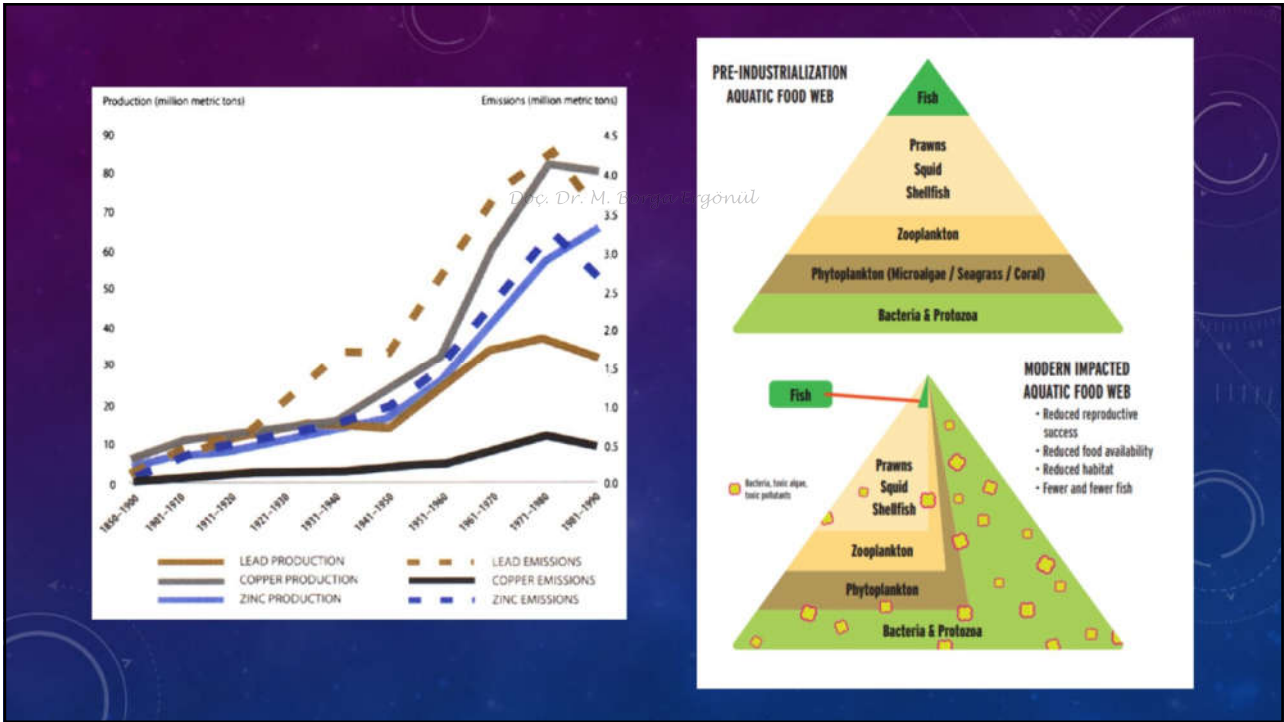


# AQUATIC POLLUTION

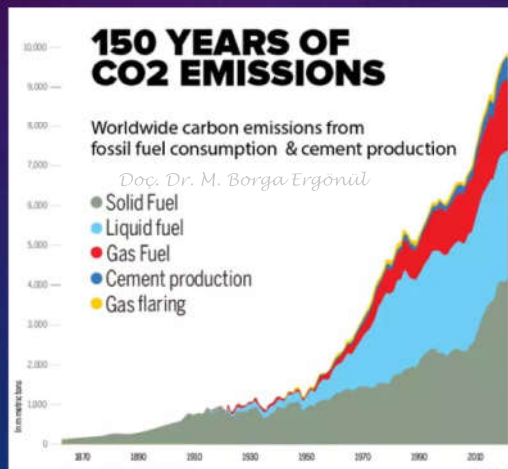
Water is an essential and general need for life with direct or indirect effects on life. All industrial, environmental, and metabolic processes are water dependent. In living organisms, water plays crucial roles such as solvent, temperature buffer, metabolite, living environment (habitat). It solves several compounds discharged into environment (or directly to water sources), or carries the non-dissolved particles to receiving aquatic habitats such as lakes and oceans.

