# Unit 8: Pollution: module 4.47: Pollution sources

**Module 47: Pollution, impacts, endocrine disruptors**

Video: Poisoned waters

Summaries: http://10.14.4.85:6875/books/ap-environmental-science/page/poisoned-waters-pbs-video

- Point source vs. non-point source: easy to trace in a river, not so easy in farmlands, or ocean
- Homeostasis: balance in organisms: temperature, nutrition, water, energy
- Pollution first causes impaired survival or activity, then acute (sharp) physiological impacts, including death
- Presence vs. concentration (also ability to clear, ability to store, lifetime exposure)
- Case studies: THC, Mercury in Sushi, PCBs in killer whales, coral bleaching
- Pollutants can by synergistic: the total impact is greater than the sum of the discrete or separate parts
- Multiple attacks, e.g. coral:
  - pesticides
  - sediments
  - ocean warming
  - ocean acidification
  - human interaction (tourism, anchorages)

**Chemical pollutants:**
Heavy metals (not the musical kind) and synthetics not found in nature
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Lead:

- in the air (tetra ethyl lead)
- in the water (lead pipes "plumber"=Pb)
- in soldered pipes
- lead paint
- damages brain, kidneys
- esp. damaging to kids, stunts mental development
- water filtration is a smart idea: sediment filters (white) plus charcoal filters (black)
- Case study: Flint Michigan: saved $5m using river water with Chlorine, leached Pb from pipes into drinking water
- EPA limit is 5 ppb (parts per billion), Flint Michigan was 13,000 ppb

Arsenic:

- can be found naturally in well water (look up India As)
- can be removed with filters
- causes cancer
- EPA limit is 10 ppb
- Arsenic poisoning in India and Bangladesh
- See also Antimony ("monk killer")
- used in mystery stories to murder people...

Mercury:

- can be inorganic (safer) or organic Methyl Mercury (much more dangerous)
- Hg from the latin Hydrargyrum, or "quick silver" (like the surf company)
- very high in coal
- also incineration of rubbish, e.g. dental fillings
- limestone heating into concrete also, since coal is used to heat the limestone, which also has Hg
- inorganic (metallic) mercury can be oxidized into organic mercury (dangerous)
- bacteria convert inorganic mercury into methyl mercury, a CNS toxin
- See Minamata disaster
- also fish and shellfish, esp. apex predators (e.g. tuna), 50% increase each decade
- actor Jeremy Piven suffered from mercury poisoning after eating sushi regularly (apex predator-Ahi Tuna)

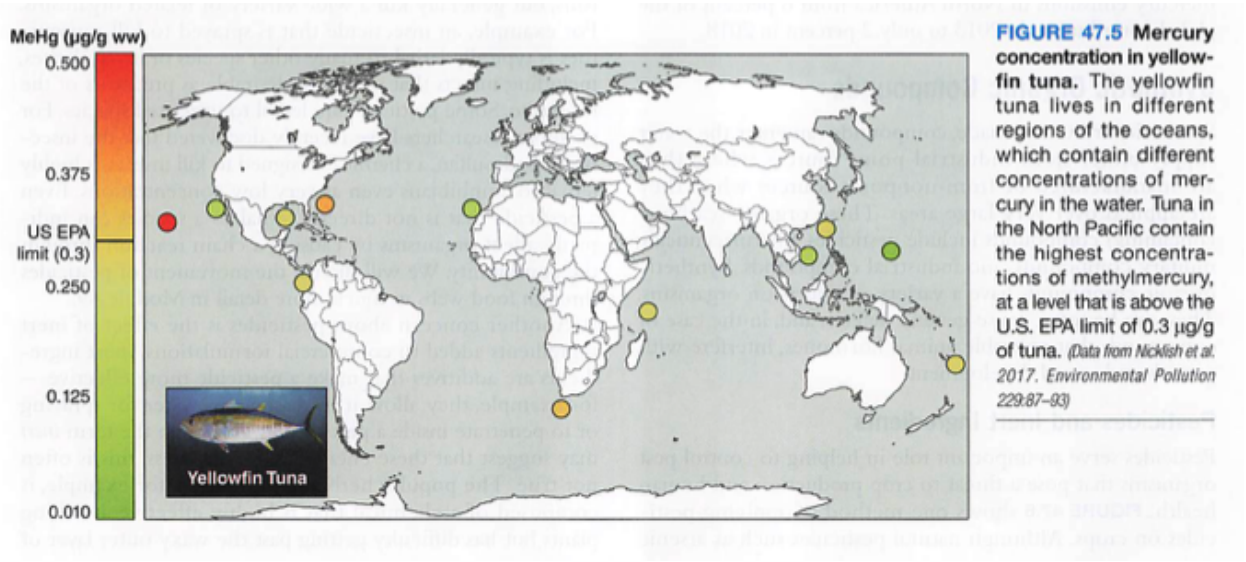



**FIGURE 47.5 Mercury concentration in yellowfin tuna.** The yellowfin tuna lives in different regions of the oceans, which contain different concentrations of mercury in the water. Tuna in the North Pacific contain the highest concentrations of methylmercury, at a level that is above the U.S. EPA limit of 0.3 µg/g of tuna. *(Data from Nicklish et al. 2017. Environmental Pollution 229:87–93)*

