ORGANIC CHEM Classwork name: ___________________________

Objective: to familiarize ourselves with organic functional groups and to learn how to recognize them in organic chemical diagrams.

You will do all of this, which will take 3 class periods, and LOOK for the patterns. When you need to draw molecules, have table R open, and make sure your functional groups get drawn perfectly. Count, every single time.

You must use a pencil.

This is BIG, but you are bigger (and smarter). Do not slack off, this will take full effort.

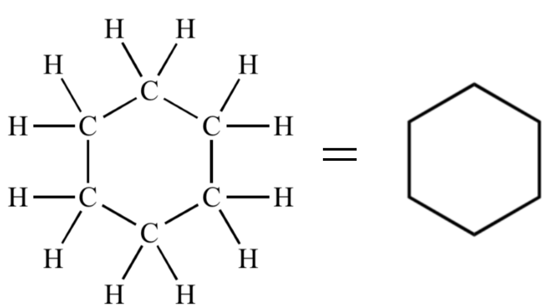
Large Organic Molecules are so big, and so repetitive, that short cuts have been created to show them.

In medicines and common things like caffeine, what at first glance appear to be complex molecules to non-chemists, are easily recognizable to us. With shapes, like hexagons, each corner is a carbon atom. If nothing is bonded to the corner, since each carbon has to make 4 bonds, sufficient hydrogen atoms are present even though they aren't drawn. Any other atoms besides H or C must be drawn for you to see. Double bonds and even triple bonds are apparent. Look at the examples, then determine the generic chemical formulas.

By rule we will list the atoms of the chemical formula in this order: C, H, N, O, etc.

1. This is cyclohexane, six carbons single bonded in a ring shape. The hexagon next to it is the "shortcut" diagram. Each corner is a carbon, and since each carbon must make 4 bonds, the formula is C_6H_{12}.

2. This is called benzene. It's similar to the first molecule, but it has alternating double bonds. It can be simplified as the hexagon with three triple bonds. The formula here is C_6H_6.



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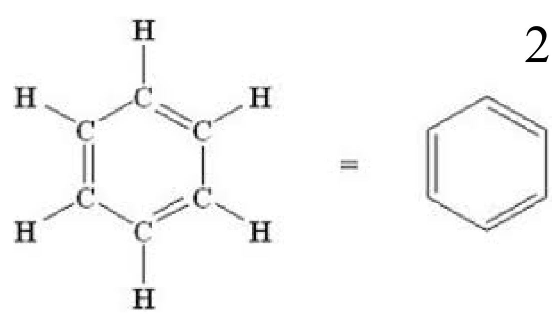


2

On the next page are 6 molecules for you to examine, put the "C" atoms in place, and add in some "H" atoms too.

See if you can get the actual formulas (answers on the bottom of page 2, upside down.

3. Number 3 is caffeine (AKA theophylline). The nitrogen atoms are labeled, but the other corners are all carbon. The molecule also has three "dashes" that lead to "nothing". At the end of each dash is a really a carbon atom, each bonded to 3 atoms of H. What is the formula for this molecule? Note the "CH_3" top left, as compared to in #4, the N atom bonds to a single "H"

4. Fourth is theobromine (not bromine!), which is what makes chocolate taste so good. It's similar to caffeine, but not quite. What is that formula?

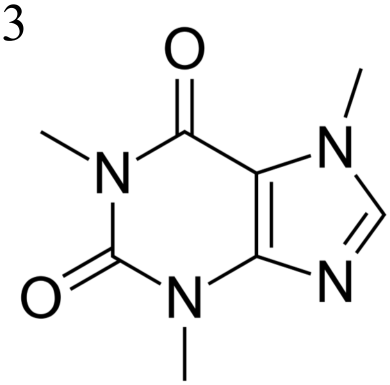
5. Aspirin (acetylsalicylic acid) for headaches is the fifth molecule. What is the formula?

6. Naphthalene is the stuff in moth balls that smells so bad! Your nose can detect it at levels of just 0.08 PPM! What's the formula?

