Organic Compounds

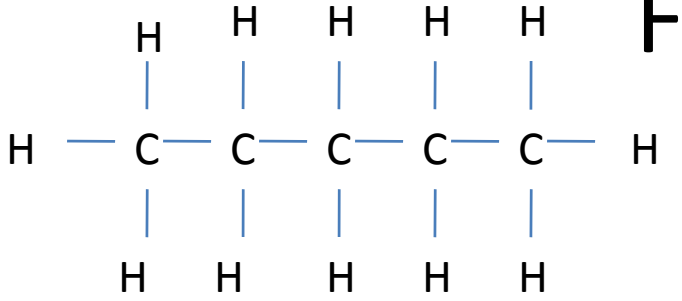
Simple Naming

- Organic compounds are made by linking carbon atoms together into chains.
- The basic naming of the chain comes from two things:
  - 1: How many carbon atoms are present in the chain.
  - 2: How many bonds are there between each carbon atom.
- If all the carbon atoms have single bonds between them then the compound is an alkane.
- Any double bonds is an alkene, and a triple bond is an alkyne.

Prefixes

- Prefixes for the number of carbons is as follows:
  - 1 – meth
  - 2 – eth
  - 3 – prop
  - 4 – but
  - 5 – pent
  - 6 – hex
  - 7- hept
  - 8 – oct
  - 9 – non
  - 10 - dec

Formulas



- This is called a structural formula.
- Each line represents a shared pair of electrons.
- Carbon can share four electrons so that it can make four bonds.
- This requires an s-electron to become a p-electron.
- This is called sp^3 hybridization.
- A short or condensed formula would be $CH_3CH_2CH_2CH_2CH_3$

Alkanes

- Hydrogens fill all open bond sites.
- The formula for an alkane is $C_nH_{2n+2,}$ So the number of hydrogen atoms is 2x the number of carbon with two more added.
- This is because each carbon bonds with at least two hydrogens and there are two extra hydrogens at the end of the molecule.
- Alkanes end in –ane to show all single bonds.
- A three carbon alkane would be called propane, prop- for three carbons, and -ane for the fact that all bonds between the carbons are single.

Alkenes

- Hydrogens fill all open bond sites.
- The formula for an alkane is $C_nH_{2n,}$ So the number of hydrogen atoms is 2x the number of carbon.
- This is because two hydrogens need to be removed from an alkane in order to make a double bond.
- Alkenes end in –ene to show a double bond.
- A three carbon alkene would be called propene, prop- for three carbons, and -ene for the fact that a double bond is present.

Alkynes

- Hydrogens fill all open bond sites.
- The formula for an alkane is $C_nH_{2n-2,}$ So the number of hydrogen atoms is 2x the number of carbon with two subtracted.
- This is because four hydrogens must be removed from the alkane to make a triple bond.
- Alkynes end in –yne to show all single bonds.
- A three carbon alkyne would be called propyne, prop- for three carbons, and -yne for the fact that a triple bond is present.

Ring structures

- If the carbons form a ring, we put the prefix cyclo- before the chain name.
- Ex. Cyclopentane would be a five carbon ring.
- The formula is C_nH_{2n} since two hydrogens need to be removed to connect the two carbons.
- If the ring has alternating single and double bonds, it is called an aromatic.
- The only one you need to know here is benzene which is a six carbon aromatic.

Saturated vs. Unsaturated

- If all the bonds between carbons are single bonds, then the molecule is called saturated.
- If there are any double or triple bonds then it is called unsaturated.
- Double and triple bonds remove hydrogens which make it easier for an outside substance to attack and break the bonds.
- That is why saturated molecules are harder to break down, and saturated fats should be avoided in your diet.

Branches

- Most organic molecules are more complex than a straight chain of carbon atoms with hydrogens all around.
- If a carbon atom or a halogen is bonded to a carbon that is part of the main chain then it is called a branch.
- A carbon branch is labeled by how many carbons are in the branch with an ending of –yl.
- So a one carbon branch would be a methyl branch, two = ethyl, etc.

