

Chapter 11

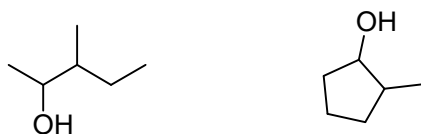
Organic Functional Groups: Intro & IUPAC Nomenclature

Organic Functional Groups Part 1 - Introduction

Certain combinations of heteroatoms and bonds are seen frequently. These characteristic arrangements are known as functional groups. Functional groups are important.

R-groups

Ex: The following two compounds can both be described as R-OH.



Both compounds above have similar chemical reactivity even though the hydrocarbon backbones are different.

Alcohols and Ethers: The C-O containing Functional Groups

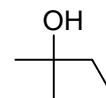
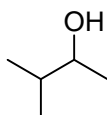
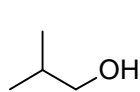
Electron geometry around O?

Molecular geometry around O?

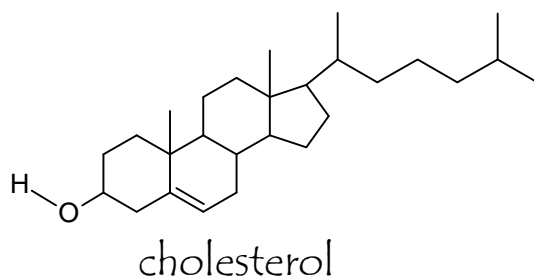
Dominant IMF for ROH and ROR'?

Alcohol Classification (R-OH)

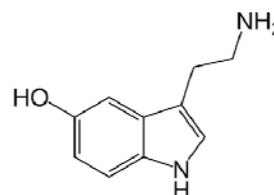
Determined by the number of carbon atoms bonded to the carbon bearing the -OH group.



The -ol ending indicates the presence of an alcohol group.
Circle the alcohol group in cholesterol below.

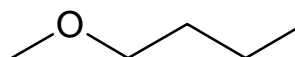
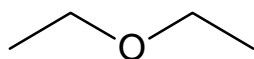


Phenols: -OH groups bonded directly to an aromatic ring



Serotonin – a neurotransmitter

Ethers



Carbonyls: The C=O Containing Functional Groups

Electron geometry around C?

Molecular geometry around C?

Structural Formula	Condensed Formula	Name of Functional Group
$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{H} \end{array}$		
$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{R} \end{array}$		
$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{O}-\text{H} \end{array}$		
$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{O}-\text{R} \end{array}$		
$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{S}-\text{H} \end{array}$		
$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{N}-\text{H} \\ \\ \text{H} \end{array}$		
$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{N}-\text{R} \\ \\ \text{H} \end{array}$		
$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{N}-\text{R} \\ \\ \text{R} \end{array}$		

Amines: The C-N Containing Functional Groups

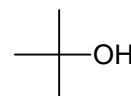
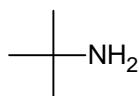
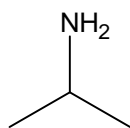
Electron geometry around N?

Molecular geometry around N?

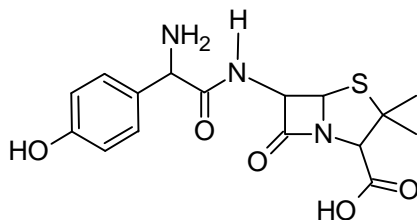
Classify amines by the number of R-groups bonded to the N atom



Classify (1°, 2° or 3°) the following.



Classify all the functional groups in amoxicillin below.








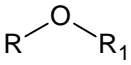
Organic Functional Groups Part 2

IUPAC Nomenclature of Alcohols, Aldehydes, Ketones, Carboxylic acids, Esters, & Amides

Guidelines for Naming Organic Compounds with Heteroatoms

Rule 1: Assign the root by finding the longest continuous carbon chain that contains the functional group.

Rule 2: Assign the suffix by replacing -ane from homologous series per the table below.

