Take notes while watching the following video tutorials to prepare for the "Organic Functional Groups Intro with Nomenclature Activity".

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.

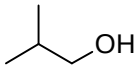
Alcohols and Ethers: The C-O containing Functional Groups

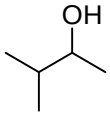
Electron geometry around O?

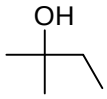
Molecular geometry around O?

Dominant IMF for ROH and ROR'?

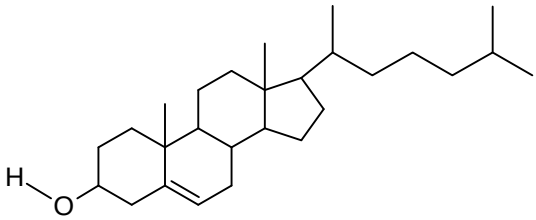
Alcohol Classification (R-OH)
Determined by the number of carbon atoms bonded to the carbon bearing the –OH group.





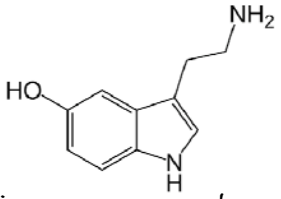


The –ol ending indicates the presence of an alcohol group.
Circle the alcohol group in cholesterol below.



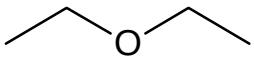
cholesterol

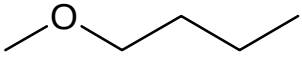
Phenols: –OH groups bonded directly to an aromatic ring



Serotonin – a neurotransmitter

Ethers

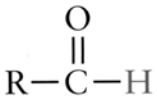
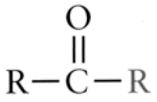
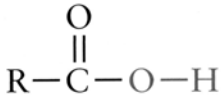
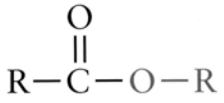
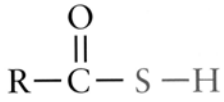
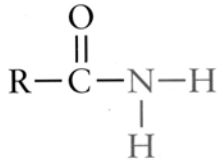
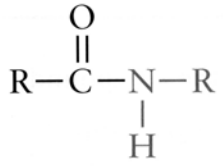
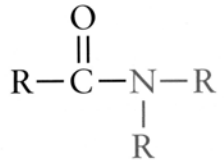




Carbonyls: The C=O Containing Functional Groups

Electron geometry around C?

Molecular geometry around C?

Structural Formula	Condensed Formula	Name of Functional Group
		
		
		
		
		
		
		
		

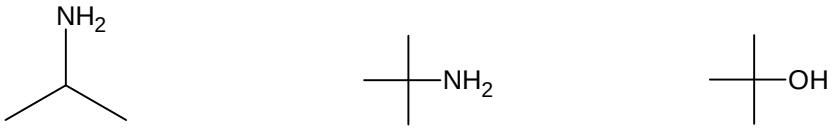
Amines: The C-N Containing Functional Groups

Electron geometry around N?

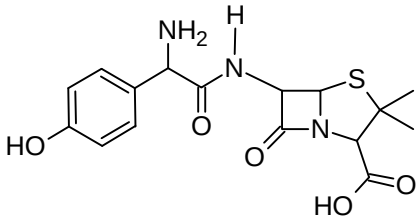
Molecular geometry around N?

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.



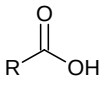
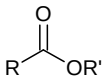
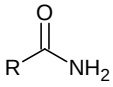
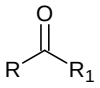
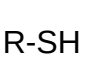
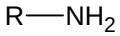
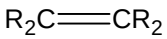
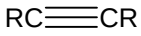
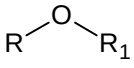
Organic Functional Groups Part 2

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	
	Alcohol	–anol	hydroxy–
	Sulfhydryl	–thiol	
	Amine	–anamine	amino–
	Alkene	–ene	
	Alkyne	–yne	
	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.

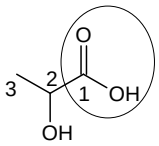
All organic compounds are named using the **same general strategy**. Once you memorize the functional group suffix names and their relative priority, naming organic compounds is very straightforward. The parts are arranged in the order shown below.

