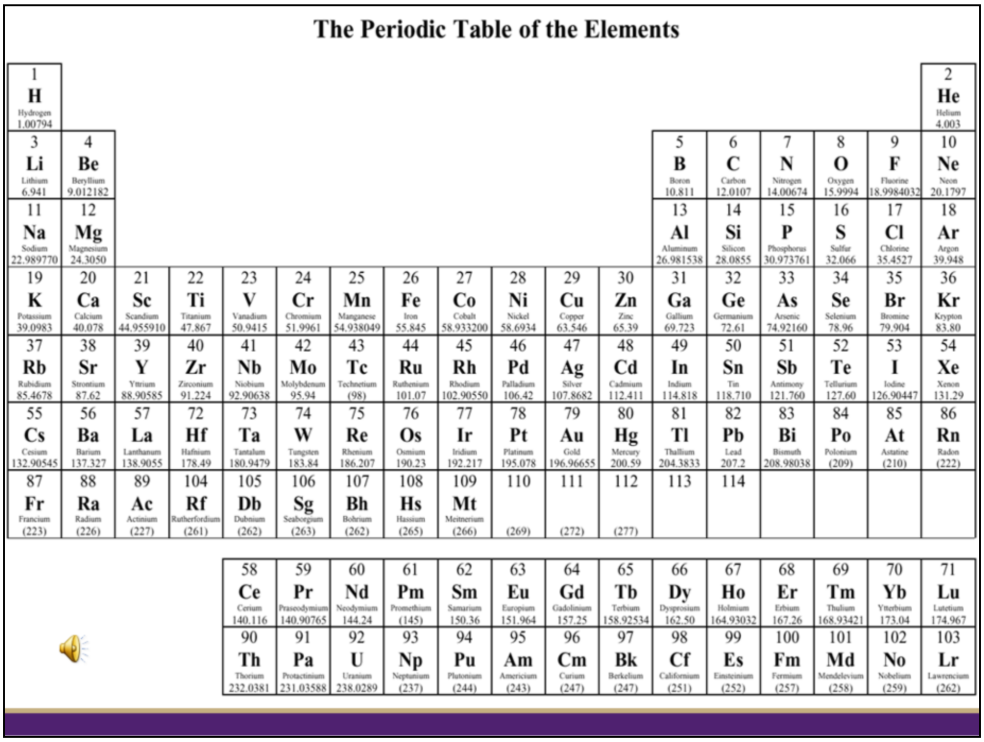
ST. CATHERINE UNIVERSITY

Chemistry



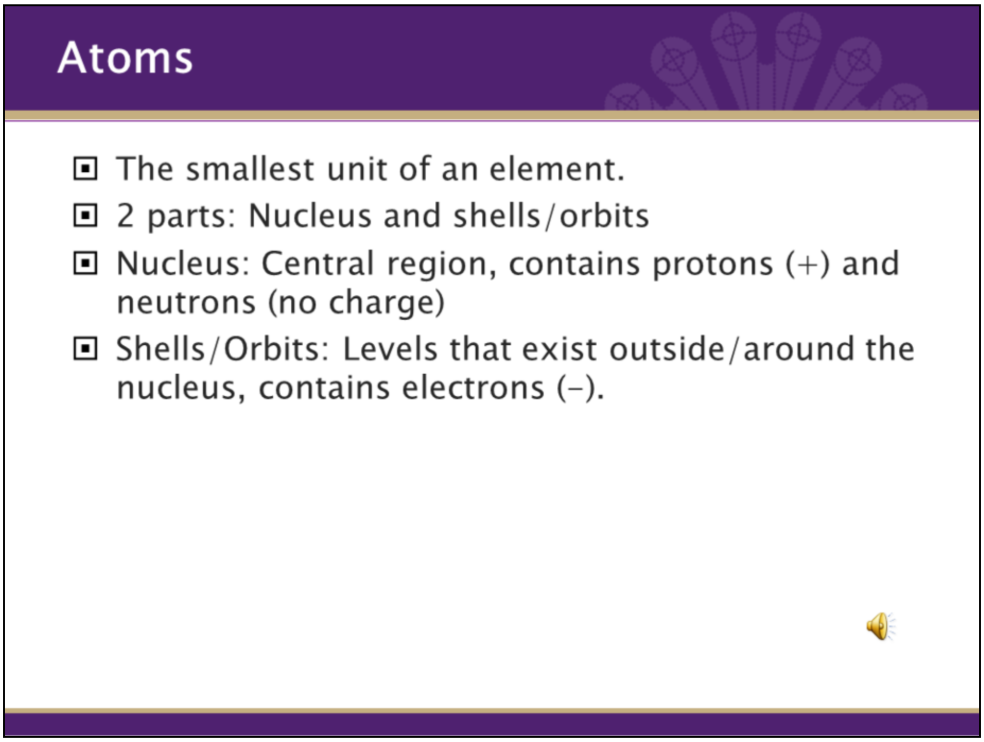
Chemistry is the study of matter.
Matter is anything that has mass and/or takes up space.
Matter is also composed of atoms of varying types of elements.
There are 91 naturally occurring elements, check out the Periodical Table on the next slide and on Appendix A of your textbook. The Periodic Table is a systematic organization of all the elements based on their atomic structure. We will come to atomic structure in a few slides.
Of all the elements listed, 24 are found in the human body.
Of those 24, 6 account for 98.5% of our weight: Carbon (C), Oxygen (O), Nitrogen (N), Hydrogen (H), Phosphorus (P), Calcium (Ca).
Other elements, such as Potassium (K), Chlorine (Cl), Magnesium (Mg), Iron (Fe), Sulfur (S), and Sodium (Na), are also found in the body, but to a lesser extent than the previously mentioned 6.
I will not test you on their abbreviations, but it would be a good idea to start to learn the 6 most common ones as they will show up regularly in your textbook, notes, and as you continue through out A&P.



The Periodic Table of the Elements

1 H Hydrogen 1.00794																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012182											5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.00674	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797
11 Na Sodium 22.989770	12 Mg Magnesium 24.3050											13 Al Aluminum 26.981538	14 Si Silicon 28.0855	15 P Phosphorus 30.973761	16 S Sulfur 32.066	17 Cl Chlorine 35.4527	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955910	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938049	26 Fe Iron 55.845	27 Co Cobalt 58.933200	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.92160	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.29
55 Cs Cesium 132.90545	56 Ba Barium 137.327	57 La Lanthanum 138.9055	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.078	79 Au Gold 196.96655	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.98038	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 (269)	111 (272)	112 (277)	113	114				
				58 Ce Cerium 140.116	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
				90 Th Thorium 232.0381	91 Pa Protactinium 231.03588	92 U Uranium 238.0289	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

This is the Periodic Table. As mentioned on the previous slide, it lists all of the elements in a systematic way. This may not be evident at the moment, but as we go through the following slides, we will talk about the key information that can be pulled from the table.



Atoms are the smallest unit of an element. All atoms of an element have the exact same properties and are different from other types of elements. You cannot breakdown an atom into smaller pieces without it changing. If you break it down further, it will not maintain its properties.

There are 2 parts of an atom, a nucleus and the shells/orbits.

A nucleus is the central region or core of the atom. One point to take note of is that you will see the term nucleus again when we discuss cells. The nucleus of an atom and a cell are different and contain different structures, but the term is used in both and refers to the core area. The atomic nucleus contains protons and neutrons. Protons are small particles that have a positive charge. Neutrons are also small particles that have no charge or are neutral. Hence the name. Neither protons or neutrons leave the nucleus. They do not travel around the atom. All atoms of the same element always have the same number of protons.

Shells/Orbits are energy levels that exist around the nucleus. This is where we find electrons. Electrons are very small, smaller than protons and neutrons. They have a negative charge and travel on paths (orbits) around the nucleus.

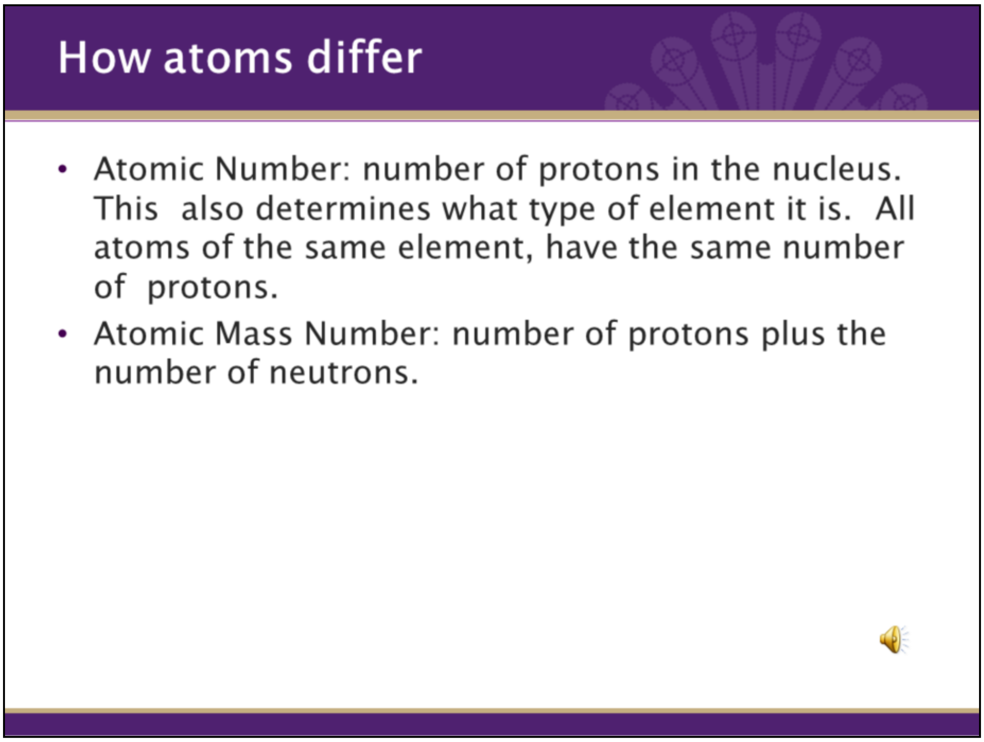
Electrons

- 2-8-8 Rule: electrons fill the inner shell first and then fill the next shell and so on.
- Valence electrons: number of electrons in the outer shell.

8/6/2016 5

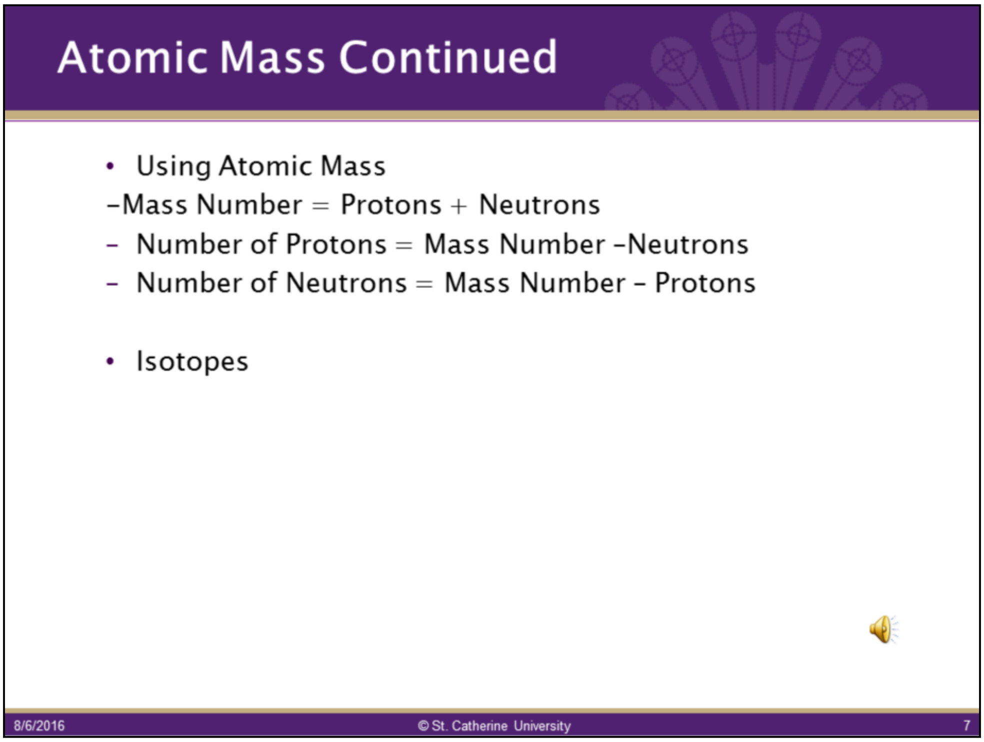
Different atoms will have a different number of electrons, but they all fill up the orbits in the same manner. The way they do this is called the 2-8-8 Rule. The first shell, or orbit, can hold up to 2 electrons. Once those two spots are filled, we move to the second shell. This shell can hold up to 8 electrons, once an atom fills that shell, it moves onto the third shell which also holds up to 8 electrons. This process will repeat until all the electrons have a place.