However, water is polluted when some of the water quality parameters have been hampered by several anthropogenic activities including urbanization, agriculture and industrialization. Thus, making it harmful or unsuitable for intended use. Unfortunately, many of those alterations in water quality are generally irreversible.

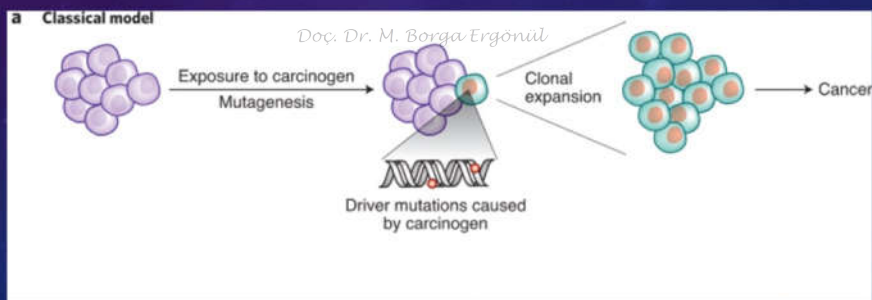




Pollution of our water bodies poses a great threat to human life and the aquatic ecosystem while marked population increase catalyzes climatic changes. For instance, various human activities and the release of greenhouse gases by industrial facilities greatly contributes to global warming, planet temperature enhancement, and lowering of atmospheric air quality. Un-effective or un-proper wastewater treatments (which are indeed built to prevent pollution) before their eventual discharge may also lead to water pollution.



Pollutant effects may vary depending on their types and source. For instance, heavy metals, dyes, and some other organic pollutants have been identified as carcinogens. On the other hand, hormones, pharmaceuticals, and cosmetics and personal care product wastes (and their residues) are known as **endocrine disruptive chemicals\***. Water borne diseases are also considered a serious health concern. These pollutants, which enter into the water body through various ways, have become a great concern on a global scale.

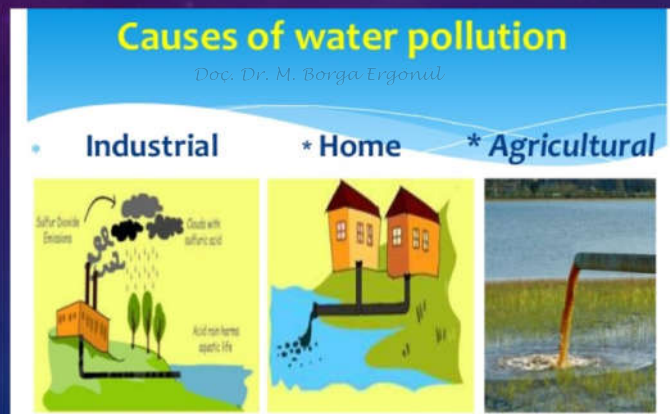


**\*Endocrine-disrupting chemicals (EDCs)** are substances that interfere with the normal function of living organisms' endocrine system.

There are many EDCs, both natural and synthetic, found in marine and aquatic environments, including industrial chemicals such as PCBs (polychlorinated biphenyl), and dioxins, perfluorinated chemicals and brominated chemicals used in many consumer goods, DDT and currently used pesticides, pharmaceuticals, detergents, as well as plastics additives such as bisphenol A and phthalates. A developing organism is particularly vulnerable to EDCs, and exposure in early life stages can result in structural and physiological defects.

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**Water pollution** can be defined as any kind of degradation (resulting from any kind of substances or activities) leading to physical, chemical or biological alterations in water sources, which might limit or totally block the use of that water sources. Any kind of activity or substance leading to this situation is considered as a pollutant.

