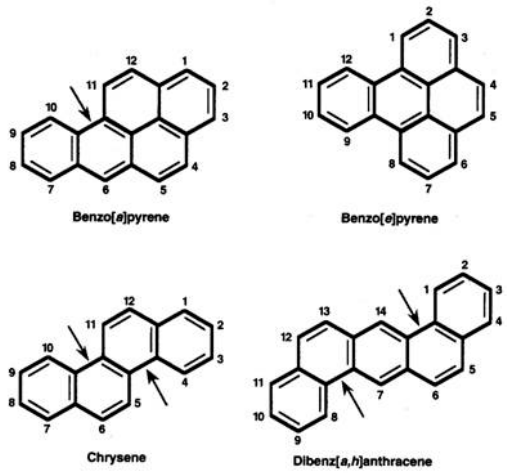
POLYCYCLIC AROMATIC HYDROCARBONS

Overview

The term polycyclic aromatic hydrocarbons (PAHs) refers to a ubiquitous group of several hundred chemically-related, environmentally persistent organic compounds of various structures and varied toxicity. Most of them are formed by a process of thermal decomposition (pyrolysis) and subsequent recombination (pyrosynthesis) of organic molecules. PAHs enter the environment through various routes and are usually found as a mixture containing two or more of these compounds, e.g. soot. However, some PAHs are manufactured and these pure PAHs usually exist as colorless, white, or pale yellow solids. Polycyclic aromatic hydrocarbons affect organisms through various toxic actions. The mechanism of toxicity is considered to be interference with function of cellular membranes as well as with enzyme systems which are associated with the membrane. They have been shown to cause carcinogenic and mutagenic effects and are potent immunosuppressants. Effects have been documented on immune system development, humoral immunity and on host resistence. The most extensively studied PAHs are 7,12-dimethylbenzo anthracene (DMBA) and benzo(a)pyrene (BaP).

Chemical Characteristics



Polycyclic aromatic hydrocarbons have two or more single or fused aromatic rings with a pair of carbon atoms shared between rings in their molecules. The term "PAH" refers to compounds consisting of only carbon and hydrogen atoms. PAHs containing up to six fused aromatic rings are often known as "small" PAHs, and those containing more than six aromatic rings are called "large" PAHs. The majority of research on PAHs has been conducted on small PAHs due to the availability of samples of various small PAHs.

The general characteristics of PAHs are high melting and boiling points (therefore they are solid), low vapor pressure, and very low aqueous solubility, which both tend to decrease with increasing molecular weight, whereas resistance to oxidation and reduction increases. PAHs are highly lipophilic and therefore very soluble in organic solvents. PAHs also manifest various functions such as light sensitivity, heat resistance, conductivity, emittability, corrosion resistance, and physiological action.

PAHs possess very characteristic UV absorbance spectra. Each ring structure has a unique UV spectrum, thus each isomer has a different UV absorbance spectrum. This is especially useful in the identification of PAHs. Most PAHs are also fluorescent, emitting characteristic wavelengths of light when they are excited (when the molecules absorb light). Aqueous solubility decreases for each additional ring.

The simplest PAHs, as defined by the International Union of Pure and Applied Chemistry (IUPAC), are phenanthrene and anthracene, which both contain three fused aromatic rings. Smaller molecules, such as benzene, are not PAHs. Naphthalene, which consists of two coplanar six-membered rings sharing an edge, is another aromatic hydrocarbon. By formal convention, it is not a true PAH, though is referred to as a bicyclic aromatic hydrocarbon.

Although the health effects of individual PAHs are not exactly alike, these 17 PAHs have been identified as being of greatest concern with regard to potential exposure and adverse health effects on humans and are thus considered as a group (profile issued by the Agency for Toxic Substances and Disease Registry):

acenaphthene
acenaphthylene
anthracene
benz(a)anthracene
benzo(a)pyrene
benzo(e)pyrene
benzo(b)fluoranthene
benzo(ghi)perylene
benzo(j)fluoranthene
benzo(k)fluoranthene
chrysene
dibenz(ah)anthracene
fluoranthene
fluorene
indeno(1,2,3-cd)pyrene
phenanthrene
pyrene

(Image of selected PAHs from ATSDR. The arrows indicate bay regions.)

Sources

Sources of PAHs can be both natural and anthropogenic.

Natural sources include:

- forest and grass fires
- oil seeps
- volcanoes
- chlorophyllous plants, fungi, and bacteria

Anthropogenic sources of PAHs include:

- petroleum
- electric power generation
- refuse incineration
- home heating
- production of coke, carbon black, coal tar, and asphalt
- internal combustion engines

Source : http://www.toxipedia.org/display/toxipedia/Polycyclic+Aromatic+Hydrocarbons