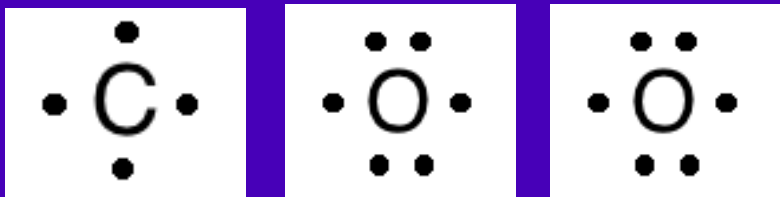


Chemistry 1010

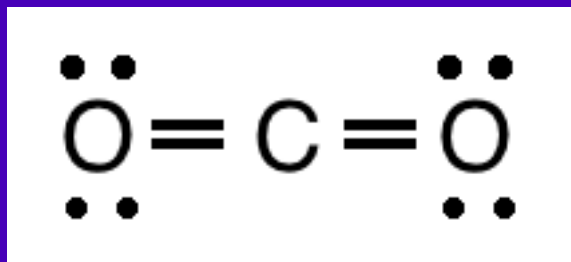
The Chemistry of Smell

Review

Draw the Lewis structures for all of the atoms in CO_2 .

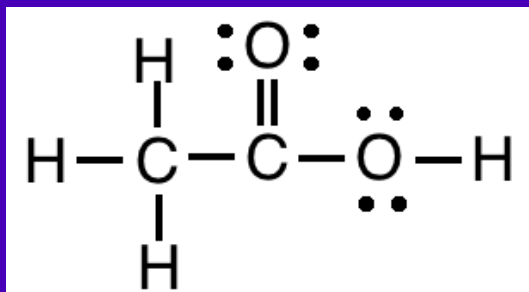


Draw the Lewis structure for the CO_2 molecule.

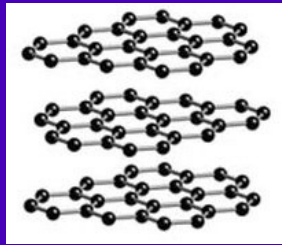
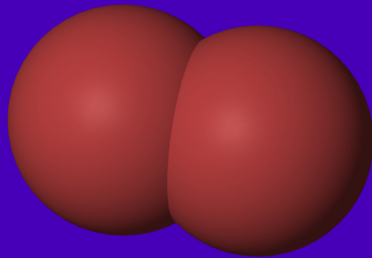
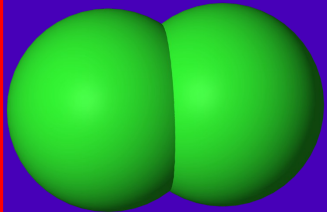
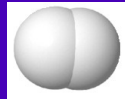
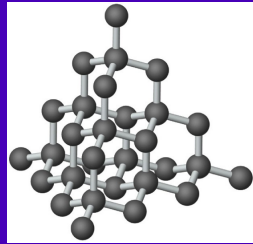
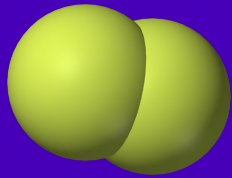
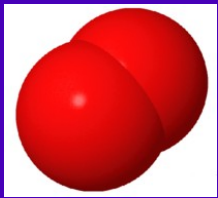


How many electrons does each O share with the C? 4

Draw an isomer for acetic acid.



What is different about these two groups of molecules?

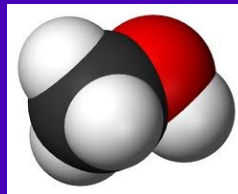
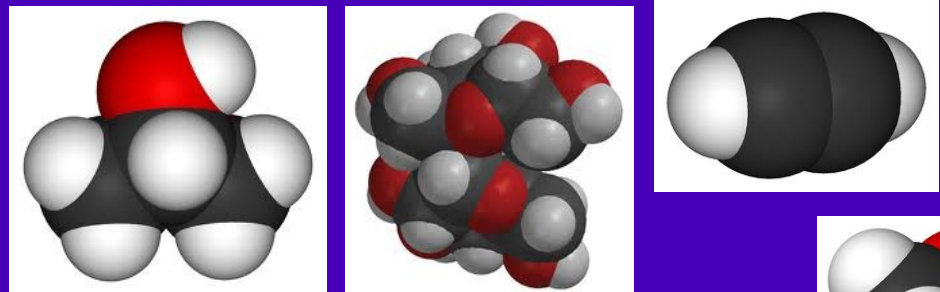
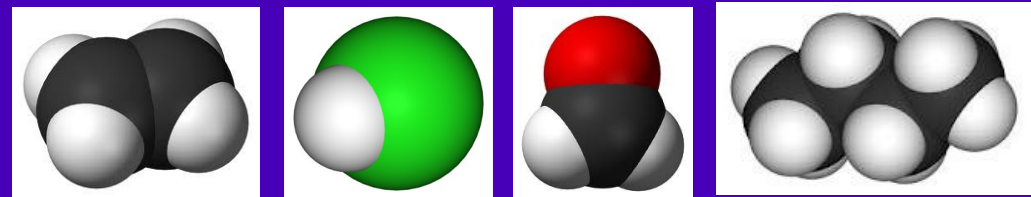
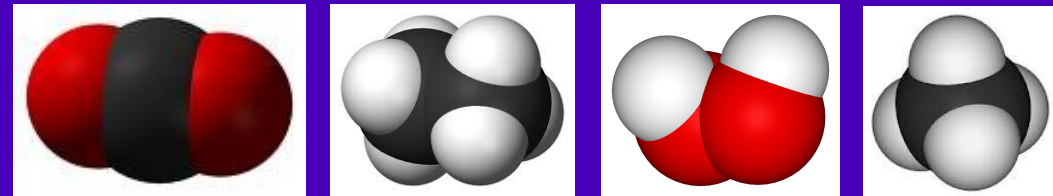
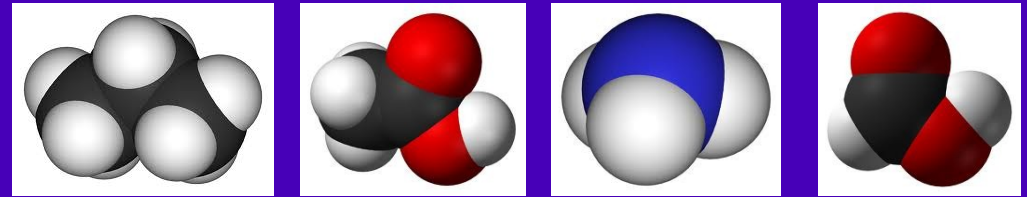
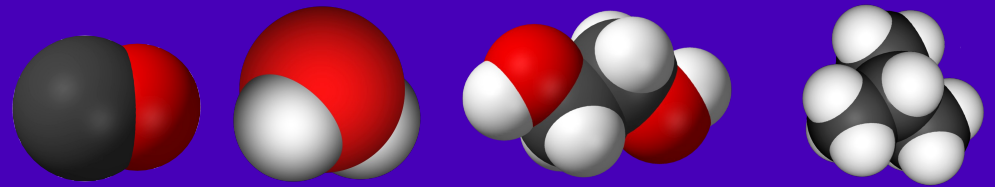


elements

Which do you think there are more of?