Valence electrons are the electrons that fill the outer most shell. These electrons are important because they will be the ones that interact with other atoms and allows them to bond.



There are a few important aspects about the atomic structure that will determine an atom’s chemical and physical properties and how it will interact with other atoms.
As mentioned, all atoms of the same element have the exact same number of protons. This is one of the defining properties of an atom. We refer to the number of protons in the nucleus as the atomic number. This number never changes. Each proton has an atomic mass unit (or weight) of 1 amu. So 1 proton = 1 amu.

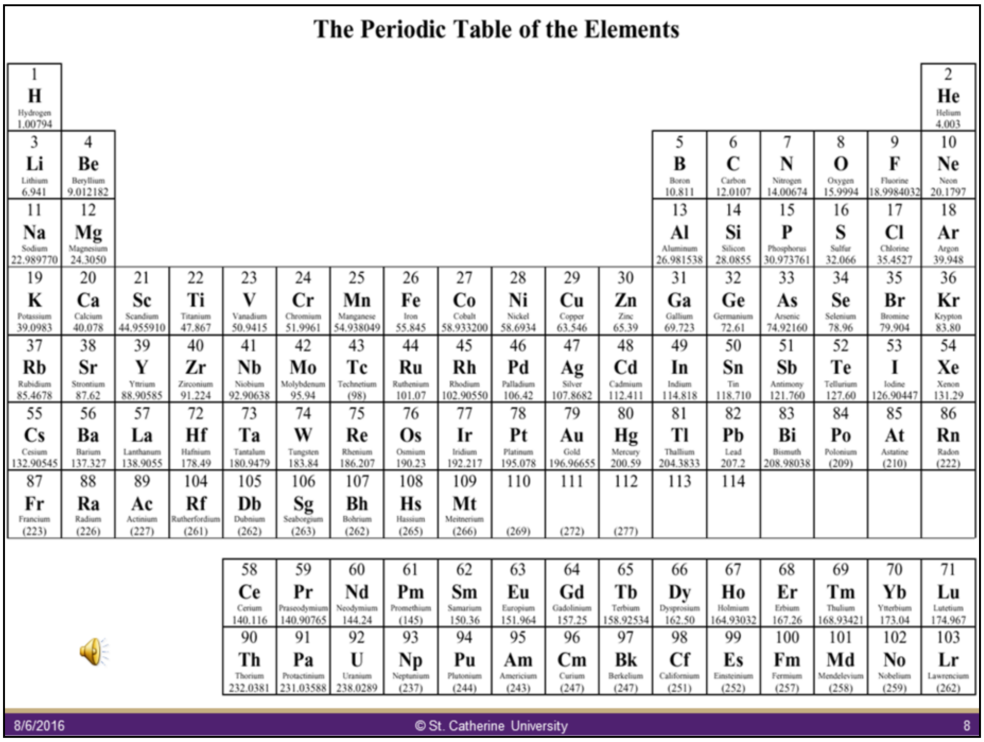
Neutrons have the same amu as a proton. We can calculate the mass of an atom by adding the number of protons and neutrons. We refer to this value as the Atomic Mass Number, or just atomic mass, of an atom. You may have noticed that electrons were not included in the atomic mass. This is because they are so small that their weight is obsolete and doesn’t contribute to the overall mass of the atom.



The atomic number and mass of an element are some of the key pieces of information we can get from the periodic table.
If we know the atomic number, we know the mass of the Protons. For example, if there are 3 protons, we know that collectively the protons weigh 3 amu. So, the atomic number tells us the number of protons and their combined weight. While the periodic table tells us the number of protons via the atomic number, it does not tell us the number of neutrons. We have to figure this out through basic algebra. We know Atomic Mass = Mass of Protons (or Atomic Number) + Mass of Neutrons. If we know the atomic mass and the atomic number, we can use it to find weight and number of neutrons. The number of neutrons can be found by subtracting the atomic number from the atomic mass. Atomic Mass – Atomic number = Number of neutrons.

If you look at the periodic table, you will see that the atomic mass is not a whole number. For example, Lithium has an atomic mass of 6.941. The reason for this is that the number of neutrons can vary slightly. Therefore, the mass is an average of the different masses of an atom found. Atoms of the same element that vary in the number of neutrons are called Isotopes. Scientists actually use isotopes for many things. They can be used in archaeology to determine the age of ancient fossils and artifacts. Forensics can look at the variation of neutrons of a particular element to determine where a person grew up or lived.

Although the number of electrons and neutrons can change, the number of protons never does. The number of protons is what identifies an atom as a certain element. If the number of protons changes, it becomes a different element with different properties.



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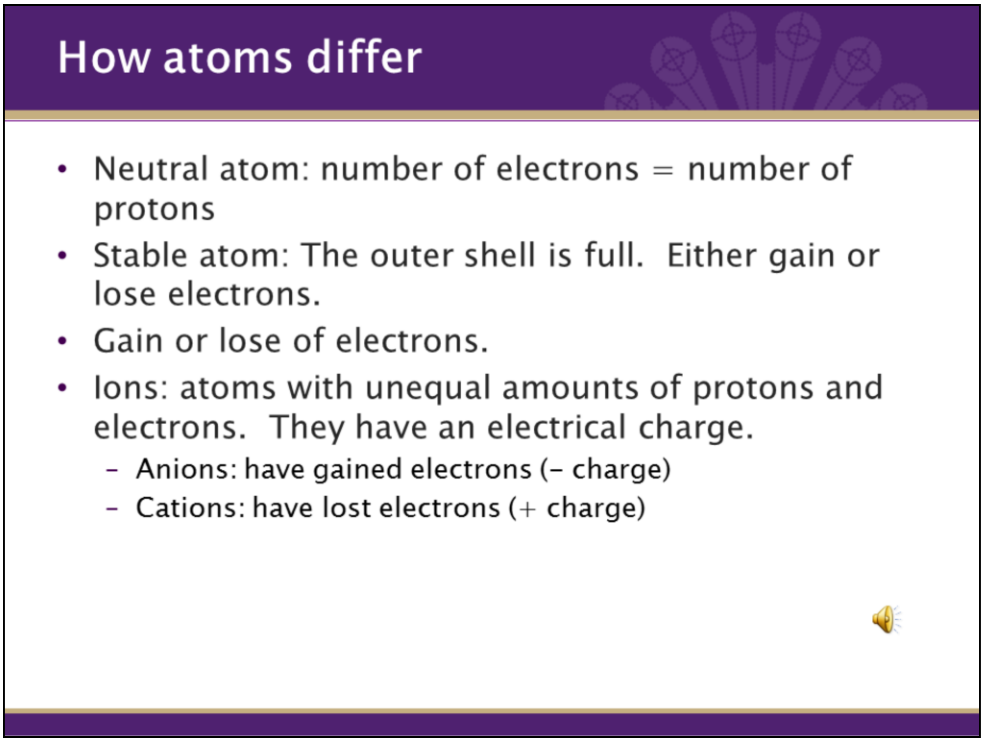
Let us return to our periodic table for another example of how to find atomic number and mass. Boron is an element towards the top right of the table and is abbreviated with “B”. On the top of the box is the number 5, this is the atomic number. On the bottom of the box is the atomic mass, 10.81.

If possible, highlight Boron while talking about it.



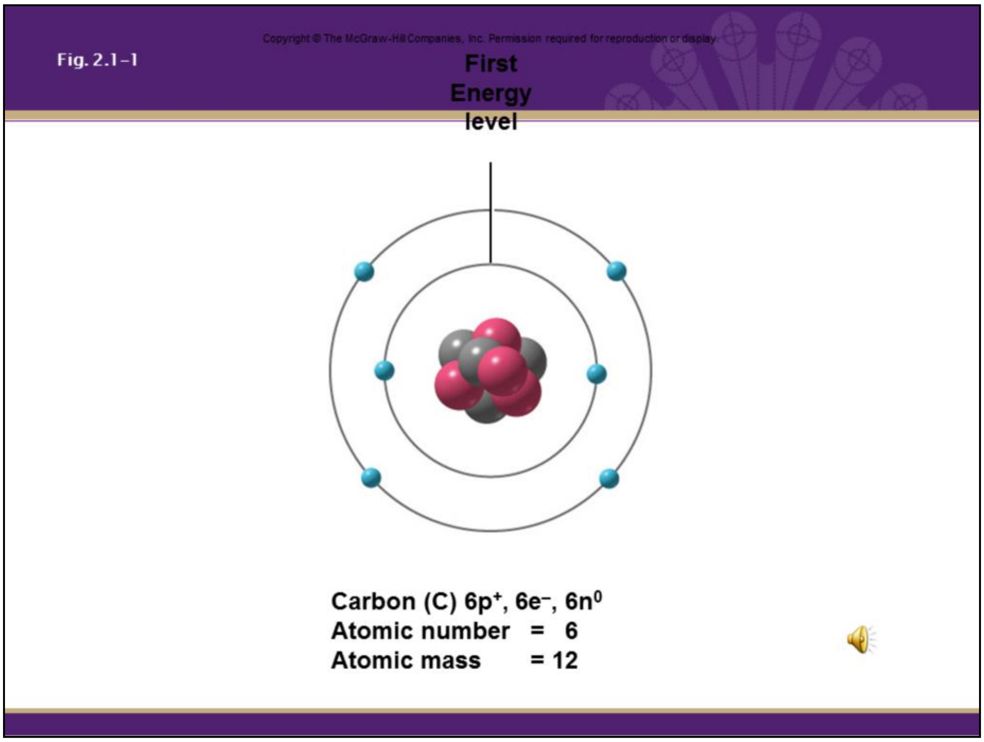
Atoms listed on the periodic table are considered neutral. Neutral atoms have the same number of electrons and protons, therefore the charges cancel each other out. This is another use for the atomic number. In a neutral atom, if we know the number of protons, we know the number of electrons. For instance, Magnesium has an atomic number of 12. So, we know that it has 12 protons. Since we are working with a neutral atom, we know that there is no charge and an equal number of protons and electrons. Therefore, we also have 12 electrons.

Stable atoms are atoms that have a full outer shell. Atoms want to be stable more than they want to be neutral. So, they will give away or take on electrons. Remember, electrons move. They move around the nucleus and it does not take them much to move from one atom to another. Atoms that have more than 4 valence electrons will take on additional electrons while those atoms with less than 4 valence electrons are more likely to give theirs away. If an atom gains or looses electrons, it will take on a either a negative or positive charge. An atom that has an unequal number of protons and electrons is called an ion. Ions have either gained or lost electrons. There are two types of ions.

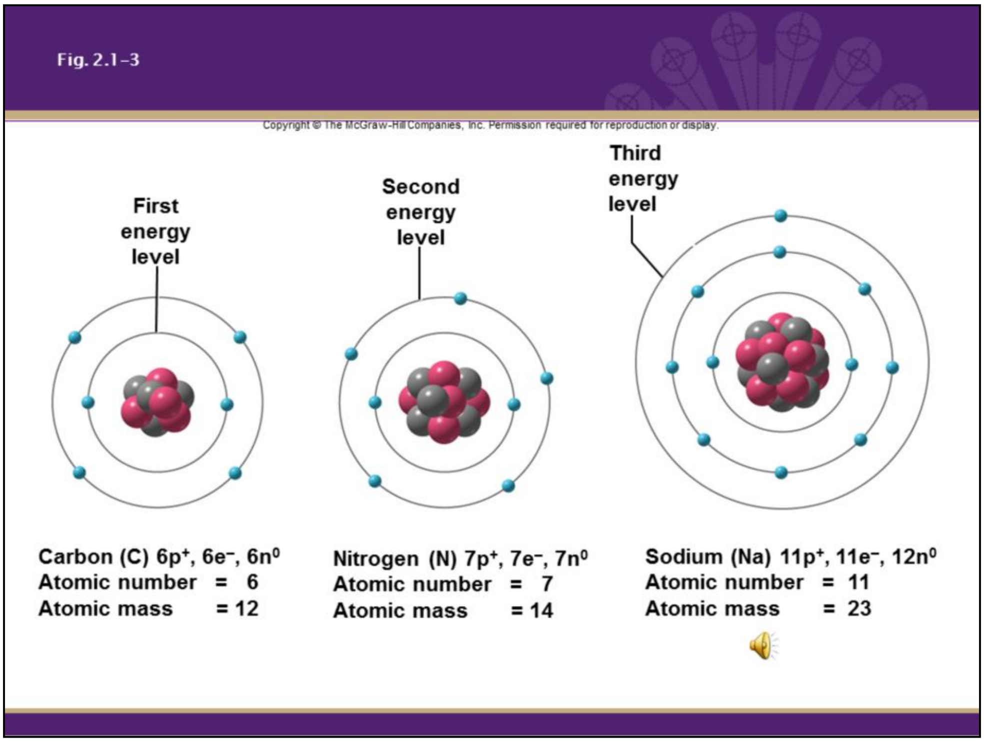
1. Anions are atoms that have GAINED electrons and have a negative charge.