Branches continued

- A halogen branch ends in –o.
- A chlorine would be a chloro, bromine – bromo, etc.
- If there is more than one of the same type of branch, you put a prefix on it to tell how many.
  - 2 – di
  - 3 – tri
  - 4 – tetra
- So if there are 3 methyl groups and 2 ethyl groups, the name would have diethyl trimethyl in it.

Functional groups

- There are certain branches that change how the whole molecule will behave chemically.
- We call these functional groups because they change the function of the molecule.
- All functional groups contain one or more of the following elements: O, N, or S.
- We will ignore sulfur in this course, but you will recognize a functional group by seeing any of these elements.
- Each functional group looks different and therefore has a different way of naming.

Alcohols

- Alcohols have an –OH bonded to a carbon on the molecule.
- The ending of the straight chain changes to –ol.
- So a two carbon alcohol with all single bonds between the carbons would be called ethanol.
- Eth- for two carbons, -an- for all single bonds, and –ol for the alcohol group.
- No numbering needed since the molecule would be the same regardless of which carbon its on.

Aldehydes

- Aldehydes have the last carbon in the main chain double bonded to an oxygen with the remaining bond being to a hydrogen.
- The ending for an aldehyde is –al.
- So a two carbon aldehyde would be called ethanal.
- Eth- for two carbons, -an- for all single bonds between the carbons, and –al for the aldehyde part.
- Notice the double bond to the oxygen does **not** make it an alkene, that's what makes it an aldehyde!

Carboxylic Acid

- A carboxylic acid has the last carbon in a chain double bonded to an oxygen and single bonded to an –OH.
- The ending is –oic acid. (pronounced o-ik)
- Ethanoic acid

Ketone

- A ketone has a double bonded oxygen bonded to a carbon somewhere in the middle of the chain.
- The ending is –one (pronounced like own)
- Propanone.
- Can’t have a two carbon ketone since there is no middle carbon.

Amine

- Has a $-NH_2$ branched off of a carbon in the chain.
- Ending is –amine.
- Ethanamine.

Amide

- Has a carbon on the end of the chain double bonded to an oxygen and single bonded to a $-NH_2$.
- Ending is –amide
- Ethanamide

Ether

- Has an oxygen linking two carbon chains together.
- Name the two chains like a branch, and then put ether on the end.
- Ex. A two carbon branch and a three carbon branch linked by an oxygen would be called ethyl propyl ether.

Ester

- A carbon chain with a double bonded oxygen at the end and the same carbon linked to another carbon chain by an oxygen.
- Its like an aldehyde and an ester put together.
- Name the part that is not connected to the oxygen as a branch, and the part that is connected to the oxygen like a straight chain and the ending is –oate.
- Methyl ethanoate would be a two carbon chain with the end carbon double bonded to an oxygen and single bonded to a second oxygen which is then bonded to a carbon.

Naming rules

- In order to have a convention that makes each different compound have its own unique name, rules must be followed. (called IUPAC rules)
- 1st – name the molecule by its longest continuous chain of carbons making sure it includes any double or triple bonds and functional groups. Put the appropriate ending on it.
- 2nd – write the names of all the branches that come off of that chain in alphabetical order.

Naming rules continued

- 3rd Number the chain from the end closest to (in this order)
  - A functional group
  - A double or triple bond
  - A branch
- If there is a tie between two, go to the next one of that type, and if there is not another, then go down the list.
- If everything is a tie, then it does not matter which end you name from. (there is a pecking order that we will ignore here.)

Naming rules finish

- Number all functional groups from the carbon they touch, all multiple bonds from the lowest number carbon they touch, and all branches from the carbon they touch.
- If there are more than one of a certain type of branch, then there must be a number for each one.
- So trichloro should be preceded by 3 numbers even if they are all off the same carbon.

Isomers

- Isomers are two molecules that have the same molecular formula, but a different arrangement.
- They must have different names to be isomers, if the name comes out to be the same, they are the same substance even if it looks different.
- Isomers may have slightly different properties depending on how they are arranged, and the bigger and more complex a molecule it, the more isomers it will have.

Boiling points.

- The longer the molecule is, the more interaction there is between the molecules and the greater the attraction. That raises the boiling point.
- The more branches a molecule has, the shorter the main chain, and the less interaction possible, so that lowers the boiling point.
- It is possible to have three different isomers with the same formula be present in different phases.