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**Synthetic compounds: man-made, not found in nature**

Pesticides: result of nerve gas research in WWII (WWI was all about using chlorine and phosgene in trenches)

- herbicides: kill plants, e.g. roundup ("liquid lawnmower" or "haole cane knife")
- fungicides: kill fungus
- rotenticide: kills rats

- many cross-species interactions: killing bees, amphibians (thin skin)
- inert additives: e.g. roundup uses a penetrant that is toxic to amphibians

Pharmaceuticals and hormones:

- antibiotics (in rivers and in poultry, beef)
- BCP and other reproductive hormones
- non-prescription drugs
- steroids
- water treatment systems don't stop these

Military compounds

- perchlorates (explosives)
- rocket fuels
- DU: depleted Uranium (Hawai'i island, PTA)

Industrial compounds:

- Cuyahoga river, Cleveland, 1969 (many other times back to the 1860's)
- CWA was one result from this



**FIGURE 47.8 A river on fire.** In 1952, the polluted Cuyahoga River caught fire after a spark ignited the film of industrial pollution that was floating on the surface of the water. *(Bettmann/Getty Images).*

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- PCBs: polychlorinated biphenyls
- used as insulation in transformers, plastics
- lethal and carcinogenic (you may see hazmat trucks near a transformer fire)
- PBDEs: poly brominated diphenyl ether: flame retardants, toxic, found in fish, birds, human milk
- PFAS: polyfluoro alkyl substances: teflon in clothing (Goretex) and in cookware
- 15,000 different types in the environment
- also known as "forever chemicals" since they never break down

Summary chart: Focus on the type--->

**TABLE 47.1** Some chemicals of major concern

| Chemical | Sources | Type | Effects |
|---|---|---|---|
| Lead | Paint, gasoline | Neurotoxin | Impaired learning, nervous system disorders, death |
| Mercury | Coal burning, fish consumption | Neurotoxin | Damaged brain, kidneys, liver, and immune system |
| Arsenic | Mining, groundwater | Carcinogen | Cancer |
| Asbestos | Building materials | Carcinogen | Impaired breathing, lung cancer |
| Polychlorinated biphenyls (PCBs) | Industry | Carcinogen | Cancer, impaired learning, liver damage |
| Radon | Soil, water | Carcinogen | Lung cancer |
| Vinyl chloride | Industry, water from vinyl chloride pipes | Carcinogen | Cancer |
| Alcohol | Alcoholic beverages | Teratogen | Reduced fetal growth, brain and nervous system damage |
| Atrazine | Herbicide | Endocrine disruptor | Feminization of males, low sperm counts |
| DDT | Insecticide | Endocrine disruptor | Feminization of males, thin eggshells of birds |
| Phthalates | Plastics, cosmetics | Endocrine disruptor | Feminization of males |

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**Chemical categories:**

Neurotoxins:

- disrupt the nervous system
- many insecticides
- ACHe inhibitors

Carcinogens:

- cause cancers
- may be acute (sudden) or long term (chronic)
- interferes with normal cell replication, causing cancer

Mutagens:

- mutate cells, causing cell death or cancers
- impact increases with age (more mutations)
- different from teratogens, which cause birth defects
- radon, asbestos, formaldehyde, tobacco
- fun fact: you get cancer every day (mutations) but your immune system cleans them out
- if your immune system is compromised, or synergistic toxins are present, cancer is more likely, e.g. radiation exposure to a smoker is worse than for a non-smoker, or alcohol plus nitrites in smoked meats...

Teratogens:

- from the Greek τέρας teras (word stem τέρατ-terat-), meaning "sign sent by the gods, portent, marvel, monster"
- cause birth defects by crossing the placenta in pregnant women

- only one generation, unless they reproduce, carrying the broken gene (see also germ editing)
- Case study: thalidomide, sleep aid, caused many tragic birth defects, around 1960, some still survive today
- alcohol is a potent teratogen, FAS (see also decreasing fertility in Russia due to alcohol use)

Allergens

- often not taken seriously
- can cause immune system impact, even death (peanuts, milk, bees, penicillin, codeine)

Endocrine disruptors

- note structure of estradiol and xenoestrogen-similar?
- disrupt normal hormonal balance, stasis or levels
- can mimic or impede binding sites (see below)
- growth, metabolism, gender (e.g. intersex in frogs)
- ED in wastewater (see video on poisoned waters) causing intersex
- drinking water treatment facilities do not remove these
- examples: birth control pills, hormones, drugs (prescription and recreational)
- U shaped response curve-very weird: low and high levels cause more impact

