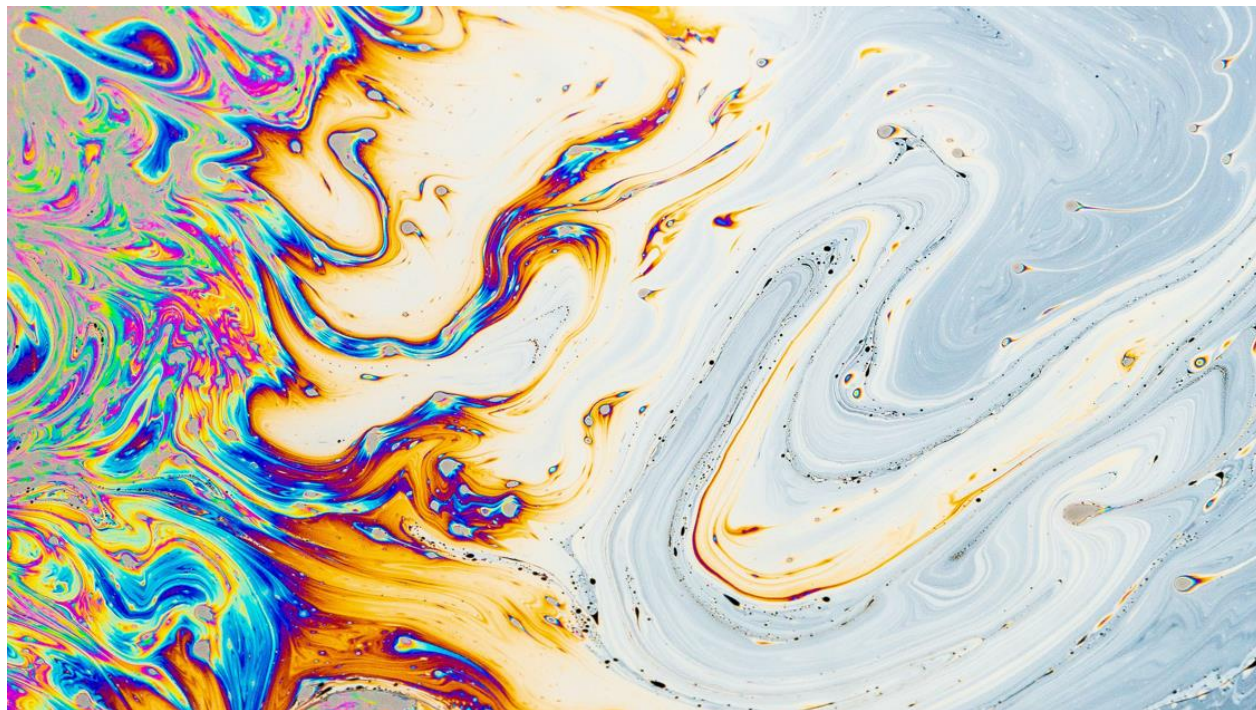


1. WHAT ARE POLYCYCLIC AROMATIC HYDROCARBONS?

Polycyclic aromatic hydrocarbons (PAHs) are a large family of organic compounds. They are mainly known as contaminants that may occur in the environment and in food, but they are not a single substance: the family includes numerous molecules with sometimes markedly different physical, chemical and toxicological properties. Understanding this diversity is essential to interpreting information about their presence in food correctly.



A FAMILY OF MOLECULES, NOT A SINGLE CONTAMINANT

In the most common chemical sense, PAHs are compounds containing only carbon and hydrogen and characterised by two or more fused aromatic rings, that is, rings sharing carbon atoms. Classic examples are structures built from six-membered rings similar to benzene. Polycyclic compounds with other geometries also exist; scientific assessments and monitoring programmes should therefore always specify which molecules are included.

The word 'hydrocarbons' means that the molecules contain only carbon and hydrogen. 'Polycyclic' refers to several interconnected rings, while 'aromatic' describes a particular arrangement of electrons that contributes to structural stability. It does not mean that these substances necessarily have a pleasant smell: the term belongs to chemistry, not perfumery.

WHY CHEMICAL STRUCTURE MATTERS

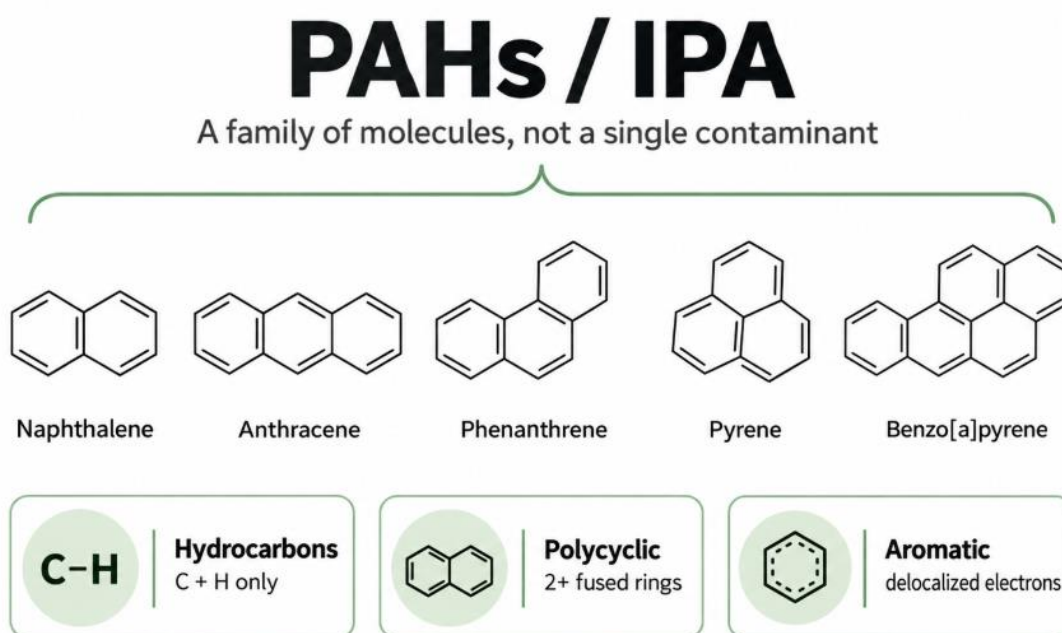
Fused aromatic rings often form relatively rigid, largely planar structures. The distribution of electrons across several atoms, known as electron delocalisation, affects their stability and reactivity. The number and arrangement of the rings, and any side groups, distinguish one molecule from another. Two PAHs can therefore have similar molecular masses but different properties and behaviour.

