Persistent organic pollutants

Persistent organic pollutants (POPs) are organic compounds that are resistant to environmental degradation through chemical, biological, and photolytic processes.

These substances Bioaccumulate in human and animal tissues and biomagnified in food chains

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POPs

- pesticides.
- Solvents,
- polyvinyl chloride
- Pharmaceuticals.

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POPs, known as the “dirty dozen”

1. Aldrin,
2. Chlordane,
3. DDT,
4. Dieldrin,
5. Endrin,
6. Heptachlor,
7. Hexachlorobenzene,
8. Mirex,
9. Polychlorinated biphenyls,
10. Polychlorinated dibenzo-p-dioxins,
11. polychlorinated dibenzofurans,
12. Toxaphene.

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Aldrin

An organochlorine insecticide

- Widely used to protect crops such as corn and potatoes,
- To protect wooden structures from termites.
- It is oxidized in the insect to form Dieldrin, a neurotoxin carcinogen as well as a mutagen.
- Binds strongly to soil particles, is resistant to leach into ground water.
- Released from soil by volatilization.
- Known to bio-concentrate.

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Aldrin- cont….

- Aldrin is toxic to humans causing headache, dizziness, nausea, general malaise, and vomiting, followed by muscle twitching's, myoclonic jerks, and convulsions.
- Occupational exposure to Aldrin, in conjunction with Dieldrin and Endrin, associated with a significant increase in liver and biliary cancer.
- Aldrin may affect immune responses.

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Chlordane

- **A broad spectrum contact insecticide,** used on agricultural crops and to control of termites
- Sticks strongly to soil particles and does not enter ground water.
- Can stay in the soil for over 20 years and breaks down very slowly.
- Bio-concentrates in fish, mammals and birds
- In both humans and animals, it can damage nervous, digestive systems and liver
- Has caused convultions and death
- Recent human studies revealed prostate and breast cancers.

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DDT

A synthetic insecticide

Half life is 2-15 years

- Breakdown products in the soil are DDE and DDD, which are also highly persistent and have similar chemical and physical properties.
- DDT and its metabolic products DDE and DDD magnify through the food chain
- DDT bio-concentrates significantly in fish and other aquatic species, leading to long-term exposure to high concentrations.
- At the chronic level, individuals who consumed contaminated fish increased diabetes occurrences.
- DDT is a probable human carcinogen.
- In 2007 a Canadian study found a positive association between DDE and non-Hodgkins Lymphoma.

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Dieldrin

- **An insecticide**
- Closely related to aldrin which itself breaks down to form dieldrin
- It accumulates in the food chain.
- Long-term exposure - toxic to many animals and human.
- Linked to Parkinson's disease, breast cancer, immune disorders, reproductive, and nervous system damage.

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Endrin

An insecticide/rodenticide

- Banned in Sri Lanka
- It is likely to adsorb onto the sediments in surface water.
- An insecticide used on cotton, maize, and rice; a rodenticide used to control mice
- Bio-concentrate in the fatty tissues of organisms living in water and toxic to aquatic organisms
- Half-life in soil estimated at over a decade
- Endrin poisoning in humans primarily affects the nervous system.
- Food contaminated with endrin has caused several clusters of poisonings worldwide, specially affecting children.

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Heptachlor

An insecticide

- Similar to the insecticide chlordane
- Has a very stable structure, and can remain in environment for decades
- Possible human carcinogen.

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Hexachlorobenzene (HCB)

A fungicide

- Formerly used as a seed treatment, especially on wheat.
- Known animal carcinogen (liver, kidney, thyroid)
- Probable human carcinogen
- After its introduction as a fungicide in 1945, for crop seeds, this toxic chemical was found in all food types.
- In humans it can cause liver disease, skin lesions, ulceration, hair loss, thyroid damage etc.
- HCB crosses the placenta to accumulate in fetal tissues and is transferred in breast milk as well.
- Extremely toxic to aquatic creatures. Risk of bioaccumulation in an aquatic species is high

