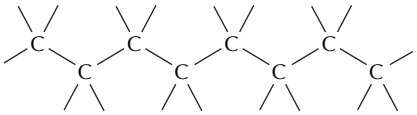
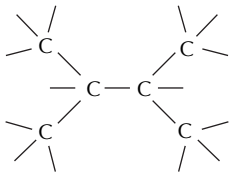
CARBON SKELETONS

Carbon has a unique role in the cell because of its ability to form strong covalent bonds with other carbon atoms. Thus carbon atoms can join to form chains.



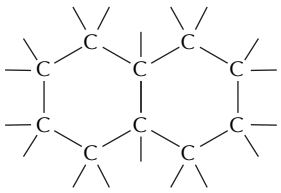
also written as

or branched trees

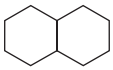


also written as

or rings



also written as

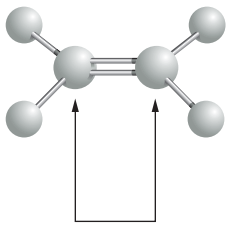


COVALENT BONDS

A covalent bond forms when two atoms come very close together and share one or more of their electrons. In a single bond one electron from each of the two atoms is shared; in a double bond a total of four electrons are shared.

Each atom forms a fixed number of covalent bonds in a defined spatial arrangement. For example, carbon forms four single bonds arranged tetrahedrally, whereas nitrogen forms three single bonds and oxygen forms two single bonds arranged as shown below.

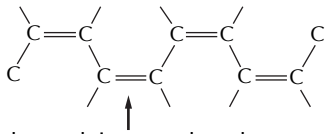
Double bonds exist and have a different spatial arrangement.



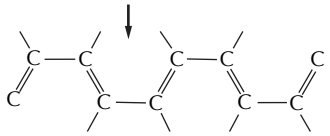
Atoms joined by two or more covalent bonds cannot rotate freely around the bond axis. This restriction is a major influence on the three-dimensional shape of many macromolecules.

ALTERNATING DOUBLE BONDS

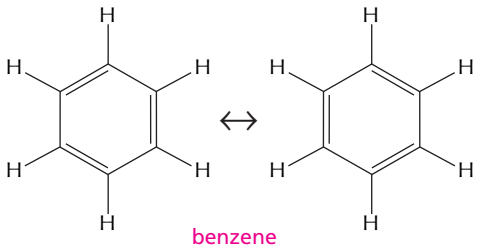
The carbon chain can include double bonds. If these are on alternate carbon atoms, the bonding electrons move within the molecule, stabilizing the structure by a phenomenon called resonance.



the truth is somewhere between these two structures



Alternating double bonds in a ring can generate a very stable structure.

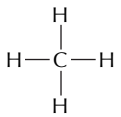


benzene

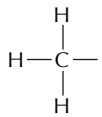
often written as

HYDROCARBONS

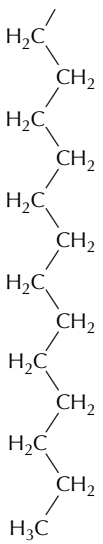
Carbon and hydrogen combine together to make stable compounds (or chemical groups) called hydrocarbons. These are nonpolar, do not form hydrogen bonds, and are generally insoluble in water.



methane



methyl group

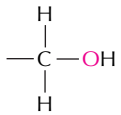


part of the hydrocarbon "tail" of a fatty acid molecule

C–O CHEMICAL GROUPS

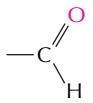
Many biological compounds contain a carbon bonded to an oxygen. For example,

alcohol

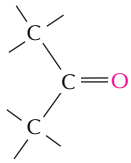


The –OH is called a hydroxyl group.

aldehyde

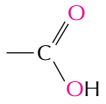


ketone



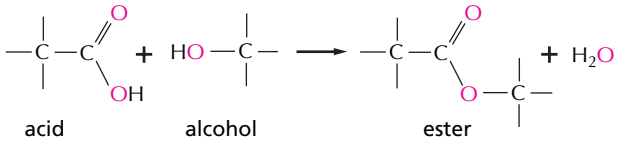
The C=O is called a carbonyl group.

carboxylic acid



The –COOH is called a carboxyl group. In water this loses an H^+ ion to become $–COO^–$.

esters Esters are formed by a condensation reaction between acid and an alcohol.

