Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)

These widespread, manmade chemicals have leached into our soil, air, and water. More research is needed to understand if and how they cause health problems.

PFAS are a large, complex, and ever-expanding group of manufactured compounds that are widely used to make everyday products more resistant to stains, grease, and water. For example, they are used to keep food from sticking to cookware, make clothes and carpets resistant to stains, and create firefighting foam that is more effective. PFAS are also used in a variety of other industries, including aerospace, automotive, construction, electronics, and military. Because they take so long to break down in the environment, they remain in air, soil, and water, including sources of drinking water, for a long time.

Why PFAS are receiving so much attention

- Widespread occurrence. Studies are finding PFAS in participants' blood and urine, and people want to know if they may cause health problems.
- Numerous exposures. PFAS are used in hundreds of products for a variety of applications, all over the world, causing multiple opportunities for exposure.
- Growing numbers. More than 4,700 known PFAS chemicals exist, and the numbers are increasing as industry invents new chemicals.[1]
- Persistent. PFAS remain in the environment for an unknown length of time and take many years to leave the body.
- Bioaccumulation. Some PFAS chemicals may accumulate in the body over time, due to more PFAS being absorbed than eliminated.

How people are exposed

Though more research is needed to fully understand all sources of exposure, people are most likely exposed to these chemicals by consuming PFAS-contaminated water or food, using products made with PFAS, or breathing air containing PFAS.

One report by the Centers for Disease Control and Prevention National Health and Nutrition Examination Survey (NHANES) found PFAS in the blood of 97 percent of Americans[2]. A more recent NHANES report suggested a reduction in blood levels of PFOS and PFOA since their removal from consumer products in the early 2000s. However, the number of new PFAS chemicals appear to be growing and exposure is difficult to assess accurately.

What they are

PFAS molecules are made up of a chain of carbon and fluorine atoms linked together. Because the carbon-fluorine bond is one of the strongest ever created, these chemicals do not degrade in the environment. In fact, PFAS products remain in the environment for so long that scientists are unable to estimate an environmental half-life, or the amount of time it takes for 50 percent of the chemical to disappear.

PO Box 12233 • Research Triangle Park, NC 27709
Phone: 919-541-3345 • **www.niehs.nih.gov**

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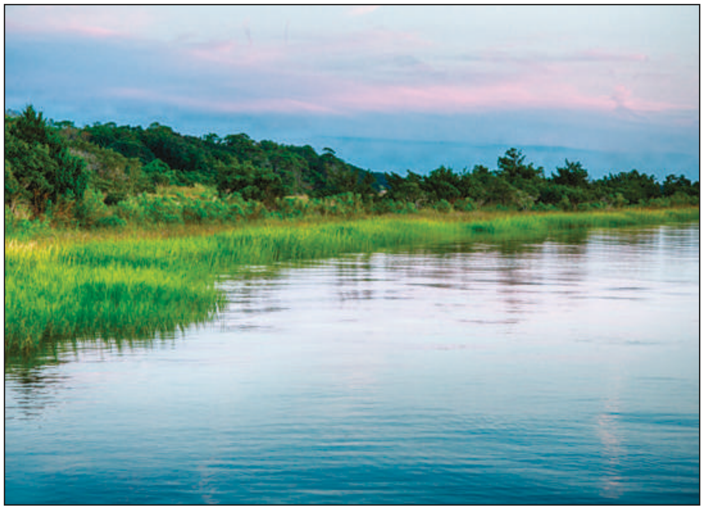
The scientific understanding of PFAS stems almost entirely from research on a select few compounds. Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) have been manufactured the longest, are the most widespread in the environment, and are the most well-studied. PFOS and PFOA, which are called long-chain PFAS, are no longer manufactured in the United States. However, U.S. chemical manufacturers have replaced these phased-out chemicals with alternative short-chain PFAS, such as GenX.

What we have learned so far

When looking for possible human health effects of chemical compounds that have become intermingled with our natural environment, it is important to understand that they are very hard to study, especially when there are thousands of individual PFAS chemicals. Still, the research conducted to date reveals possible links between human exposures to PFAS and adverse health outcomes. These include potential effects on metabolism,[3] pregnancy,[4] children's cognition and neurobehavioral development,[5] and the immune system.[6]

Much of the research has been supported or led by the National Institute of Environmental Health Sciences (NIEHS) and the National Toxicology Program (NTP), an interagency testing program headquartered at NIEHS. For example, in 2016, NTP concluded that PFOA and PFOS were a hazard to immune system function in humans, based on evidence from prior studies.[7]



Cape Fear River

While knowledge about the potential health effects of PFAS has steadily grown in recent years, many questions remain unanswered. Therefore, NIEHS and NTP continue to fund or conduct research to better understand the effects of PFAS exposure.