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Mirex

An organochlorine insecticide, flame retardant

- A persistent, accumulative, and toxic pollutant.
- Used to control fire ants and as a flame retardant in plastic, rubber, paint, paper and electronics industries.
- Mirex is transported across the placenta and mother to child through breast milk
- Most effected in animals is the liver
- Proven carcinogenic risk to humans
- Toxic for a range of aquatic organisms like crustacea
- Mirex induces long-term physiological and biological disorders in vertebrates.
- Mirex accumilates in aquatic and terrestrial food chains to harmful levels
- Mirex is one of the most stable of the organochlorine insecticides in the environment and cause long-term hazard to the environment

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PCBs (polychlorinated biphenyls)

- Used as coolants,flexible PVC coatings of electrical wiring and electronic components, pesticide extenders, flame retardants, hydraulic fluids, sealants, adhesives, wood floor finishes and paints.
- PCBs are very stable compounds and do not degrade readily.
- Bio-concentrates in animals
- PCBs can be transmitted via breast milk as well as through the placenta.
- In humans, PCBs can cause liver diseases, ocular lesions, lessened immune responses.

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- Babies born to women exposed to PCBs have been shown to have weight loss, have problems with motor skills, a decrease in short-term memory, and compromised immune systems.
- PCBs alter estrogen levels and contribute to reproductiiv problems.
- Some studies indicate that PCBs are associated with cancer in humans, such as cancer of the liver and biliary tract.
- PCBs are known to induce Vitamin A deficiency in mammals

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PCDDs (Polychlorinated dibenzodioxins) – commonly referred to as DIOXINS

- Dioxins are teratogens, mutagens, potential human carcinogens
- Accumulate in humans and wildlife due to dioxins' ability to dissolve in fats and oils and their tendency to be water insoluble.
- Hence even small amounts in contaminated water can bio-concentrate up the food chain to dangerous levels.
- In humans, they can cause effects in reproductive/sexual development and immune system damage, thyroid disorders, nervous system disorders and diabetes.

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- Studies have shown that exposure to dioxin increases the ratio of female births to male births among a population.
- The estimated elimination half-life for dioxins in humans ranges from 7.8 to 132 years.
- Dioxin enters the general population almost exclusively from ingestion of food
- Because Dioxins are lipophilic, breast fed children are susceptible to dioxin more
- 80% of Dioxin emissions are caused by coal burning plants, municipal waste incinerators, metal melting, diesel trucks, land application of sewage sludge etc.

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Polychlorinated dibenzofurans

- Highly toxic
- Properties and chemical structure similar to dioxins

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Toxaphene

- **Highly toxic insecticide**
- Exposure can cause damage to lungs, nervous system, kidneys and can be fatal

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Chemical properties of POPs

1. Low water solubility
2. High lipid solubility,
3. Semi-volatility,
4. High molecular masses.
5. POPs with molecular masses lower than 236 g/mol are less toxic, less persistent in the environment, and have more reversible effects than those with higher molecular masses.
6. POPs are frequently halogenated, usually with chlorine.
7. The more chlorine groups a POP has, the more resistant it is to being broken down over time.
8. One important factor of their chemical properties such as lipid solubility results in the ability to pass through biological phospholipid membranes and bioaccumulate in the fatty tissues of living organisms

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Long-range transport

1. The indirect routes include attachment to particulate matter, and through the food web. The chemicals' semi-volatility allows them to travel long distances through the atmosphere before being deposited.
2. POPs can be found all over the world, including in areas where they have never been used and remote regions such as the middle of oceans and Antarctica.
3. The chemicals' semi-volatility also means that they tend to volatilize in hot regions and accumulate in cold regions, where they tend to condense and stay.