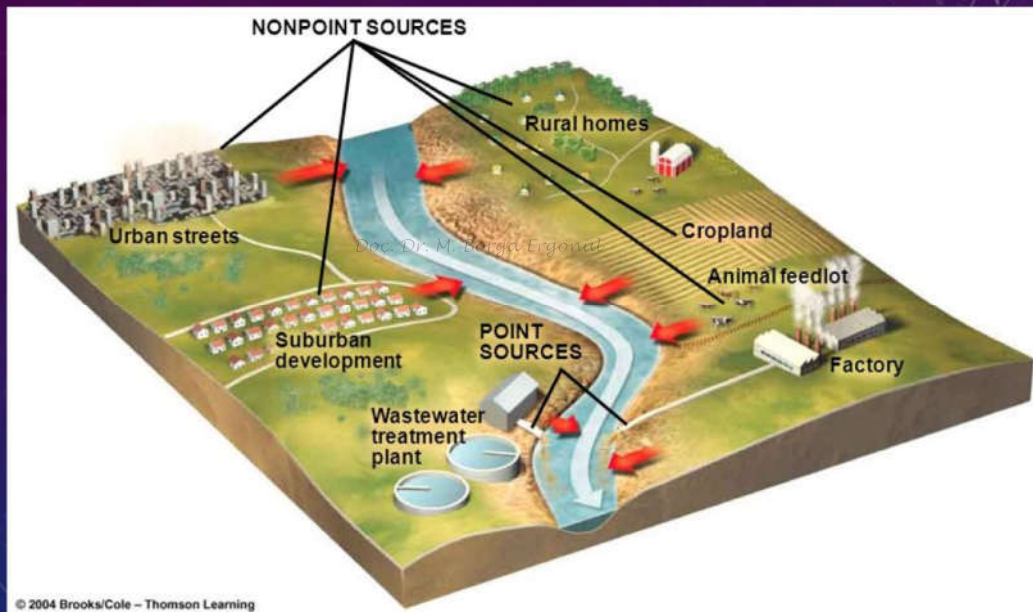


Water pollution can occur from two sources.

1. Point source
2. Non-point source

Point sources of pollution are those which have a direct and identifiable source. Example includes pipe attached to a factory, oil spill from a tanker, effluents coming out from industries. Point sources of pollution include wastewater effluent (both municipal and industrial) and sewer discharge.

However, non-point sources of pollution are those which arrive from different sources of origin and number of ways by which contaminants enter into groundwater or surface water and arrive in the environment from different non identifiable sources. Examples are runoff from agricultural fields, urban waste etc. Sometimes pollution that enters the environment in one place has an effect hundreds of miles away. For example, the radioactive waste that travels through the oceans from nuclear reprocessing plants to nearby countries.



Pollutants can be classified into 2 groups based on their chemical structure:

1. **Organic** pollutants:

### What is Organic Pollution?

Organic pollution is when human activity allows organic compounds to enter a water body which causes harm to the ecosystem

The main types of organic waste are:

- Sewage
- Silage
- Animal slurry: urine and faeces washed off farmyards and fields
- Food processing waste
- Chippings from paper mills
- Effluent from leather tanneries

These wastes are rich in organic compounds such as proteins, lipids and carbohydrates



The leather tanneries in Morocco

## 2. Inorganic water pollutants:

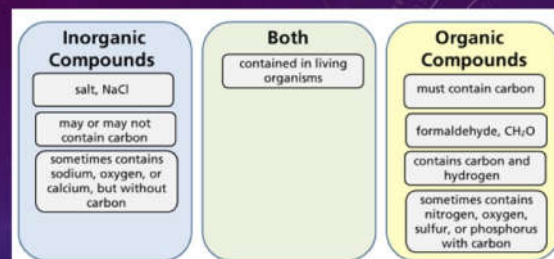
- **Metals**
  - Many metals such as mercury, lead, cadmium, and nickel are highly toxic.
    - Highly persistent and tend to bioaccumulate in food chains.
      - Lead pipes are a serious source of drinking water pollution.
    - Mine drainage and leaching are serious sources of environmental contamination.
- **Nonmetallic Salts**

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  - Many salts that are non-toxic at low concentrations can be mobilized by irrigation and concentrated by evaporation, reaching levels toxic to plants and animals (selenium & arsenic).
  - Leaching of road salts has had detrimental effect on many ecosystems.
- **Acids and Bases**
  - Often released as by-products of industrial processes.