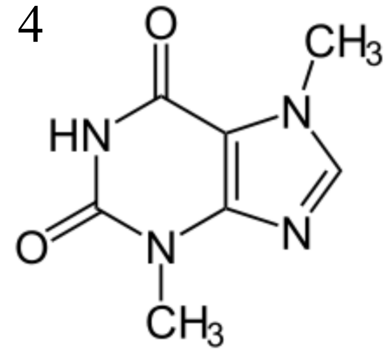
7. The large multi-ringed molecule at the bottom is a type of cholesterol that clogs your arteries when you're old (eat well now!). Try that formula too. (don't miss that tiny –OH in the corner)

8. Methyl Phenylacetate is the fancy name for another wonderful smell called HONEY. (Pooh loves honey, U2 sings about "Wild Honey", the Beatles sang about "Honey Pie"). That funky hexagon ring with the circle means that the single and double bonds altername (and resonate), so the five corners there are all "C" single bonded to "H". What is the formula?

3



4



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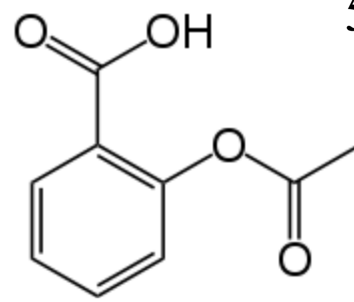

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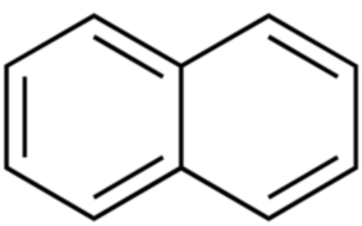

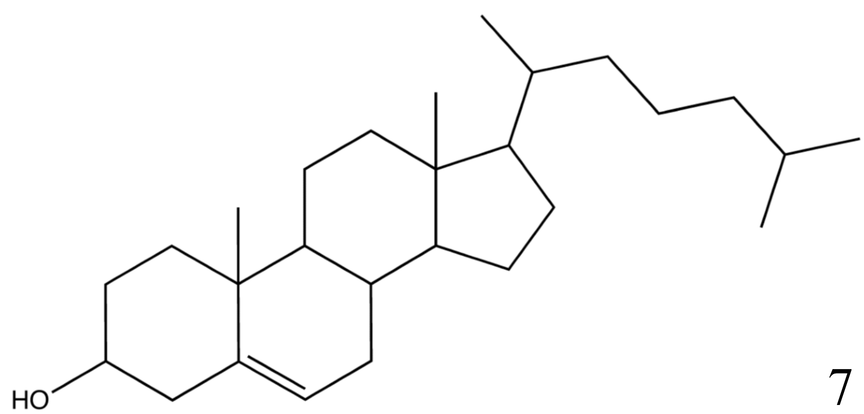

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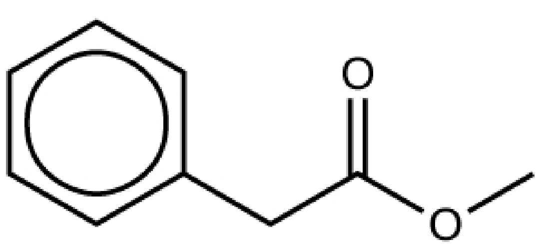
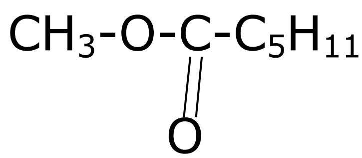
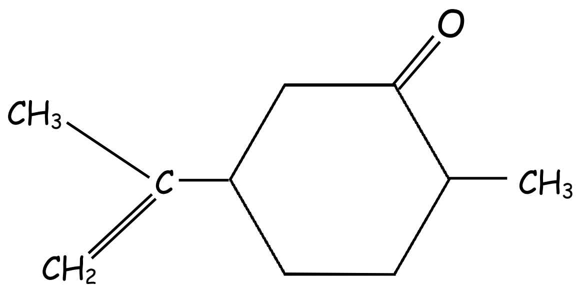
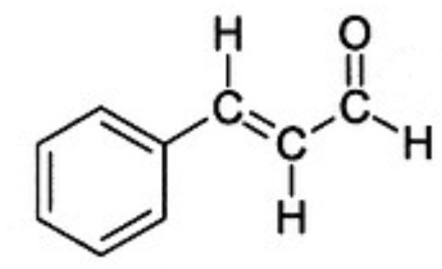
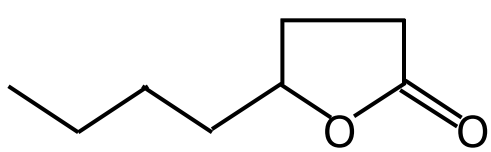
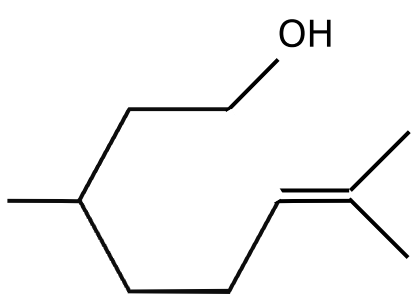
8