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

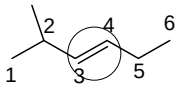
#-stereochemistry-#-substituent-#-alk"suffix"

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,

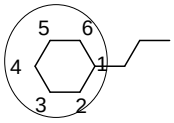
a) circle the suffix which names the highest ranking functional group
b) box the parent carbon chain name
c) underline the substituents



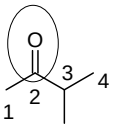
2-hydroxypropanoic acid



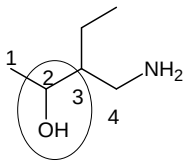
trans-2-methyl-3-hexene



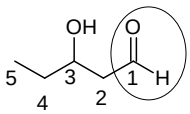
propylcyclohexane



3-methyl-2-butanone



4-amino-3-bromo-2-butanol

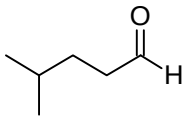


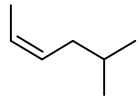
3-hydroxypentanal

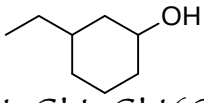
Stereochemistry Cis or Trans R or S D or L + or -	Substituents cited alphabetically with position indicated by their number on the parent carbon chain	Parent Chain longest carbon chain containing the highest ranking functional group	Suffix is determined by the highest ranking functional group

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

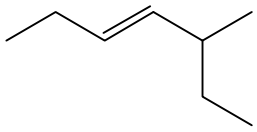
Give the IUPAC name for each of the following compounds.

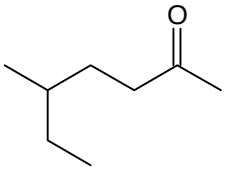
a) 

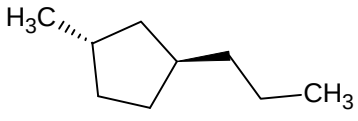
b) 

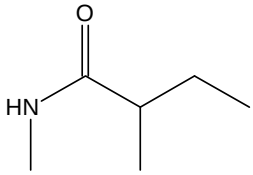
c) 

d) $CH_3CH_2CH_2CH(CH_2CH_3)CH_2CHO$

e) 

f) 



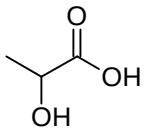


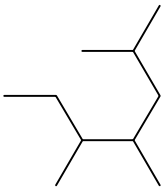
g) h)

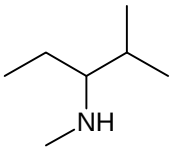
Stereochemistry Cis or Trans R or S D or L + or -	Substituents cited alphabetically with position indicated by their number on the parent carbon chain	Parent Chain longest carbon chain containing the highest ranking functional group	Suffix is determined by the highest ranking functional group

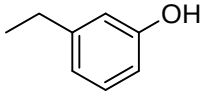
#-stereochemistry-#-substituent-#-alk"suffix"

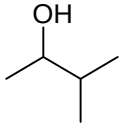
i) $CH_3CH_2CH(CH_3)CH_2CHO$ j) $CH_3CH_2CH(NH_2)CH_2CH(CH_2CH_3)CH_3$

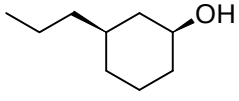
k) 

l) 

m) 

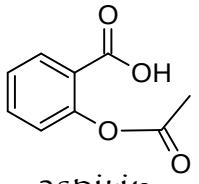
n) 

o) 

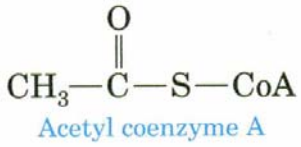
p) 

