Persistent organic pollutants (POPs)

Some pollutants remain after the activity that released them has stopped. POPs combine slow breakdown, accumulation in organisms, long-range transport and harmful biological effects.

1. PERSISTENT + ORGANIC

Persistent means resistant to environmental breakdown, not literally indestructible. Organic means carbon-based, not harmless or organically farmed. DDT and PCBs are synthetic examples. Their chemical structures resist degradation; being synthetic or containing carbon alone does not make every chemical a POP.

2. FAT SOLUBILITY HELPS EXPLAIN RETENTION

Classic POPs such as DDT and PCBs dissolve readily in fats relative to water. They can accumulate in fatty tissues when uptake exceeds breakdown and elimination. Low water solubility does not prevent exposure: contaminated food and particles can carry the chemicals into organisms.

3. CONNECT EXAMPLES TO THEIR SOURCES

Example	Use or formation
DDT	An insecticide used historically in agriculture and in insect-borne disease control. Residues can remain long after applications stop.
PCBs	Industrial chemicals used in electrical equipment, including transformers and capacitors. Leaks and improper disposal can release old stocks.
Dioxins	Unwanted by-products of some combustion and industrial processes. A POP does not have to be intentionally manufactured for use.

These are examples, not a complete list. Learn the shared properties rather than assuming every pesticide or every carbon compound is a POP.

Properties: Stockholm Convention, What are POPs?
DDT persistence and use: US EPA, DDT - A Brief History and Status.
Industrial uses and legacy equipment: US EPA, Learn about PCBs.
Unintentional dioxin formation: US EPA, POPs - A Global Issue, A Global Response.

Scope: College Board AP Environmental Science CED, Topic 8.7, p. 164.

A local release can become a distant risk

Wind and water can carry POPs beyond the place of release. Persistence gives them time to travel before they are redeposited into another ecosystem.

1. FOLLOW ONE ATMOSPHERIC PATHWAY

ENTER THE AIR

Some POPs evaporate; others attach to airborne particles.

→

TRAVEL

Winds move gases and contaminated particles away from their source.

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REDEPOSIT

Rain, snow or settling particles deliver POPs to land and water.

Rivers and ocean currents provide additional transport routes. Some chemicals can re-enter the air after deposition and travel again. This helps explain contamination in remote places, including the Arctic, where a chemical may never have been used locally.

2. SEDIMENT CAN STORE A LEGACY OF POLLUTION

Many classic POPs associate with organic matter and particles that settle into sediment. Burial can reduce immediate exposure, but storage is not the same as chemical destruction. Disturbance can return contaminated particles to the water and make them available to organisms again.

3. DISTINGUISH TWO BIOLOGICAL PROCESSES

Bioaccumulation is the buildup of a contaminant within an organism over time. Biomagnification is an increase in concentration across successive trophic levels in a food web. One fish retaining POPs is accumulation; higher concentrations in its predators can indicate magnification. Topic 8.8 develops this food-web comparison.

Low concentration in a water sample does not automatically mean low exposure through food. Water, sediment and organism tissues answer different questions.

Transport and sediment reservoirs: US EPA, POPs - A Global Issue, A Global Response.
Distribution and biological effects: Stockholm Convention, What are POPs?
PCB persistence, cycling and food exposure: US EPA, Learn about PCBs.

Scope: College Board AP Environmental Science CED, Topic 8.7, p. 164.

Stop new inputs; manage the legacy

Persistence links past releases to present exposure. Reducing a source helps, but a rapid end to use does not mean a rapid disappearance from soils, sediments or organisms.

1. CONNECT EXPOSURE TO BIOLOGICAL EFFECTS

POPs can impair reproduction, development, immune function or nervous-system function; some disrupt hormone signaling. Effects vary with the chemical, dose, exposure duration and organism. A detected residue establishes presence, not by itself the severity of harm.

2. EXTENSION: PREVENT FURTHER RELEASES

Use safer substitutes and restrict harmful uses. Manage old stocks and equipment to prevent leaks; control unintentional by-products through cleaner processes. International cooperation matters because transport crosses borders. The Stockholm Convention coordinates action on listed POPs.

3. EXTENSION: CLEANUP MUST MATCH THE SITE

Address active sources first to avoid recontamination. Sediment options include monitored natural recovery, capping, or dredging with suitable treatment or disposal. Capping isolates rather than destroys a chemical. Monitor results over time; no method is best for every site.

4. EXTENSION: SLOW LOSS STILL LEAVES RESIDUES

Illustrative model: start with 100 g, a constant 5-year degradation half-life, and no new input or movement into or out of the compartment.

0 years	5 years	10 years	15 years
100 g	**50 g**	**25 g**	**12.5 g**

After three half-lives, 12.5% remains. These are invented values, not a measured DDT or PCB half-life; actual degradation depends on the chemical and conditions.

Biological effects: Stockholm Convention, What are POPs?
Source control and international cooperation: US EPA, Global Issue/Response.
Sediment remedies and monitoring: US EPA, How Superfund Cleans Up Sediment Sites.

Scope: College Board AP Environmental Science CED, Topic 8.7, p. 164.