

**Benzene** causes cancer and other illnesses. Benzene is a notorious cause of bone marrow failure. Vast quantities of epidemiologic, clinical, and laboratory data link benzene to aplastic anemia, acute leukemia, and bone marrow abnormalities.<sup>[43][44]</sup> The specific hematologic malignancies that benzene is associated with include: acute myeloid leukemia (AML), aplastic anemia, myelodysplastic syndrome (MDS), acute lymphoblastic leukemia (ALL), and chronic myeloid leukemia (CML).<sup>[45]</sup>

The American Petroleum Institute (API) stated in 1948 that "it is generally considered that the only absolutely safe concentration for benzene is zero."<sup>[46]</sup> The US Department of Health and Human Services (DHHS) classifies benzene as a human carcinogen. Long-term exposure to excessive levels of benzene in the air causes leukemia, a potentially fatal cancer of the blood-forming organs, in susceptible individuals. In particular, Acute myeloid leukemia or acute non-lymphocytic leukaemia (AML & ANLL) is not disputed to be caused by benzene.<sup>[47]</sup> IARC rated benzene as "known to be carcinogenic to humans" (Group 1).

Outdoor air may contain low levels of benzene from automobile service stations, wood smoke, tobacco smoke, the transfer of gasoline, exhaust from motor vehicles, and industrial emissions

Vapors from products that contain benzene, such as glues, paints, furniture wax, and detergents, can also be a source of exposure, although many of these have been modified or reformulated since the late 1970s to eliminate or reduce the benzene content. Air around hazardous waste sites or gas stations may contain higher levels of benzene. Because petroleum hydrocarbon products are complex mixtures of chemicals, risk assessments for these products, in general, focus on specific toxic constituents. The petroleum constituents of primary interest to human health have been the aromatic hydrocarbons (i.e., benzene, ethylbenzene, toluene, and xylenes). OSHA requires that a mixture "shall be assumed to present a carcinogenic hazard if it contains a component in concentrations of 0.1% or greater, which is considered to be a carcinogen."<sup>[50][51]</sup>

The short-term breathing of high levels of benzene can result in death; low levels can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, and death.

The major effects of benzene are manifested via chronic (long-term) exposure through the blood. Benzene damages the bone marrow and can cause a decrease in red blood cells, leading to anemia. It can also cause excessive bleeding and depress the immune system, increasing the chance of infection. Benzene causes leukemia and is associated with other blood cancers and pre-cancers of the blood.

Human exposure to benzene is a global health problem.<sup>[vague]</sup> Benzene targets liver, kidney, lung, heart and the brain and can cause DNA strand breaks, chromosomal damage, etc. Benzene causes cancer in both animals and humans. Benzene was first reported to induce cancer in humans in the 1920s.<sup>[citation needed]</sup> The chemical industry<sup>[who?]</sup> claims it was not until 1979 that the cancer-inducing properties were determined "conclusively" in humans, despite many references to this fact in the medical literature- Benzene has been shown to cause cancer in both sexes of multiple species of laboratory animals exposed via various routes.<sup>[52][53]</sup>

Some women having breathed high levels of benzene for many months had irregular menstrual periods and a decrease in the size of their ovaries. Benzene exposure has been linked directly to the neural birth defects spina bifida and anencephaly.<sup>[54]</sup> Men exposed to high levels of benzene are more likely to have an abnormal amount of chromosomes in their sperm, which impacts fertility and fetal development.<sup>[55]</sup>

Animal studies have shown low birth weights, delayed bone formation, and bone marrow damage when pregnant animals breathed benzene.

Benzene has been connected to a rare form of kidney cancer in two separate studies, one involving tank truck drivers, and the other involving seamen on tanker vessels, both carrying benzene-laden chemicals.

**Ethylbenzene** exposure can irritate the eyes, nose and throat. High concentration can cause dizziness, light headedness, or unconsciousness. Very high levels can cause paralysis, trouble breathing and death. Prolonged exposure can cause drying, scaling and even blistering. High exposure may damage the liver. Chronic (long term) health effects can occur at some time after exposure to ethylbenzene and can last for months or years.

**Toluene** exposure is often associated with effects such as: psychoorganic syndrome,<sup>[23]</sup> visual evoked potential (VEP) abnormality,<sup>[23]</sup> toxic polyneuropathy, cerebellar, cognitive, and pyramidal dysfunctions,<sup>[22][23]</sup> optic atrophy; and brain lesions.<sup>[22]</sup>

Exposure of pregnant women to toluene during critical stages of fetal development could cause serious disruption to neuronal development.<sup>[24]</sup> Low to moderate levels can cause tiredness, confusion, weakness, drunken-type actions, memory loss, nausea, loss of appetite, and hearing and color vision loss. These symptoms usually disappear when exposure is stopped. Inhaling high levels of toluene in a short time may cause light-headedness, nausea, or sleepiness. It can also cause unconsciousness, and even death