Organic Functional Groups Part 3

Esters, Thioesters, Phosphoesters, & Phosphoanhydrides

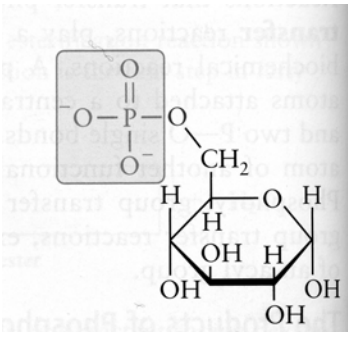


aspirin

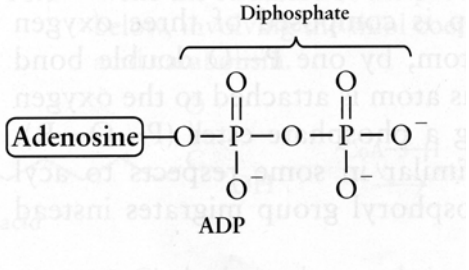


Acetyl coenzyme A

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

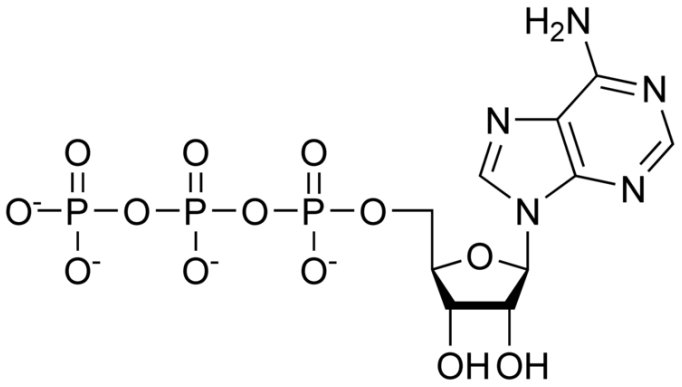


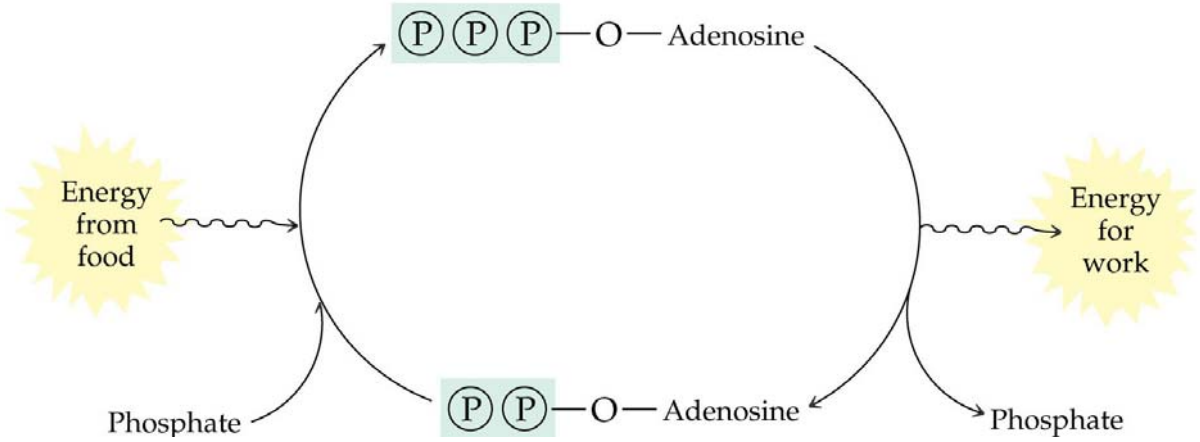
Phosphoanhydride bonds form when the O atoms of one phosphate group bonds with the P atom of another phosphate group.

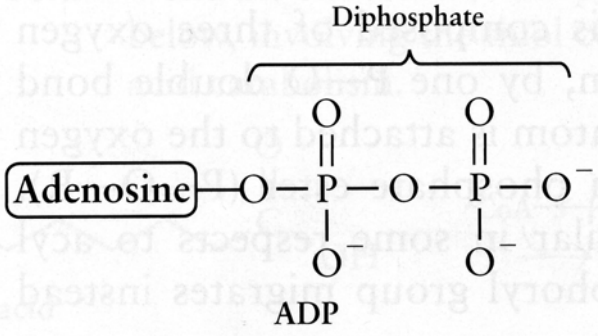


ADP

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



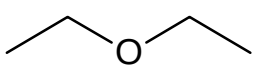


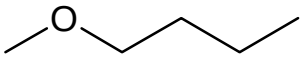


Organic Functional Groups Part 4 – Naming Ethers, Phenols, and Esters

Common Names for Ethers

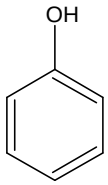
Name each R groups as though it were a substituent (-yl suffix from homologous series) and then end the name with the word 'ether'

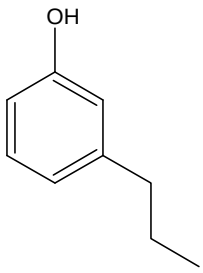




Phenols: -OH groups bonded directly to an aromatic ring

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





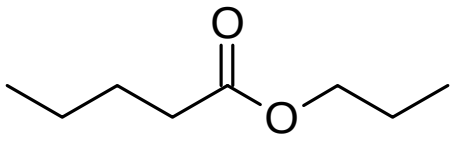
What is the condensed formula for phenol?