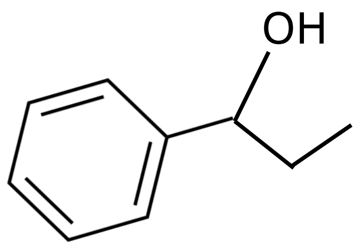
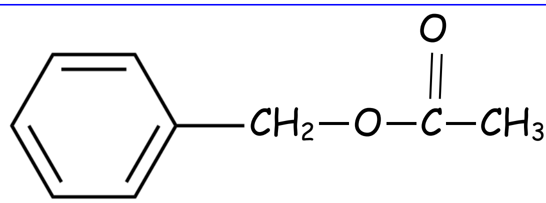
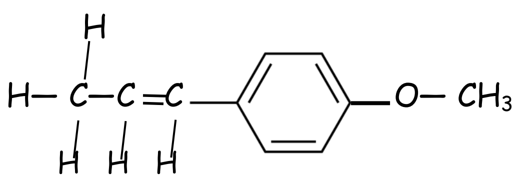
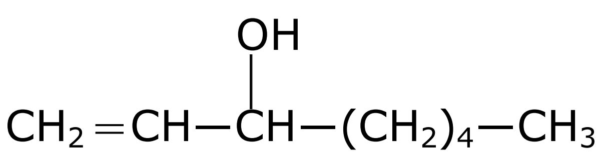
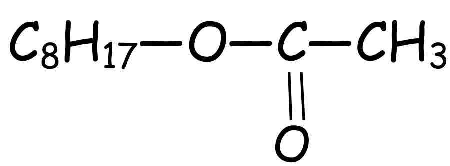
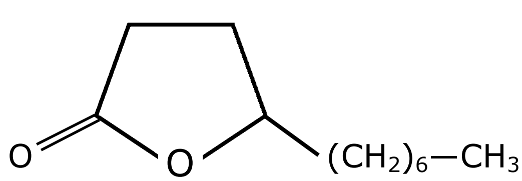