## Organic vs. Inorganic Compounds

CRITERIA	ORGANIC COMPOUNDS	INORGANIC COMPOUNDS
Source	Living/Non-living things	Non-living things
Elements	C, H, O, N, P, S, Si, X	All
Chemical bond	?	?
<b>Solubility</b>		
1. Water/Polar Solvent	Soluble	Insoluble
2. Organic/ Non-polar Solvent	Soluble	Insoluble
Boiling point	Low	High



Organic	Inorganic
Based on C	Not based on C
Nonelectrolyte	Electrolyte (acids, bases, salts)
Covalent bonding	Ionic bonding
Low boiling and melting point	High boiling and melting point
Soluble in nonpolar solvents	Soluble in polar solvents (water)
Complex structure	Simple structure
Millions of compounds	Thousands of compounds

**Unique** *Doç. Dr. M. Borge Ergönül*  
 Covalent bonds with itself  
 Covalent bonds with others



Pollution can also be grouped based on physical and chemical alterations they lead in water sources; chemical (both organic and inorganic pollution) – physical pollution (thermal pollution)

## Sources of Thermal Pollution

⚠️ Power plants use cool water from surface/ground water sources nearby to cool steam used to turn a turbine back into water to reuse



Doc. Dr. M. Raza Ullah

- Steel mills, paper mills, and other manufacturing plants also use cool water to cool down machinery & return warmed water to local surface waters
- Urban stormwater runoff can also cause thermal pollution due to heat from blacktop/asphalt

☹️ Nuclear power plants require especially large amounts of cool water to cool steam back into water & to cool the reactor core

## What is Thermal Pollution?



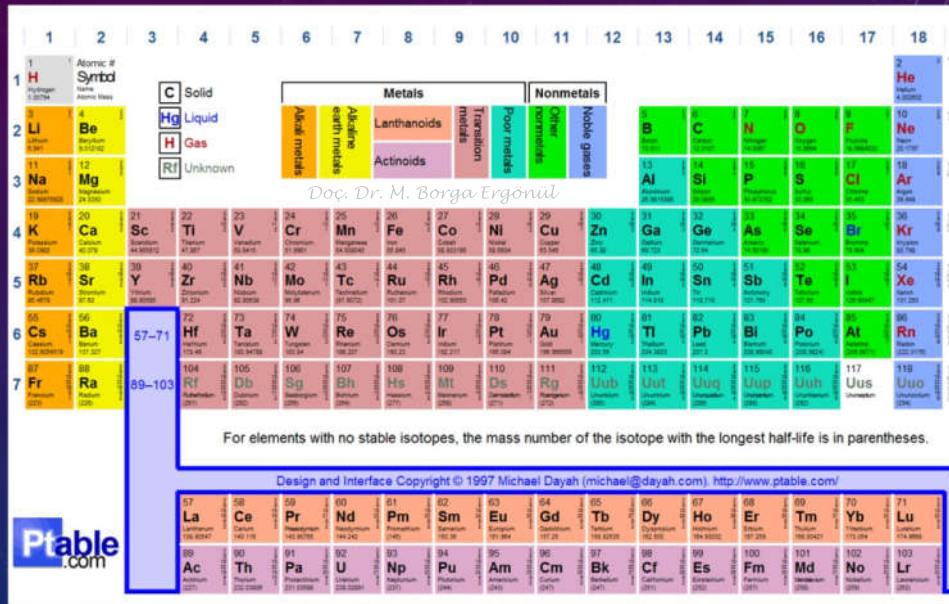
## Heavy metals

Heavy metals are natural components of the Earth's crust. Thus, “heavy metals” are natural elements of the environment typically occurring in rather low concentration. But their concentrations have increased during the last 50 years.