Guidelines for Naming Esters

Rule 1: Assign the root to the carbon chain that contains the carbonyl carbon

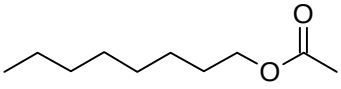
Rule 2: Assign the suffix by changing the 'ane' to 'anoate'

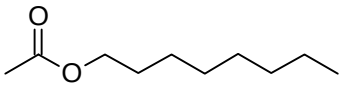
Rule 3: assign the prefix to the R group attached to the oxygen atom and use the 'yl' as we would for any substituent



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

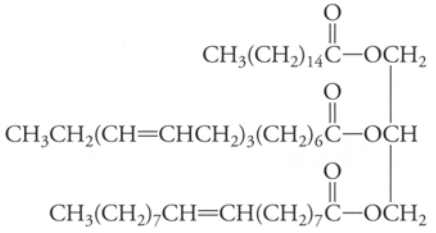
Give the IUPAC name for orange flavor. The skeletal-line structure is shown in two different orientations to help you recognize esters.

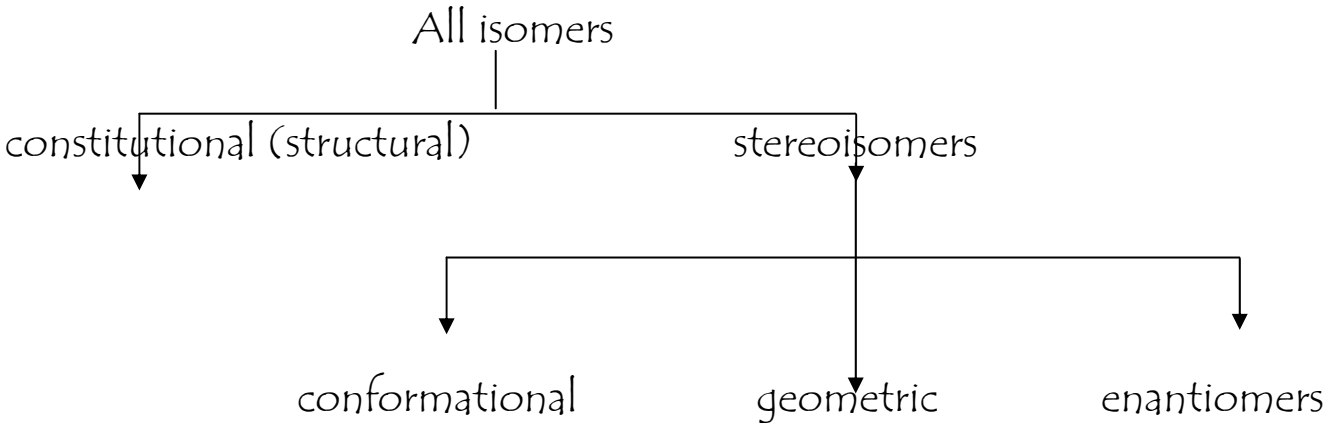




Fats and Oils are also called Triglycerides

Circle the 3 esters groups in the triglyceride below.





Stereoisomers

chiral carbon = chirality center = stereocenter = asymmetric carbon

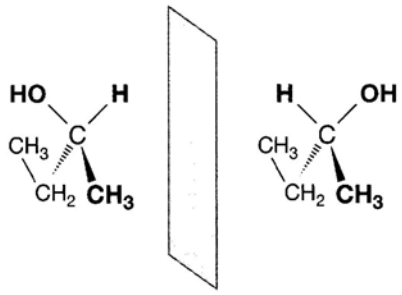
chiral carbon:

2-butanol is a chiral compound, because carbon-2 is bonded to four different groups. 2-propanol is achiral.

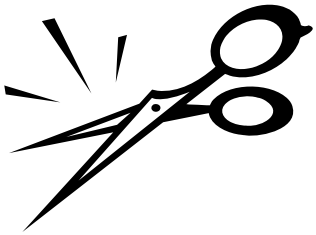
Enantiomers

chiral compounds

Compounds with one chiral carbon exist as a "pair of enantiomers".



There are chiral objects in everyday life. They tend to occur in pairs or are described as "right" or "left".
Classify the following objects as chiral or achiral.



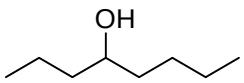
a) _____

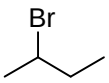
b) _____

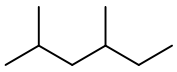
c) _____

d) _____

Star the chiral carbons

a) 

b) 

c) 

Draw the skeletal-line structure for 3-ethyl-4-methylhexane and star any chiral carbons.