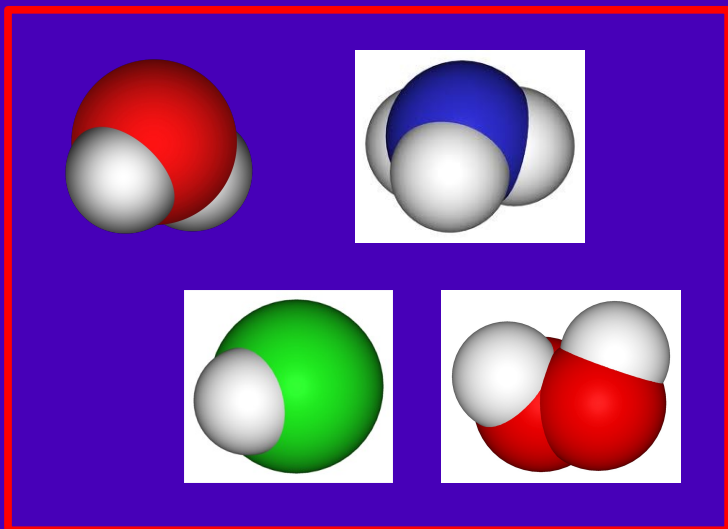
elements – 15

compounds – 10 to 100 million



compounds

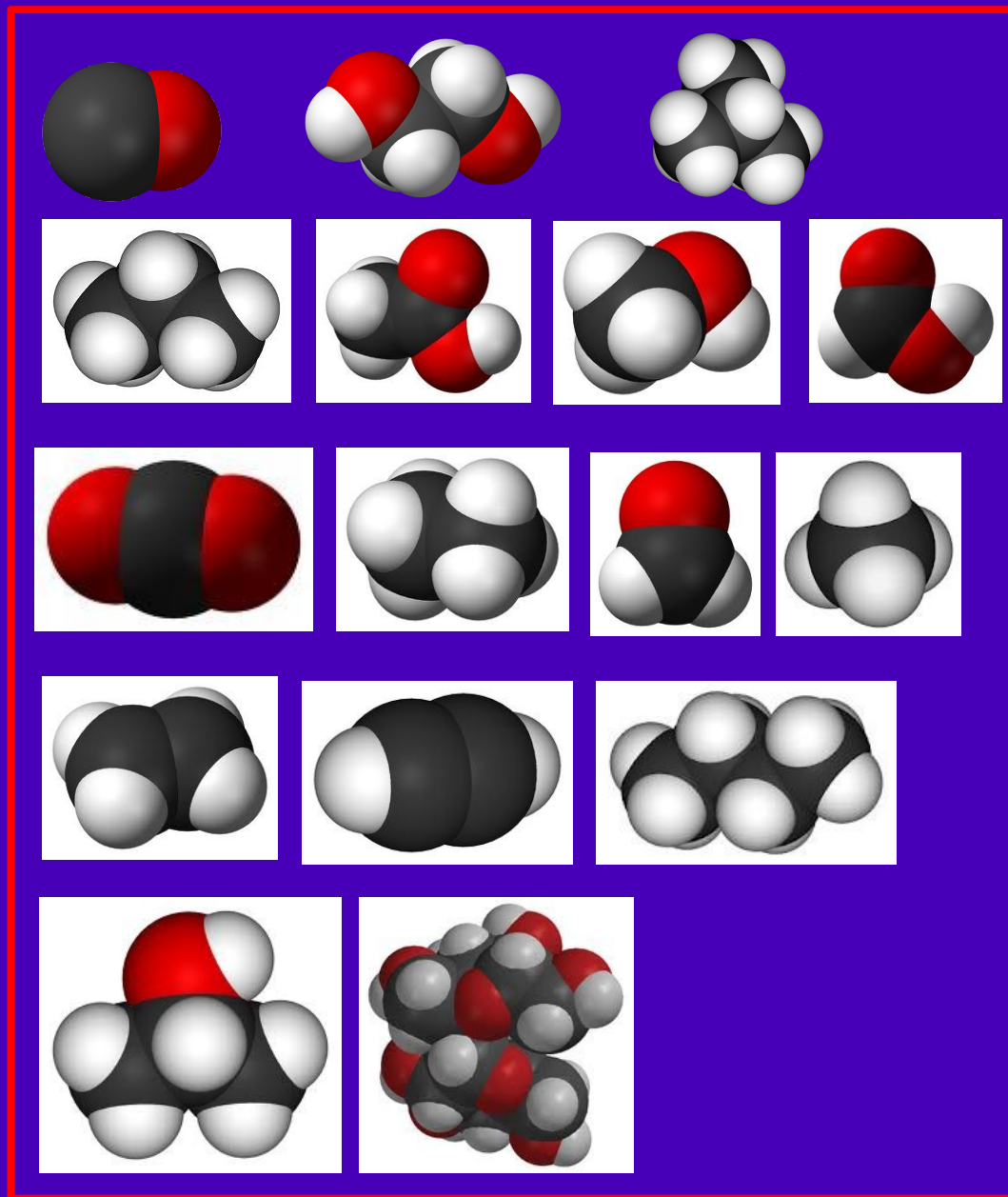
What is different about these two groups of molecules?



do not contain carbon
inorganic compounds

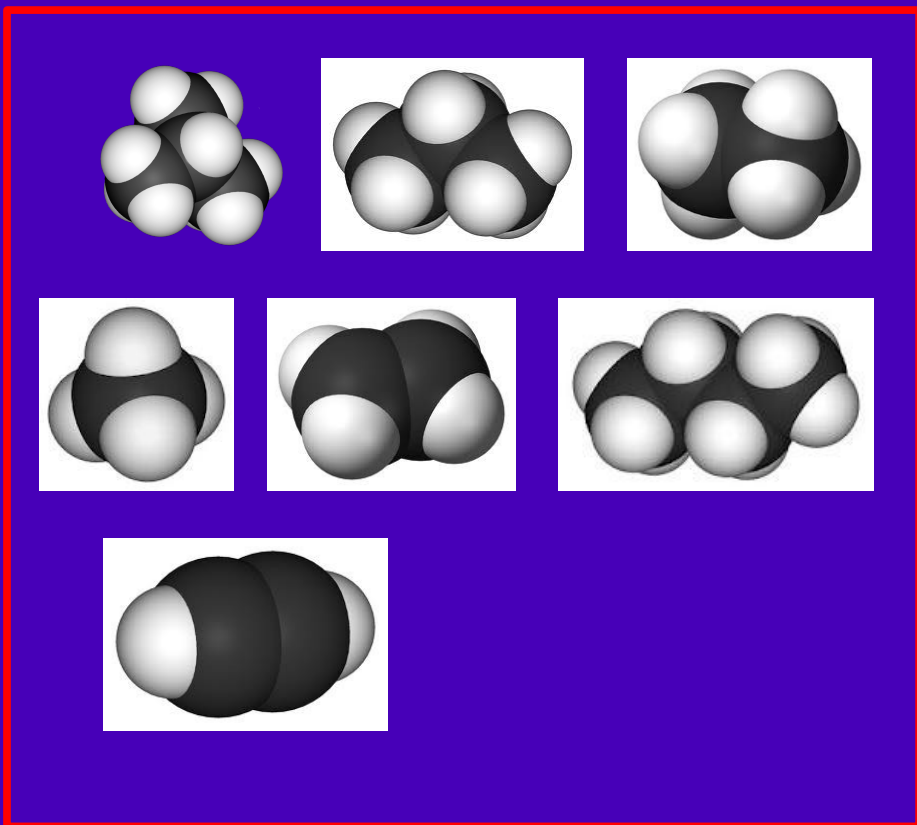
Which of these do you think
there are more of?

organic
95% of all compounds

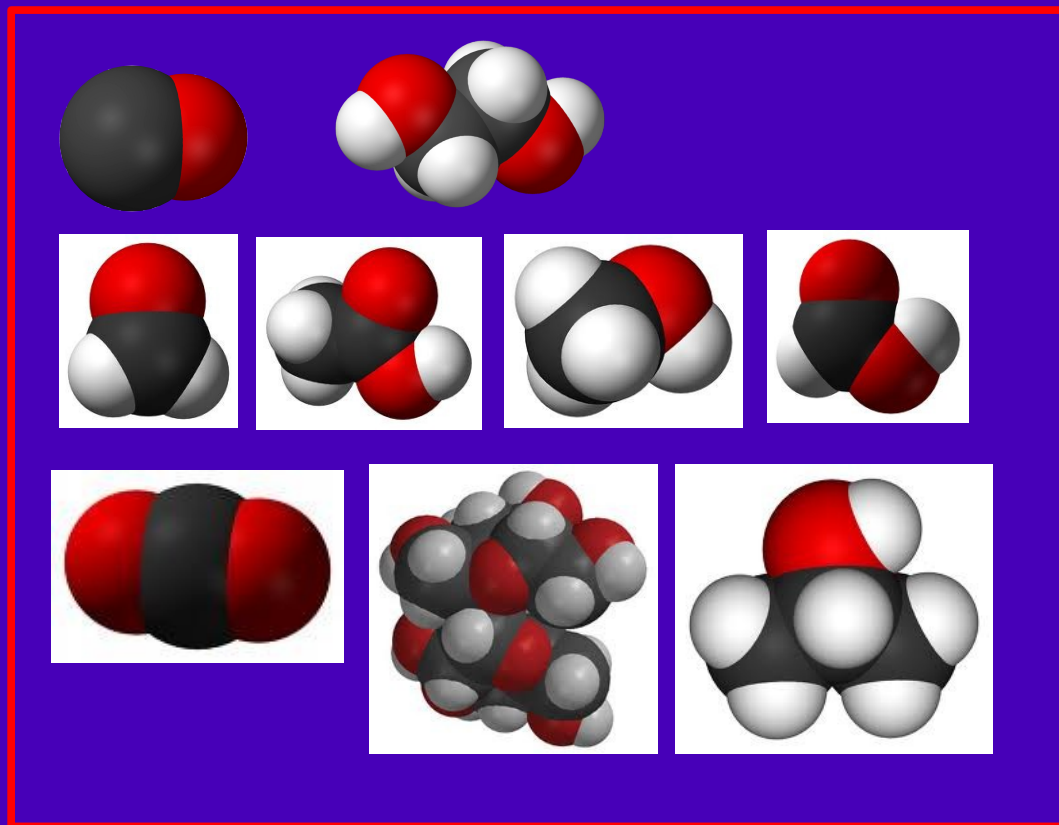


contain carbon
organic compounds

What is different about these two groups of molecules?

