

## CY-1018: Environmental Chemistry Theory

Know our environment (chemistry of lithosphere, energy balance, sustainability and recycle), Know about global warming (infrared absorption, molecular vibration, atmospheric window, residence time of greenhouse gases, evidences and effects of global warming), Deeper analysis of atmospheric pollution (Chemistry of CO, NO<sub>x</sub>, VOCs, SO<sub>2</sub>, Industrial smog, photochemical smog), Ozone depletion (production, catalytic destruction), **Organic Chemicals in the Environment, Insecticides, Pesticides, Herbicides and Insect Control, Soaps, Synthetic Surfactants, Polymers, and Haloorganics. Fate of organic/inorganic chemicals in natural and engineered systems (fate of polymers after use, detergents, synthetic surfactants insecticides, pesticides etc. after use)**, Aspects of transformations in atmosphere (microbial degradation of organics-environmental degradation of polymers, atmospheric lifetime, toxicity). Green Chemistry and Industrial Ecology. Future challenges (CO<sub>2</sub> sequestering, Nuclear energy). A project on environment related topic.

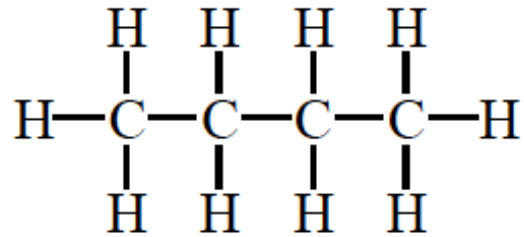
**Reference: Principles of Environmental Chemistry By James E. Girard, Third Edition**

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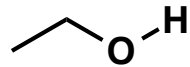
# Organic Chemicals in the Environment

**Organic compounds:** Compounds that mainly contain Carbon and Hydrogen atoms

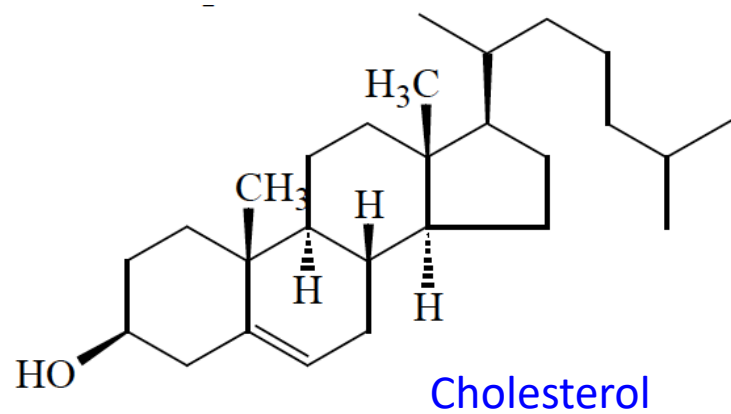
Ex.



n-butane



Ethanol



Cholesterol

Glucose: C<sub>6</sub>H<sub>12</sub>O

DNA

Amino acids

Proteins

Medicines

Plastics

Pesticides

# Organic Chemicals in the Environment

- Thousands of different organic chemicals are synthesized each year for use as cosmetics, insecticides, detergents, and plastics
- Some of them are not adequately tested for toxicity before being put on the market
- Many of these chemicals persist in the environment for long periods of time

## Persistent organic pollutants (POPs)

Media	Half-Life of Chemical		
	Not Persistent	Persistent	Highly Persistent
Water	< 2 months	$\geq$ 2 months	> 6 months
Soil	< 2 months	$\geq$ 2 months	> 6 months
Air	$\leq$ 2 days		> 2 days
Sediment	< 2 months	$\geq$ 2 months	> 6 months

# Organic Chemicals in the Environment

## Persistent organic pollutants (POPs)

- POPs can enter into water and food chains and can cause serious health and environmental problems
- POPs can go from one place to other via wind and water
- POPs generated in one country can affect the people and wildlife in other countries even though they are very far from each other
- Some POPs evaporate from water or land surfaces into the air, then return to Earth in snow, rain, or mist