One of the following molecules is chiral, but the other two are not. Draw the skeletal-line structure for each compound. Circle the chiral compound and star its chiral carbon.

a) 2-methylheptane

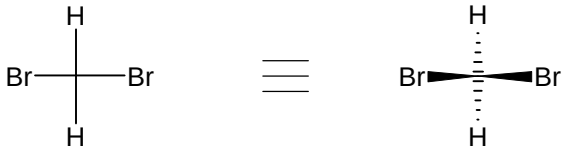
b) 3-methylheptane

c) 4-methylheptane

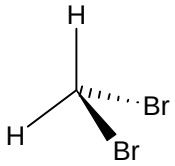
Drawing Enantiomers

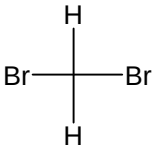
Let's start simple – an achiral molecule

Fischer Projections

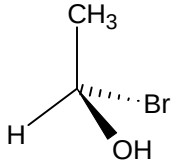


Perspective formula ⇔ Fischer Projections

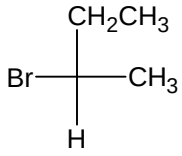




Draw the Fischer Projection for the following compound.



Draw the perspective formula for the following compound.



Optical Rotation of Polarized Light

Enantiomers share many properties

bp, mp, density, refractive index & solubilities

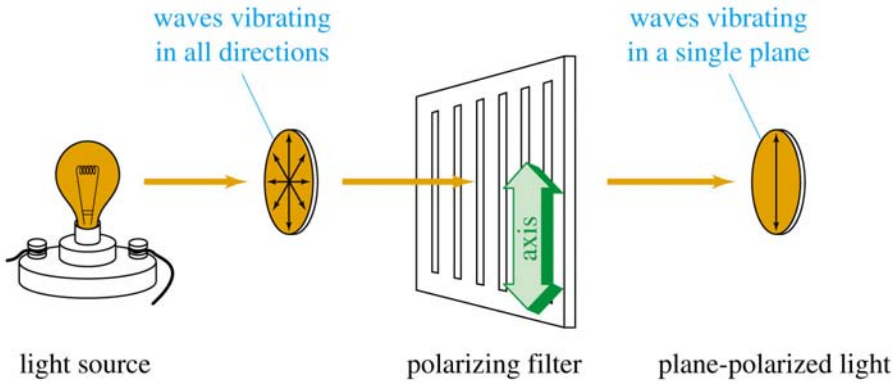
However, they interact differently with polarized light.

Enantiomers rotate polarized light in equal & opposite directions, so they are also called optical isomers.

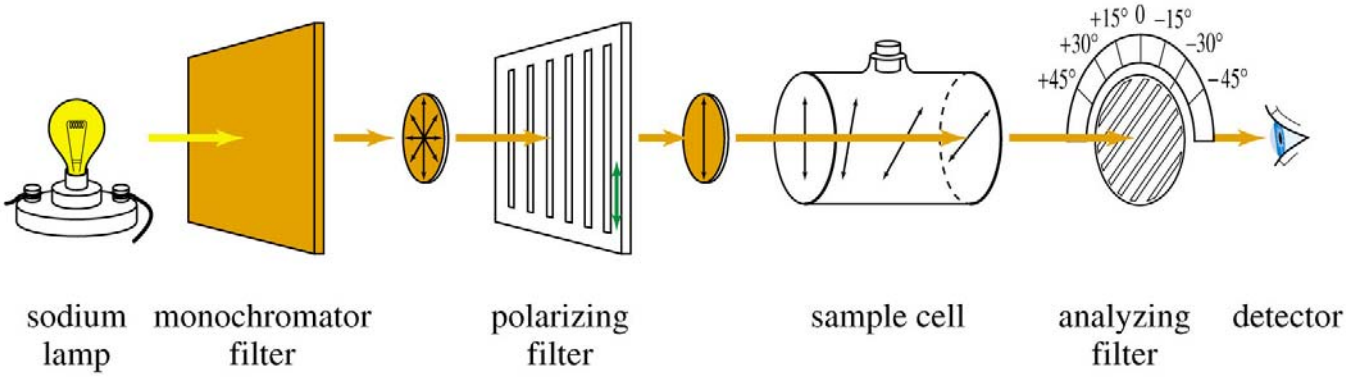
Optical activity = capable of rotating the plane of polarized light

Polarized Light

The waves of plane polarized light vibrate in a single plane.



