Lect 1 Notes: Carbon Chemistry

3 ec pts printing

Video 1: Let's review bonding: (take notes!) Lewis Dot Diagram Space

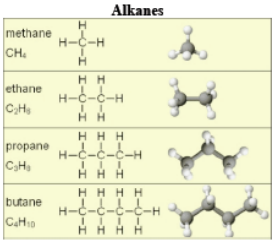
_____

_____

_____

What is pencil lead made of if it isn't lead?

Pencil lead is a mixture of _____. Graphite is one form of the element _____. Other forms of carbon are diamond - the hardest naturally occurring substance on the earth, soot, charcoal and coke. Pencils used to be made with lead, many years ago. Lead is poisonous and so sucking the end of your pencil could be quite dangerous. We now use graphite and clay because it is safer and because we can make pencils of different hardness

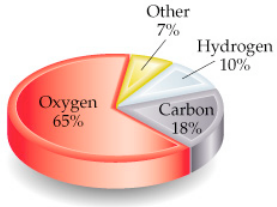


Chemistry of Living Things

Living things are a lot like laboratories… There's some serious chemistry going on inside. Your body is an incredibly complex chemical machine taking in chemicals & food, and causing countless reactions to occur every second. _____ is the study of substances & processes occurring in all living organisms.

I'm made of what???

Guess how many elements your body is made up of? Only about **25** elements make up all living things. In fact, about 97% of your body's mass is made of just 4 elements: _____,_____, _____, & _____. Two other major elements found in the body are **phosphorous** and **sulfur**. Of course, other elements are also important, but they're often found in small amounts. They may seem insignificant, but they're not. For example, iron makes up only 0.004% of your body mass, but you can't live without it!



Human body

Major Compounds in the Body

The human body also relies on many compounds, especially _____. The human body typically consists of _____water. In other words, 2/3 of your body weight is water. Water is important because many of our body's chemical reactions can only occur in solutions containing water. Blood, sweat, urine… all mostly water! Salt is also important because of how it can separate into its two ions: Na^+ and Cl^-. Sodium ions regulate the amount of water in our cells, while chlorine ions help our body digest food.

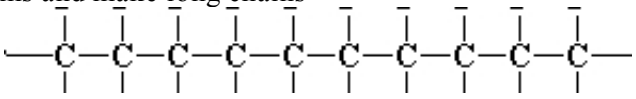
The most important element is… _____ If you take away the water, the rest of the human body is 53% _____. It may not be the most abundant element in living things, but it certainly is the most important. At one time, scientists thought that the chemical reactions that took place inside of living things could not occur outside of them. The carbon molecules were so complex, scientists thought they must have been made in some unknown way. They called these carbon compounds _____ compounds. The word "organic" has lots of meanings. Eventually, scientists realized that the reactions occurring inside the body could occur outside it as well. They also learned how important carbon is in all living things, because of its ability to _____with other atoms. Not all substances made of carbon are living. Diamonds and graphite are pure forms of carbon. Nonorganic carbon compounds, and compounds without carbon, are called _____ compounds.

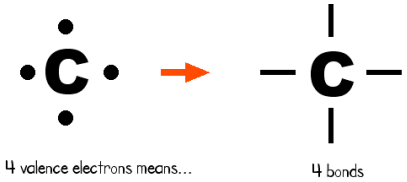
What is organic chemistry? We used to describe organic chemistry as the chemistry of living things. Since the chemistry of living things is based on carbon, the chemistry of carbon compounds has come to be known as _____. It now includes the study of carbon compounds which are not found in living things and so is an incredibly large branch of modern chemistry.