# Organic Chemicals in the Environment

**Insecticides:** Substances used to kill insects

**Pesticides:** Substances used to kill pests including weeds

**Herbicides:** Pesticide used to kill unwanted plants

**Fungicides:** Substances used to kill fungus

Approximately 80,000 synthetic chemicals are on the market today and most of them have never been tested for toxicity

# Organic Chemicals in the Environment

- POPs contamination is also found in arctic regions, which are thousands of miles from anywhere the POPs are manufactured or used

## Stockholm Convention

In 2001 **“dirty dozen” POPs**

- Out of 12 chemicals, 10 were intentionally produced by industry
- 9 were produced as **insecticides or fungicides**
- Two are unintentionally produced in combustion processes

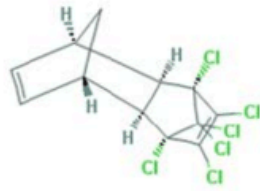
# Organic Chemicals in the Environment

## The 12 Key POPs—the Dirty Dozen

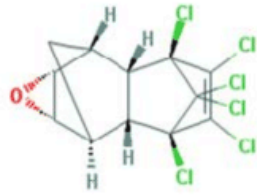
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POP	Use
Aldrin	crop insecticide (corn, cotton)
Chlordane	crop insecticide (vegetables, citrus, cotton, potatoes)
DDT	crop insecticide (cotton)
Dieldrin	crop insecticide (cotton, corn)
Endrin	crop insecticide (cotton, grains)
Heptachlor	insecticide (termites and soil insects)
Hexa-chlorobenzene	fungicide for seed treatment
Mirex	insecticide (termites, fire ants)
Toxaphene	insecticide (livestock and crops)
PCBs	industrial chemical (heat exchange fluid for electrical transformers, paint and plastic additive)
Dioxins	unintentionally produced during combustion
Furans	unintentionally produced during combustion

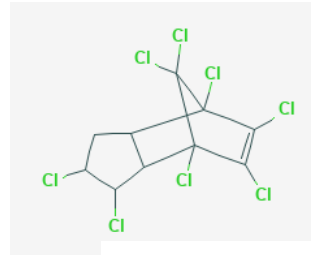
# Organic Chemicals in the Environment



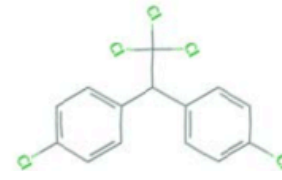
**Aldrin**



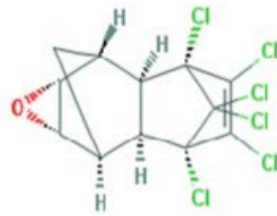
**Dieldrin**



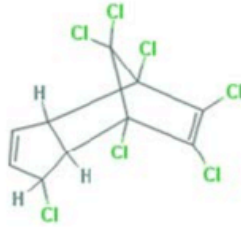
**Chlordane**



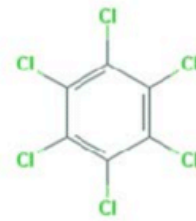
**DDT (Dichlorodiphenyltrichloroethane)**