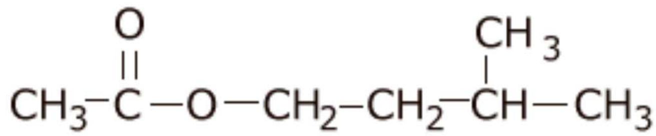
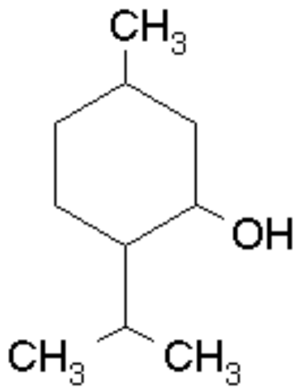
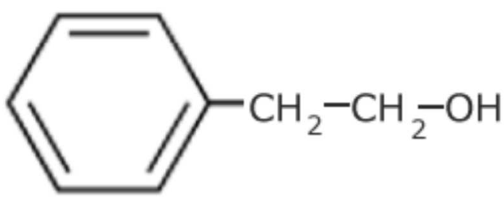
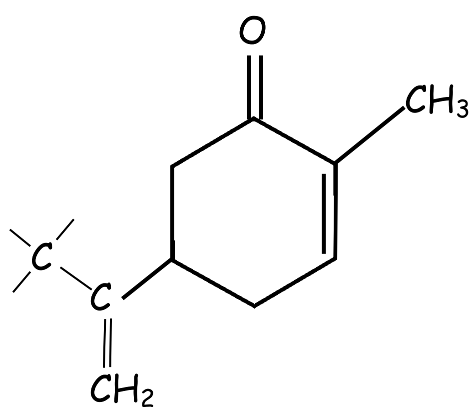
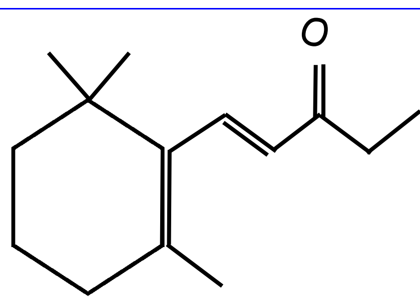
3 Caffeine is $C_8H_{10}N_4O_2$
4 Chocolate is $C_7H_8N_4O_2$
5 Aspirin is $C_9H_8O_4$
6 Naphthalene moth balls is $C_{10}H_8$
7 Cholesterol is $C_{27}H_{46}O$
8 Honey is $C_9H_{10}O_2$

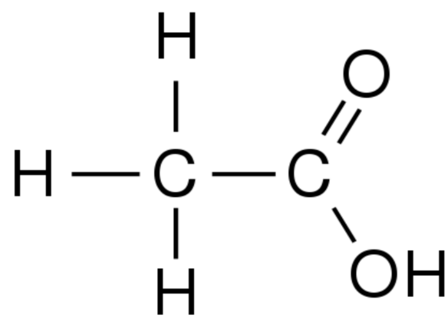
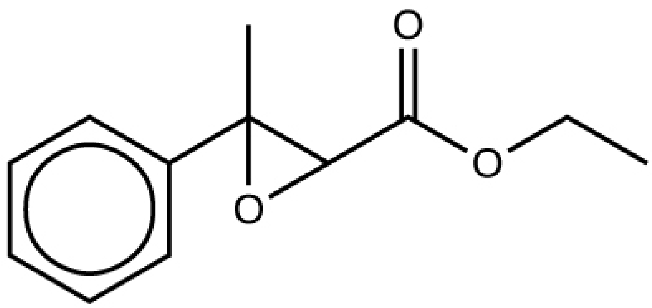
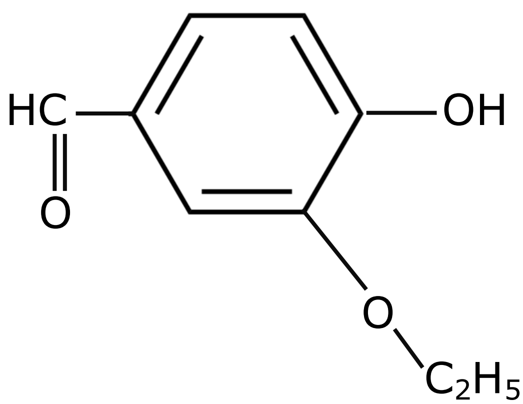
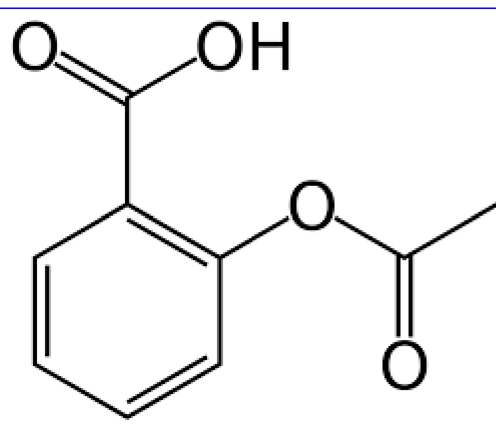
Draw these compounds. Make them BIG, and put 8 per page.
You do NOT have to draw all of the hydrogen atoms.
You do have to draw every “H” if it’s in a functional group, or if the molecule is a “meth” (single carbon) molecule, that shows you KNOW what you’re doing.
Use pencil, no big cross outs will be accepted!