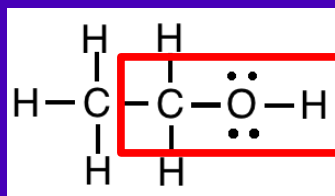


contain only C, H
hydrocarbons

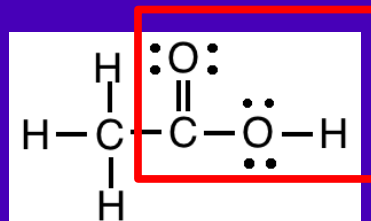


contain C, H, O
have functional groups

What two functional groups have we talked about so far?



alcohols



carboxylic acids

Introduction

Today we will be talking about the chemistry of smell.

What are some of your favorite smells?



baking bread



lilacs



sun on pine
needles



rain in the
desert



spaghetti
sauce

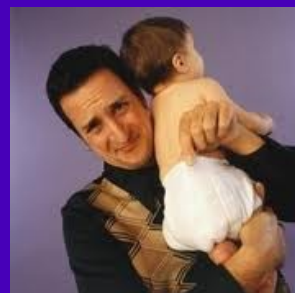
Of course, there are some bad smells too. Examples?



skunks



smelly socks



stinky
diaper



food
gone bad

Besides things that naturally have a smell, there are lots of products that have smells added to make us want to buy them.

What are some you can think of?



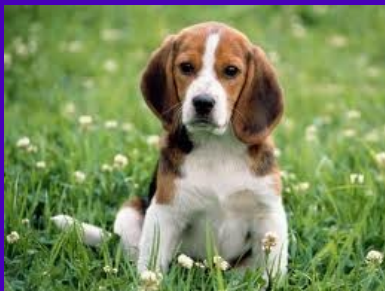
lip gloss dish soap shampoo candles air freshener

How many smells do you think that there are?

humans can distinguish over 10,000 different smells

Are there any other animals that can smell better than we can?

yes!



Name that smell

See if you can identify the smell in each of these bottles.

Here are your choices:



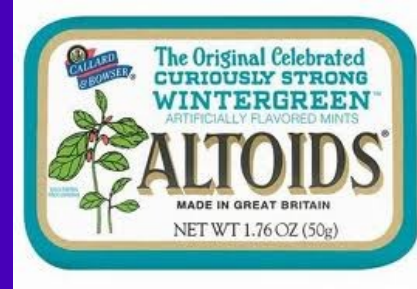
E
vanilla



C
cinnamon



A
bananas



B
wintergreen



D
lemon

Where do these come from?

Vanilla

- comes from vanilla beans that grow on an orchid flower native to Mexico
- 97% of all vanilla beans now come from Madagascar
- scientific name is *Vanilla planifolia*
- 75% of vanilla is sold to make ice cream or chocolate



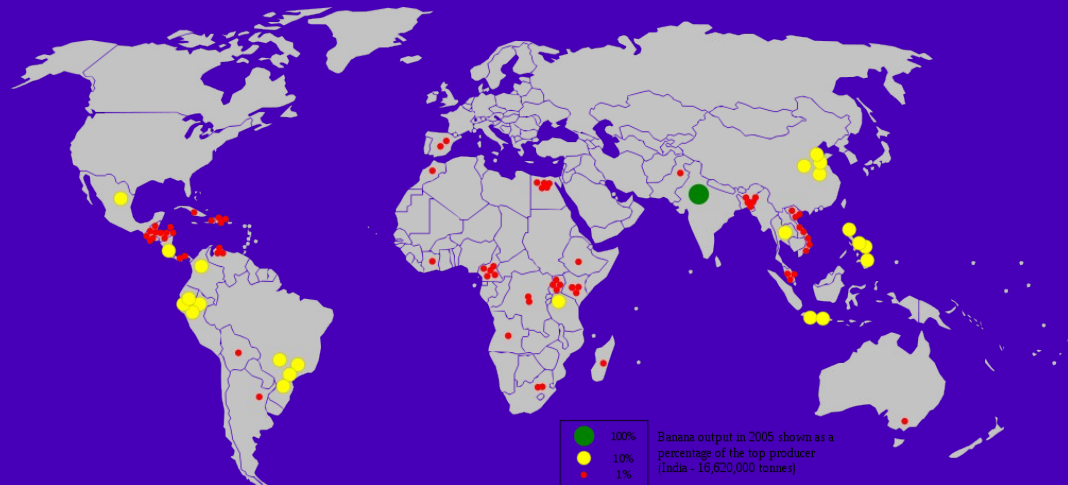
Cinnamon

- comes from the bark of cinnamon trees
- scientific name is *Cinnamomum verum*
- a small evergreen tree native to Sri Lanka, and also grown in places like Brazil, India, Vietnam, Madagascar, and Egypt (warm, usually wet climates)



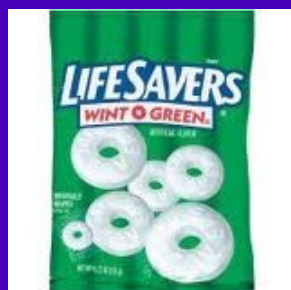
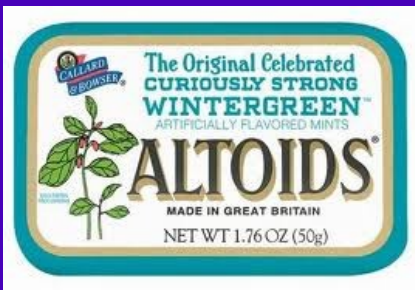
Bananas

- come from banana plants, which are big enough to be trees but have watery stems that can be cut through with one swing of a machete
- scientific name is *Musa acuminata*
- grown in many tropical countries such as Ecuador, Costa Rica, China, India, and the Philippines
- each stem makes only one set of bananas, then dies, and another stem comes up
- bananas grow up from the stem in circular groups



Wintergreen

- comes from leaves of a plant that gets its name because it stays green in the winter
- scientific name is *Gaultheria procumbens*
- used as a flavoring for chewing gum, mints, candies, mouthwash, and toothpaste



Lemon

- grown on lemon trees, which grow in Mexico, India, Argentina, China, and the US
- scientific name is *Citrus limon*
- there are many different varieties



How Smells Work

Before looking at how smells work, let's review what you know about the other senses.



sight: light bounces off things around us and reaches our eyes, where special cells detect the light and send a message to our brain



hearing: pressure waves in the air (sound) make our eardrums vibrate, which is detected by special cells in our ears, which send a message to our brain



touch: cells in our skin detect pressure, heat, and cold, and send a message to our brain



taste: when certain molecules touch our tongues, they activate special cells that send a message to our brains



smell: molecules from objects around us evaporate and travel to our noses, where they activate special cells that send a message to our brains

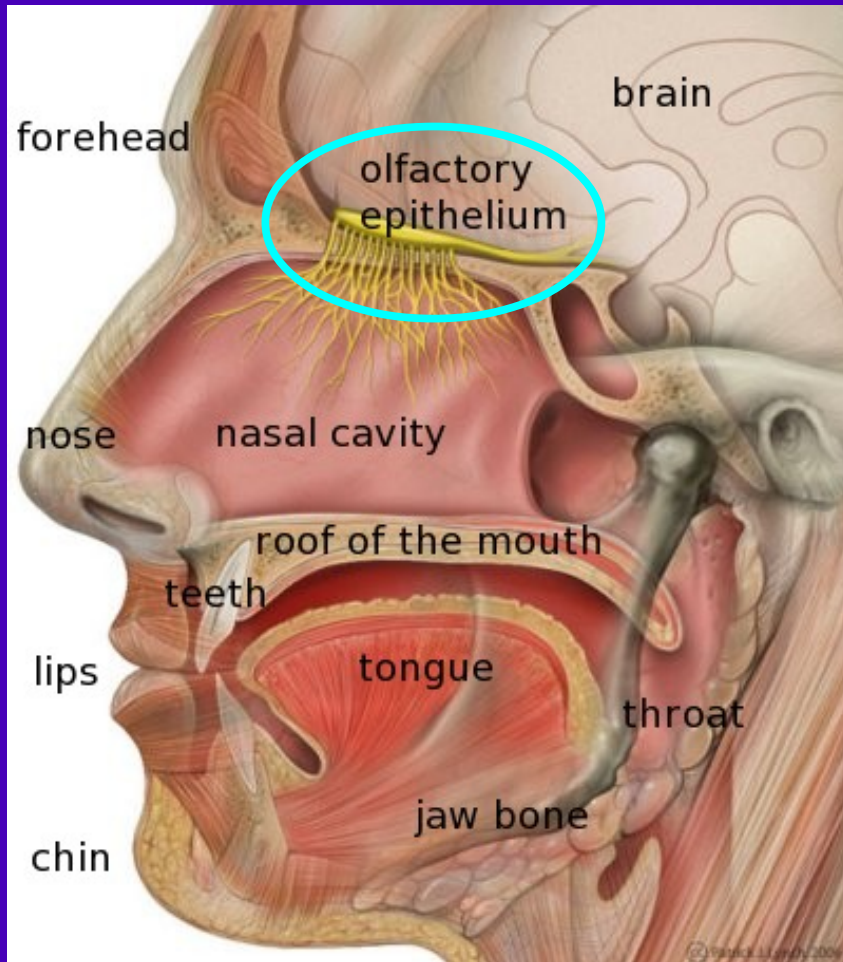
What do these all have in common?

we have special cells that detect things and send messages to our brains

Which of the senses involve sensing molecules?

taste and smell

Where are the cells that sense molecules and send messages to your brain about smells?