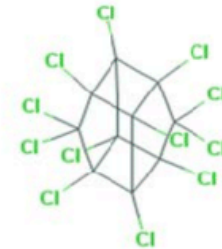
**Endrin**



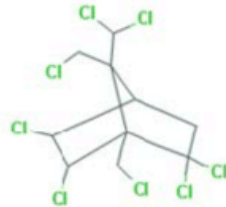
**Heptachlor**



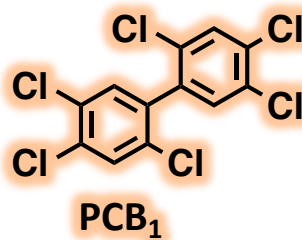
**HCB**



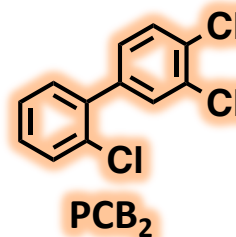
**Mirex**



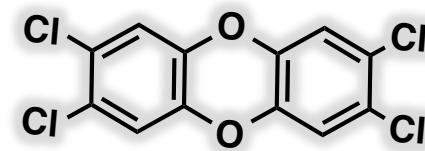
**Toxaphene**



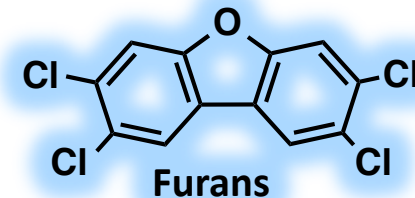
**PCB<sub>1</sub>**



**PCB<sub>2</sub>**



**Dioxins**



**Furans**

**Polychlorinated compounds**

2,3,7,8-tetrachlorodibenzo[*b,d*]furan



# Organic Chemicals in the Environment

## Stockholm Convention

Added 8 more substances to the agreement in 2009 and one more in 2011

### New POPs Added to the Stockholm Convention in 2009 and 2011

POP	Use
Hexachlorocyclohexane	Unintentional by-product of lindane production
Chlordecone	Insecticide (ant and roach)
Hexabromobiphenyl	Fire-suppressing chemical
Hexabromodiphenyl modiphenyl ether and Heptabro-	Flame retardant
Lindane	Broad-spectrum insecticide
Pentachlorobenzene	PCB
Perfluorooctane sulfonic acid	Key ingredient in Scotchgard fabric protector
Tetrabromodiphenyl ether	Flame retardant
Endosulfan	Crop insecticide

# Organic Chemicals in the Environment

## Stockholm Convention

Added 8 more substances to the agreement in 2009 and one more in 2011

- Five of the new POPs are also poly chlorinated compounds which are used as insecticides
- Polychlorinated hydrocarbons are insoluble in water but soluble in fats
- Polychlorinated hydrocarbons concentrated in the fatty tissues of fish and of birds, and of humans who eat them
- For the first time, polybrominated compounds that were used in the 1970s as flame-retardant agents were added to the list
- Perfluorooctane sulfonic acid, the key ingredient in Scotchgard fabric protector, was added to the list of new POPs

# Organic Chemicals in the Environment

## Persistent, Bioaccumulative, and Toxic (PBT) Pollutants Program

- Launched by **EPA** (Environmental Protection Agency) in 1998
- Wider scope than the Stockholm Convention and has the same goals of reducing the use and release of PBT pollutants while making sure that these chemicals are disposed of properly
- PBT program is also focusing a list of 12 priority pollutants and most of them are already listed in **dirty dozen**
- PBT list includes inorganic elements, such as mercury or organometallic compounds that contain an inorganic atom

# Organic Chemicals in the Environment

## Persistent, Bioaccumulative, and Toxic (PBT) Pollutants Program

### The EPA's Priority Level-1 PBTs

PBT Compound	Use
Aldrin/Dieldrin	crop insecticide (corn, cotton)
Alkyl-lead	octane booster in leaded gasoline
Benzo(a)pyrene	unintentionally produced during combustion
Toxaphene	insecticide (livestock and crops)
Chlordane	crop insecticide (vegetables, citrus, cotton, potatoes)
DDT	crop insecticide (cotton)
Dioxins/Furans	unintentionally produced during combustion
Hexachlorobenzene	fungicide for seed treatment
Mercury and mercury compounds	incineration of medical and municipal waste
Mirex	insecticide (termites, fire ants)
Octachlorostyrene	produced from carbon electrodes used in electrolytic process for producing chlorine
PCBs	industrial chemical (heat exchange fluid for electrical transformers, paint and plastic additive)