Dioxins are mainly byproducts of industrial practices. They are produced through a variety of incineration processes, including improper municipal waste incineration and burning of trash, and can be released into the air during natural processes, such as forest fires and volcanoes. Almost every living creature has been exposed to dioxins or dioxin-like compounds (DLCs).

Strict regulatory controls on major industrial sources of dioxin have reduced emissions into the air by 90 percent, compared to levels in 1987.

Today people are exposed to dioxins primarily by eating food, in particular animal products, contaminated by these chemicals. Dioxins are absorbed and stored in fat tissue and, therefore, accumulate in the food chain. More than 90% of human exposure is through food, mainly meat and dairy products, fish and shellfish, according to the [World Health Organization](https://www.who.int/news-room/fact-sheets/detail/dioxins-and-their-effects-on-human-health).

Before safeguards and regulations were introduced, dioxin releases were a major problem in the United States. The [Polychlorinated Biphenyls (PCBs)](https://www.epa.gov/pcbs/learn-about-polychlorinated-biphenyls-pcbs) worked with industry to ban products containing dioxin and to curb dioxin emissions. In 1979, the EPA banned the manufacture of products containing [Polychlorinated Biphenyls (PCBs)](https://www.epa.gov/pcbs/learn-about-polychlorinated-biphenyls-pcbs) some of which are included under the term dioxin.

However, dioxins break down very slowly and emissions released long ago remain in the environment. Some dioxins endure a long time, are extremely resistant to environmental degradation, and therefore are classified as persistent organic pollutants (POPs). Dioxin contamination is an increasing problem in some developing countries, particularly with uncontrolled burning, and dismantling and recycling of electronic products, such as computers.

**Health Effects**

The dioxin TCDD, or [Mutagen: Talking Glossary of Genetic Terms](https://www.genome.gov/genetics-glossary/Mutagen), is a known cancer-causing agent, and other DLCs are known to cause cancer in laboratory animals. Additionally, dioxin exposure has been linked to a number of other diseases, including type 2 diabetes, ischemic heart disease, and an acne-like skin disease called chloracne, a hallmark of dioxin exposure.

Dioxins can cause developmental problems in children, lead to reproductive and infertility problems in adults, result in miscarriages, damage the immune system, and interfere with hormones.

Exposure to dioxins has widespread effects in nearly every vertebrate species, at nearly every stage of development, including in the womb.

**The Science of Dioxins**

Dioxins are a family of compounds that share distinct chemical structures and characteristics. Numerous dioxin-like compounds have been identified that are considered to have significant toxicity and can cause disease. The singular term dioxin refers to the most toxic compound, TCDD.

NIEHS researchers continue to explore the detailed chemical pathway through which dioxin damages the body, but scientists are now confident that the first step takes place when dioxin binds to an intracellular protein known as the aryl hydrocarbon receptor (AhR). When that happens, the AhR can alter the expression, or function, of certain genes. The resulting cellular imbalance leads to a disruption in normal cell function and ultimately adverse health effects.

In addition to TCDD, many other chemicals bind to AhR. About 400 compounds in the environment act on the body through the AhR receptor. Public health officials around the world are concerned about the combined effects of multiple chemicals that activate the AhR, and are developing health standards that take into account the fact that people are exposed to mixtures of DLCs, not just one at a time.

**Dioxins' Impact**

The public health threats posed by dioxins were highlighted dramatically in the public consciousness in the late 1970s and early 1980s. Newspapers and television broadcasts were full of stories about ailing veterans who had been exposed to dioxins through Agent Orange, an herbicide and defoliant used in the Vietnam War.

Concerns about Agent Orange and other DLCs continue today. Research supported by NIEHS and many others, examining the link between dioxin and serious illnesses, has helped lead the [U.S. Department of Veterans Affairs (VA)](https://www.va.gov/) to recognize certain cancers and other health problems as presumptive diseases associated with exposure to Agent Orange or other herbicides during military service. Presumptive diseases are certain diseases that the VA assumes can be related to a Veteran's qualifying military service.

Dioxins were also brought to light in 1982, when the town of Times Beach, Mo., was declared off-limits, because of dioxin contamination. This incident in Missouri, as well as others, helped spark passage of legislation that created Superfund, the environmental program established to address abandoned hazardous waste sites.

NIEHS administers the [Superfund Research Program (SRP)](https://www.niehs.nih.gov/research/supported/centers/srp/index.cfm), which involves a network of university grants that are designed to seek solutions to the complex health and environmental issues associated with the nation's hazardous waste sites. The research conducted by this program is coordinated with EPA, the federal entity charged with cleaning up the worst hazardous waste sites in the country, including those contaminated with dioxins.

Hazards posed by dioxins have diminished in the U.S., as environmental controls reduced the introduction of new industrial sources of dioxin. However, legacy problems persist, and the scientific community works to further reduce exposures and associated health effects.

Assessment of dioxin-like compounds also continues. NIEHS staff consulted with the World Health Organization (WHO) to review estimates of toxicity for dioxin-like compounds that were established in 2005. The findings of this [expert consultation](https://www.who.int/news/item/15-11-2022-who-expert-consultation-on-updating-the-2005-toxic-equivalency-factors-for-dioxin-like-compounds-including-some-polychlorinated-biphenyls), conducted in October 2022, will be published in a peer-reviewed paper in early 2023.

**Dioxin and Breast Cancer**

Certain dioxin (polychlorinated dibenzo-p-dioxins and dibenzofurans) are often produced during the combustion of chlorinated organic compounds. Some of these compounds are known to be carcinogenic.

The NIEHS [Sister Study](https://sisterstudy.niehs.nih.gov/English/slide2.htm) evaluated, in 2023, whether [dioxin may be associated with breast cancer risk](https://pubmed.ncbi.nlm.nih.gov/36642125/). They used publicly available data on industrial emissions at facilities located near participant's homes to estimate dioxin exposure levels. Then associations between estimated dioxin exposure and breast cancer risk were evaluated. Researchers found that long-term exposure to airborne dioxin emissions within 3km of participants' residences was associated with increased breast cancer risk. This association was strongest for emissions from municipal solid waste facilities. These findings indicate that living in proximity to industrial emissions facilities may be linked to higher breast cancer rates.