page 1	propane 3-nonene ethanol di-propyl ether	pentane 2-butyne methanoic acid 1,1,2 trifluoro ethane
page 2	1-bromo-2-hexyne butane octane 2,3,6, tri-chlorodecane	4-nonyne propene butyl methanoate ethyl propyl ether
page 3	1-butanol methyl-propyl ether pentanal propanoic acid	tri-iodo methane 3-hexanone 2,4 dimethyl hexane ethanamide
page 4	ethanoic acid 1 bromo,4 chloro 2-pentene chloromethane butyl hexyl ether	ethyl butanoate heptanoic acid 3 pentanol 1-bromo, 3-chloro, 4-fluro, 6-iodo-nonane
page 5	ethanol 3-heptanone hexanimide methyl-ethyl ether	ethene propyl hexanoate 3,4 dibromo1 hexyne cyclo-pentane
page 6	4 ethyl,2-methyl octane ethyl ethanoate 2-octene 2-butyne	3-hexanamine pentanamide methyl pentanoate cyclo-butane
page 7	**Draw out the structural diagrams for each: addition, substitution, polymerization, fermentation, esterification, and saponification.** Addition: 2pentene + Br_2 into one product Substitution: propane + Cl_2 form 2chloropropane (and???) Polymerization: tetrafluoroethene forms polytetrafluoroethane (show at lease 3 molecules and one product) Fermentation of GLUCOSE ($C_6H_{12}O_6$) into 2 products. Make sure to show yeast and water by the arrow. Esterfication of 1-propanol and pentanoic acid (makes 2 products, which you will name) You do not have to draw saponification, but you do need to state the general word formula for soap making (both reactants and both products).	

SCENT	Circle the Functional Groups ONLY in these STRUCTURAL FORMULAS	Name the types of Functional Groups present
banana		Name this compound
caraway (rye bread)		How many hydrogen atoms in molecule?
cinnamon		
coconut		How many carbon atoms in molecule?
geraniums (flowers)		

SCENT	Circle the Functional Groups ONLY in these STRUCTURAL FORMULAS	Name the types of Functional Groups present
hyacinth (flowers)		
jasmine		
licorice		
mushroom		Total hydrogen atoms?
orange		Name this compound
peach		Total hydrogen atoms?

SCENT	Circle the Functional Groups ONLY in these STRUCTURAL FORMULAS	Name the types of Functional Groups present
pear		
peppermint		
roses		Total hydrogen atoms?
spearmint		
violets		Total number of carbon atoms?

SCENT	Circle the Functional Groups ONLY in these STRUCTURAL FORMULAS	Name the types of Functional Groups present
Vinegar		name this compound
strawberry		
vanilla		
wintergreen		How many double bonds are in this molecule? ______

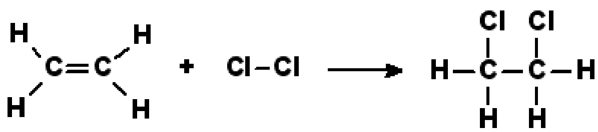
Homologous Series Name	general formula n = number of carbon atoms	EXAMPLES	
		Name (4 Carbon chains)	Structural Formulas (draw all hydrogen atoms)
alkanes		butane	
alkenes		1-butene	
alkynes		2-butyne	