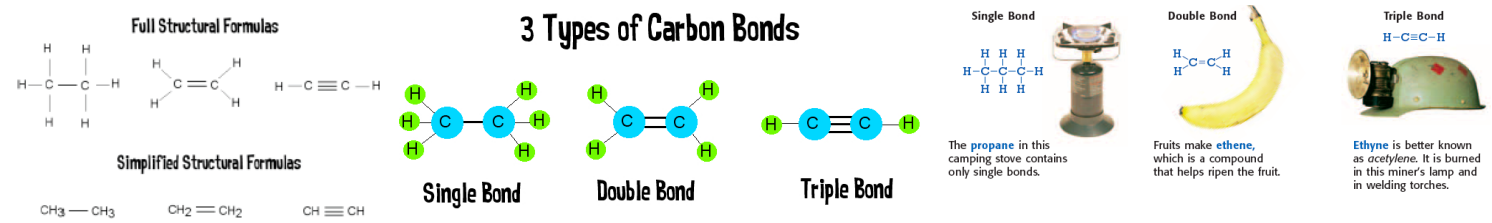
Why is life based on the element carbon? There are two important properties of carbon that make it a suitable element to form the compounds in living things: Firstly, **carbon atoms can _____to form stable chains of great length.** Carbon atoms bind strongly to each other and so often form very large molecules, which are built around a carbon _____ The _____between two carbon atoms is strong so that the backbones _____. In all of these compounds simple sub-units called monomers are linked together by condensation reactions.

What makes carbon so special?

It literally has a "central" role in all living organisms. Here's why:
It has _____ electrons. It can make _____ bonds. It can bond with any element , but really loves to bond with other carbon atoms and make long chains

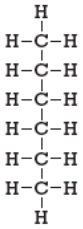




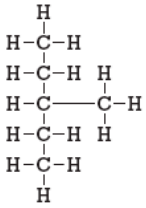


Carbon forms Long Chains: One carbon chain may contain hundreds of carbon atoms. Unlike other elements, carbon atoms can bond to each other to form very long chains. One carbon chain may contain hundreds of carbon atoms. Notice how the CH_2 units repeat. A very large carbon-based molecule made of repeating units is called a _____ Each unit of a polymer is called a _____. Polymers can be *thousands* of atoms long.

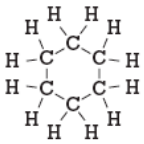
3 Types of Carbon Backbones



Straight chain
Carbon atoms are connected one after another.



Branched chain
The chain of carbon atoms branches when a carbon atom bonds to more than two other carbon atoms.

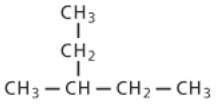


Ring
The chain of carbon atoms forms a ring.

More Examples:

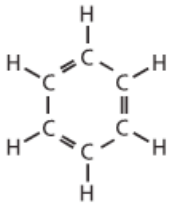
Straight Chain

Branched Chain



Carbon forms RINGS:

Carbon-based molecules also can be shaped like rings. Most carbon rings contain **5** or **6** carbon atoms. One of the most important carbon rings is_____. It has 6 carbon atoms and 6 hydrogen atoms, with alternating double bonds. Many compounds are based on Benzene. They often have very strong smells or aromas, so they are called _____ compounds. An example of one aromatic compound is a molecule called vanillin. Guess what that smells like!



Benzene Ring

Simplified Benzene Ring

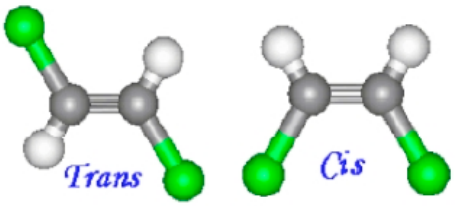
Silicon is similar to carbon. Why are there no life forms based on silicon?
Silicon is unsuitable because, although it is a valency IV element like carbon, (4 electrons to share) the Silicon - Silicon covalent bond is not strong enough for it to form long stable chains. So, it cannot form molecules of the complexity needed to make up cells like carbon can!

The alkanes make up a series of **saturated hydrocarbons**, called an **homologous series** because they have similar properties and have the same general formula:
The first four members of the series are gases at room temperature and are called:
methane, CH_4
ethane, C_2H_6
propane, C_3H_8
butane, C_4H_{10}

Alkanes with increasing numbers of carbon atoms have names are based on the Greek word for the number of carbon atoms in the chain of each molecule. So you can get, for example, **pentane (5), hexane (6), heptane (7) and octane (8).**
From pentane onwards, approximately the next thirty alkanes in the series are liquids. Alkanes with even longer chains are waxy solids. They are typical covalent compounds, insoluble in water but able to mix with each other. Alkanes burn in oxygen to produce carbon dioxide and steam.