2. Cations are atoms that have LOST electrons and have a positive charge. Cations can be a little confusing at first. People see that they

have a positive charge, so they think that they gain protons. But, remember that protons never move! Cations become positive because they have lost electrons or lost some of their negative charge.



Let's work through this example of an atom. This is carbon. It has an atomic number of 6 which means it has 6 protons. The atomic mass is 12. We can use this number to figure out the number of neutrons. Atomic Mass = Protons + Neutrons. We know the atomic mass (12) and we know the atomic number, or number of protons (6). To find the neutrons we subtract the number of protons or atomic number from the atomic mass (Atomic Mass – Atomic Number = Number of Neutrons). So, for this example, it would be 12-6. We have 6 neutrons. Next, let's think about the electrons. Atoms start out neutral, so in a neutral atom, the number of protons equals the number of electrons. If we have 6 protons, we have 6 electrons. If you look at the picture, you can see how the electrons start to fill the shells. The first shell only has 2 spots, so the first 2 electrons fill it. There are four remaining electrons and they go into the next shell. Since there are no more electrons, there are no more shells. The four electrons in the outer shell will be referred to as valance electrons and these will be the ones that interact with other atoms.



This picture compares the atom of Carbon to the atoms of Nitrogen and Sodium. Using the atomic number and atomic mass, can you determine the number of neutrons and electrons?

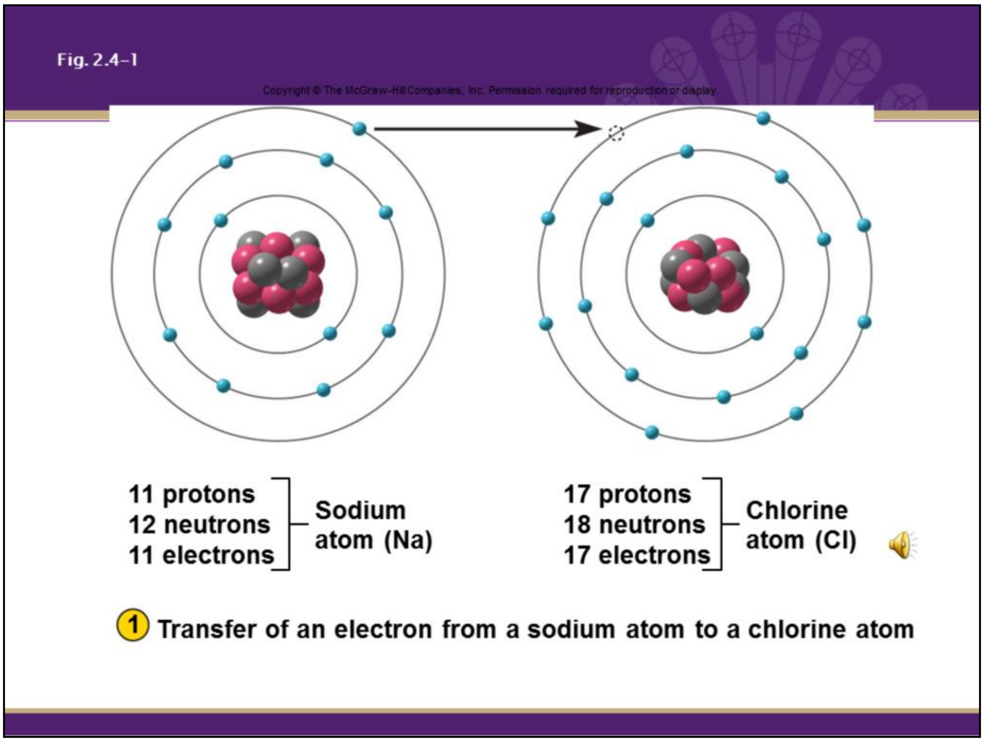
How many valance electrons are in Nitrogen and Sodium?

Work through it on the video as another example.

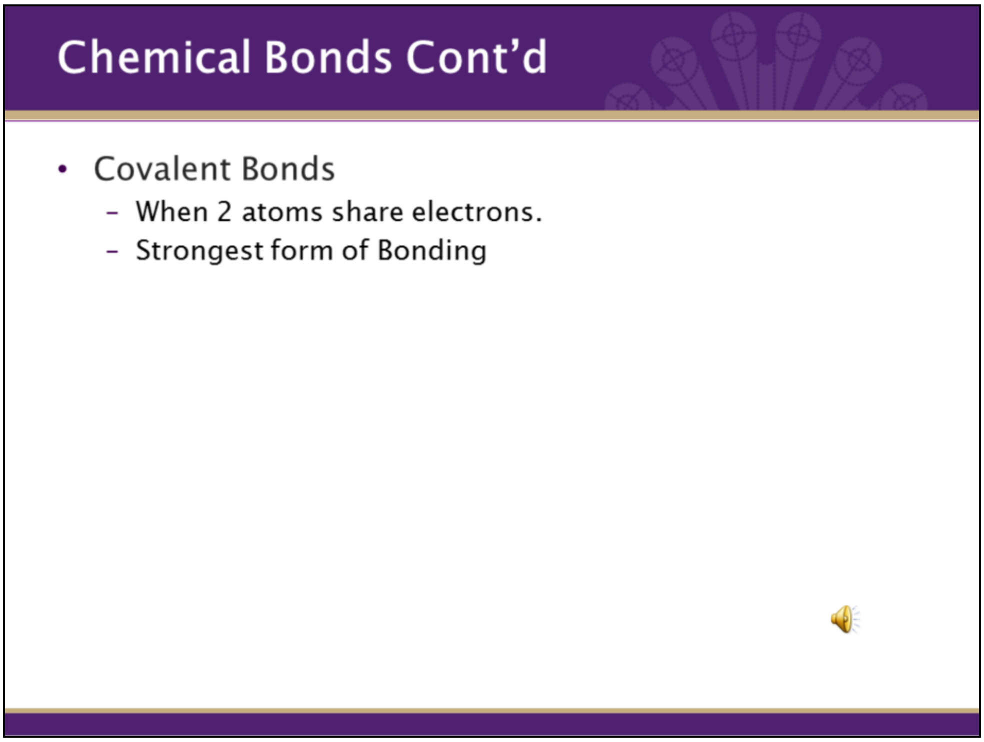
Chemical Bonds

- Chemical Bonds:
  When 2 or more atoms combine to form a molecule or a compound.
- Ionic Bond
  - Attraction between 2 ions with opposite electrical charges.
  - Transfer of electrons
  - Weak

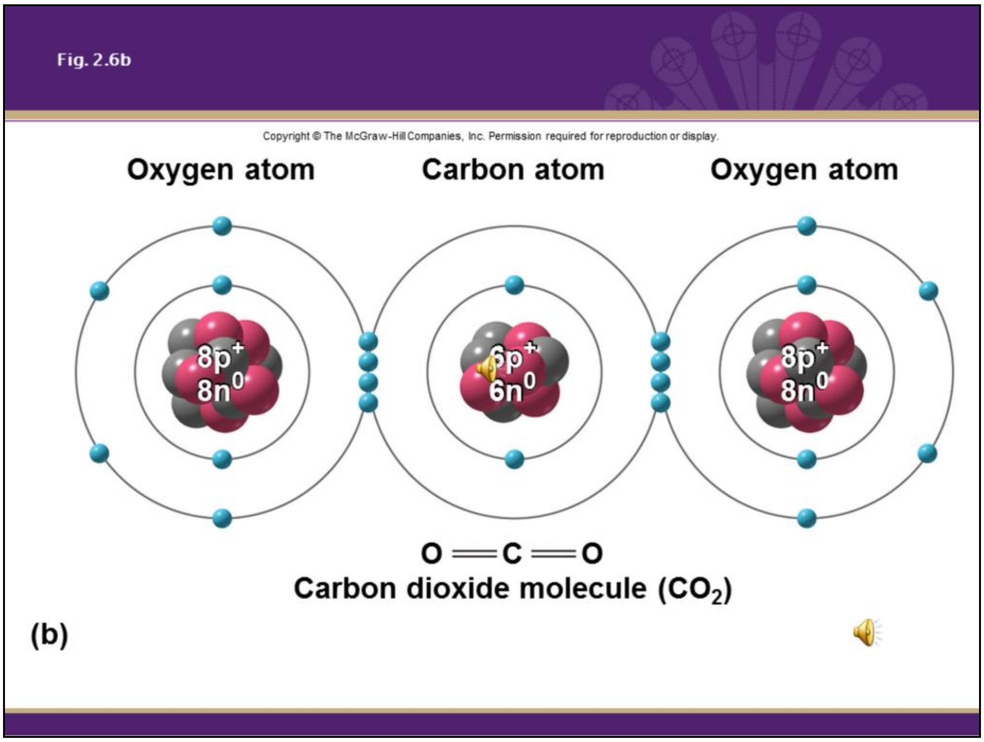
When atoms combine with other atoms is what we refer to as chemical bonding. There are three types of bonding: ionic, covalent, and hydrogen bonding.
Ionic bonding is the attraction between 2 ions with opposite electrical charges, or an attraction between a cation and anion. In this type of bond, electrons are transferred from one atom to another resulting in cations and anions, or what we call ionization. These ions are then attracted to each other in an ionic bond. Ionic bonds are weak and easily broken, especially in water. An example would be table salt or NaCl. We will walk through how salt forms ionic bonds in the next slide.



In this example, sodium has 1 valence electron in the 3rd shell. It is a lot of work to keep that one electron. On the other hand, chlorine has 7 valence electrons in its 3rd shell. Sodium would rather give its electron to chlorine than keep it. When sodium gives up that electron, that last shell is now empty and no longer needs to be there. By transferring electrons, both atoms become stable with sodium having a full 2nd shell and chlorine have a full 3rd shell. This transferring of electrons is referred to as ionization. The transferring of electrons also gives each ion a charge. When sodium gives up its electron, it becomes positively charged. When chlorine takes on an additional electron, it becomes negatively charged. The charges allow the atoms to be attracted to each other and create an ionic bond. As previously mentioned, these bonds are weak and can be easily broken. For instance, if we place our salt of bonded sodium and chlorine into water, they will break apart into their separate ions keeping their individual charges.



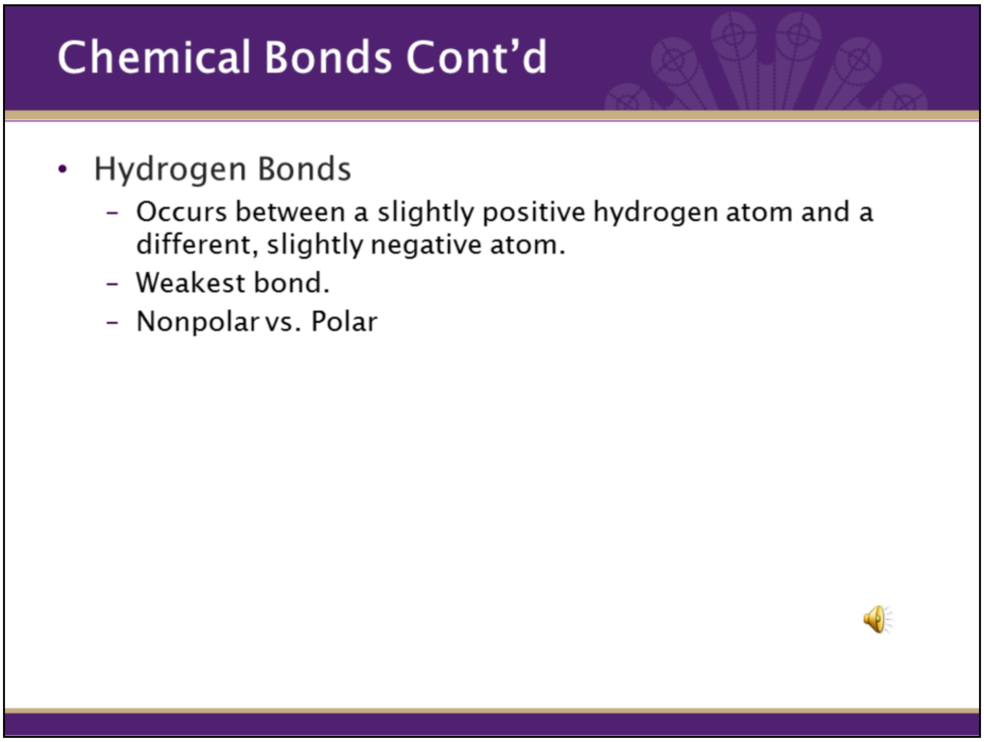
Covalent bonds are different. This is a situation when atoms share electrons. Neither atom of a bond wants to give any of its electrons up, so the two share them. This allows them to have a full outer shell without giving away any electrons. This form of bonding is strong and difficult to break apart.