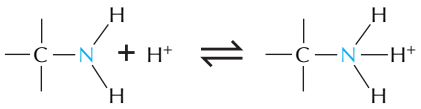


acid alcohol ester

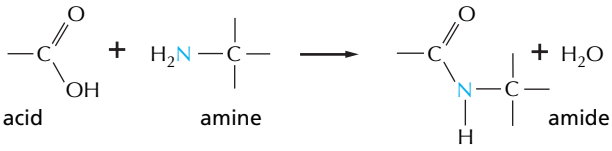
C–N CHEMICAL GROUPS

Amines and amides are two important examples of compounds containing a carbon linked to a nitrogen.

Amines in water combine with an H^+ ion to become positively charged.

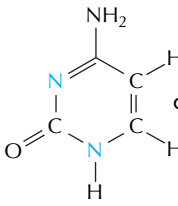


Amides are formed by combining an acid and an amine. Unlike amines, amides are uncharged in water. An example is the peptide bond that joins amino acids in a protein.



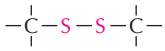
acid amine amide

Nitrogen also occurs in several ring compounds, including important constituents of nucleic acids: purines and pyrimidines.



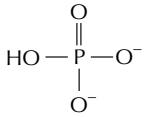
cytosine (a pyrimidine)

SULFHYDRYL GROUP

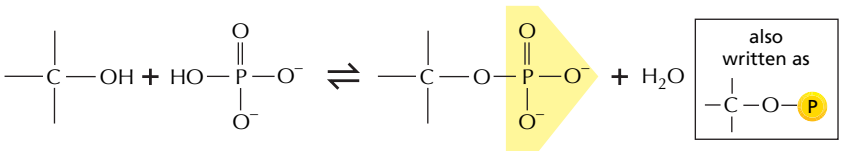
The  is called a sulfhydryl group. In the amino acid cysteine the sulfhydryl group may exist in the reduced form,
or more rarely in an oxidized, cross-bridging form, 

PHOSPHATES

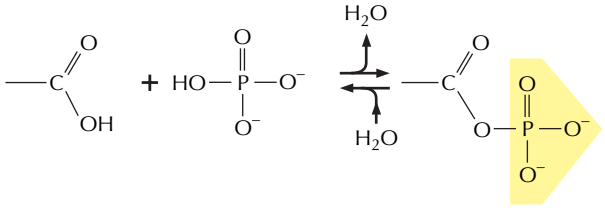
Inorganic phosphate is a stable ion formed from phosphoric acid, H_3PO_4. It is often written as P_i.



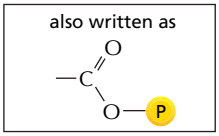
Phosphate esters can form between a phosphate and a free hydroxyl group. Phosphate groups are often attached to proteins in this way.

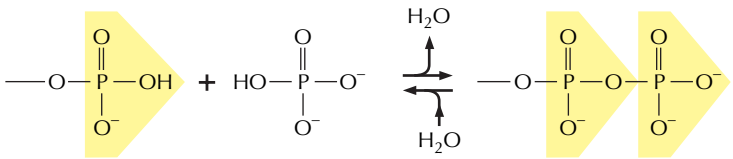


The combination of a phosphate and a carboxyl group, or two or more phosphate groups, gives an acid anhydride.



high-energy acyl phosphate bond (carboxylic–phosphoric acid anhydride) found in some metabolites





phosphoanhydride—a high-energy bond found in molecules such as ATP