	Functional Group	Suffix Name	Substituent Name
	Carboxylic acid	-anoic acid	
	Ester	-anoate	
	Amide	-anamide	
	Aldehyde	-anal	
	Ketone	-anone	
$R-OH$	Alcohol	-anol	hydroxy-
$R-SH$	Sulfhydryl	-thiol	
$R-NH_2$	Amine	-anamine	amino-
$R_2C=CR_2$	Alkene	-ene	
$RC\equiv CR$	Alkyne	-yne	
R	Alkane	-ane	alkyl-
	Ether	---	

Rule 3: Assign a locator number to the root indicating the location of the functional group. Give the functional group the lowest possible number. For alkyl substituents on the nitrogen of amines, use an "N" as the locator. A functional group on a cycloalkane does not need a locator number.

Rule 4: Assign a prefix if the main chain contains substituents.

All organic compounds are named using the **same general strategy**. Once you memorize the functional group suffix names and their relative priority, naming organic compounds is very straightforward. The parts are arranged in the order shown below.

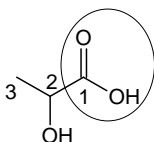
<p>Stereochemistry Cis or Trans R or S D or L + or -</p>	<p>Substituents cited alphabetically with position indicated by their number on the parent carbon chain</p>	<p>Parent Chain longest carbon chain containing the highest ranking functional group</p>	<p>Suffix is determined by the highest ranking</p>
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#-stereochemistry-#-substituent-#-alk"suffix"

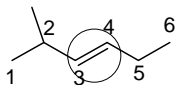
Read through these examples of IUPAC nomenclature. The highest ranking functional group has been circled. Note the numbering of the parent carbon chain and alphabetical citing of the substituents.

For each compound and corresponding IUPAC name,

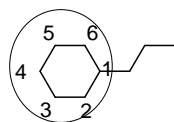
- circle the suffix which names the highest ranking functional group
- box the parent carbon chain name
- underline the substituents



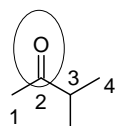
2-hydroxypropanoic acid



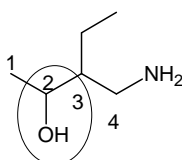
trans-2-methyl-3-hexene



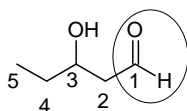
propylcyclohexane



3-methyl-2-butanone



4-amino-3-bromo-2-butanol



3-hydroxypentanal

Stereochemistry

Cis or Trans

R or S

D or L

+ or -

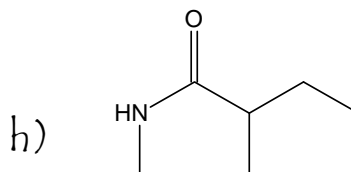
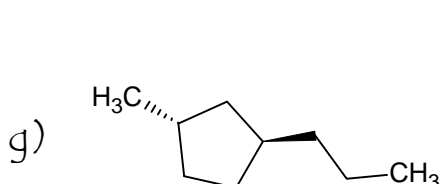
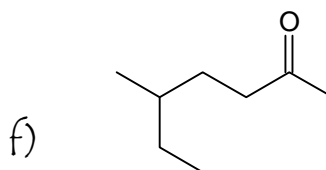
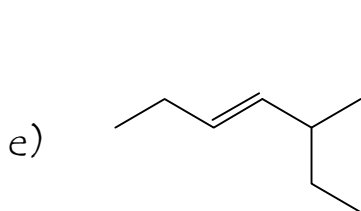
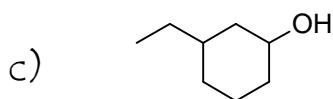
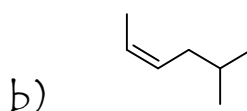
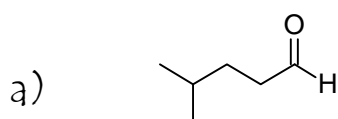
Substituents
cited alphabetically with
position indicated by
their number on the
parent carbon chain

Parent Chain
longest carbon
chain containing
the highest ranking
functional group

Suffix is
determined by the
highest ranking
functional group

#-stereochemistry-#-substituent-#-alk"suffix"

Give the IUPAC name for each of the following compounds.