**at the top of your nasal cavity
called the olfactory epithelium**

in humans, it is about 2.5 cm²

inside are 50 million receptor cells

**each cells has receptors that have
a certain shape to fit a certain
molecule, like a lock and key**

So, when you smell a rose, what happens?



- 1) molecules from the rose evaporate**
- 2) they float through the air and get in your nose and hit the olfactory epithelium**
- 3) they reach a receptor that they fit into**
- 4) the cell the receptor is on gets activated and sends a message to your brain**
- 5) you recognize the smell of a rose**

Why do some things not have a smell?



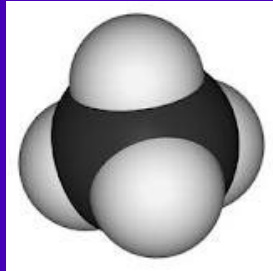
gold doesn't evaporate
no molecules reach your nose

What does that mean about everything that does have a smell?

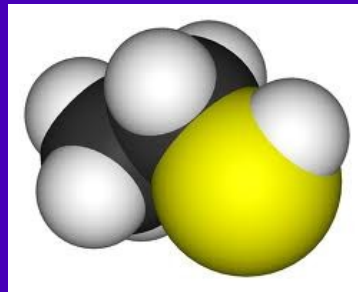


it must have molecules coming off of it and getting into your nose

Is it possible for molecules to be evaporating and reaching your nose but not causing a smell?



methane is odorless
we don't have receptors for it



ethanethiol is added
to give it a smell
detectable at 1:2.8 billion

Why does strawberry shampoo smell good but taste bad?



You are only smelling the molecules that evaporate, but you are tasting all of the other molecules too (the soap).

Why can other animals smell things much better than we can?



1) more receptor cells

bloodhounds' olfactory epithelium is 60 cm², contains 300 million receptor cells, can detect much lower amounts

2) more kinds of receptors

can detect odors that we can't

3) larger portion of their brains are devoted to processing smell

can put it all together

Taste and smell

How are taste and smell connected?



your tongue can only detect sweet, sour, salty, bitter, and meaty

everything else you can taste is actually a smell



root beer is actually not a flavor, but a smell

ingredients: water, sugar, salt, CO₂, root beer extract



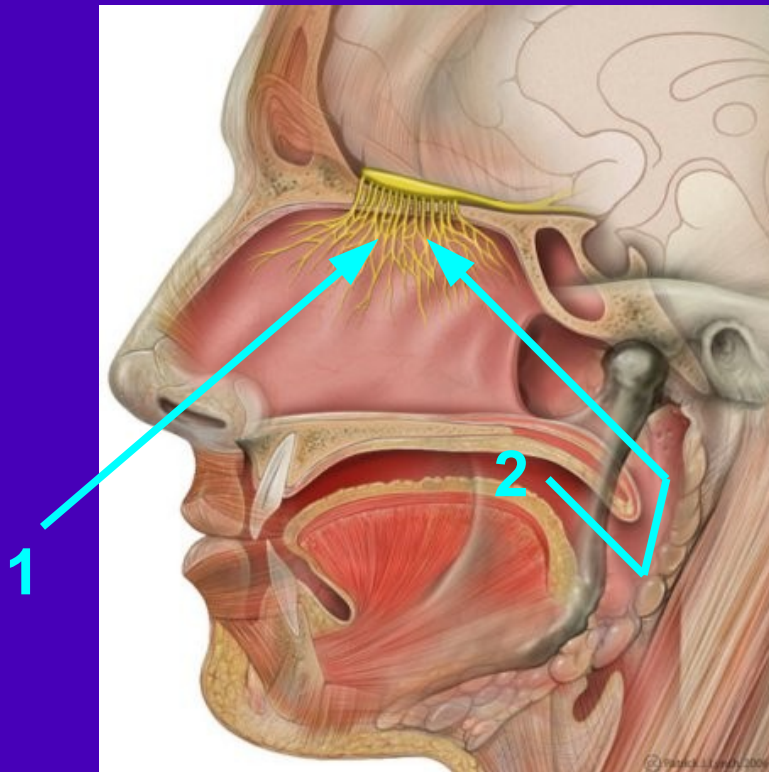
the taste of pineapple comes from sweet, sour, plus all of the odor compounds

How could you test this yourself?



chew on something with a flavor, then hold your nose and keep chewing – after a few seconds, the flavor will disappear

How do the gaseous molecules from food reach your nose?



1) from outside your body when you breathe in

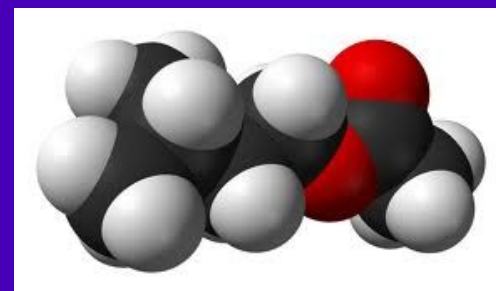
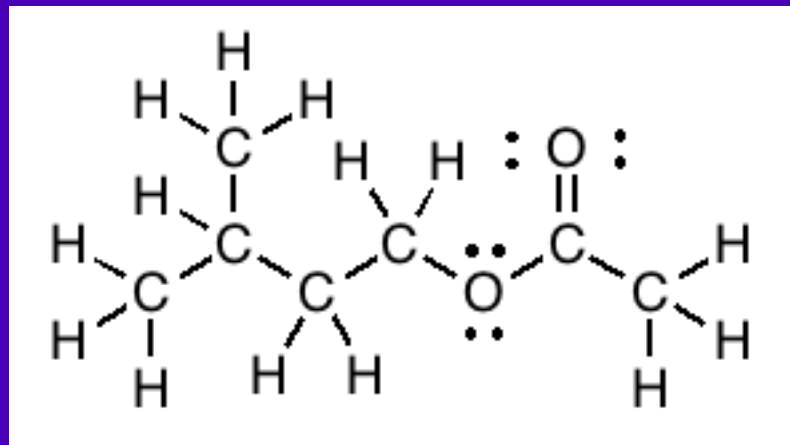
increases desire and anticipation

2) from inside your mouth up your throat while you chew

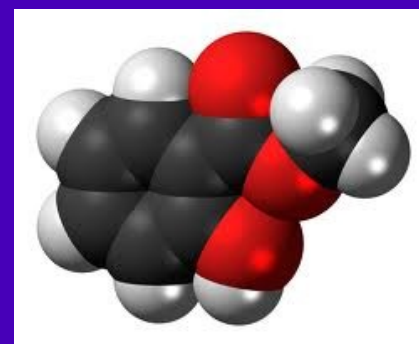
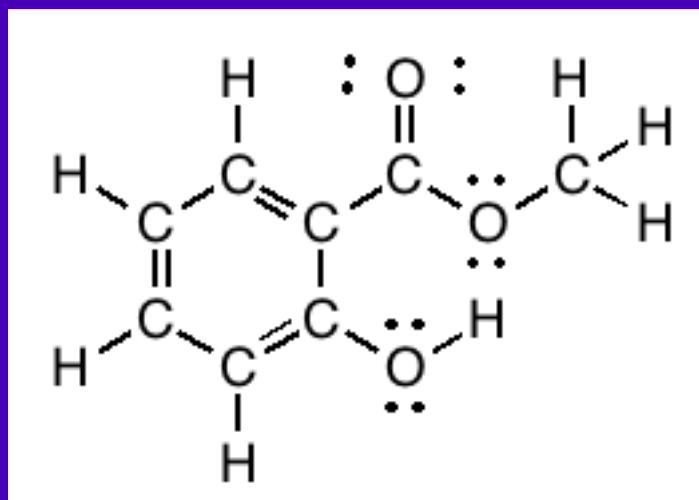
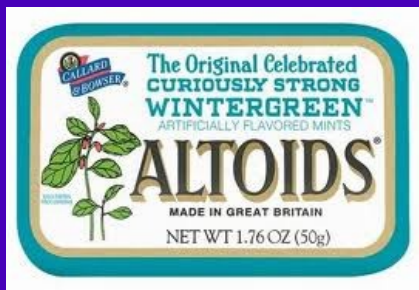
increases satisfaction

Molecules of Smell

Let's go back to the 5 smells that you identified. What do the molecules look like, and what are their names and formulas?