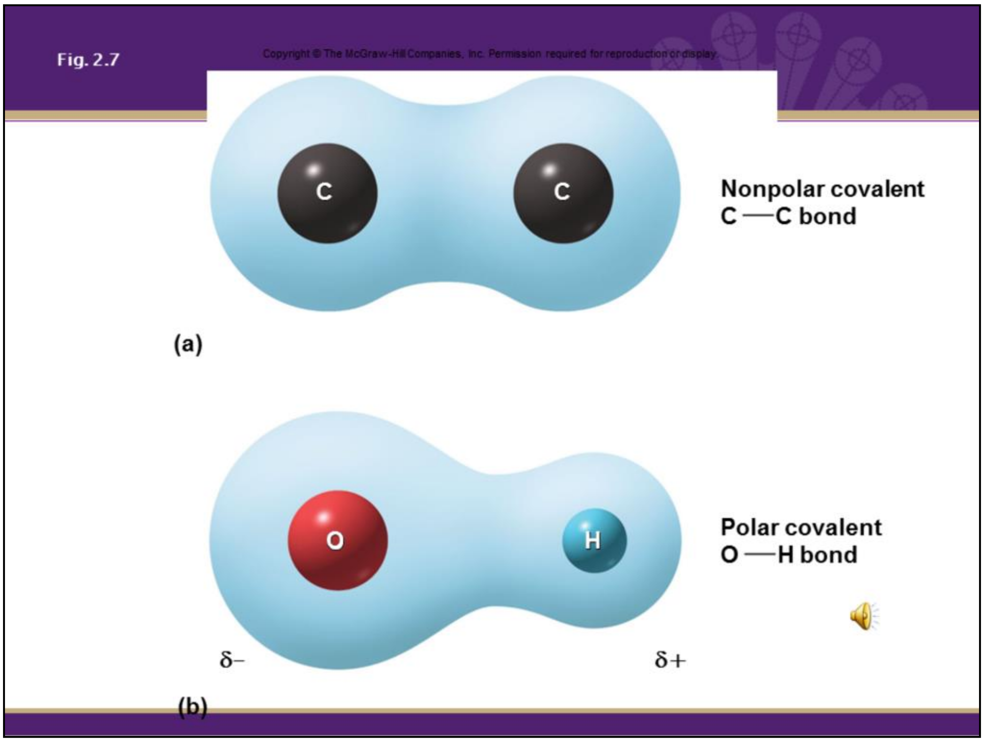
Notice in this diagram that the carbon in the middle is sharing electrons with the oxygens on its sides. Lets just look at one side of the diagram, or one oxygen, to begin with. Carbon has 4 valence electrons and oxygen has 6. Ideally, oxygen would want to just take 2 electrons from carbon and just be happy with a full outer shell. But, carbon doesn't want to give them up. In fact, it wants to find 4 more electrons. So, they come to an agreement of sorts and share the electrons. The 4 electrons that are lined up on the outer shell between the two count as valence electrons for both carbon and oxygen. This sharing allows oxygen to get a full outer shell, but carbon still needs more, so it forms another relationship with an additional oxygen.

In the example above, carbon and oxygen form a double bond. That is they are sharing electrons twice, or a double amount. Each atom is contributing 2 electrons to the bonding relationships. Covalent bonds can occur in a singular form, where atoms only contribute 1 electron, or as a triple bond, when each atom contributes 3 electrons.

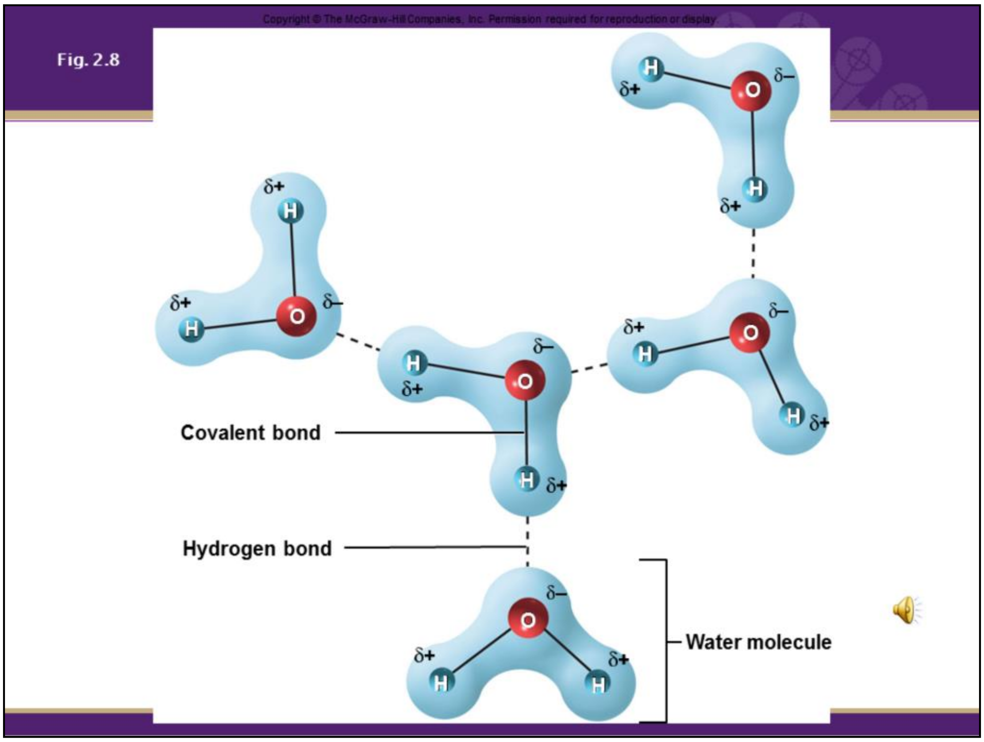
Covalent bonds allow the atoms to become stable without having to lose electrons.



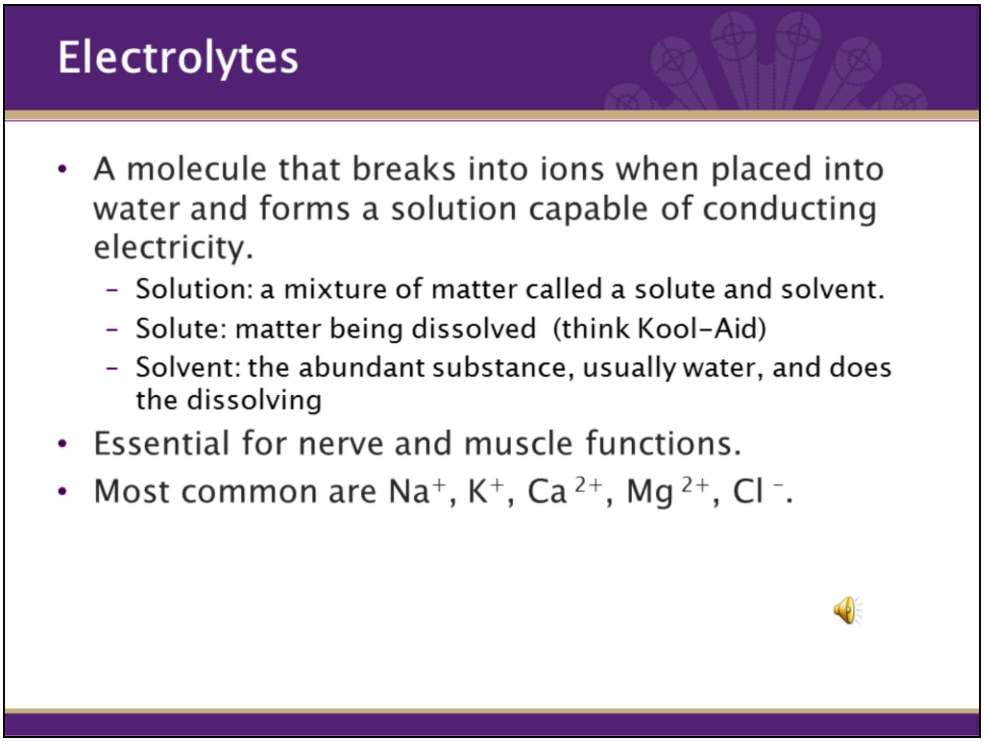
The last type of bond we are going to talk about is a Hydrogen Bond. Hydrogen bonds are very weak and are easily broken. They occur between a slightly positive hydrogen in one molecule and a slightly negative atom of another. In some molecules, electrons spend more time with one atom and this creates a positive side and a negative side. The molecule becomes a magnet of sorts, with a positive side and a negative side. These molecules are called polar. Molecules who share their electrons equally are neutral and called nonpolar. Hydrogen bonds occur between polar molecules. For example, the oxygen atom of one water molecule is attracted to a hydrogen atom of another water molecule.



Here is an example of nonpolar and polar bonds. In the top molecule, the electrons are evenly orbiting the two carbons, therefore the molecule is neutral. In the bottom molecule, the electrons spend more time around the oxygen. This makes the molecule more negative around the oxygen and positive around the hydrogen.



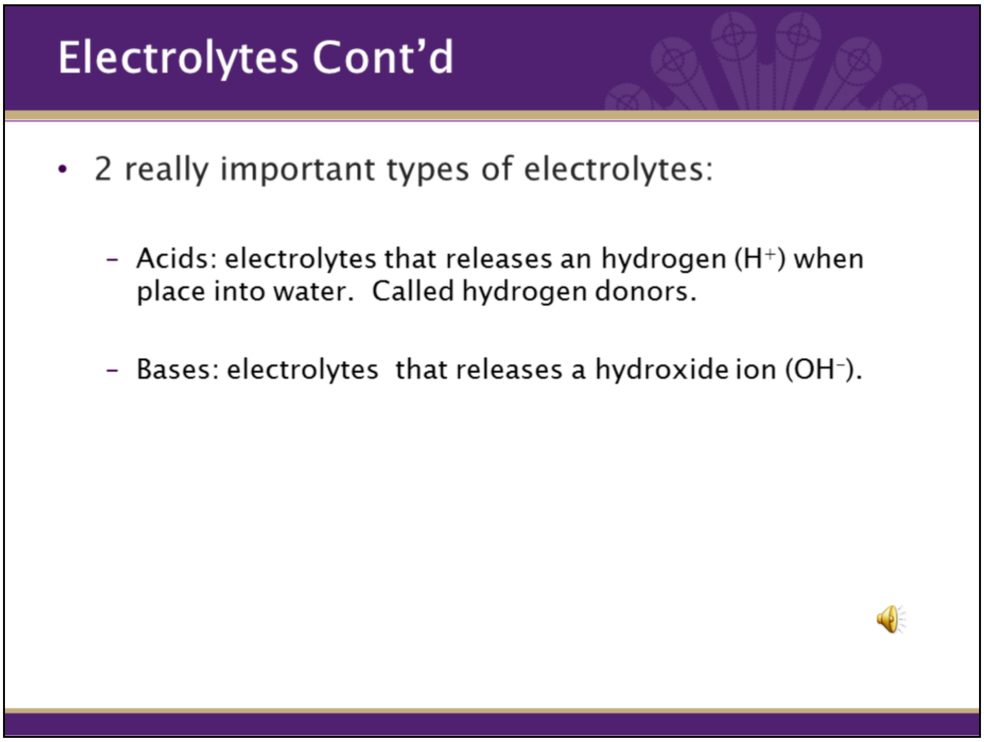
In this picture, we see a number of water molecules. The dashed lines represent the hydrogen bond. The hydrogen of one molecule is attracted to the oxygen of another molecule because of the polar nature of the individual molecules.