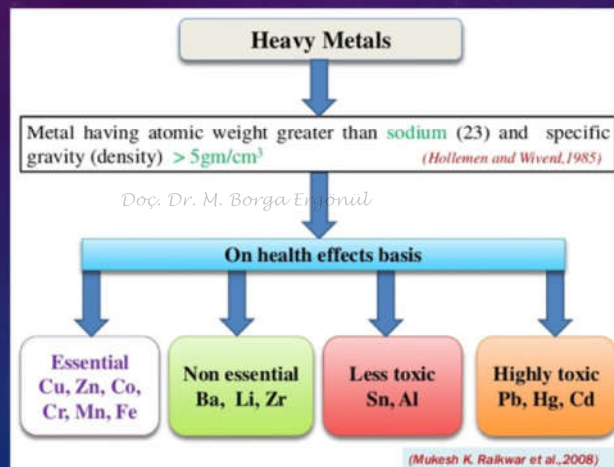
They are characterized by their rather high atomic mass and their high density. Although, they can be found all through the crust of our planet. Commonly, a density of at least  $5 \text{ g cm}^{-3}$  is used to define a heavy metal and to differentiate it from other metals. Other, broader definitions for “heavy metals” require an atomic mass higher than 23 or an atomic number exceeding 20. But all of these definitions are highly confusing. Both alternative definitions cause the inclusion even of nonmetals.

As arsenic 74.92	Cd cadmium 112.411	Pb lead 207.2	Hg mercury 200.59
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«heavy metals comprise a block of all the metals in Groups 3 to 16 that are in periods 4 and greater»



Different meanings may be attached to the term, depending on the context. In metallurgy, for example, a heavy metal may be defined on the basis of density, whereas in physics the distinguishing criterion might be atomic number, and a biologist will be more concerned with toxicity. Although, there is no widely agreed criterion-based definition of a heavy metal, several researchers use «toxic metal» instead of heavy metal since many of them exert toxic effects in quite low concentrations.





They cannot be degraded or destroyed. They are persistent chemicals which are very stable and don't break down over time. They enter our bodies via food, drinking water and air or in contact. They may be found in a living organism in very small amounts. Some heavy metals (e.g. copper, selenium, zinc, iron) are essential to maintain the metabolism of the human body. However, at higher concentrations they can lead to poisoning. However, non-essential heavy metals (lead, cadmium, mercury etc.) are very toxic even at very low amounts. They have no known functions in the human body. They can not be decomposed or metabolised.

### Paracelsus



Paracelsus [; 1493/4 – 24 September 1541], born Theophrastus von Hohenheim (full name Philippus Aureolus Theophrastus Bombastus von Hohenheim), was a Swiss physician, alchemist and astrologer of the German Renaissance.

Born: November 11, 1493

Died: September 24, 1541

Nationality: Swiss

Occupation: Scientist

Dr. M. Borgia Ergönül

Poison is in everything, and no thing is without poison. The dosage makes it either a poison or a remedy.

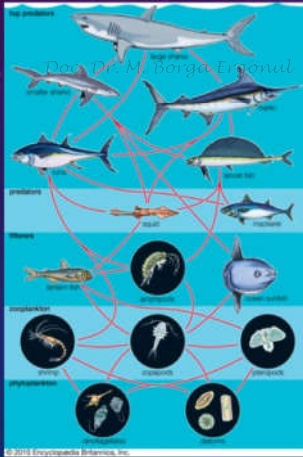
Heavy metals are dangerous because they tend to bioaccumulate. Bioaccumulation means an increase in the concentration of a chemical in a biological organism **over time**, compared to the chemical's concentration in the environment. In other words it can be defined as, the accumulation of a chemical in an organism relative to its level in the ambient medium.

Bioaccumulation is considered a major environmental and health concern. Thus, monitoring chemical concentrations in biota are widely and increasingly used for assessing the chemical status of aquatic ecosystems.