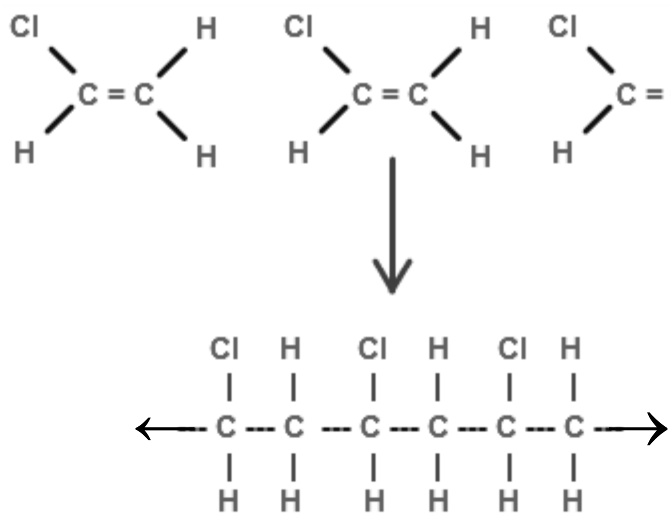
Draw	Structural Diagrams of these BRANCHED HYDROCARBONS
2,5 dimethyl 3fluoro heptane	
5ethyl 3,6,7 trimethyl 1-octene	
1chloro 3,3 difluoro 4,5 dimethyl 1 hexyne	

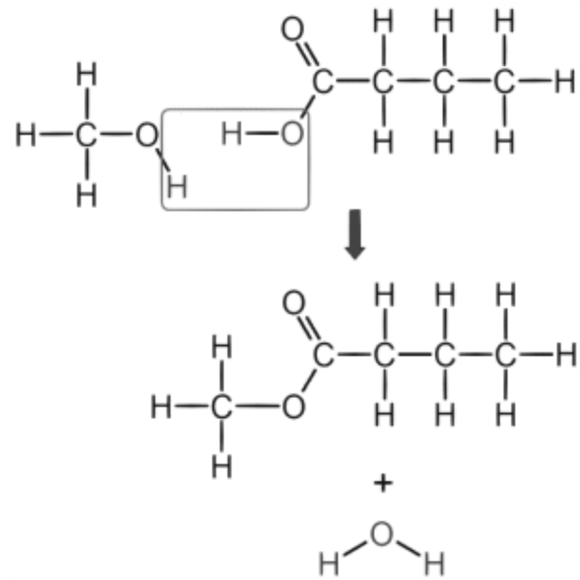
In each BOX of the following organic reactions, name each type of reaction shown.

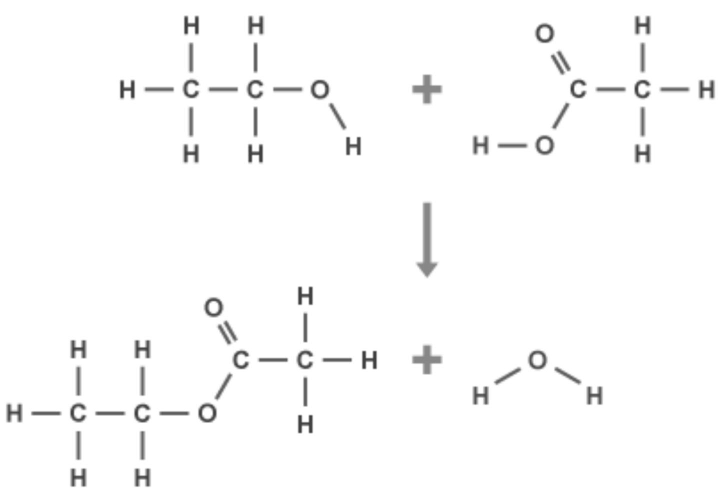
$$CH_4 + Cl_2 \longrightarrow CH_3Cl + HCl$$

Draw out the molecules to show 2butyne + fluorine form into 2,3 difluro 2butene









Name the 2 products as well.

$$C_6H_{12}O_{6(AQ)} \xrightarrow[+\ \text{water}]{\text{Enzymes}} CO_{2(G)} + C_2H_5OH_{(AQ)}$$

Not balanced! FIX.

