Table 5.2 Common Organic Functional Groups

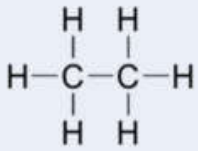
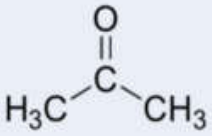
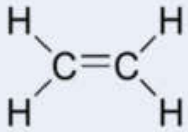
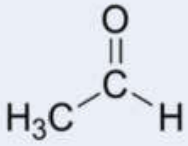
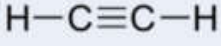
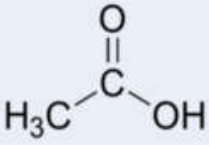
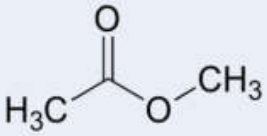
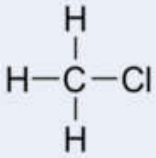
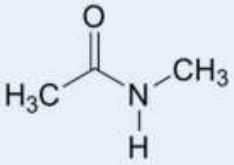
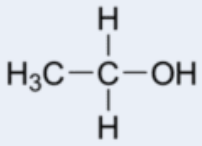
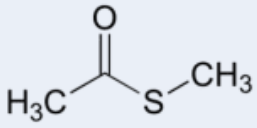
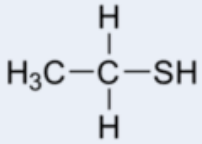
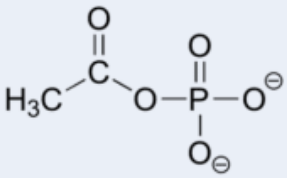
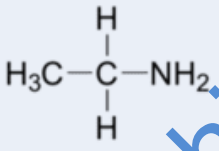
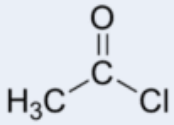
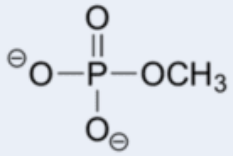
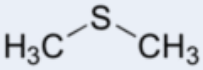
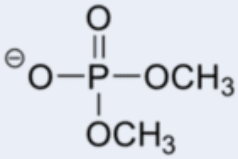
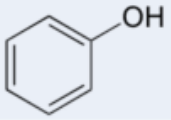
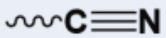
alkane		ketone	
alkene		aldehyde	
alkyne		carboxylic acid	
aromatic		ester	
alkyl halide		amide	

Table 5.2 Common Organic Functional Groups

alcohol		thioester	
thiol		acyl phosphate	
amine		acid chloride	
ether		phosphate monoester	
thioether		phosphate diester	
phenol		nitrile	

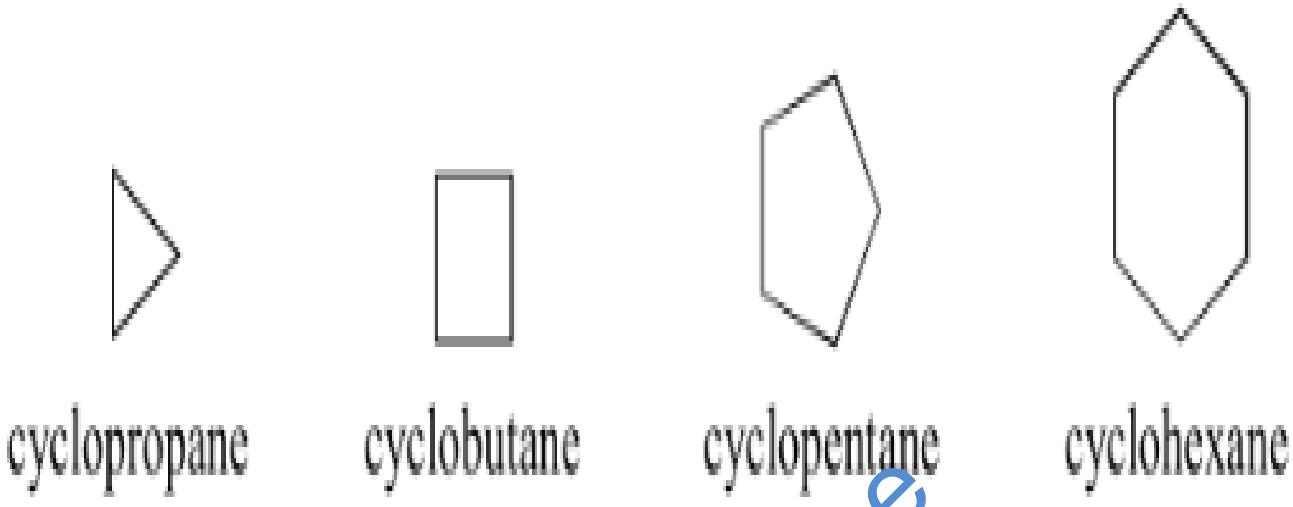
Names for straight-chain alkanes:

carbon	methane
carbons	ethane
carbons	propane
carbons	butane
carbons	pentane
carbons	hexane
carbons	heptane
carbons	Octane
carbons	nonane
carbons	decane

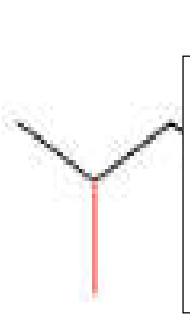
Names for straight-chain alkanes:

Molecular Formula	Name of straight chain	Synonyms
CH_4	methane	methyl hydride; natural gas
C_2H_6	ethane	dimethyl; ethyl hydride; methyl methane
C_3H_8	propane	dimethyl methane; propyl hydride
C_4H_{10}	*n*-butane	butyl hydride; methylethyl methane
C_5H_{12}	*n*-pentane	amyl hydride; Skellysolve A
C_6H_{14}	*n*-hexane	dipropyl; Gettysolve-B; hexyl hydride; Skellysolve B
C_7H_{16}	*n*-heptane	dipropyl methane; Gettysolve-C; heptyl hydride; Skellysolve C
C_8H_{18}	*n*-octane	dibutyl; octyl hydride
C_9H_{20}	*n*-nonane	nonyl hydride; Shellsol 140
$C_{10}H_{22}$	*n*-decane	decyl hydride

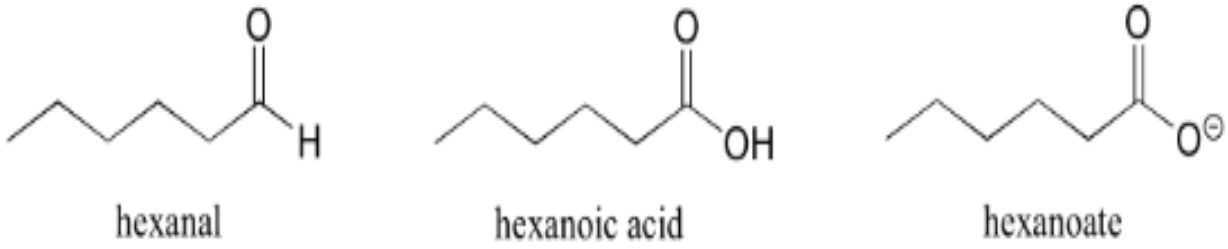
Cyclic alkanes are called cyclopropane, cyclobutane, cyclopentane, cyclohexane, and so on:



In the case of multiple substituents, the prefixes *di*, *tri*, and *tetra* are used.



Some groups can only be present on a terminal carbon, and thus a locating number is not necessary: aldehydes end in 'al', carboxylic acids in 'oic acid', and carboxylates in 'oate'.

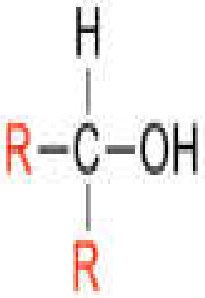


hexanal hexanoic acid hexanoate

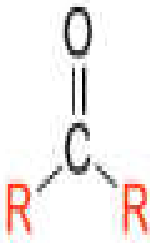
Drawing abbreviated organic structures

Often when drawing organic structures, chemists find it convenient to use the letter ‘R’ to designate part of a molecule outside of the region of interest. If we just want to refer in general to a functional group without drawing a specific molecule, for example, we can use ‘R groups’ to focus attention on the group of interest:

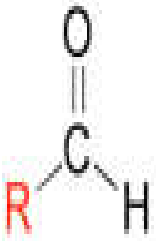
a primary alcohol



a secondary alcohol



a ketone



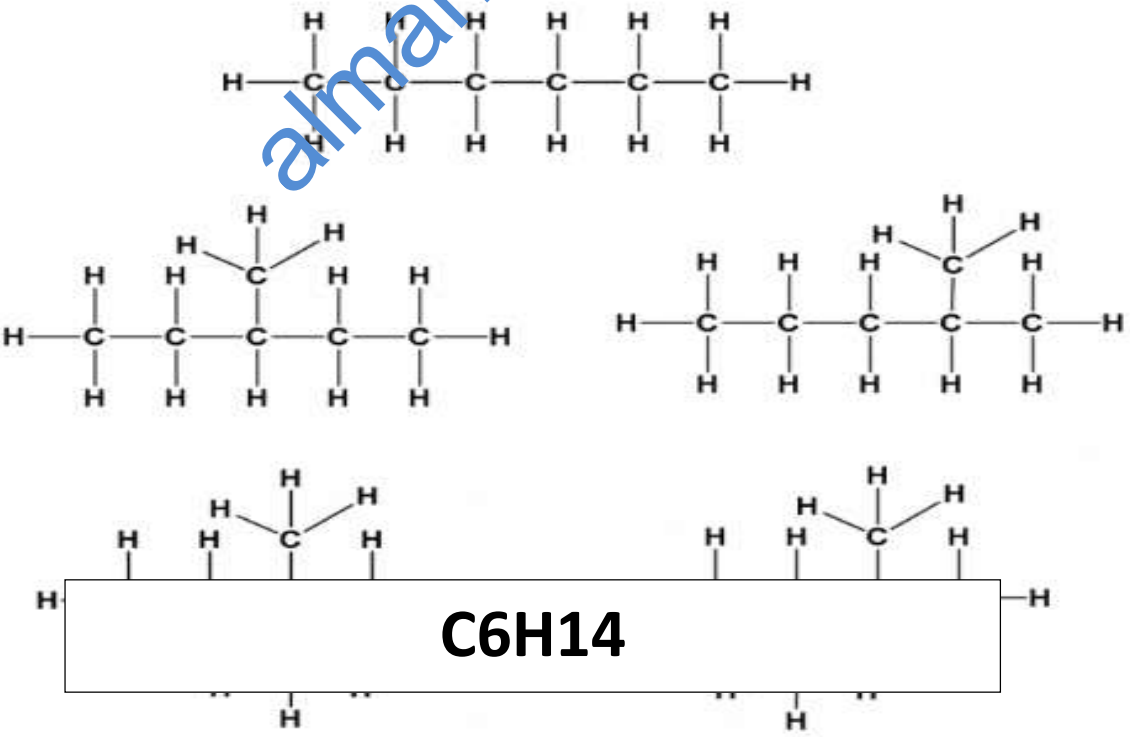
an aldehyde

Practice Question

How many structural isomers can you make from the molecular formula C_6H_{14}?

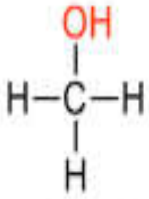
Solution: Start by drawing the straight chain version of the molecule, with all of the carbons attached in one row. Add on the hydrogens, so that each carbon has a total of four bonds. Next, start moving carbons into branched positions off of the main chain. Start with a 5 carbon chain and one branched carbon. How many possibilities are there? Next move to a 4 carbon main chain with 2 carbons branching. How many possibilities are there? Keep going until all possibilities are exhausted. In the end, you will find that there are 5 structural isomers possible from the molecular formula, C_6H_{14}

Structural isomers of C_6H_{12}

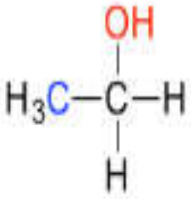


Alcohols, Phenols, and Thiols

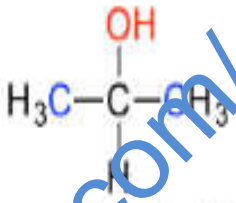
In the ***alcohol*** functional group, a carbon is single-bonded to an OH group (the OH group, when it is part of a larger molecule, is referred to as a ***hydroxyl group***). Except for methanol, all alcohols can be classified as primary,secondary, or tertiary. In a primary alcohol, the carbon bonded to the OH group is also bonded to only one other carbon. In a secondary alcohol and tertiary alcohol, the carbon is bonded to two or three other carbons, respectively. When the hydroxyl group is *directly* attached to an aromatic ring, the resulting group is called a ***phenol.*** The sulfur analog of an alcohol is called a thiol (from the Greek *thio*, for sulfur).