**Xylene** is an irritant of the eyes and mucous membranes at concentrations below 200 ppm, and it is narcotic at high concentrations [AIHA 1978; Proctor, Hughes, and Fischman 1988, p. 511]. The estimated oral LD(50) for humans is 50 mg/kg [EPA Health Advisory, 1987, p. 4]. Of three workers exposed to xylene concentrations of approximately 10,000 ppm for 18.5 hours, one died and two recovered slowly after a period of unconsciousness and retrograde amnesia; disturbances of liver and kidney function were noted in these workers [ACGIH 1986, p. 637; Baselt 1980, p. 286; Clayton and Clayton 1981, p. 3292]. Ingestion of xylene causes gastrointestinal distress and may cause toxic hepatitis [Clayton and Clayton 1981, p. 3294]. Aspiration of xylene or acute exposure to high vapor concentrations of this substance may cause chemical pneumonitis, hemorrhage into the air spaces, and pulmonary edema [Clayton and Clayton 1981, p. 3294; Klaassen, Amdur, and Doull 1986, p. 351]. A worker exposed to the vapors of a solvent containing 75 percent xylene (approximate airborne xylene concentration of 60 to 350 ppm) developed giddiness, anorexia, and vomiting [Proctor, Hughes, and Fischman 1988, p. 511]. After inhalation of high (not further specified) concentrations of xylene, workers may become flushed, feel hot, and experience confusion, dizziness, tremors, and other signs or symptoms of central nervous system toxicity [Clayton and Clayton 1981, p. 3294]. Blood dyscrasias that have proven fatal in at least one case are reported to have been the result of chronic xylene exposure, but these hematopoietic effects are now believed to have been caused by benzene, formerly a common contaminant of xylene [ACGIH 1986, p. 637]. Chronic exposure to xylene may cause central nervous system depression, anemia, mucosal hemorrhage, bone marrow hyperplasia, liver enlargement, liver necrosis, and nephrosis [Clayton and Clayton 1981, p. 3295]. Repeated contact of the skin with xylene causes drying and dermatitis [Clayton and Clayton 1981, p. 3295].

\* Signs and symptoms of exposure

1. Acute exposure: The signs and symptoms of acute exposure to xylene include headache, fatigue, irritability, lassitude, nausea, anorexia, flatulence, irritation of the eyes, nose, and throat, and motor incoordination and impairment of equilibrium. Flushing, redness of the face, a sensation of increased body heat, increased salivation, tremors, dizziness, confusion, and cardiac irritability have also been reported.
2. Chronic exposure: The signs and symptoms of chronic exposure to xylene may include conjunctivitis; dryness of the nose, throat, and skin; dermatitis; and kidney and liver damage.

**Naphthalene** may damage or destroy red blood cells. Humans, in particular children, have developed this condition, known as hemolytic anemia, after ingesting mothballs or deodorant blocks containing naphthalene. Symptoms include fatigue, lack of appetite, restlessness, and pale

skin. Exposure to large amounts of naphthalene may cause confusion, nausea, vomiting, diarrhea, blood in the urine, and jaundice (yellow coloration of the skin).<sup>[9]</sup>

When the U.S. National Toxicology Program exposed male and female rats and mice to naphthalene vapors on weekdays for two years,<sup>[10]</sup> male and female rats exhibited evidence of carcinogenic activity based on increased incidences of adenoma and neuroblastoma of the nose, female mice exhibited some evidence of carcinogenic activity based on increased incidences of alveolar and bronchiolar adenomas of the lung, and male mice exhibited no evidence of carcinogenic activity.

The International Agency for Research on Cancer (IARC)<sup>[11]</sup> classifies naphthalene as possibly carcinogenic to humans and animals (Group 2B). The IARC also points out that acute exposure causes cataracts in humans, rats, rabbits, and mice; and that hemolytic anemia, described above, can occur in children and infants after oral or inhalation exposure or after maternal exposure during pregnancy. Under California's Proposition 65, naphthalene is listed as "known to the State to cause cancer".<sup>[12]</sup>

**Polycyclic aromatic hydrocarbons** known for their carcinogenic, mutagenic and teratogenic properties are benz[a]anthracene and chrysene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, benzo[ghi]perylene, coronene, dibenz(a,h)anthracene (C<sub>20</sub>H<sub>14</sub>), indeno(1,2,3-cd)pyrene (C<sub>22</sub>H<sub>12</sub>) and ovalene.<sup>[11]</sup>

High prenatal exposure to PAH is associated with lower IQ and childhood asthma.<sup>[12]</sup> The Center for Children's Environmental Health reports studies that demonstrate that exposure to PAH pollution during pregnancy is related to adverse birth outcomes including low birth weight, premature delivery, and heart malformations. Cord blood of exposed babies shows DNA damage that has been linked to cancer. Follow-up studies show a higher level of developmental delays at age three, lower scores on IQ tests and increased behavioral problems at ages six and eight.<sup>[13]</sup>

In addition, a 2012 Columbia University study in *Environmental Health Perspectives* linked prenatal exposure to pollutants and eventual child behavioral outcomes. The study found that exposure to higher levels of PAH exposure was associated with a 24% higher score of anxiety/depression for children ages 6 to 7 than those with low exposure levels. Infants found to have elevated PAH levels in their umbilical cord blood were 46% more likely to eventually score highly on the anxiety/depression scale than those with low PAH levels in cord blood.<sup>[14][15]</sup>