Stereochemistry

Cis or Trans

R or S

D or L

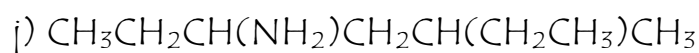
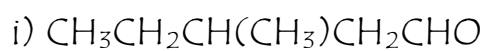
+ or -

Substituents
cited alphabetically with
position indicated by
their number on the
parent carbon chain

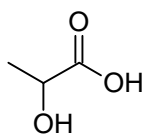
Parent Chain
longest carbon
chain containing
the highest ranking
functional group

Suffix is
determined by the
highest ranking
functional group

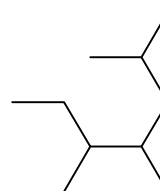
#-stereochemistry-#-substituent-#-alk"suffix"



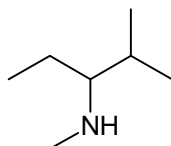
k)



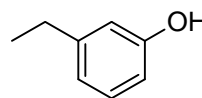
l)



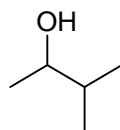
m)



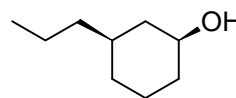
n)



o)

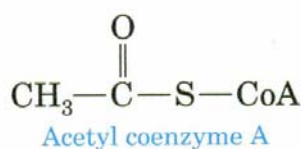
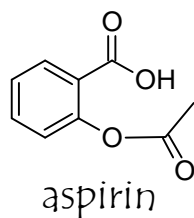


p)

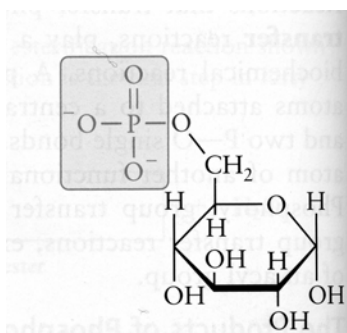


Organic Functional Groups Part 3

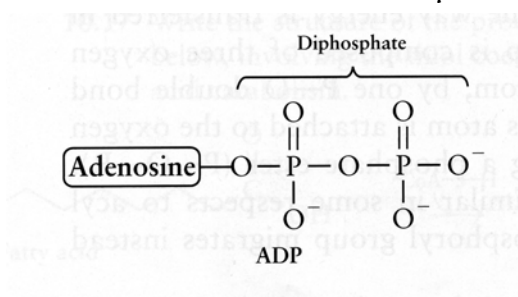
Esters, Thioesters, Phosphoesters, & Phosphoanhydrides



Phosphate esters are formed when 1 or more of the H atoms of phosphoric acid is (are) replaced with 1 or more R groups.

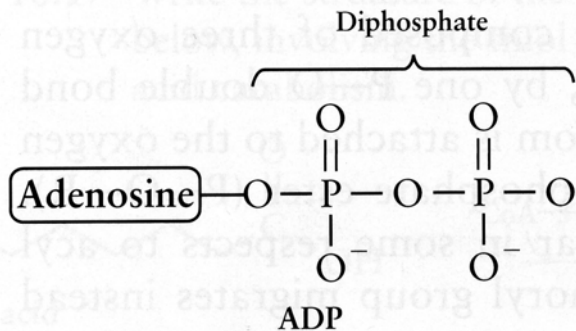
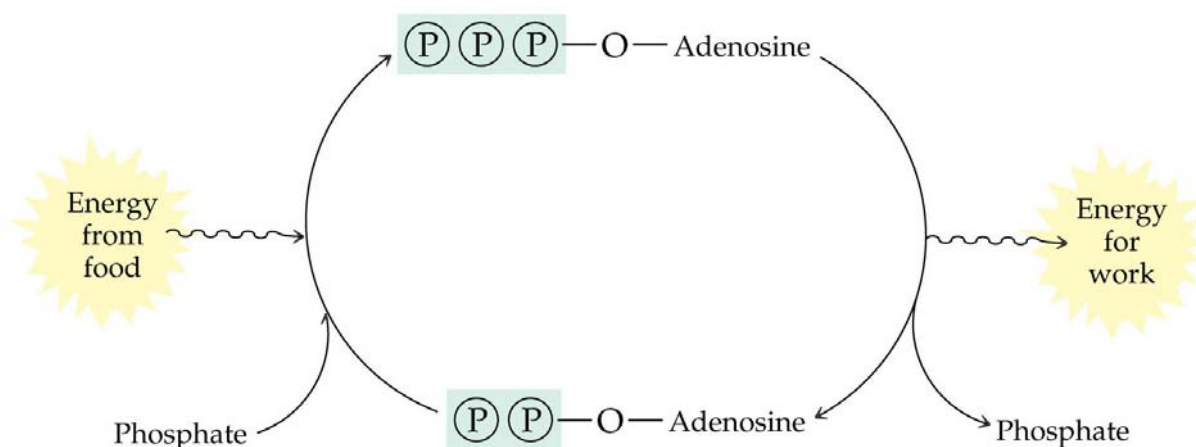
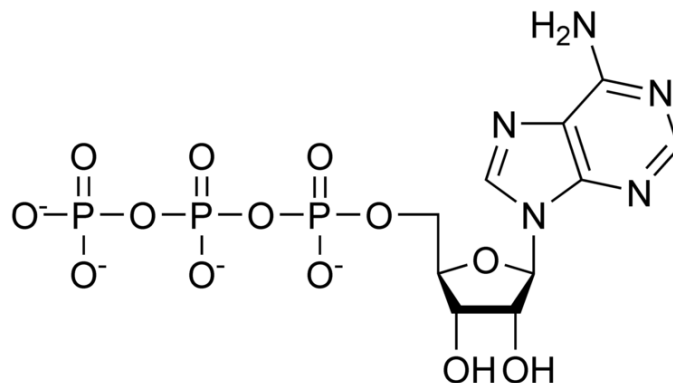