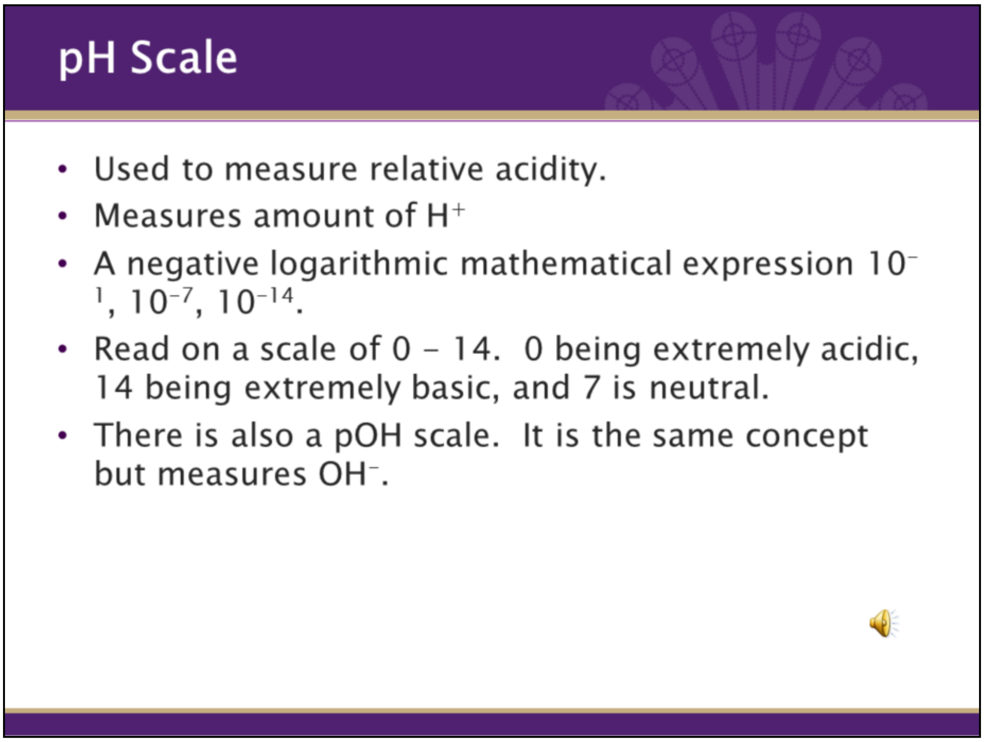
Another important molecule to consider is an electrolyte. An electrolyte is a molecule that breaks up into individual ions when placed into water and form solutions capable of conducting electricity.

A solution is a mixture of matter. There are two parts: a solute and a solvent. A solute is the matter being dissolved. A solvent is a type of matter, usually water, doing the dissolving, it is the abundant substance. Think about making kool-aide. The packet of kool-aide would be the solute. The solvent would be the water. Together, when the kool-aid is dissolved into the water it is called a solution.

Electrolytes are essential for nerve and muscle functions. The most common ions are sodium, potassium, calcium, magnesium, chlorine ions.

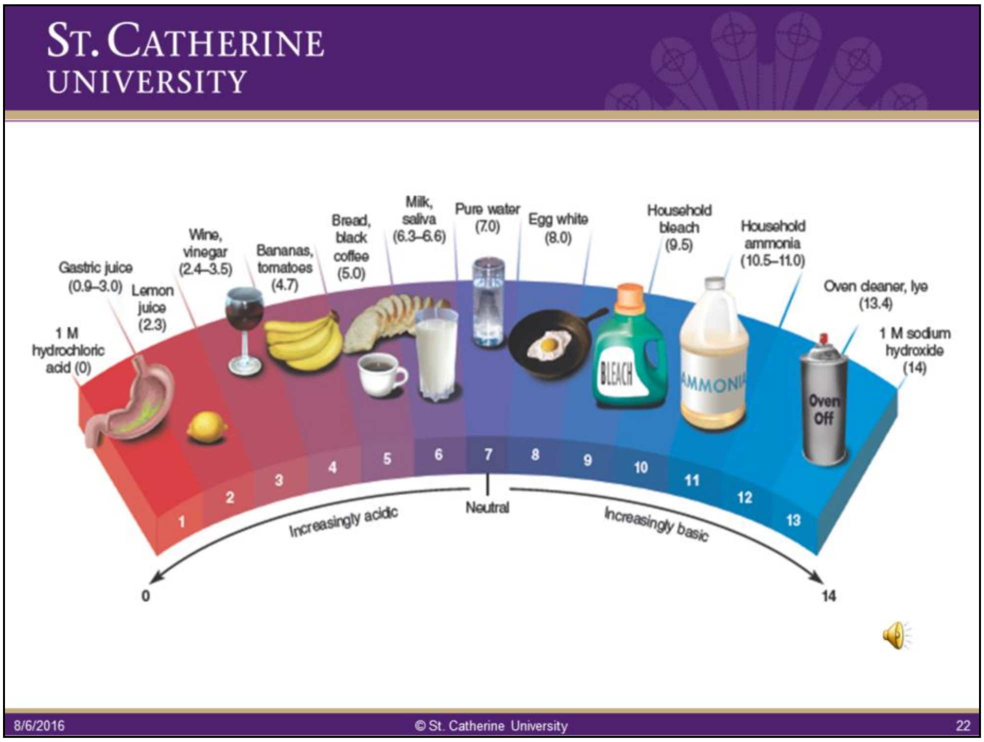


There are 2 really, really important types of electrolytes called acids and bases. Acids are electrolytes that release hydrogen when placed into water. They are called "Hydrogen Donors" since they add hydrogens. An example is HCl, hydrochloric acid. When placed into water, HCl will break into H+ and Cl- ions. Bases are electrolytes that release hydroxide (OH) groups when placed in water. An example is potassium hydroxide.

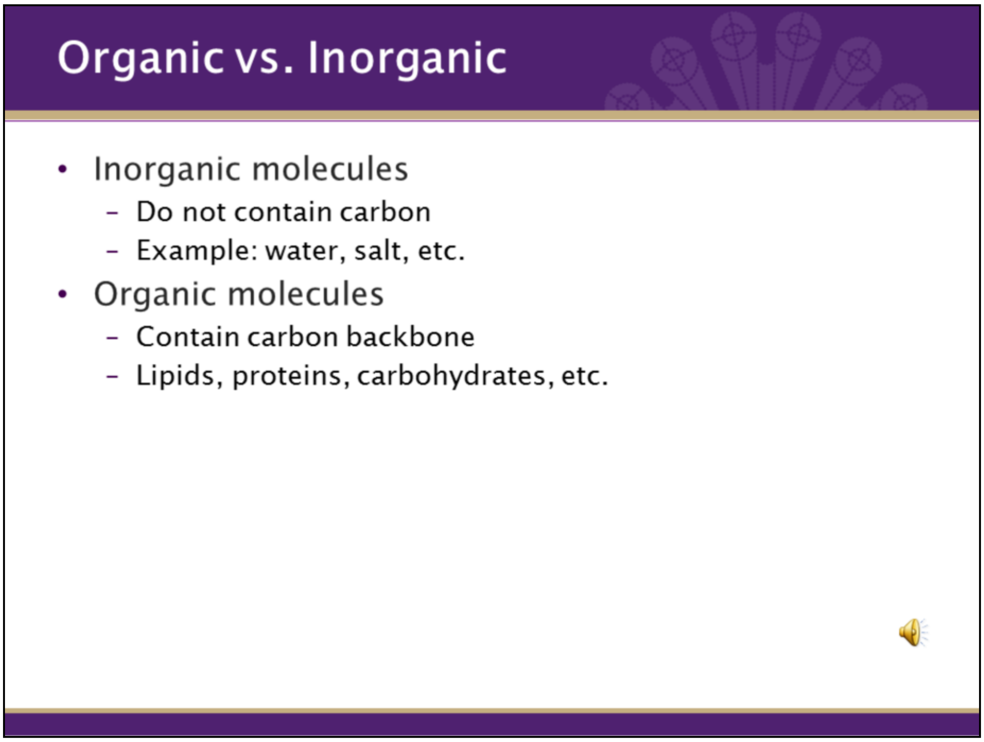


A pH scale is used to measure relative acidity or alkalinity (basic) of a substance. The scale measures the amount of H in negative logarithmic mathematical equation. The values of the scale are the exponents from the logarithm. The scale goes from 0 to 14. 0 is very acidic, lots of H ions have been donated. 14 is very basic, or little H ions have been contributed to the solution. 7 is neutral. Water and blood are examples of neutral substances.

There is also an pOH scale, it is the inverse of pH and measures the amount OH that is contributed to the solution. But, pH is more commonly used.



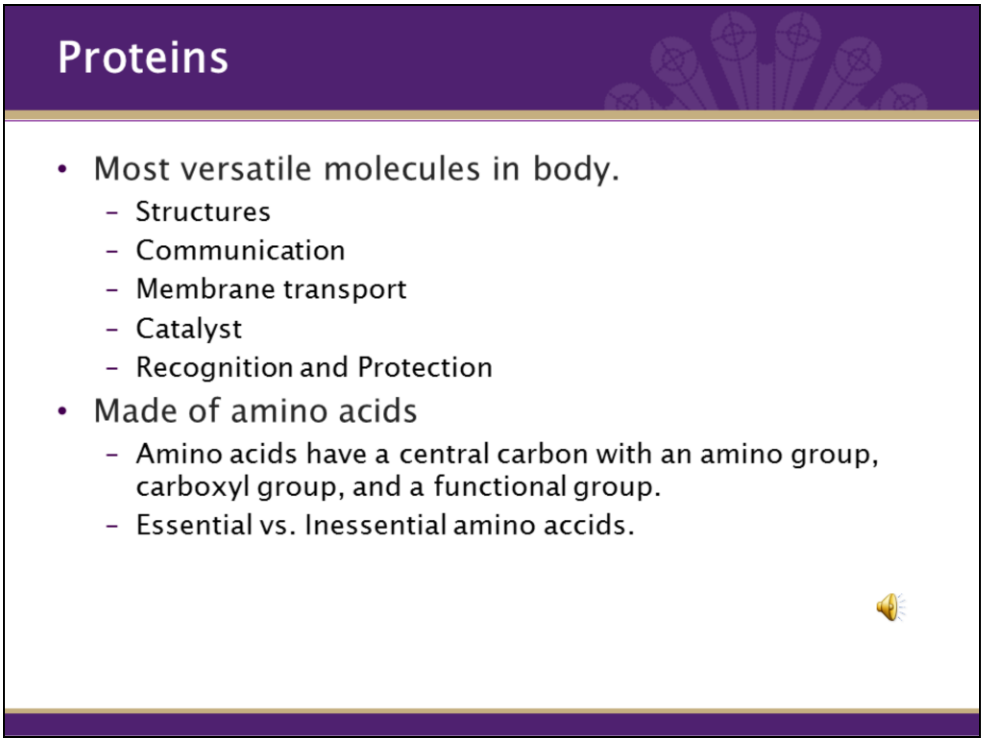
In this slide we can see every day things that span the wide range of the pH scale. Acids will be from 1-6 on the pH scale and bases will be from 8-14 on the scale.



The molecules in the body can be broken into inorganic and organic molecules.

Inorganic molecules do not contain carbon. Organic molecules have a carbon backbone to the molecules, meaning that one or more carbon atoms are central to the formation of the that molecule.

We are going to focus on the key organic molecules, our proteins, carbohydrates, lipids, nucleic acids, and ATP.



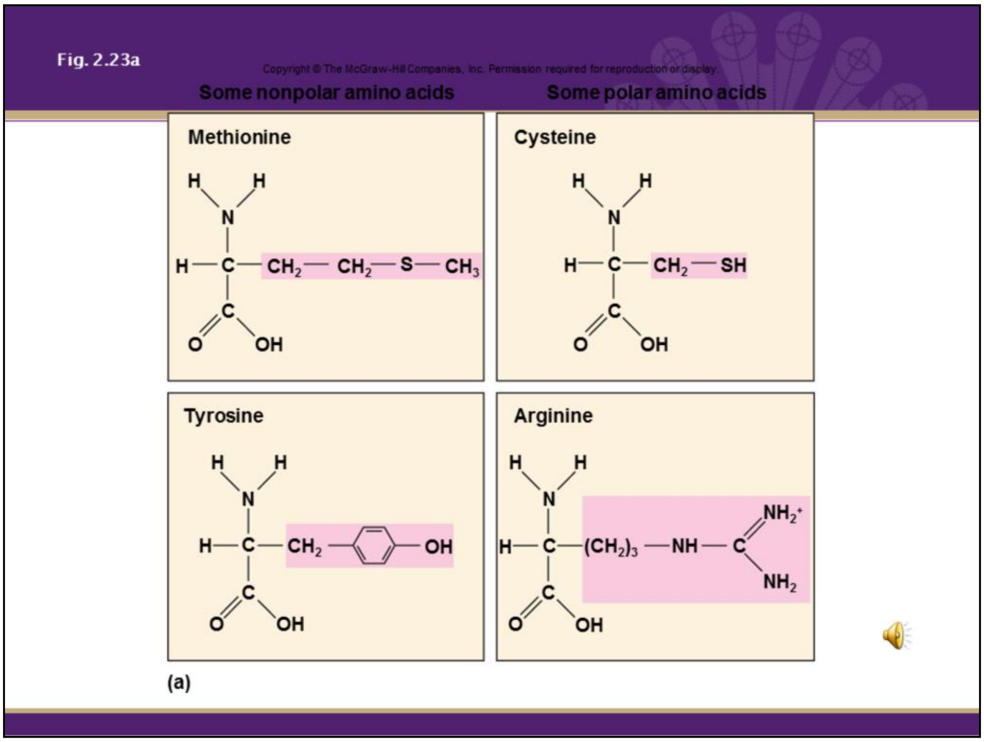
Proteins are some of the most versatile molecules in body. Their functions are as follows:

1. They form structures such as hair and skin.
2. They are vital for communication between cells and through hormones.
3. They are used in membrane transport.
4. They are needed for metabolic pathways as catalysts.
5. The immune system uses them for recognition of foreign cells and to protect us.
6. They are used in the contractile units of muscles.