These molecules can be pictured as shapes made of hexagons joined along some of their sides. Changing the number of hexagons or the way they connect produces a different structure. This is more than a change in shape: it affects how the substance interacts with water, fats, solid surfaces and living organisms.

SOME EXAMPLES: FROM NAPHTHALENE TO BENZO[A]PYRENE

Naphthalene is one of the simplest PAHs and contains two fused aromatic rings (formula $C_{10}H_8$). Phenanthrene and anthracene each have three rings and the same molecular formula ($C_{14}H_{10}$), but differ in ring arrangement: they are structural isomers. This pair illustrates why the number of atoms alone cannot identify a substance.

Among four-ring PAHs is chrysene ($C_{18}H_{12}$). Benzo[a]pyrene ($C_{20}H_{12}$), composed of five fused aromatic rings, is particularly well known because of its importance in food-contamination assessments. The designation in square brackets, as in benzo[a]pyrene, identifies a particular ring arrangement: it is not an optional detail, since similarly named compounds can have different properties.



Different monitoring programs may include different PAH molecules.

These examples are not an exhaustive list. The PAH family includes many other substances, and the choice of what to measure depends on the purpose of the investigation, the matrix examined, and the scientific or regulatory criteria employed.

LIGHT AND HEAVY PAHs A USEFUL BUT NOT ABSOLUTE DISTINCTION

Scientific publications often distinguish, as a general guide, between low-molecular-weight PAHs, usually containing two or three rings, and higher-molecular-weight PAHs, frequently containing four or more. This classification helps describe general trends but does not replace information on individual molecules.

In general, smaller PAHs are more volatile and relatively more soluble in water than many higher-mass PAHs. Larger PAHs tend to have lower vapour pressures, very limited water solubility and greater affinity for organic matter and certain solid surfaces. There are exceptions and sometimes substantial differences even within a group.

'Volatility' means a substance's tendency to enter the gas phase. It does not mean that all light PAHs are gases at ordinary ambient temperatures: some are solids that can nevertheless evaporate or sublime to varying degrees. Similarly, describing a PAH as 'heavy' does not mean that it is necessarily more hazardous; hazard must be assessed individually on the available evidence.

WATER SOLUBILITY, AFFINITY FOR FATS AND ADSORPTION

Many PAHs dissolve poorly in water and have an affinity for organic or lipid phases. This behaviour is often described as 'hydrophobicity', whereas the tendency to partition into a lipid phase rather than water is associated with 'lipophilicity'. The two properties are related but are not exact synonyms.

One parameter used to compare molecules is the octanol–water partition coefficient (K_{ow}), commonly reported as $\log K_{ow}$. A high value indicates a marked preference for the organic phase in this reference system. It is a useful indicator but cannot, on its own, predict how much of a substance will be present in food or absorbed by an organism.

PAHs may also be adsorbed, meaning that they adhere to the surfaces of solid particles, such as airborne particulate matter, sediments and soils rich in organic matter. Adsorption differs from absorption, which means that a substance enters a material or an organism. This terminological distinction is also important for understanding their behaviour in the environment and in food.

PERSISTENCE AND TRANSFORMATION: THEY DO NOT ALL BEHAVE ALIKE

Fused aromatic rings can make some molecules relatively resistant to certain degradation processes, but they do not make PAHs indestructible. Light, oxidising

agents, microorganisms and environmental conditions can transform them, at rates that vary widely with chemical structure and circumstances.

Persistence does not automatically mean bioaccumulation, just as lipophilicity does not necessarily lead to progressively increasing concentrations along every food chain. Organisms may absorb, transform and eliminate PAHs with differing efficiency. Their transport through the environment and food webs is discussed in a separate chapter.

WHY PAHs ARE STUDIED IN FOOD

PAHs deserve attention because they can reach food through different pathways and because some family members have toxicological properties of particular concern. Nevertheless, simply detecting a PAH does not establish that harm to health will occur. It is necessary to know which compound is present, its concentration, how much of the food is eaten and the substance's toxicological profile.

For the same reason, an analytical result described generically as 'total PAHs' can be interpreted only if the compounds actually summed are known. No universal list of molecules corresponds automatically to this expression: different analytical methods and monitoring programmes may cover different lists.

This initial distinction provides the starting point for understanding the impact of these substances: PAHs constitute a chemical family, whereas contamination, exposure and risk are separate issues that require further assessment.

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