

## Aromatic Hydrocarbons

Both straight-chain and branched hydrocarbons have open chains of carbon atoms. Open chains have at least two end carbon atoms, or carbon atoms that are bonded to only one other carbon atom.

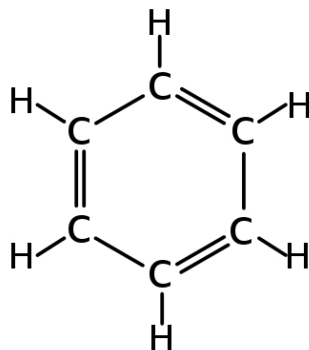
Carbon's versatility allows it to form closed chains, or rings, as well. The carbon atoms in a closed chain form a circle, in which each carbon is bonded to at least two other carbon atoms. Hydrocarbons that contain a carbon ring are called **cyclic hydrocarbons**.

### Benzene

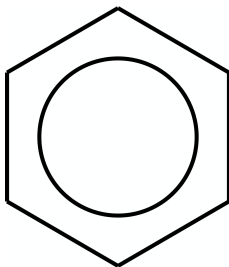
Benzene is one of the most common, and stable, cyclic hydrocarbons. It is an organic compound with the molecular formula  $C_6H_6$ .

Benzene is a colorless and highly flammable liquid with a sweet smell. Because it is a known carcinogen, its use as an additive in gasoline is now limited, but it is an important industrial solvent and precursor in the production of drugs, plastics, synthetic rubber, and dyes. Benzene is a natural constituent of crude oil, and may be synthesized from other compounds present in petroleum. Other natural sources of benzene include volcanic emissions and forest fires.

The structure of benzene is illustrated below.



Benzene rings are often represented using the following symbol as well.



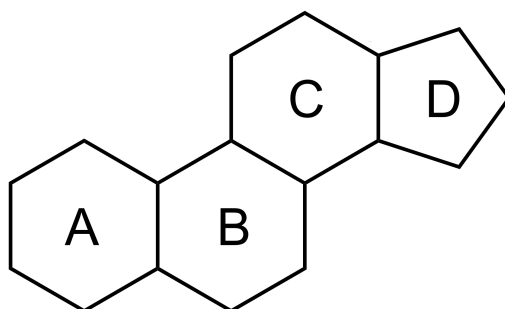
While benzene exists as an individual molecule, its characteristic ring is usually found as a part of larger molecules. Many of these compounds have distinctive odors, and for this reason are often called **aromatic compounds**. Some foods whose distinctive aromas come from aromatic compounds include cloves, vanilla beans, and almonds.

Some other common aromatic compounds include:

- polychlorinated biphenyls (PCBs)
- caffeine
- steroids
- organic solvents (toluene xylene)

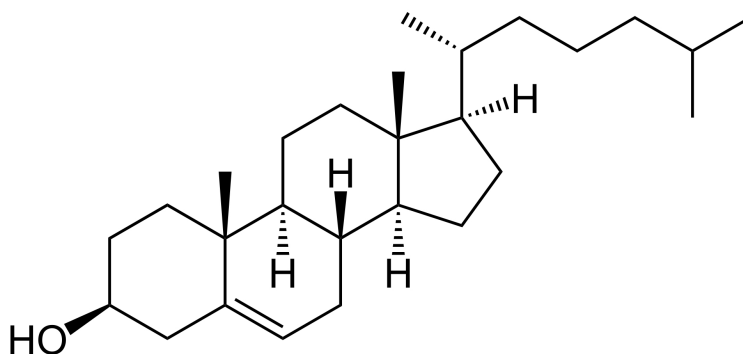
## Steroids

A steroid is a type of organic compound that contains a specific arrangement of four hydrocarbon rings that are joined to each other. These four rings have 6, 6, 6, and 5 carbons respectively, and are generally arranged as shown below:



Steroids vary by the functional groups attached to this four ring core and by the oxidation state of the rings.

Hundreds of distinct steroids are found in plants, animals, and fungi. Examples of steroids include the dietary fat cholesterol (shown below), the sex hormones estradiol and testosterone, and the anti-inflammatory drug dexamethasone.

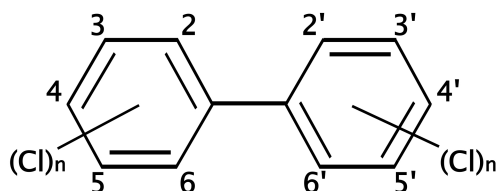


Anabolic steroids are synthetically produced variants of the naturally occurring male hormone testosterone.