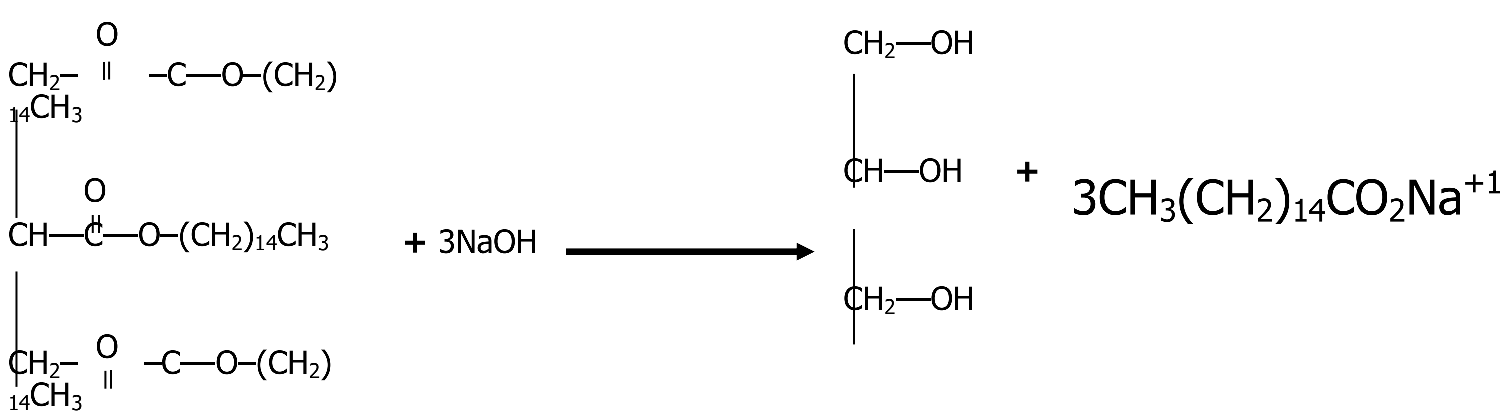
Draw the structural diagrams AND condensed structural formulas showing these 3 reactions.
Substitute in only ONE halogen atom at a time.

Substitute in a fluorine atom with ethane, forming fluoro-ethane + HF
Substitute in a chlorine atom with propane, forming 1-chloropropane + HCl
Substitute in an iodine atom with propane, this time forming 2-iodo-propane + HI
Substitute in a bromine atom with pentane, this time forming 2-bromopentane + HBr
Substitute in a fluorine atom with 2-bromopentane, this time forming 1-fluror,2-bromopentane + HF

Addition reactions require you to start with an *unsaturated* hydrocarbon, so you have the room in the molecule to add either F_2, Cl_2, Br_2, I_2, or even H_2. You must start with an alkene, or alkyne. Alkenes open the double bond to a single, allowing two places to open to add the diatomic halogen (or hydrogen). If you start with an alkyne, you convert the triple bond to a double, then add in the two new atoms. In each box, draw structural formulas for each.

Add a bromine molecule to 2-pentene
Add a chlorine molecule to 2-butyne
Add a hydrogen molecule to propene
Add a hydrogen molecule to 1-butyne

Saponification is the production of soap. This reaction has four parts. In the wrong order they are a triple alcohol, three bases, a triple ester (also known as a fat), and the three soap molecules. Label these reactants and products. CIRCLE all of the organic ester and alcohol functional groups.



Esterification is the process of combining organic acids to alcohols by the removal of $HOH_{(L)}$, forming an ester. Strangely, acids are known for liberating hydrogen ions when ionizing in water. Alcohols do not ionize at all.
In this reaction, the acid will lose the –OH part of the COOH group, and the alcohol will lose just the H from its –OH group. The HOH forms water, and the molecules join with a COO group in the middle. We always name esters this way: FIRST name is the group attached to the oxygen "tail", the second name contains all the other carbons.

Draw and label the structural diagrams for propanoic acid and for ethanol, and the two products. Make sure the functional groups are both drawn **towards** each other. Circle the OH and the H that makes the water. NAME both products that form.

Now combine methanol with hexanoic acid to produce the wonderful smell of bananas! Do the same as above, draw 2 diagrams for the acid and the alcohol, circle the –OH and the –H that forms water, then draw and properly name both products that form.