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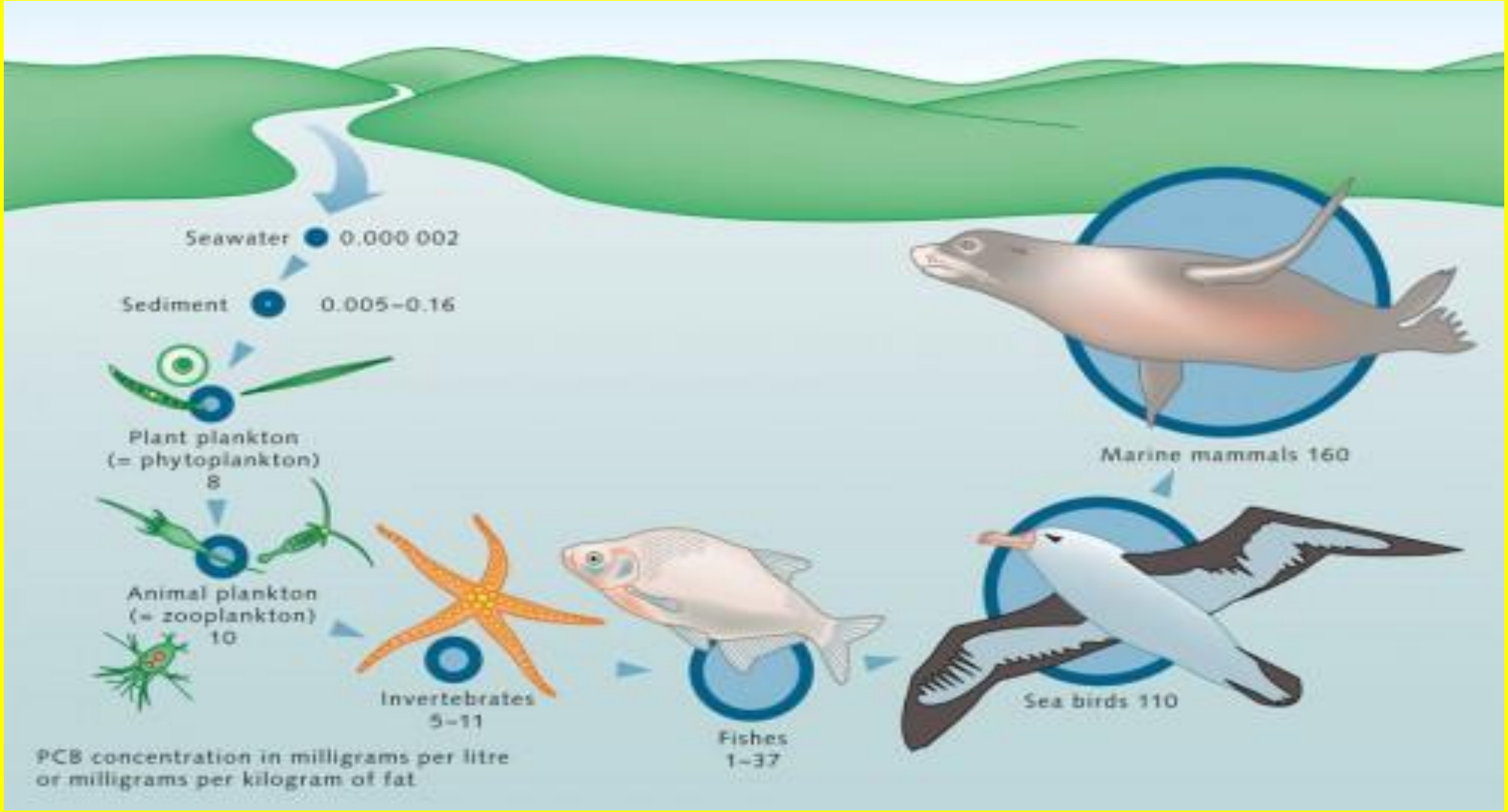

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Health effects of POPs

- **Disruption of the endocrine, reproductive, and immune systems;**
- **Neurobehavioral disorders;**
- **Cancers possibly including breast cancer.**
- **A study published in 2006 indicated a link between blood serum levels of POPs and diabetes. (Eg-DDT, dioxins, PCBs and Chlordane)**

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Health Effects- ctd

- As most exposure to POPs is through consumption of animal fats, and thus the consumption of the fats themselves, or other associated factors may be responsible for the increase in insulin resistance.
- Another possibility is that insulin resistance causes increased accumulation of POPs.
- Among study participants, obesity was associated with diabetes only in people who tested high for these pollutants.
- These pollutants are accumulated in animal fats, so minimizing consumption of animal fats may reduce the risk of diabetes.

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