### Bioaccumulation

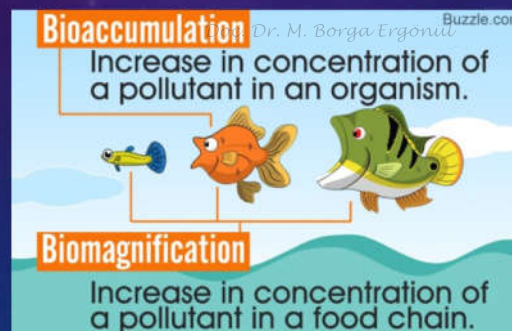


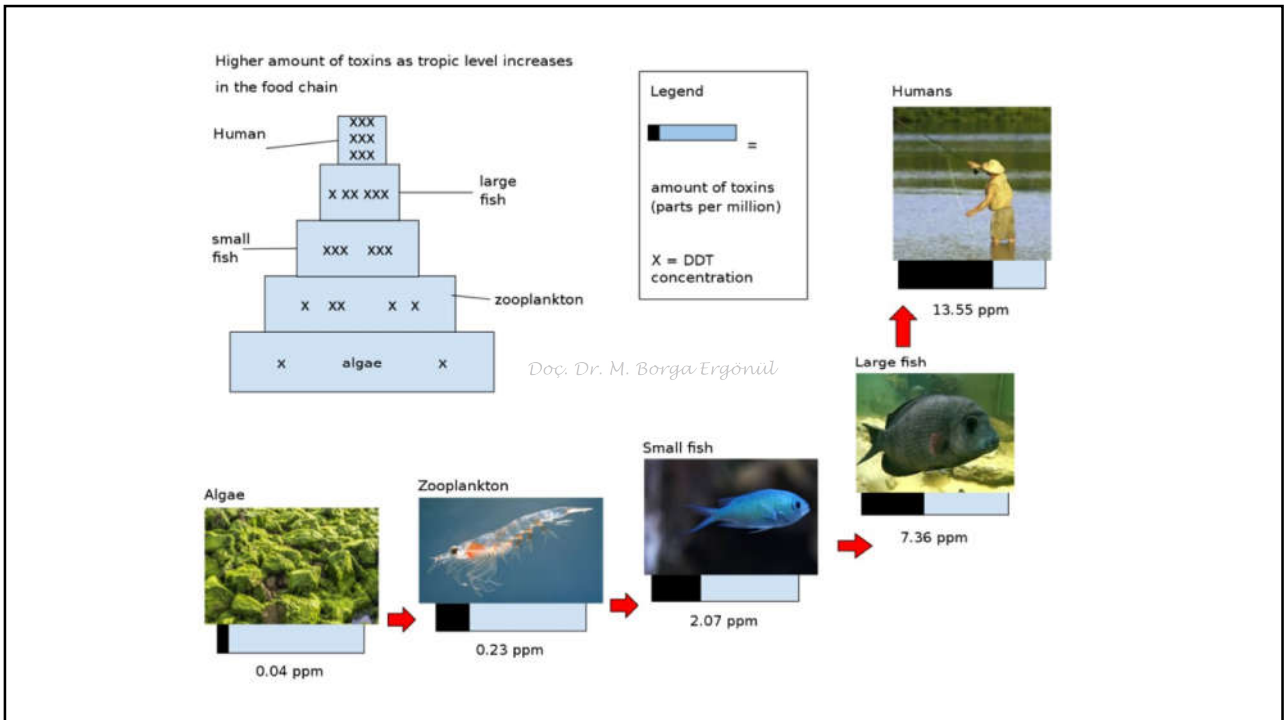
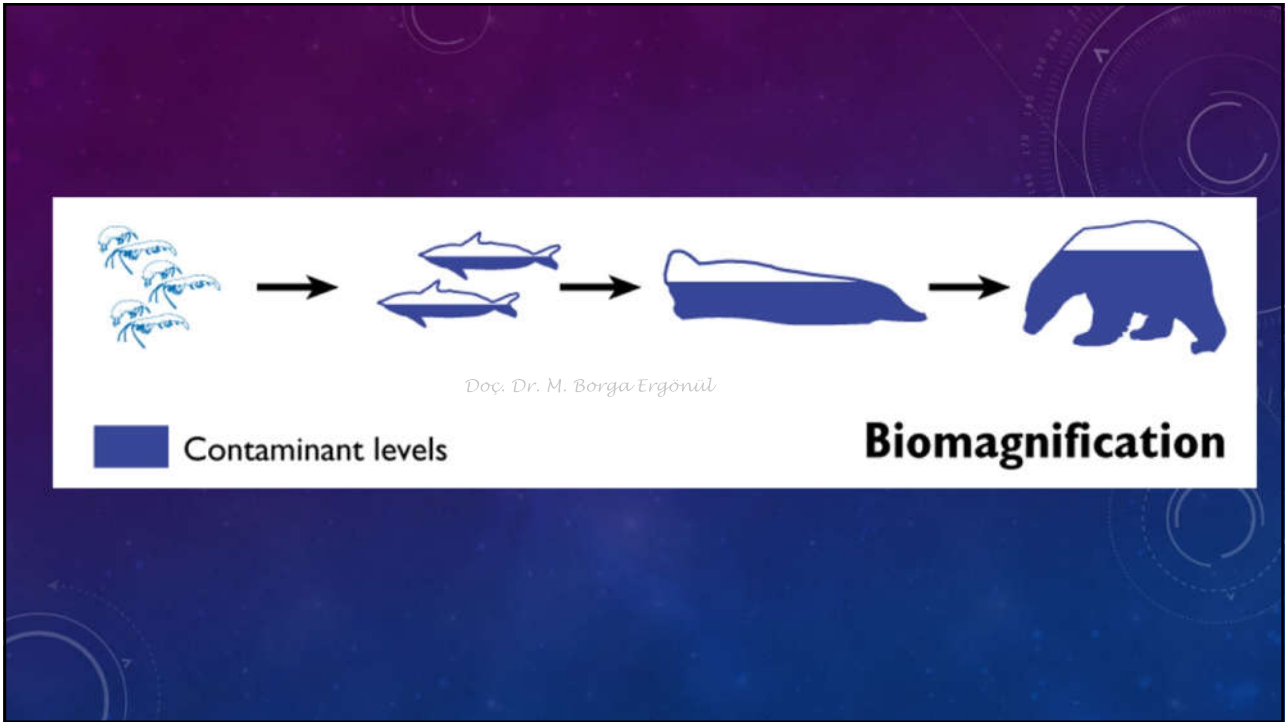
Bioaccumulation occurs at the base of a food web, usually within primary producers like phytoplankton. These microscopic photosynthetic organisms absorb persistent pollutants such as heavy metals directly from the water and accumulate them in their bodies over time. The toxins build up in their tissues because they are absorbed from the water at a rate faster than they can be metabolized or excreted. The longer the biological half-life of a toxic substance, the greater the risk of chronic poisoning, even if environmental levels of the toxin are not very high.