What we are doing

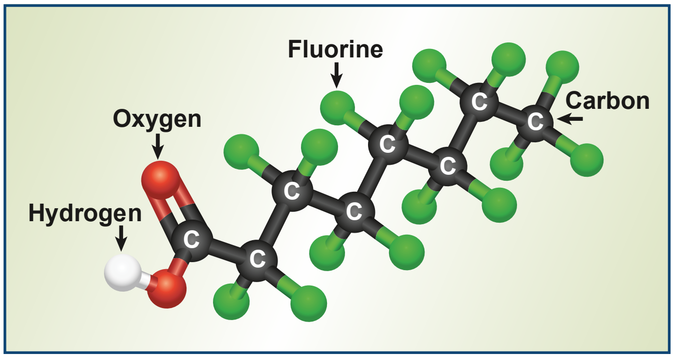
NTP is leading multi-faceted toxicology studies to evaluate and identify the adverse effects of PFAS chemicals, such as:

- A systematic literature review of six PFAS chemicals — PFNA, PFHxS, PFHxA, PFDA, PFBA, PFBS — to determine whether they weaken the body's response to vaccinations.
- Animal studies, including a two-year study on PFOA and 28-day studies on seven PFAS chemicals — PFNA, PFHxS, PFHxA, PFDA, PFBA, PFBS, PFOA.

In addition to the NTP effort, NIEHS awards many grants to organizations across the U.S. to conduct their own PFAS studies, including:

- Time-sensitive studies including PFAS exposures in residents near Colorado Springs whose water was contaminated with the PFAS known as perfluorohexane sulfonate (PFHxS), and contamination of the Cape Fear River in North Carolina by GenX.
- Long-term epidemiological studies of health effects of PFAS exposures, some beginning before birth, including one study on more than 300 children in the Faroe Islands.[8]

- Children's environmental health research studies. For example, one study found that verbal and non-verbal IQ scores were lower in children with higher prenatal exposure to PFOA and PFOS.[9]
- Long-term studies, including one showing a link between PFAS exposure and an increased risk of Type 2 diabetes in women.[10]



PFOA chemical symbol

The NIEHS Superfund Research Program (SRP) funds the search for practical applications to protect the public from exposures to hazardous substances. Examples include:

- A project called Sources, Transport, Exposure, and Effects of PFASs (STEEP) at the University of Rhode Island is identifying sources of PFAS contamination, assessing human health effects, and educating communities on ways to reduce exposure.[11]
- The Michigan State Superfund Research Center is developing energy-efficient nanoreactors capable of breaking the carbon-fluorine bond that keeps PFAS from degrading.
- Scientists at the University of California, Berkeley are working on options to degrade and destroy aqueous film-forming foams (AFFF) used for firefighting, a major source of PFAS contamination.
- Small Business Innovation Research (SBIR) grantee CycloPure, Inc., is developing new ways to remove hazardous PFAS from water.
- Another SBIR project by EnChem Engineering, Inc. is developing an innovative technology to speed up removal of PFAS at Superfund sites.

Impact on public health

- NIEHS grantees and NTP contribute significantly to the field of alternatives assessment, to ensure harmful chemicals are not replaced by equally harmful, but less well-studied, related compounds.
- NIEHS leadership was part of an international group co-authoring a commentary on PFAS[12] calling for more collaboration among those researching, regulating, and using PFAS. The document is known as the Zurich statement because it grew out of a November 2017 workshop in Zurich, Switzerland.
- Collectively, the work of NIEHS grantees, NTP, and their collaborators will help determine the toxicity of PFAS chemicals and their potential adverse human health effects. Such data will be of value to regulatory agencies and policymakers who will use the information to protect public health and help make informed decisions.
- Some state agencies are reviewing current PFAS research findings from NIEHS grantees, NTP, and others, to help assess and evaluate the impact of these chemicals on human health in their communities.

The importance of collaboration

PFAS contamination is a complex issue that no single entity or agency will be able to address alone. NIEHS and NTP are actively coordinating efforts with other government agencies to gain a clearer understanding of the ways in which PFAS may affect human health.

- NTP is collaborating with the U.S. Environmental Protection Agency on the Responsive Evaluation and Assessment of Chemical Toxicity (REACT) program, which is developing a new approach to screen more than 100 representative PFAS in search of a common basis for toxicity.
- NIEHS is working with the Agency for Toxic Substances and Disease Registry to initiate exposure assessments and health studies authorized by the National Defense Authorization Act for Fiscal Year 2018.
- NIEHS is working closely with the U.S. Food and Drug Administration on PFAS-related food safety, and the Centers for Disease Control and Prevention on monitoring PFAS exposure levels.

Learn more

- National Toxicology Program
  https://ntp.niehs.nih.gov
- Agency for Toxic Substances and Disease Registry
  www.atsdr.cdc.gov/pfas
- Centers for Disease Control and Prevention
  www.cdc.gov/biomonitoring/PFAS_FactSheet.html
- U.S. Environmental Protection Agency
  www.epa.gov/pfas/epas-pfas-action-plan

For more information on the National Institute of Environmental Health Sciences, go to **www.niehs.nih.gov**.

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