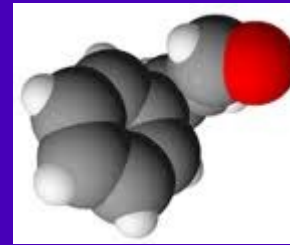
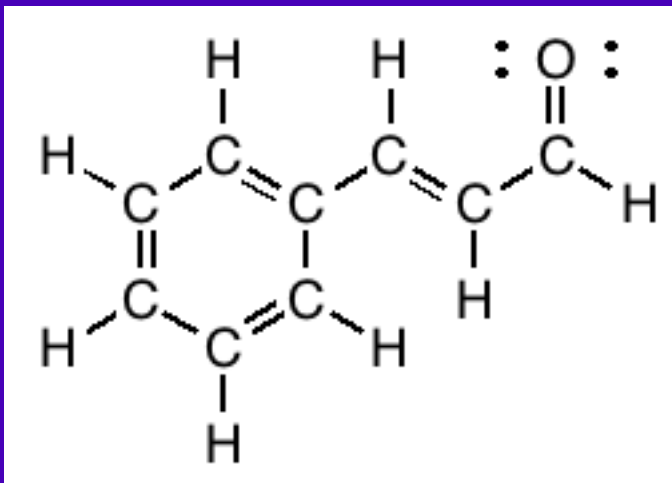


isopentyl acetate

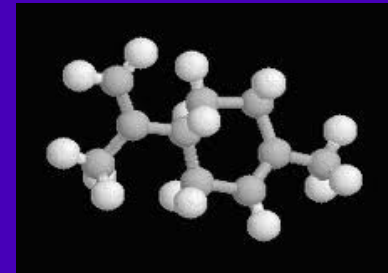
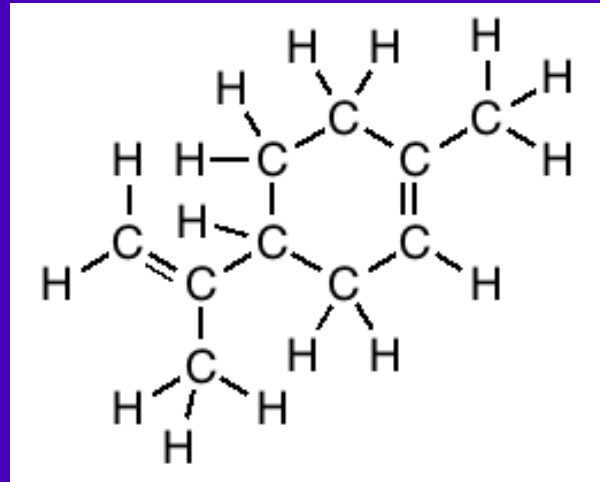


methyl salicylate

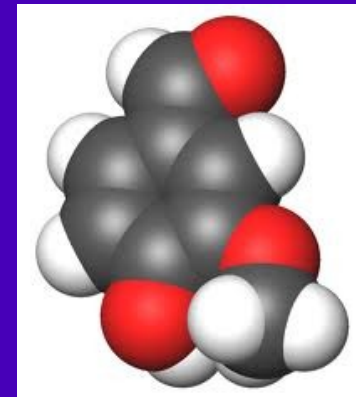
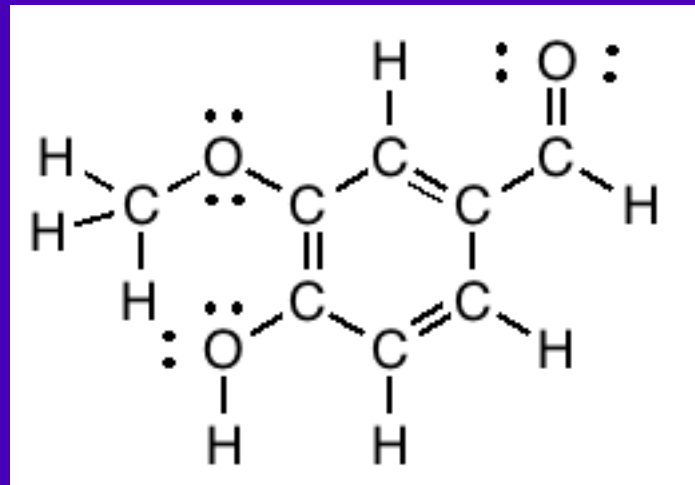




cinnamaldehyde



limonene



vanillin



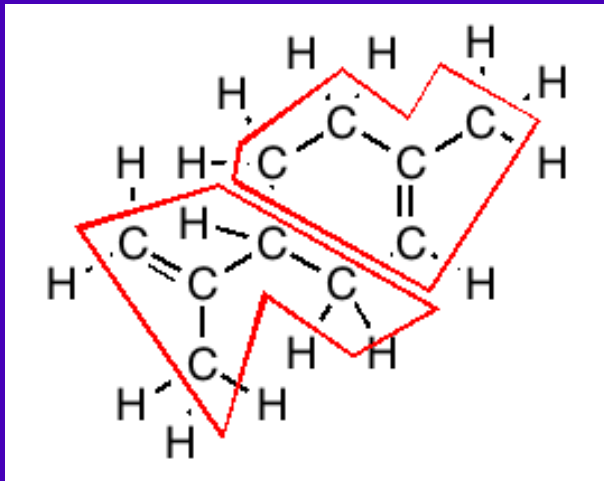
How do these molecules compare to the ones from the previous lecture?

lots more atoms

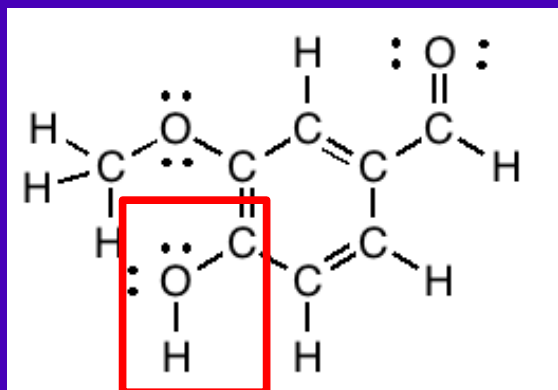
Which of these molecules is a hydrocarbon?

limonene – the only one that has only C and H

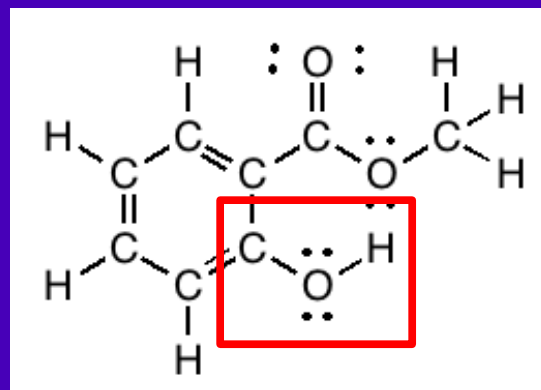
Molecules are called terpenes when they are made of groups of 4 carbon atoms in a row with one branch off of them. Terpenes are also commonly found in fruits, flowers, and perfumes. Limonene is a terpene – circle its groups.



Do you see any alcohols here?