What are the important properties of alkanes?
Alkanes have the typical properties of covalent compounds. The physical state at room temperature depends on the strength of the intermolecular forces, which depend on the size of the molecule. _____because of the non-polar nature of their molecules.
They burn in a plentiful supply of oxygen to give carbon dioxide and steam.

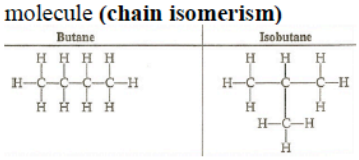
Lots of carbon compounds seem to be isomers. What is an isomer?
In organic chemistry, there are many examples of **different compounds, which have the same molecular formula as each other, but different arrangements (_____)** of the atoms in their molecules. These are called: _____.
These compounds are said to be isomers of one another. Isomerism also occurs in inorganic chemistry, but it is less common. Isomer examples are shown to the right-→



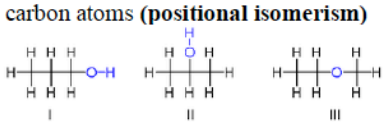
If isomers have the same atoms in them, surely they have the same properties, so what's the point? In fact, these small changes in structure can have significant effects on the properties of the substance! But, it is important to realize that this can have significant effects in a living system. One optical isomer of glucose, for example, can be used by a living cell, but the other isomer cannot. This is because the enzyme in the cell which recognizes glucose, is sensitive to only one form.

_____ **isomers** of a compound have the atoms of their molecules **linked in a** _____. This can come about in one of three ways:

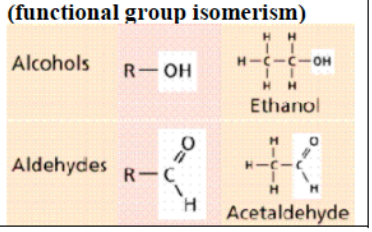
different carbon skeletons in the molecule **(chain isomerism)**



functional group linked to different carbon atoms **(positional isomerism)**

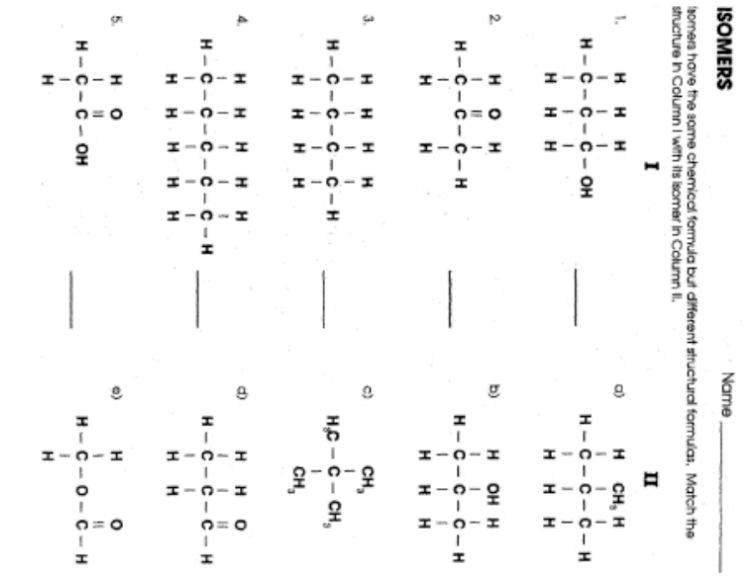


different functional groups **(functional group isomerism)**



_____ **isomers** of the same compound are very similar. There may be small difference in physical properties such as melting or boiling point due to different strengths of intermolecular bonding. Their chemistry is likely to be identical. _____ **isomers** are also usually similar. There are slight physical differences, but the chemical properties are usually very similar. However, occasionally, positional isomers can have quite different properties e.g. oxidation of alcohols. A simple example of **isomerism** is given by propanol: it has the formula C_3H_8O (or C_3H_7OH) and two isomers propan-1-ol (n-propyl alcohol; **I**) and propan-2-ol (isopropyl alcohol; **II**) Note that the position of the oxygen atom differs between the two: it is attached to an end carbon in the first isomer, and to the center carbon in the second. The number of possible isomers increases rapidly as the number of atoms increases; for example the next largest alcohol, named butanol ($C_4H_{10}O$), has four different structural isomers.