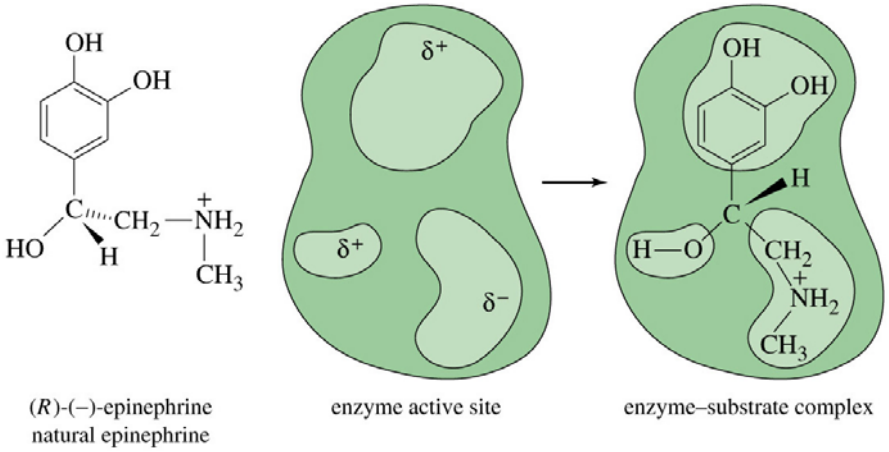
An enantiomer rotates the plane of the polarized light.

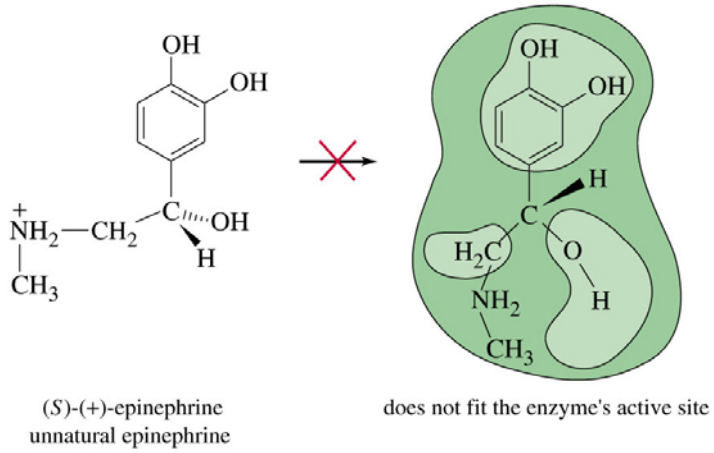


The pair of enantiomers are distinguished by the direction they rotate polarized light: d = dextrorotatory = (+) for clockwise rotation and l = levorotatory = (–) for counter-clockwise rotation.

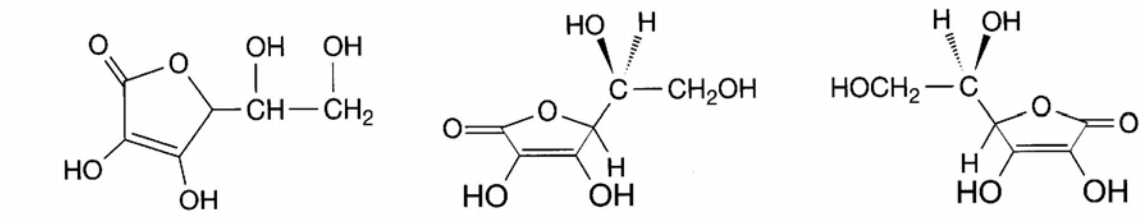
Biological Discrimination of Enantiomers

epinephrine (adrenalin)

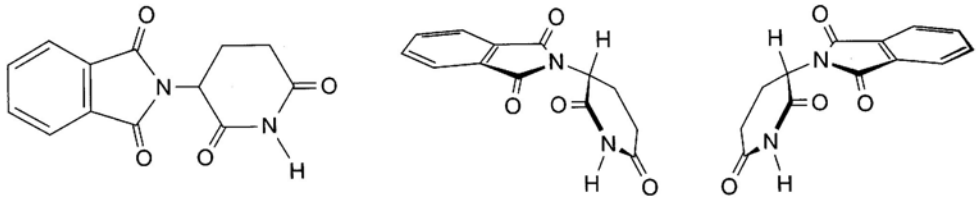




vitamin C (ascorbic acid)



thalidomide



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