Bioaccumulation/Biomagnification

Bioaccumulation

Contaminant Levels

TIME

Biomagnification

Contaminant Levels
Bioaccumulation = the gradual build up of organic (earth made) and synthetic (man made) chemicals in living organisms.

- These chemicals are present because decomposers cannot break them down through biodegradation processes.
- Chemicals will accumulate in the body if more are taken in and stored by an organism than can be broken down and used (metabolized) or excreted.
  - Chemicals can be stored as fat

The Process of Detoxification and Elimination

- Toxins Enter Through:
  - Lungs
  - Skin
  - Gut/Intestine (Large)

- Liver (Primary Detoxifying Organ)

- Toxins Exit Through:
  - Skin
  - Kidneys
  - Colon
  - Lungs

Excess Toxins Get Stored In:

- Fat-Soluble Toxins (e.g. pesticides, hormones, heavy metals) have affinity for:
  - Fat Cells
  - Bone Marrow
  - Liver
  - Central Nervous System/Brain

Side Effects & Signs of Toxicity:

- Acne/skin rashes
- Allergies
- Arthritis/_joint pain
- Autoimmune disorders
- Cardiovascular disease
- Chronic fatigue
- Constipation
- Diabetes
- Gastroesophageal reflux disease (GERD)
- Headaches
- Hormone imbalance
- Inflammatory disorders
- IBS
- Neurologic disorders
- Obesity/overweight

Water-Soluble Toxins (e.g. nicotine, vasopressin, other chemicals) have affinity for:

- Joints
- Blood
- Tissues
- Muscles
• Chemicals can enter an organism through: food intake, skin contact, or respiration (breathing).
• If the accumulation of a chemical in an organism is too high it can be harmful.
• These chemicals can harm the nervous system, the immune system and reproductive system. They can cause birth defects and/or reproductive sterility.
• Biomagnification = the process in which chemicals accumulate and become more concentrated at each trophic level.

• Pollutants that are stored in plant tissue (producers), then get eaten by animals (herbivores/primary consumers) and the pollutants stay there until that fat tissue is broken down to be used (usually by secondary consumers/carnivores/omnivores).

• Ex: herbivores must eat a lot of producers to survive (since only 10% of the energy is passed on to the herbivore from the producer).
  – Thus small concentrations in producers can then eventually build up to toxic levels in higher trophic levels.
Types of Pollutants

• PCBs and Orchas
  – PCB (polychlorinated biphenyls)
  – Synthetic chemicals in paints, plastic from 1930-1970s
  – Dangerous due to long half life: it takes the chemical many many years to decrease by half, therefore stays in the ecosystem a long time.
  – Causes: suppression of the immune system, reproductive system and may cause cancer

• DDT and ecosystems
  – Dichlorodiphenyl trichloroethane is a persistent organic pollutant
  – Pollutants that contain carbon and stay in the soil and water for many years, used to control mosquitoes that carry disease.
  – Dangerous due to long half life (15 years)
  – Binds strongly to soil particles which are then used by plants, which are then eaten by other animals and stored in their fat. Also can be washed away into streams, rivers, lakes and thus affect aquatic food webs as well.
  – Causes: nervous system, immune system and reproductive disorders.

• Lead (Pb) (Heavy metal) and soil
  – Naturally present in all soil (geosphere) and cannot be broken down or degrade (no half life)
  – Human activity has increased lead levels in soil (in paint, insecticides, gasoline, batteries)
  – Very toxic even at low levels for humans and other animals (fish/birds)
  – Causes: anemia, nervous system damage, sterility in men, low fertility in women, impaired mental development, kidney failure
Types of Pollutants Continued...

• Cadmium (Cd) (Heavy metal) and soil
  – naturally present in earth’s crust (lithosphere part of the geosphere) and released through rock weathering, volcanos, forest fires
  – Half life (30 years)
  – Human activity has increased cadmium levels (plastics, nickel-cadmium batteries, zinc production and phosphate ore mining)
  – Binds strongly to organic matter in soil, plants take up the cadmium and animals eat the plants. Worms and other soil organisms also may eat the cadmium, which are then eaten by birds.
  – Causes: higher death rates, lower reproduction and growth rates (especially in fish), lung disease, infertility, damage to DNA, immune system and central nervous system (humans)

• Mercury (Hg) (Heavy metal) and soil
  – naturally present in earth’s crust (lithosphere part of the geosphere) and released through rock weathering, volcanos, geothermal springs
  – Human activity has increase mercury levels (burning fossil fuels, waste incineration, mining, battery production)
  – Returns to the earth through rainfall and dust and binds to soil particles which then can be transported by wind or air.
  – Soil bacteria change mercury sulphide (HgS) into the more toxic form methyl mercury (CH₃Hg) which then bioaccumulates and biomagnifies in different organisms.
  – Causes: affects the nerve cells, heart, kidneys, lungs and supressed the immune system.
Reducing Chemical Pollution Effects

- Trapping the chemical in the soil and not allow it to pass from the geosphere to the biosphere or the hydrosphere.
  - Ex: using phosphate fertilizer with lead contaminate soil will change lead (Pb) into lead pyromorphite/lead chlorophosphate \((\text{Pb}_5(\text{PO}_4)_3\text{C})\) which is less harmful because it doesn’t dissolve well in water and will not travel as easily.

- Using nature to help with the biodegradation process.
  - Bioremediation = the use of living things and microorganisms/plants to clean up faster
  - Ex: extracting enzymes from chemical eating bacteria or pesticide resistant insects to create new technologies for environmental clean up.
  - Ex: plants such as fescue, alfalfa, juniper and poplar trees naturally trap pollutants in soil and concentrate them in their tissues. They also help reduce erosion from wind and water by stabilizing the soil they are planted in.
  - Ex: forestry, mining and energy production companies sometimes used bioremediation such as using bacteria to help clean up oil spills from underground leaks.