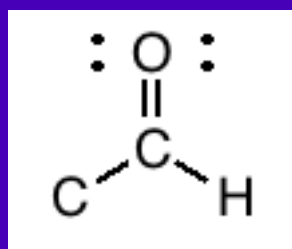


vanillin

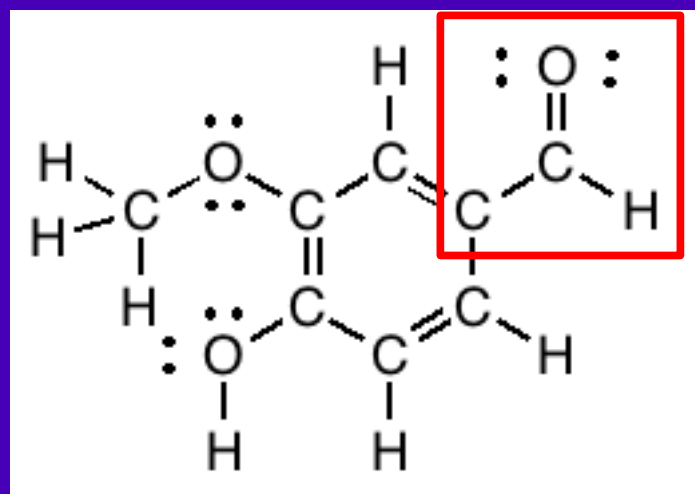


methyl salicylate

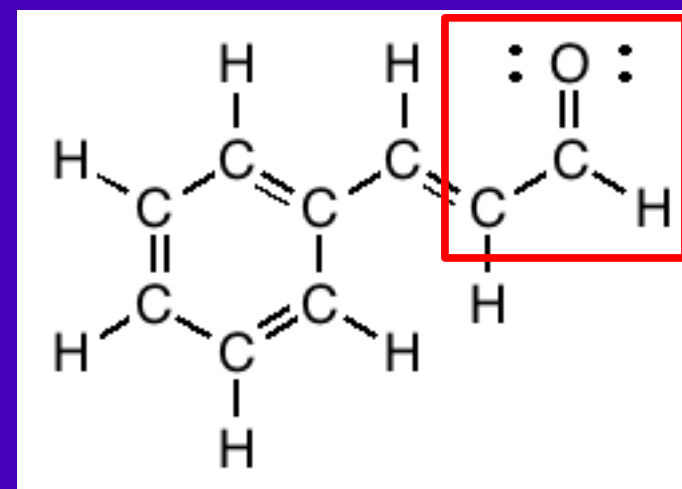
Aldehydes are another functional group. They have a C=O with a H directly attached. Which of these molecules is an aldehyde?



aldehyde



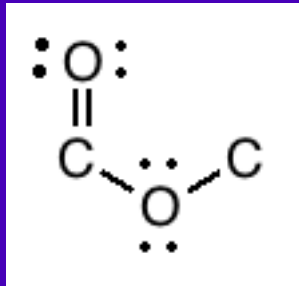
vanillin



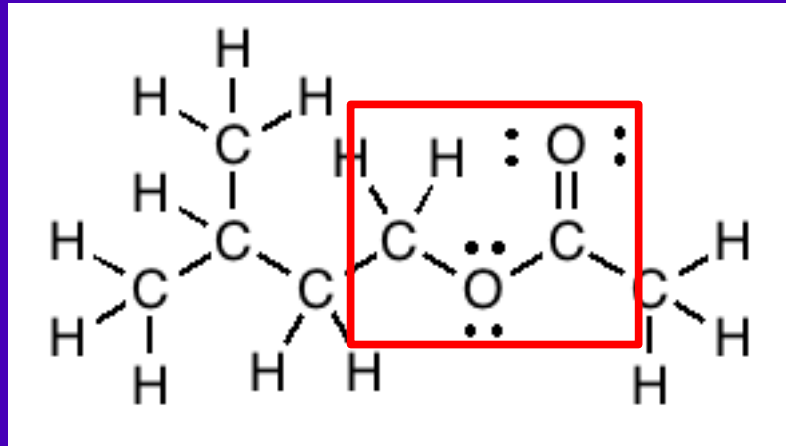
cinnamaldehyde

When a carbon is double bonded to an oxygen, then another oxygen with a carbon, this is called an ester. Esters are commonly found in fruits, flowers, and perfumes.

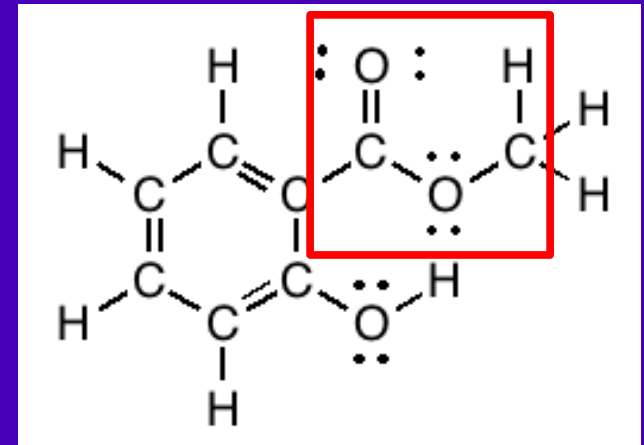
Which molecules are esters?



ester



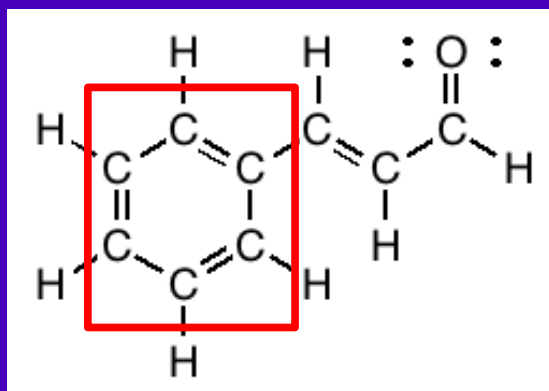
isopentyl acetate



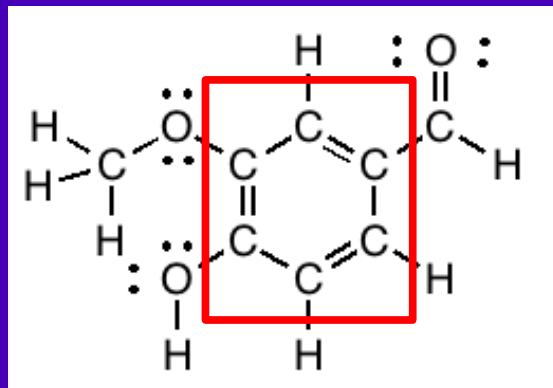
methyl salicylate

When a molecule has a ring of 6 carbons with double bonds between every other carbon, the molecule is called an aromatic molecule. This name comes from the fact that the first compounds that were discovered with this ring all had a strong smell.

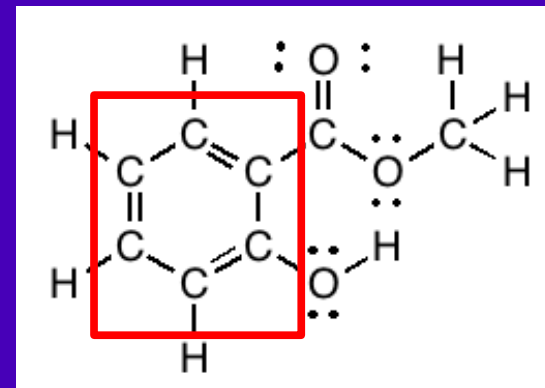
Which molecules are aromatic?



cinnamaldehyde



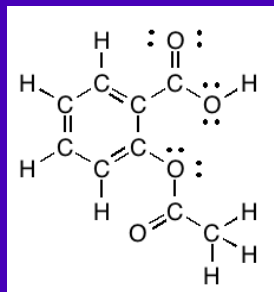
vanillin



methyl salicylate

Are all compounds which have a smell aromatic? **no**

Do all compounds which are aromatic have a smell? **no**



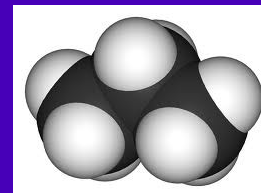
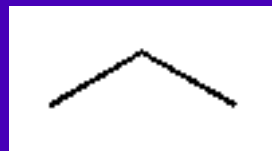
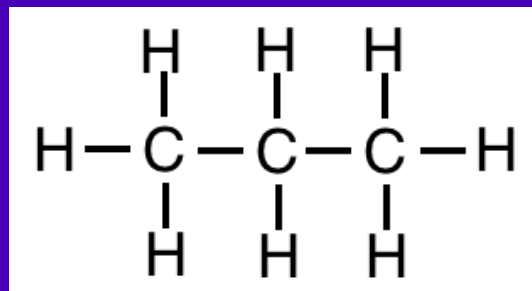
aspirin – aromatic, but no smell

When molecules get this large, we need a shorter method to write their structures. We call these line structures.