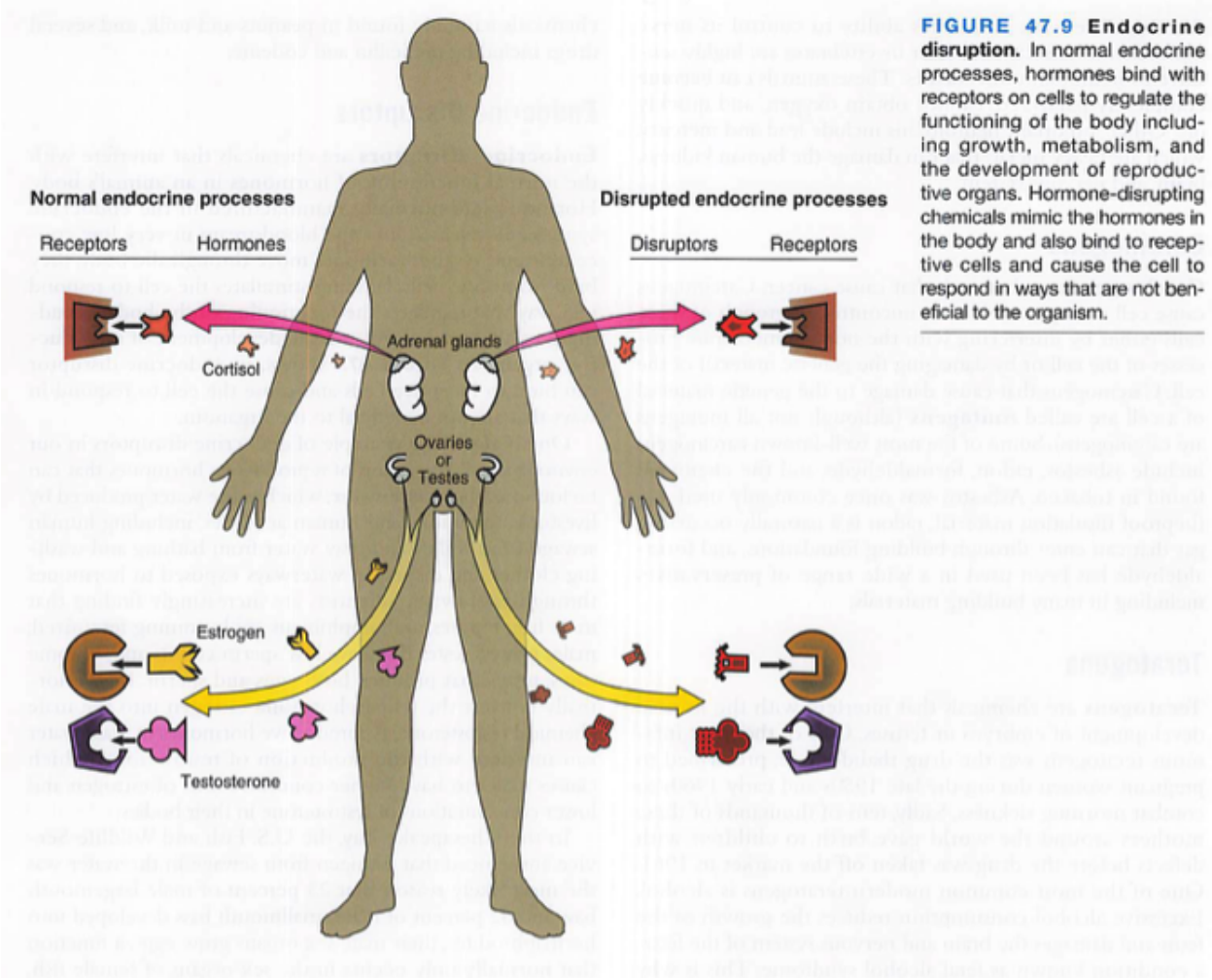



**FIGURE 47.9 Endocrine disruption.** In normal endocrine processes, hormones bind with receptors on cells to regulate the functioning of the body including growth, metabolism, and the development of reproductive organs. Hormone-disrupting chemicals mimic the hormones in the body and also bind to receptive cells and cause the cell to respond in ways that are not beneficial to the organism.

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Oil Pollution:

- historically leaking from ground (Native Americans) or in seawater (rare until 1870)
- since 1870 usually from spills (tankers like the Exxon Valdex in AK) or oil well disasters (Deepwater Horizon)
- Exxon Valdez: 11 million gallons of crude oil
- Deepwater Horizon: 206 million gallons of crude oil
- serious impact to coastline, fisheries, corals, seabed
- remediation:
  - booms to isolate
  - dispersants (e.g. Dawn dish soap: why is there a duck on their label?)
  - burning
  - GMO bacteria

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