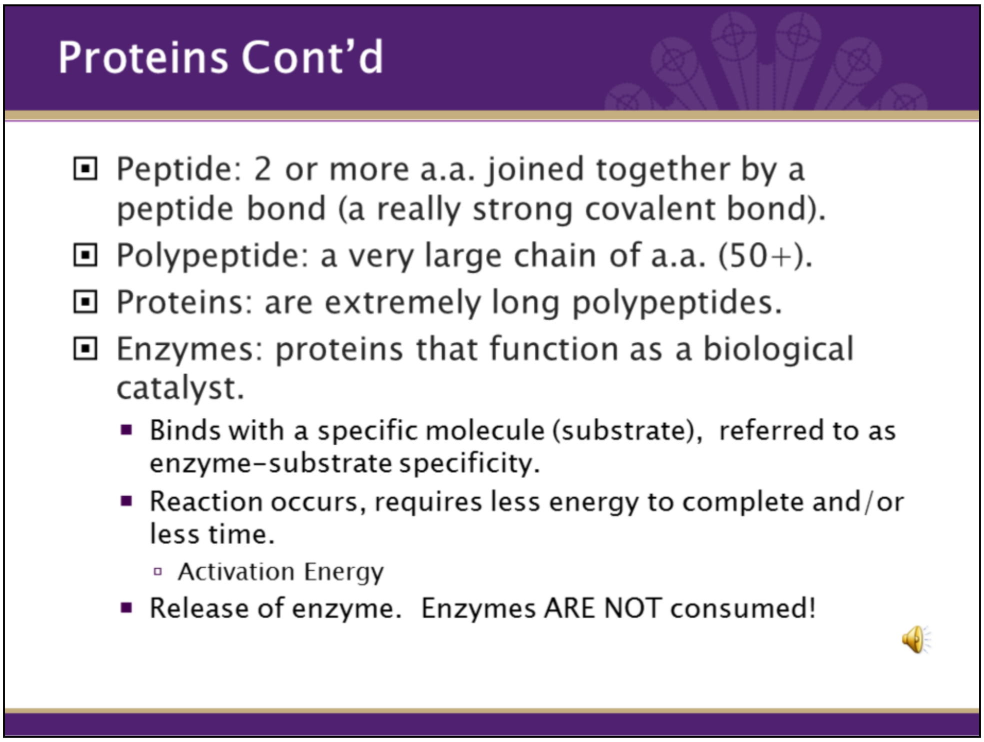
Proteins are made of amino acids. Amino acids have a central carbon, an amino group, a carboxyl group, and a functional group.

There are 20 different amino acids, the functional group is what makes them different from one another.

Amino acids are broken into two categories, essential and inessential. Essential amino acids can't be made by the body, we need to get them through our diet. Inessential amino acids can be made by the body.

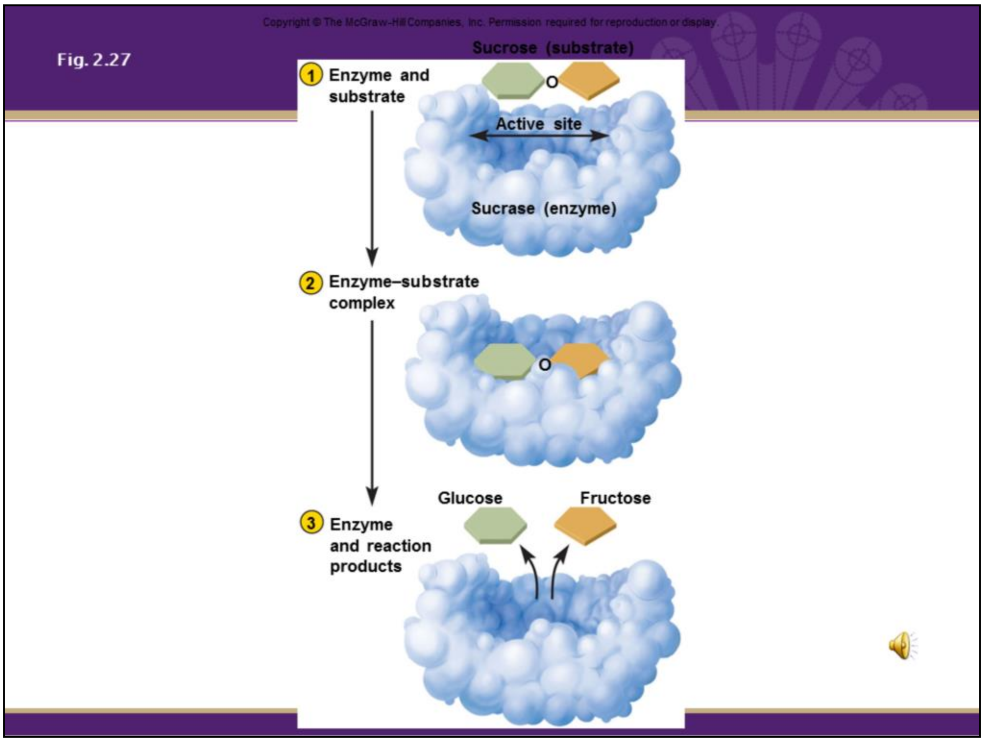


Here are four examples of amino acids. The portion highlighted in purple is the function group and what distinguishes each type of amino acid.

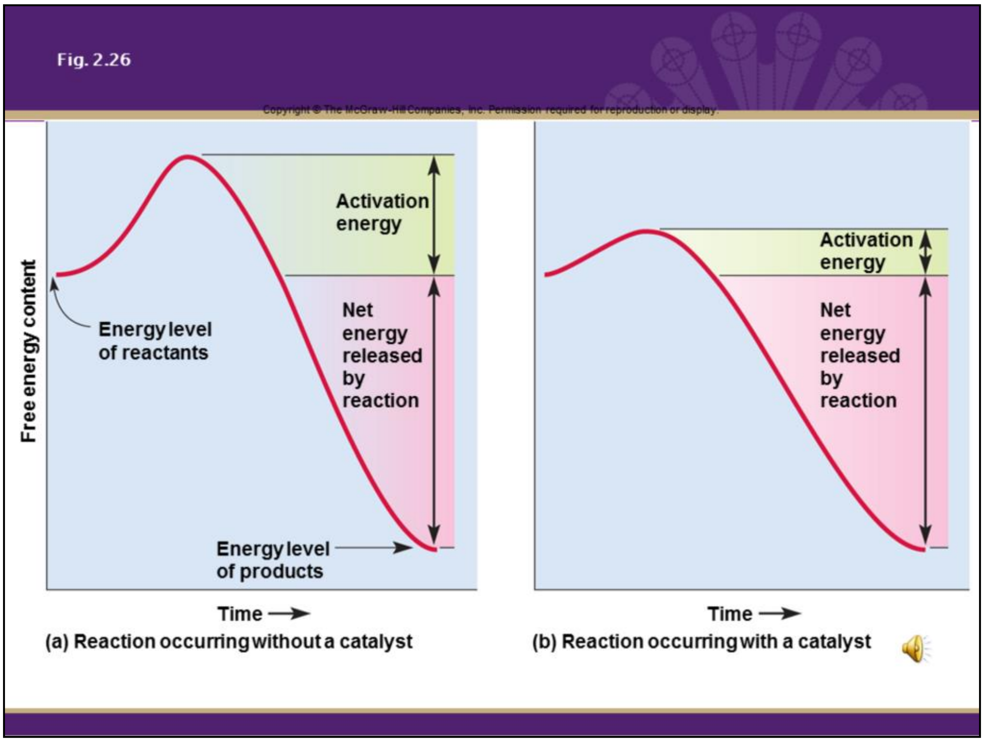


Proteins are made by joining amino acids together. The bond that holds amino acids together is called a peptide bond, it is covalent and very strong.
A Peptide is 2 or more a.a. joined together. A polypeptide is a very large chain of amino acids (50+), or a protein.

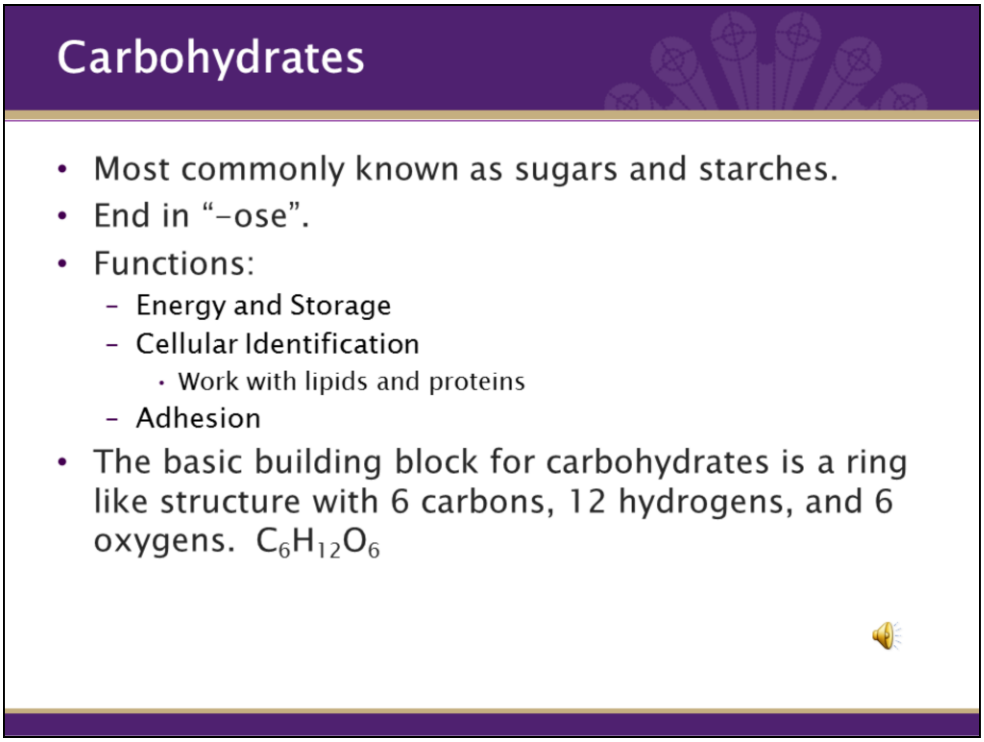
A specific type of protein is an enzyme. An enzyme is a proteins that function as a biological catalyst.
A catalyst allows a reaction to occur at a faster rate and with less energy.
The enzyme binds with a substrate (molecule). This binding is very specific. Each enzyme binds with one particular type of substrate. It is similar to a lock and key. One key opens one lock. It is the same with the enzyme. This is called enzyme-substrate specificity.
As mentioned, enzymes allow reactions to occur with less energy and time to complete. They do this by lowering the activation energy of reaction. Activation Energy is the amount of energy required for a reaction to occur. Once the reaction has been completed, the enzymes are released. This an important trait of enzymes. They are not consumed during the reaction, they are recycled. Also, enzymes are not changed during the reaction.



This picture demonstrates the enzyme-substrate complex.



The diagram on the left hand side shows the energy levels of a reaction without an enzyme. The right hand side shows the energy levels of the same reaction, but with the enzyme. Notice that the activation energy is dramatically lower with the enzyme. Consider your car, it takes a certain amount of energy to start it. But, if it is cold or an old starter, it takes more effort and energy for the car to start. The enzyme would act as a new starter in your car. The new starter requires less energy to get the job done.

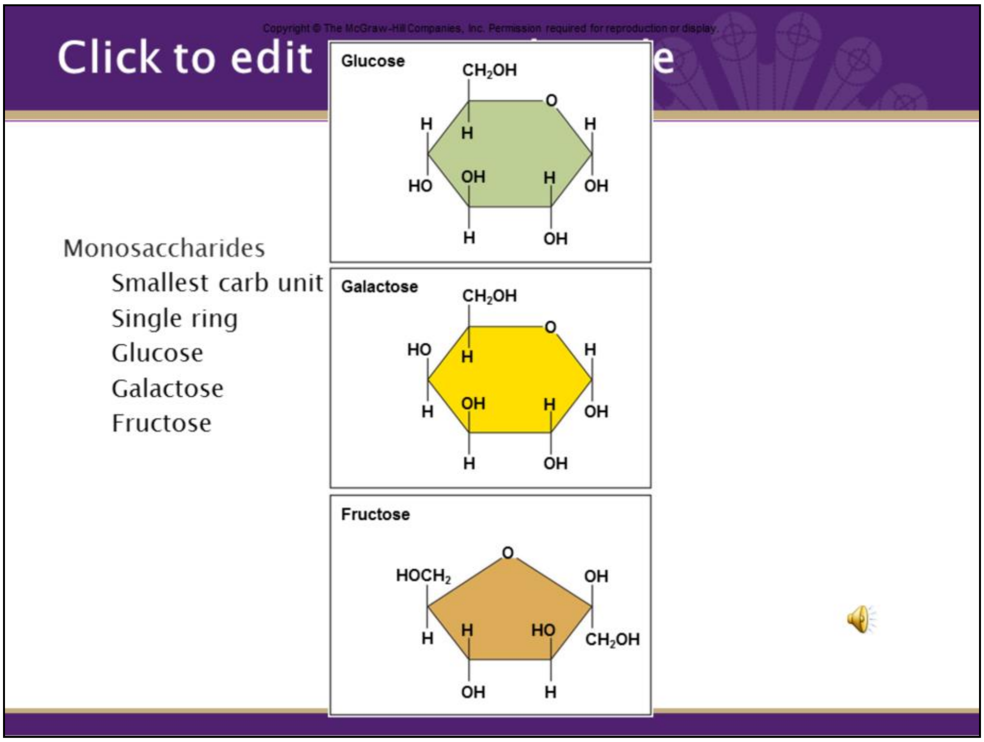


Carbohydrates are another organic molecule. They are most commonly known as sugars and starches. You can always recognize the name of a carbohydrate because it ends in –ose.