**Biomagnification** occurs when slightly larger organisms (such as zooplankton, fish etc) that feed upon the contaminated phytoplankton and in turn absorb these pollutants into their own tissues at a higher concentration. The more contaminated phytoplankton a zooplankton eats, the more pollutants it will have in its body. In other words, they can pass from producer to consumer (to consumer, to consumer, and so on...) Biomagnification can continue all the way up the food web or chain. Since the amounts of heavy metals become more and more concentrated at each trophic level, some of the ocean's apex predators are at risk of gaining potentially fatal levels of these pollutants within their bodies.

«Biomagnification, also known as bioamplification or biological magnification, is the concentration of a toxin in the tissues of tolerant organisms at successively higher levels in a food chain»





## Pesticides

A pesticide is defined as a chemical agent used to destroy or control pests or to increase crop production. The root word is the Latin word "cida" which means to kill. The generic term "pesticides" can apply to a wide spectrum of chemicals, including insecticides, rodenticides, herbicides, fungicides, biocides, and similar chemicals.

Doc Dr. M. Durga Prasad

The Food and Agriculture Organization (FAO) has defined pesticide as:

*any substance or mixture of substances intended for preventing, destroying or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals, causing harm during or interfering with the production, processing, storage, transport, or marketing of food, wood and wood products or animal feedstuffs.*

## Types of Pesticides

Pesticides can be grouped according to the types of pests which they kill:

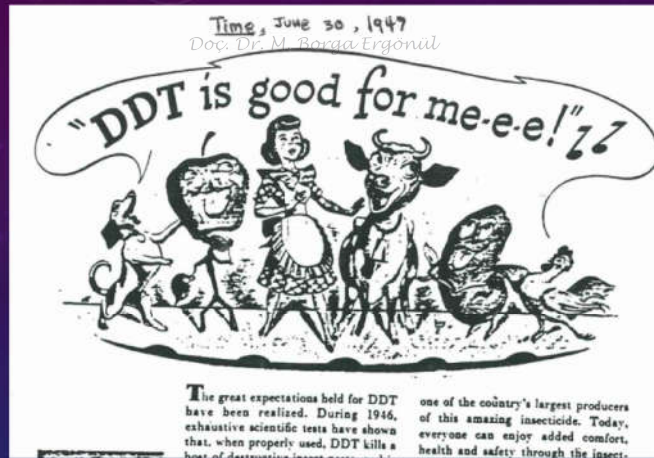
- Insecticides – insects
- Herbicides – plants
- Rodenticides – rodents (rats & mice)
- Bactericides – bacteria
- Fungicides – fungi
- Larvicides – larvae

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Based on how biodegradable they are pesticides can also be considered as:

**Biodegradable:** The biodegradable kind is those which can be broken down by microorganisms and other living beings or sunlight into harmless compounds.

**Persistent:** While the persistent ones are those which may take months or years to break down.



DDT and related compounds are very persistent in the environment and as much as 50% can remain in the soil 10-15 years after application. DDT has been detected in virtually all organochlorine monitoring programs and is generally believed to be ubiquitous chemical throughout the global environment.

Another way to classify pesticides are based on their chemical forms or production method.

**Organophosphate:** They affect the nervous system by disrupting the enzyme that regulates the Ach neurotransmitter.

**Carbamate:** Similar to the organophosphorus pesticides, the carbamate pesticides also affect the nervous system by disrupting the enzyme Ach-esterase that regulates the neurotransmitter. However, the enzyme effects are usually reversible.

**Organochlorine insecticides:** They were commonly used earlier, but now many countries have been removed Organochlorine insecticides from their market due to their health and environmental effects and their persistence (e.g., DDT, chlordane, and toxaphene).

**Pyrethroid:** These are a synthetic version of pyrethrin, a naturally occurring pesticide, found in *Chrysanthemum* spp. (Flower). They were developed in such a way as to maximise their stability in the environment.

**Sulfonylurea herbicides:** The sulfonylureas herbicides have been produced for weed control such as cyclosulfamuron, terbacil, rimsulfuron etc inhibit the biosynthesis of branched-chain amino acids in plants, through inhibition of the enzyme acetolactate synthase.

**Biopesticides:** The biopesticides are eco-friendly pesticides derived from natural materials including animals, plants, bacteria, and certain minerals.

**Biological pest Control:** the use of living organisms to control pests.

- **Pathogens:** Organisms that cause disease are used. Most common: *Bacillus thuringiensis* (Bt). Used to kill the caterpillars of moths and butterflies. *Doç. Dr. M. Borya Ergönül*
- **Plant Defenses:** Bred into plants. Can be resistant to fungi, worms, and viruses. Include: chemical compounds that repel pests and physical barriers like tougher skin.
- **Chemicals from Plants:** Uses the plants' defensive chemicals. Used mostly in home use insect sprays – because they are less harmful to people/pets.