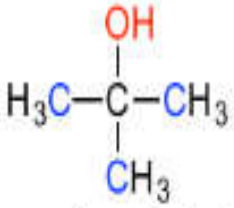
methanol



primary alcohol

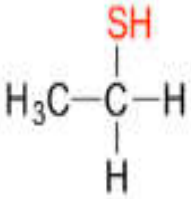


secondary alcohol



tertiary alcohol

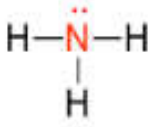
phenol



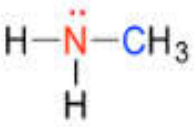
thiol

Amines: are characterized by nitrogen atoms with single bonds to hydrogen and carbon. Just as there are primary, secondary, and tertiary alcohols, there are primary, secondary, and tertiary amines. Ammonia is a special case with no carbon atoms.

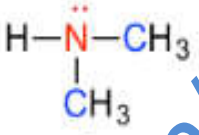
One of the most important properties of amines is that they are basic, and are readily protonated to form ammonium cations. In the case where a nitrogen has four bonds to carbon (which is somewhat unusual in biomolecules), it is called a quaternary ammonium ion.



ammonia

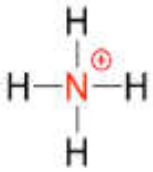


a primary amine

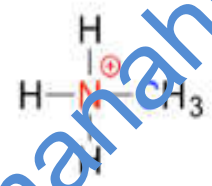


a secondary amine

a tertiary amine



ammonium ion

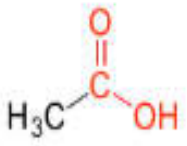


a primary ammonium ion

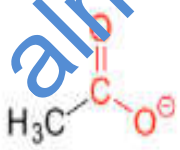
a quaternary ammonium ion

Carboxylic Acids and Their Derivatives

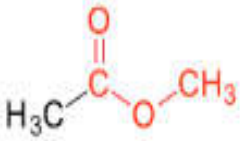
When a carbonyl carbon is bonded on one side to a carbon (or hydrogen) and on the other side to an oxygen, nitrogen, or sulfur, the functional group is considered to be one of the 'carboxylic acid derivatives', a designation that describes a set of related functional groups. The main member of this family is the *carboxylic acid* functional group, in which the carbonyl is bonded to a hydroxyl group. The *carboxylate ion* form has donated the H^+ to the solution. Other derivatives are *carboxylic esters* (usually just called 'esters'), *thioesters, amides, acylphosphates, acid chlorides*, and *acid anhydrides*. With the exception of acid chlorides and acid anhydrides, the carboxylic acid derivatives are very common in biological molecules and/or metabolic pathways, and their structure and reactivity will be discussed in more detail in later chapters.



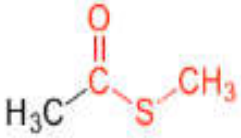
a carboxylic acid



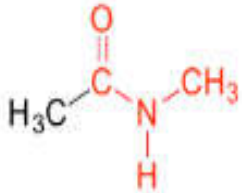
a carboxylate ion



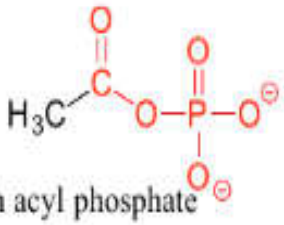
a carboxylic ester



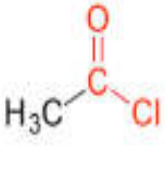
a thioester



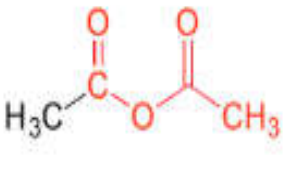
an amide



an acyl phosphate



an acid chloride



an acid anhydride