The functions of carbohydrates are as follows:

1. They are used for energy and storage. This is the key function of carbohydrates.
2. They are also used in cellular identification. They also work with lipids and proteins to do this.
3. They help to form components in other molecules such as DNA.
4. They also aid in cell adhesion, they hold cells and tissues together and trap particles in mucous.

The basic structure of carbohydrates is a ring made of 6 carbons, 12 hydrogens, and 6 oxygens. So, the basic chemical formula is C6H12O6 or 6 carbons, 12 hydrogens, and 6 oxygens. The arrangement of atoms may vary slightly, creating different variants. They may also be strung together to form larger variants.



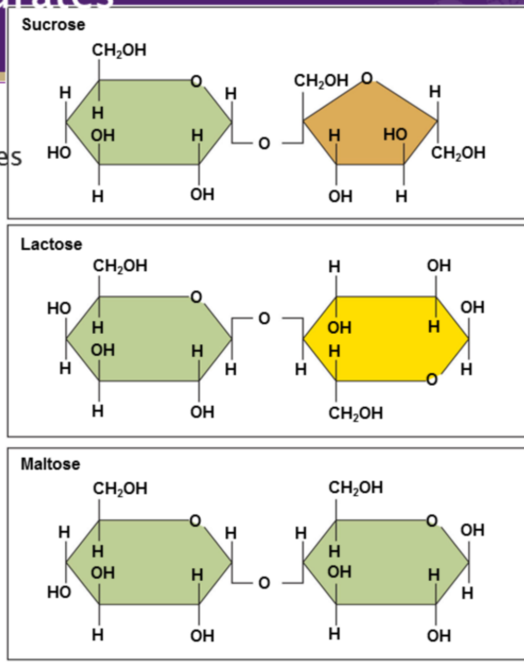
Monosaccharides are a single ring and the simplest form of a carbohydrate. Three of the most common monosaccharides are glucose, galactose, and fructose. Glucose is the most important for humans. This is the form that our body uses most commonly for energy. Galactose is similar to glucose, it varies only in the location of one OH group. Although it is similar to glucose, it is not easily used by our bodies but can be easily converted to glucose. As a sugar, it is less sweet than glucose and is used in dairy products and needed to make lactose. It is also found in sugar beets and naturally occurring gums.
Fructose is the third type of monosaccharide. It is the sugar found in fruit and honey. It is the sweetest of all sugars.

Carbhydrates Cont'd

Disaccharides

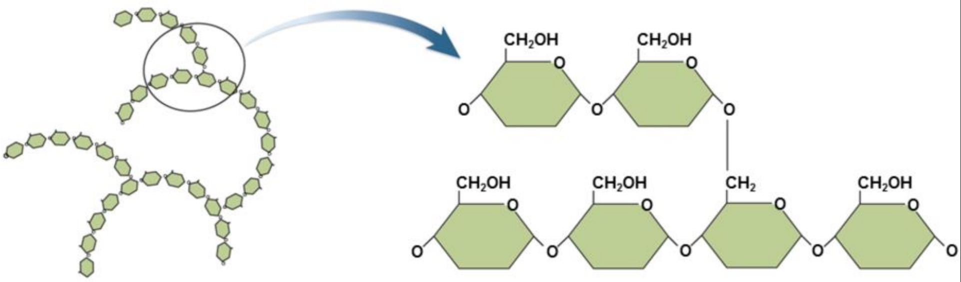
2 carb units

Sucrose
Lactose
Maltose



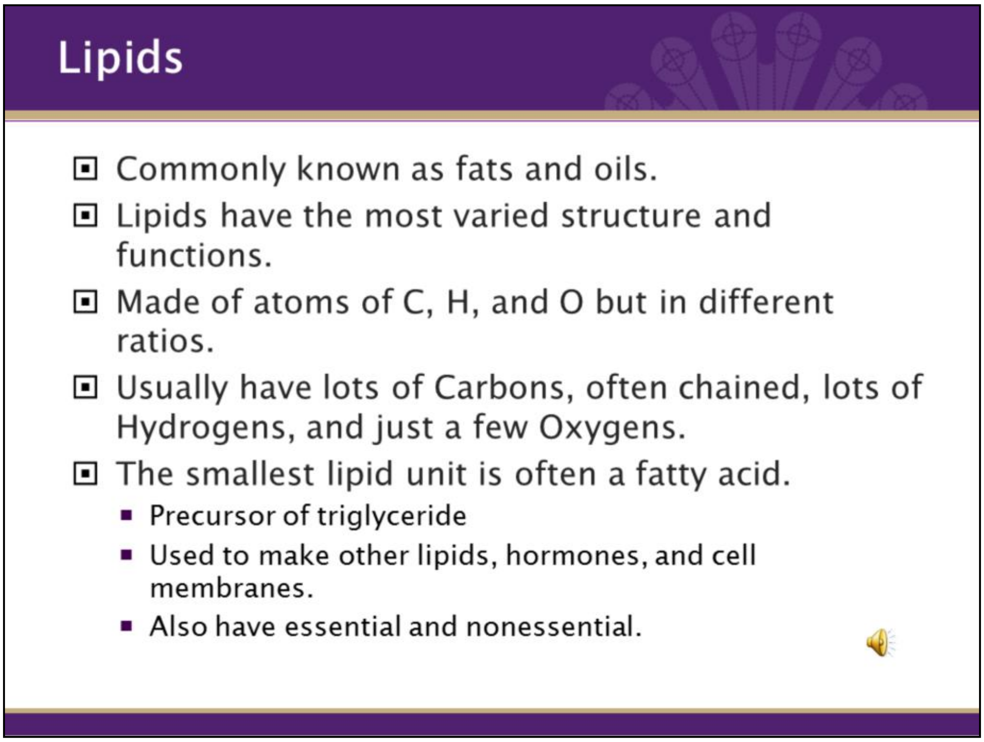
Disaccharides are made up of 2 carbohydrate units, or monosaccharides. Three examples of disaccharides are sucrose, lactose, and maltose. Sucrose is cane sugar, lactose is milk sugar, and maltose is malt sugar (comes from different grains).

Carbohydrates Cont'd



Polysaccharides
- Chains of many sugars
- Cellulose
- Starch
- Glycogen

Polysaccharides have multiple carbohydrate units and are long chains. Cellulose is only found in plants and it is a structural sugar. We can ingest (or eat) cellulose, but our bodies cannot digest it or break it down. Starch is how plants store energy. This is a plant polysaccharide that we can both ingest and digest. Animals, and humans, store our glucose as a polysaccharide called Glycogen. After our body has used all the glucose it needs, it stores the remainder as glycogen in the muscles and liver.



Lipids are commonly known as fats and oils. They do not have a specific formula or subunit like proteins and carbohydrates. Their structure varies greatly based on they type. They are made of atoms of C, H, O, but in different ratios. There are usually a lot of carbons (often chained), many H, and some O.

There is also a wide variety of functions associated with lipids. They are an energy source, provide insulation for organs, are essential in cellular structure and are need for communication within the body.

The smallest lipid unit is often a fatty acid. A fatty acid is a precursor of triglycerides, are a source of energy, used to make other lipids and hormones, and are also used to build cell membranes. There are two types of fatty acid, unsaturated and saturated. In unsaturated some carbons are joined by covalent double bonds. Therefore, they don’t carry as many H as possible. They are also easier to digest. Saturated have only single bonds between the carbons and as many H as the molecule can carry. They are harder to digest because they are more stable due to the way the liver repackages them.
There are also essential and nonessential fatty acids. Similar to amino acids, essential fatty acids must be obtained through diet, body cannot make.

Lipids Cont'd

- Triglycerides
  - Molecules consisting of 3 fatty acids bonded to a 3-carbon alcohol (glycerol).
  - Saturated vs. Unsaturated
  - Primarily used as energy storage.
- Steroids
  - Consists of various carbon rings.
  - Has 17 carbons.
  - Often hormones or chemical messengers.
  - Cholesterol is a steroid and is a precursor to all other steroids (cortisol, estrogens, testosterone) and is also used in cell membranes.
- Phospholipids
  - Type of lipid used in cell membranes

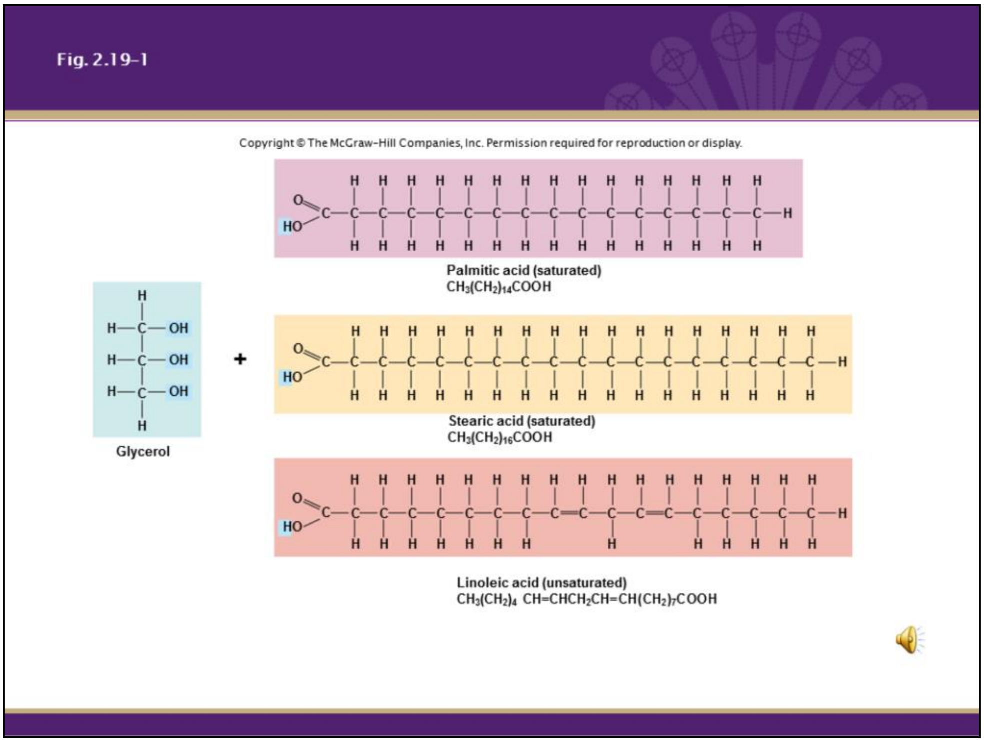
  (more of this later)

There are a few more examples of lipids that need to be covered.