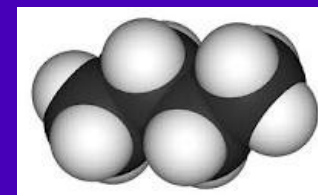
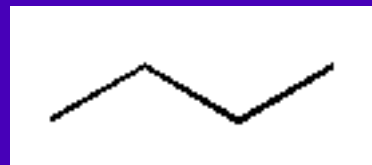
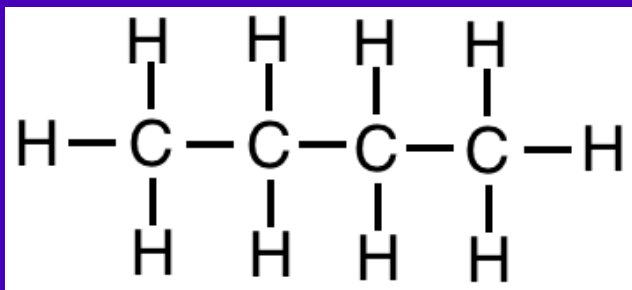
Lewis structure

line structure

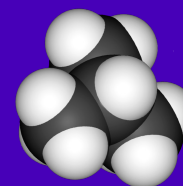
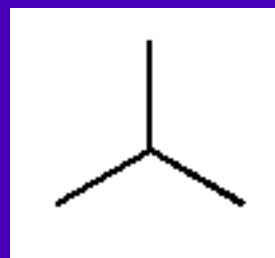
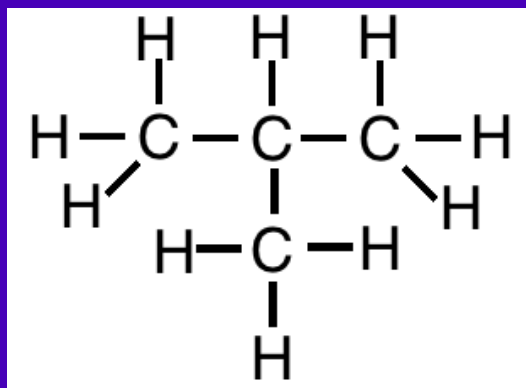
propane



butane



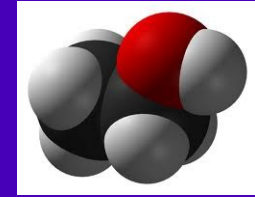
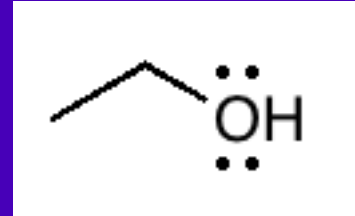
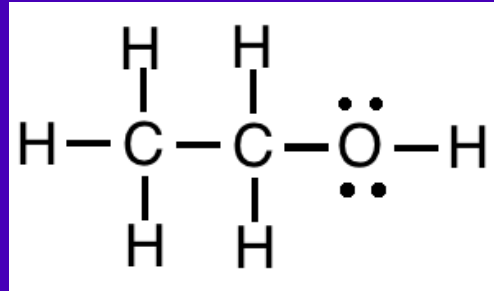
isobutane



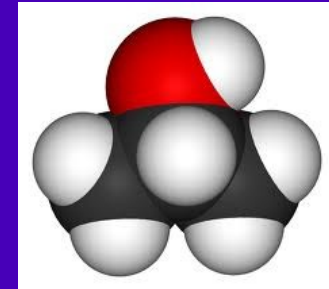
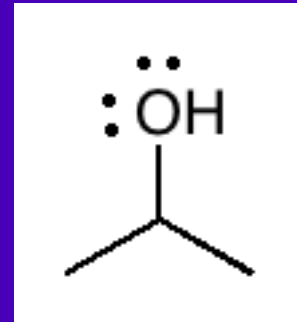
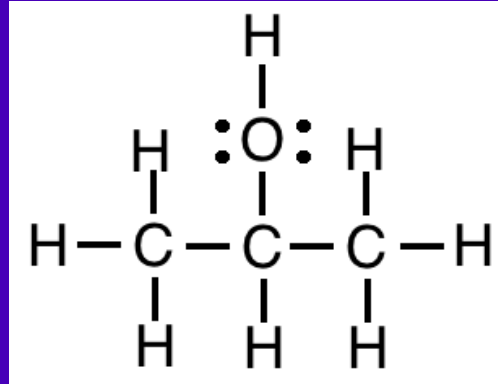
Lewis structure

line structure

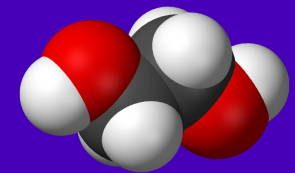
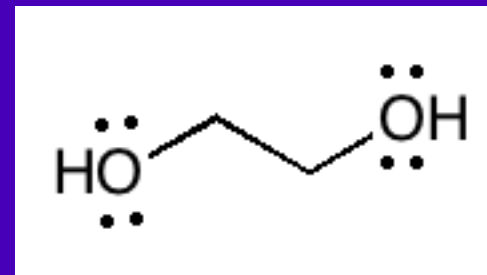
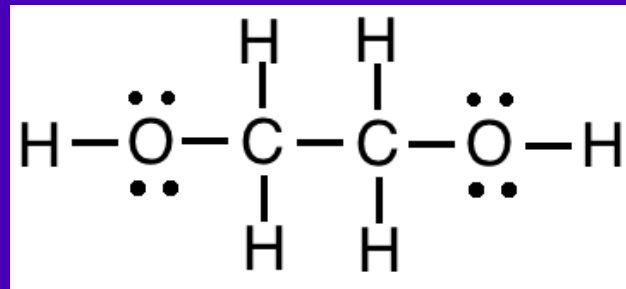
ethanol



isopropyl alcohol



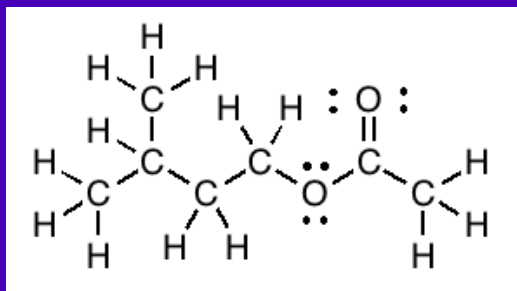
ethylene glycol



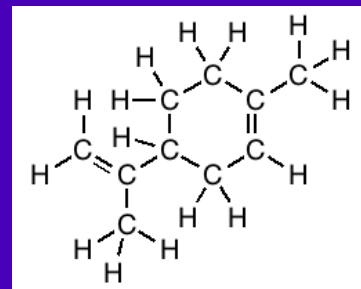
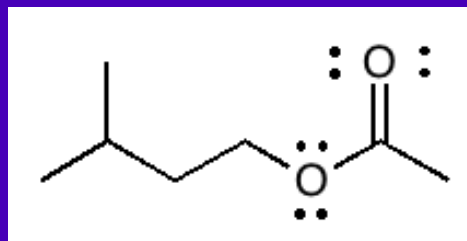
What are the rules for making line structures?

show all lines between C, remove H's and bonds to them,
put H's next to O's

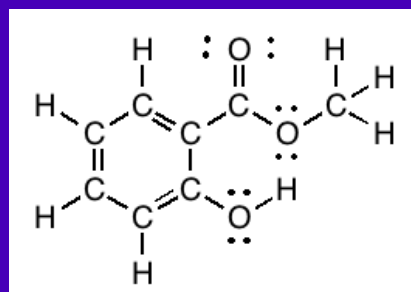
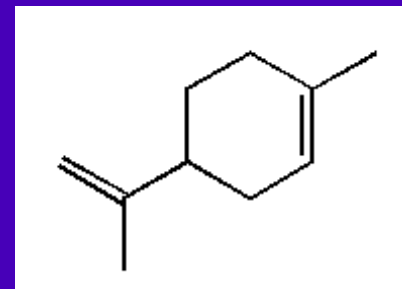
Fill in the Lewis structures for the molecules we were looking at.



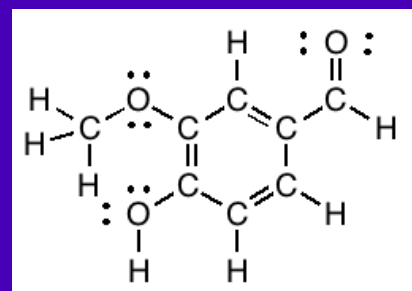
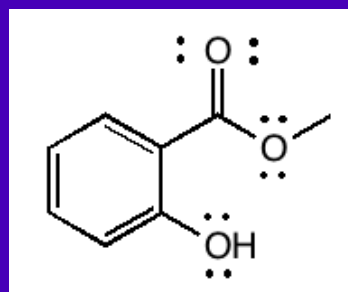
isopentyl acetate



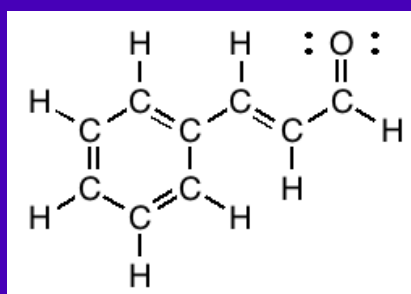
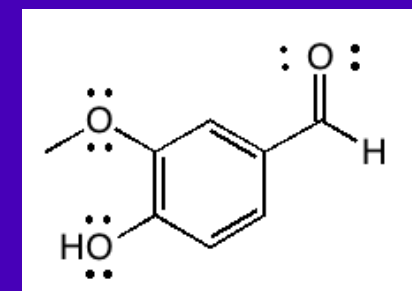
limonene