Phosphoanhydride bonds form when the O atoms of one phosphate group bonds with the P atom of another phosphate group.



Energy Currency, Phosphoanhydride bonds, & ATP

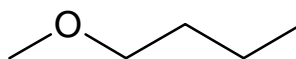
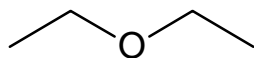
Our body stores and transports energy in the phosphoanhydride bonds of ATP.



Organic Functional Groups Part 4 – Naming Ethers, Phenols, and Esters

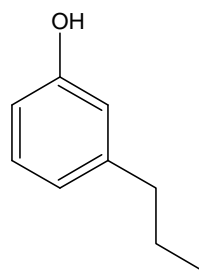
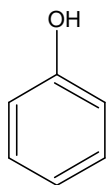
Common Names for Ethers

Name each R groups as though it were a substituent (-yl suffix from homologous series) and then end the name with the word 'ether'



Phenols: -OH groups bonded directly to an aromatic ring

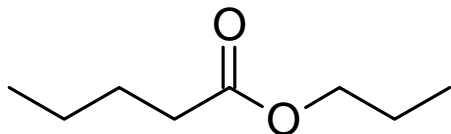
To name a phenol, follow the rules for naming substituted benzene changing the root name to phenol.



What is the condensed formula for phenol?

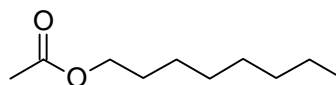
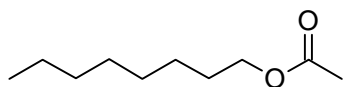
Guidelines for Naming Esters

- Rule 1: Assign the root to the carbon chain that contains the carbonyl carbon
- Rule 2: Assign the suffix by changing the 'ane' to 'anoate'
- Rule 3: assign the prefix to the R group attached to the oxygen atom and use the 'yl' as we would for any substituent



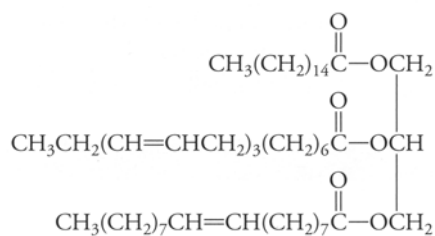
Draw the skeletal line structure for ethyl butanoate (pineapple flavor).

Give the IUPAC name for orange flavor. The skeletal-line structure is shown in two different orientations to help you recognize esters.



Fats and Oils are also called Triglycerides

Circle the 3 esters groups in the triglyceride below.



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