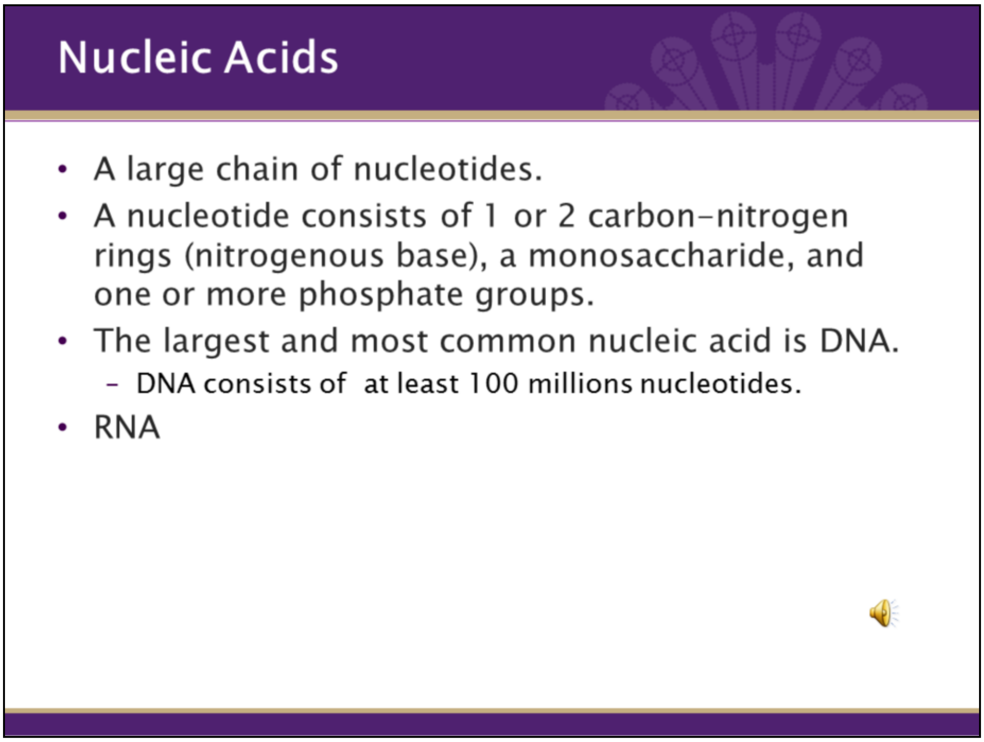
Triglycerides are molecules consisting of 3 fatty acids bonded to a molecule of glycerol (a type of alcohol). Triglycerides from animal fats are usually saturated and solid at room temperature. Plant fats are usually unsaturated. They are liquid at room temperature and called oils.

Next are steroids. Steroids consist of various carbon rings that contain a total of 17 carbons. The most well known steroid is Cholesterol.
Cholesterol is the precursor to all other steroids and is also used to make cell membranes.
We often hear about LDL and HDL when we have our cholesterol checked.
LDL refers to low-density lipoprotein, which is bad because it takes cholesterol to tissues where it can be stored and/or block arteries.
HDL, or high-density lipoprotein, is extracted and sent to the liver. There it is used to make bile. HDL is considered better because it allows cholesterol to be extracted and processed, not stored. Steroids can also be hormones. We'll talk about hormones later in the semester.

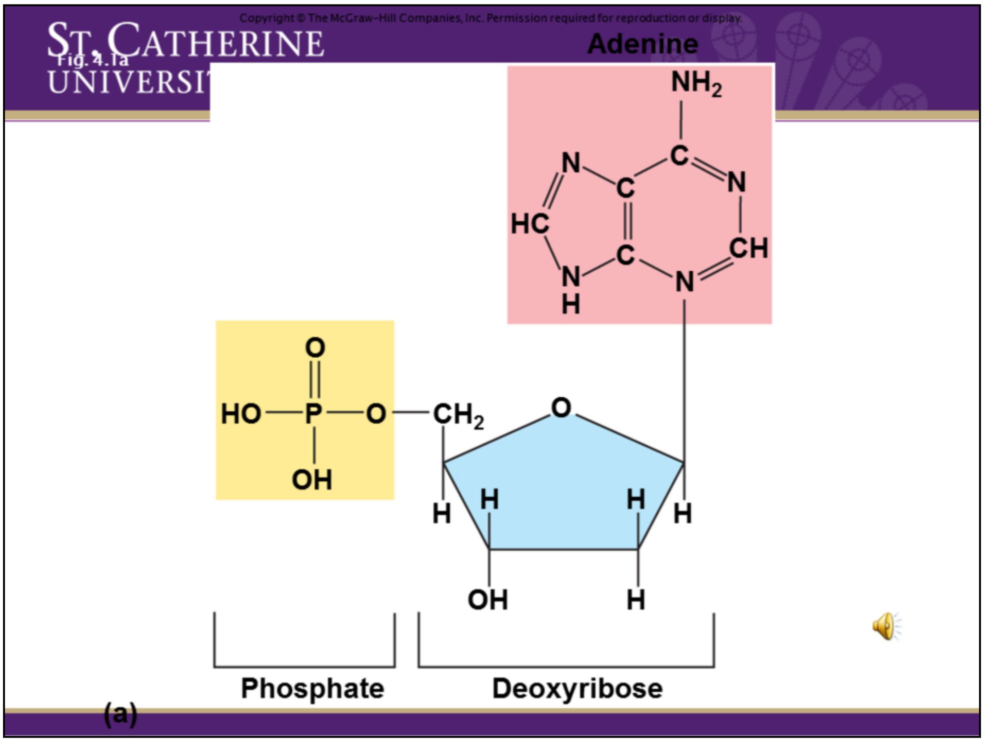
Phospholipids are a type of lipid used in cell membrane. We'll talk about phospholipids more in cytology.



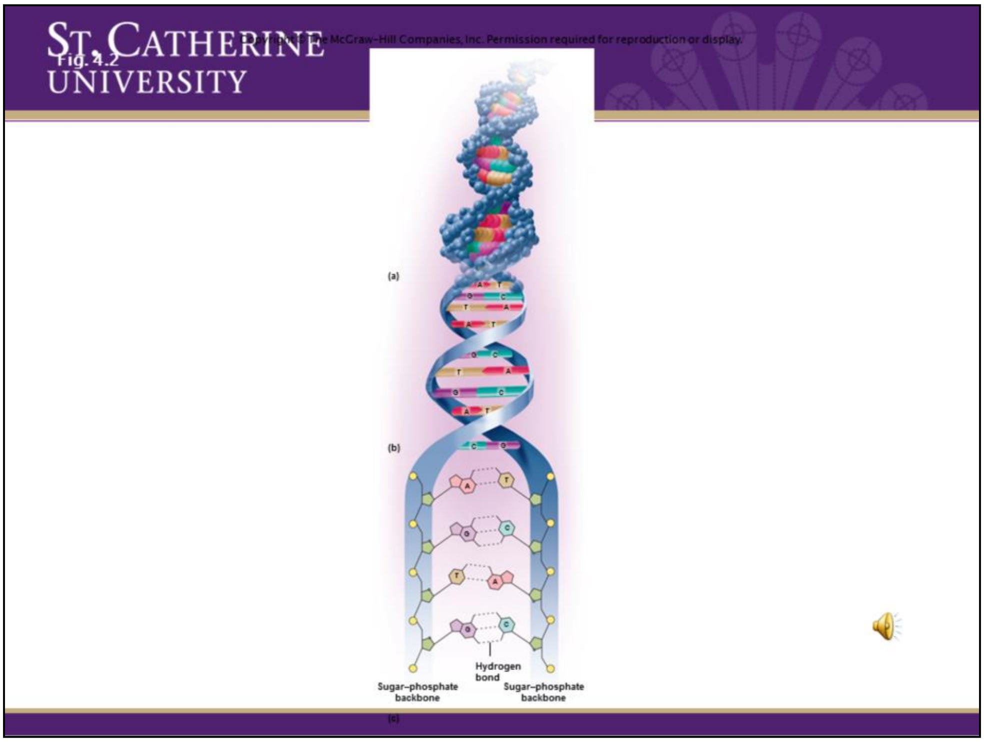
Here is picture of a triglyceride. The molecule in blue is the glycerol and the other three molecules are different fatty acid. They connect to the glycerol like tails.



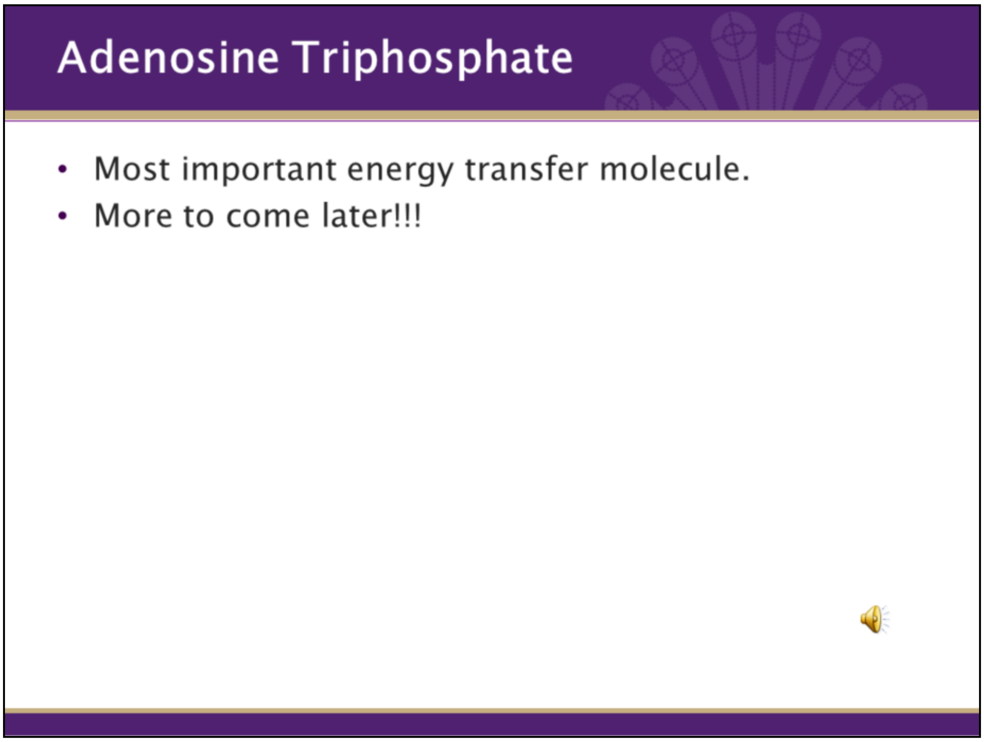
Nucleic acids are large chains of nucleotides.
A nucleotide consists of 1 or 2 carbon-nitrogen rings (nitrogenous bases), a monosaccharide, and one or more phosphate groups.
DNA is the largest example of a nucleic acid. It is 100 million nucleotides long and has double helix formation. DNA codes for everything in the body, it is the blueprints for our body. RNA, or ribonucleic acid, is another example of a nucleic acid. They are molecules that help carry out the instructions in DNA.



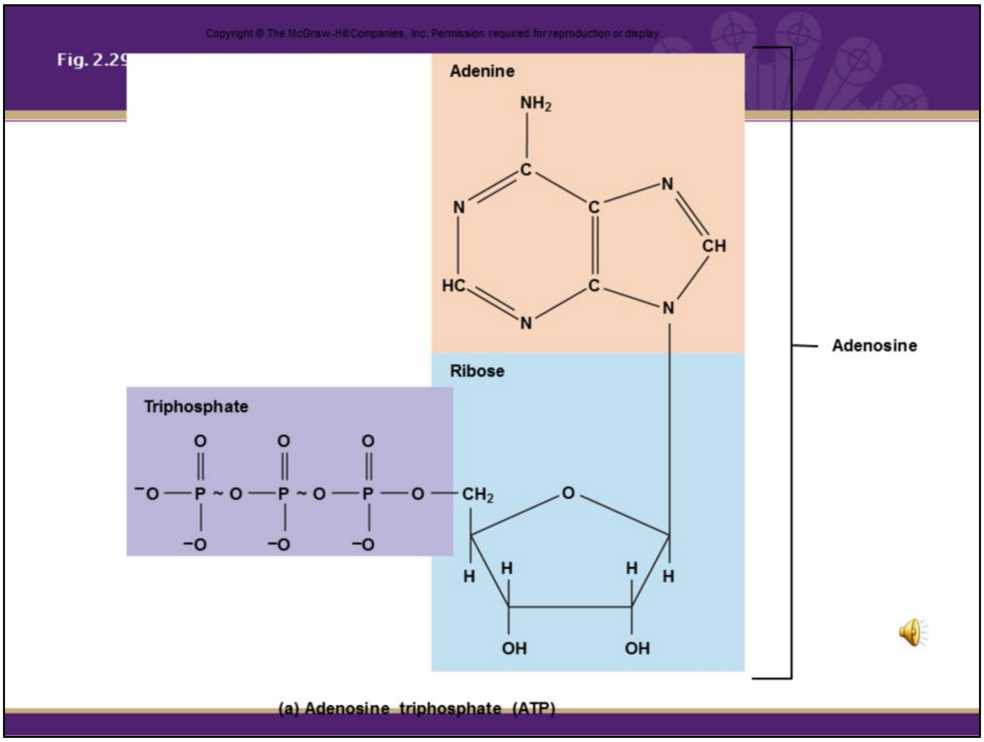
This is a picture of a nucleotide. In this example, adenine is the nitrogenous base and deoxyribose is the sugar and there is also a phosphate group.



DNA is an example of a nucleic acid.



The final organic compound I wish to mention is ATP . ATP stands for adenosine triphosphate. ATP is the most important energy transfer molecule. We will come back to this in muscles.



Here is a picture of ATP. In some ways it looks very similar to the nucleotide we just saw in a previous slide. But notice, there is a string of 3 phosphate groups strung together. This string of phosphates is what will be key in creating energy. We'll talk about the specific mechanisms of this process in muscles.