## Polychlorinated Biphenyls (PCBs)

Polychlorinated biphenyls (PCBs) are a class of organic compounds with 1 to 10 chlorine atoms attached to biphenyl, which is a molecule composed of two benzene rings. There are no known natural sources of PCBs.

The chemical structure of PCBs is shown below.



The possible positions of chlorine atoms on the benzene rings are shown by the numbers assigned to the carbon atoms. In theory, there are 209 PCB compounds that are possible.

PCBs are odorless, tasteless, clear to pale-yellow, viscous liquids (highly chlorinated mixtures are more viscous and deeper yellow).

PCBs were widely used for many applications, especially as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators.

Due to PCB's toxicity and classification as a persistent organic pollutant, PCB production was banned by the United States Congress in 1979 and by the Stockholm Convention on Persistent Organic Pollutants in 2001.

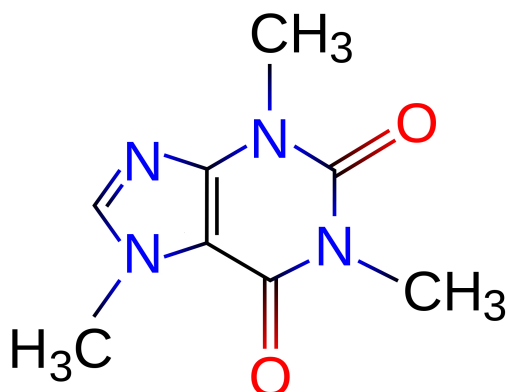
The health effects of PCBs are numerous, with skin conditions (acne or rashes) being the most common. Other effects may include:

- cancer
- liver damage
- skin and eye lesions
- irregular menstrual cycles
- lowered immune responses
- fatigue, headache, coughs
- poor cognitive development in children
- lower birth weight for children born to mothers exposed to high levels of PCBs
- endocrine disruption (results in children born with both sets of reproductive organs)

## Caffeine

Caffeine is a bitter, white crystalline xanthine alkaloid that is a psychoactive stimulant drug. Its proper chemical name is 1,3,7-trimethyl-1*H*-purine-2,6(3*H*,7*H*)-dione.

The chemical structure of caffeine is shown below.

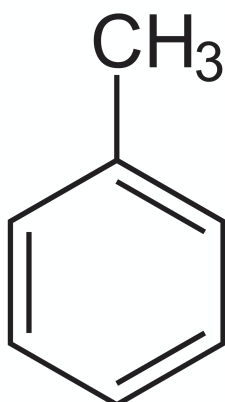


In humans, caffeine acts as a central nervous system (CNS) stimulant, temporarily warding off drowsiness and restoring alertness. Caffeine is the world's most widely consumed psychoactive substance, but, unlike many other psychoactive substances, is legal and unregulated in nearly all jurisdictions. Beverages containing caffeine, such as coffee, tea, soft drinks, and energy drinks, enjoy great popularity.

Caffeine has diuretic properties (makes you urinate more frequently) when administered in sufficient doses to subjects that do not have a tolerance for it. Regular users, however, develop a strong tolerance to this effect, and studies have generally failed to support the common notion that ordinary consumption of caffeinated beverages contributes significantly to dehydration.

## Toluene

Toluene is a clear, water-insoluble liquid with the typical smell of paint thinners. Chemically, it consists of a benzene ring where a single hydrogen atom has been replaced by a methyl group.



Toluene occurs naturally at low levels in crude oil and is usually produced in the processes of making gasoline. It can also be isolated from a resin produced by the Tolu balsam tree.

Toluene is a common solvent, able to dissolve paints, paint thinners, silicone sealants, many chemical reactants, rubber, printing ink, adhesives (glues), lacquers, leather tanners, and disinfectants.

Toluene can be used to break open red blood cells in order to extract hemoglobin in biochemistry experiments.

Toluene has also been used in the process of removing the cocaine from coca leaves in the production of Coca-Cola syrup.

## **Xylene**

The term xylene refers to a mixture of three structural isomers of the aromatic hydrocarbon dimethylbenzene: ortho-xylene (1,2-dimethylbenzene), meta-xylene (1,3-dimethylbenzene), and para-xylene (1,4-dimethylbenzene).

Xylene is a clear, colorless, sweet-smelling liquid that is very flammable. It occurs naturally in crude oil, and can be removed during the refining process.

Xylene is used as a solvent in the printing, rubber, and leather industries. It is also used as a cleaning agent, a paint thinner, and in paints and varnishes. Small amounts are present in gasoline and airplane fuel. Xylene is also abused as an inhalant drug for its intoxicating properties.