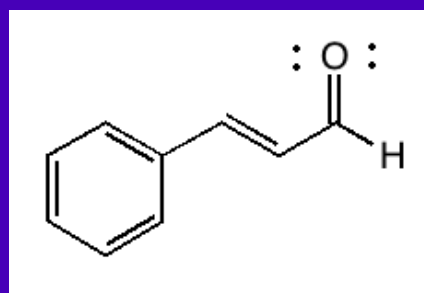
methyl salicylate



vanillin

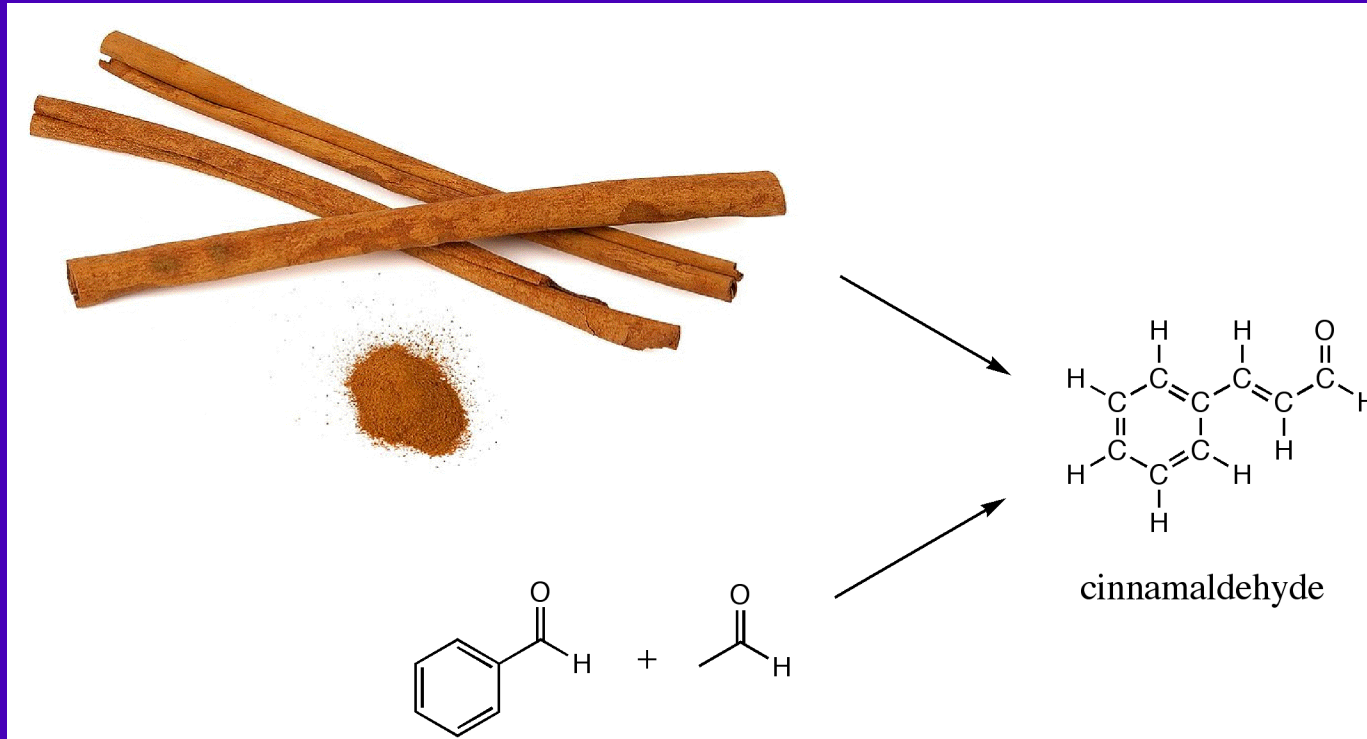


cinnamaldehyde



Natural and Artificial Flavors

Not all of the cinnamaldehyde we use comes from nature.

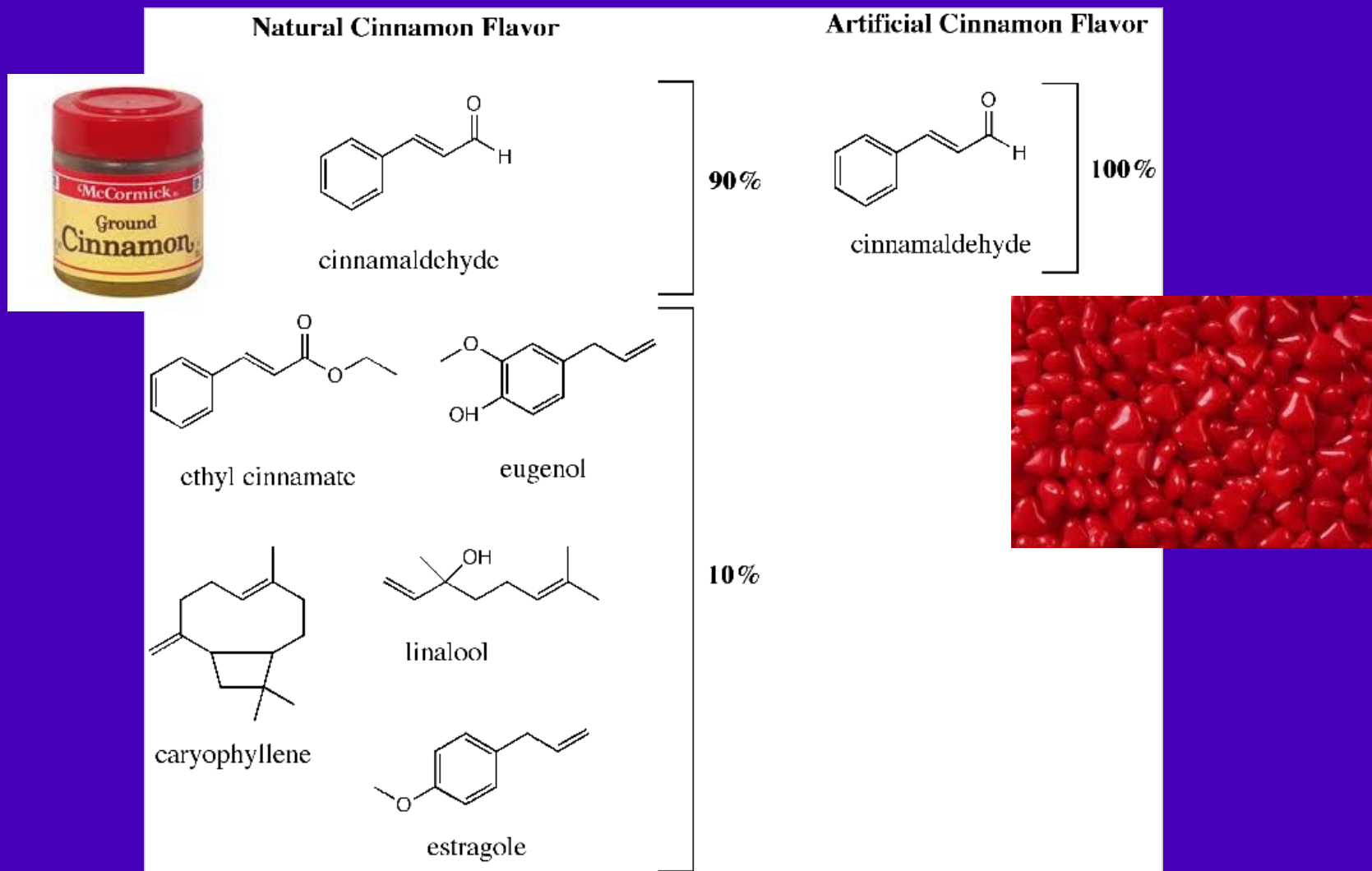


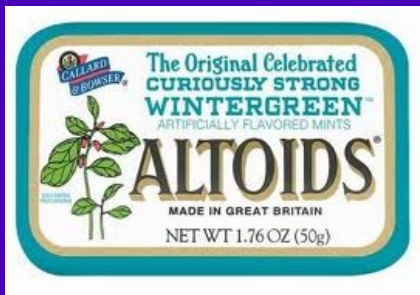
the same molecule can come from the tree,
or it can be made from other chemicals

Does cinnamaldehyde from a tree taste the same as from a when it is made from a chemical reaction?

yes – its the same molecule

no – in the tree, it comes with other molecules





wintergreen – 98% methyl salicylate, 2% other compounds



vanilla – 200 other compounds besides vanillin



banana – lots of other compounds



lemon – lots of other compounds