_____ **isomers** are likely to be both physically and chemically dissimilar.



Since so many organic compounds contain the same elements, how do you name them?

There is a system of naming organic compounds, which is based on the name of the alkane with the same number of carbon atoms as the longest carbon chain in the molecule of the compound. Side-chains of carbon atoms or other functional groups attached to the molecule are called _____
The carbon atoms of the longest chain need to be numbered to show where the substutuents are joined on.

When you are naming the organic molecule you put the number of the carbon atom that the substituent is joined to first, then the name of the substituent, then the name ofthe parent molecule (longest chain of carbon atoms). If there is more than one substituent then you put them in alphabetical order.

Naming the Organic Compound:

1 _____		Methan-
2_____		Ethan-
3_____		Propan-
4_____		Butan-
5_____		Pentan-
6	Hexane	Hexan-
7	Heptane	Heptan-
8	Octane	Octan-

Here is a list of some functional groups with their names:

Structure	Structure Name
CH3-	methyl -
-OH	hydroxy-, -ol
CH3CH2-	ethyl-
-COOH	-oic acid
CH3CH2CH2-	propyl-
-NH2	amino-, -amine

Structure	Structure Name
-F	fluoro-
-NO2	nitro-
-Cl	chloro-
-CHO	-al
-Br	bromo-
-CO	-one
-I	iodo-
-C6H5	phenyl -

BrainPop: The Carbon Cycle:

1. Carbon is present in all: A. Water molecules B. Matter in the entire universe C. Life on Earth
2. What gaseous form does carbon most commonly take? A. Carbon monoxide B. Carbon dioxide C. Carbon trioxide
3. How do animals add carbon dioxide to the atmosphere? A. Eating B. Drinking C. Breathing
4. During what process do plants soak up carbon dioxide? A. Photosynthesis B. Root growth C. Pollination
5. Because plants remove more carbon from the atmosphere than they add to it, they are knows as Carbon A. sinks B. banks C. stores
6. How does some of the carbon locked up in the earth's crust get returned to the atmosphere?
   A. It gets spewed out by the oceans B. Volcanic eruptions C. Mudslides
7. The carbon cycle seems to be out of balance because more and more carbon is entering the: A. Oceans B. Earth's crust C. Atmosphere
8. Which of these human activities probably contributes the least to the carbon cycle imbalance?
   A. Breathing B. Burning rainforests C. Burning fossil fuels
9. What is the warming up of the Earth's atmosphere by certain gases called? The: A. Coriolis effect B. greenhouse effect C. quickening
10. Since the start of the Industrial Revolution, atmospheric carbon has increased by about: A. 10% B. 25% C. 40%

Chemistry & Your Body

FACTS:

- You are made of about 65% water. In fact, ALL living organisms are made of molecules consisting largely of carbon, hydrogen, nitrogen, oxygen, phosphorous & sulfur. Living organisms are also made up of MANY different kinds of molecules, including small ones like water & salt, and very large ones like carbohydrates, fats, proteins & DNA. Right now you will learn more about these teeny tiny elements you are made of.

Follow the steps to calculate just how much of each element is in your body.

GOAL: Find out how many pounds of the major elements are in your body.

Step 1: Estimate your weight in pounds.

Step 2: If all of the water was removed from your body, you would be made of following percentages of elements

I weigh approximately _____ pounds (lbs).

Step 3: To calculate the amount of element in your body in pounds, multiply the decimal by your weight.

Element	% found in body	decimal	Amount of Element in Body (pounds)
Carbon	53%	.53	
Oxygen	21%	.21	
Nitrogen	9%	.09	
Hydrogen	8%	.08	
Calcium	4%	.04	
Phosphorous	3%	.03	
Sulfur & Sodium	1%	.01	
All other elements	1%	.01	

Video 2: Title: _____

Video 3: Title: _____

Video 4: Title: _____

Video 5: Title: _____