

C3 Analyze and evaluate mechanisms affecting the distribution of potentially harmful substances within an environment

C3.1 describe mechanisms for the transfer of materials through air, water and soil; and identify factors that may accelerate or retard distribution (e.g., wind speed, soil porosity)

Transport of Material through Air, Soil, and Water

The transport of substances in the environment occurs in three stages: the **release** of chemicals from the source, the **dispersion** of chemicals into the atmosphere, and the **deposition** of chemicals in soil or water.

Pollutants transported through air are called airborne pollutants. The direction and distance travelled by airborne chemicals is determined by factors such as the properties of the chemical pollutants, the speed of the wind, and the direction of the wind.

Hazardous chemicals can enter into surface water as effluent from sewage treatment plants or runoff from agricultural fields that use pesticides and fertilizers. If a low concentration of a chemical can be dissolved in water and dispersed over a wide area, the toxicity of the chemical will be reduced. The problem lies with insoluble substances deposited near the pollution source. As they accumulate, the substances will create an area of contamination.

Water flows through the ground and seeps down in the soil. It will eventually reach the groundwater zone. Groundwater moves, but the rate at which it moves is very slow.

This means that it takes a long time for pollutants dissolved in the groundwater to disperse. If the groundwater is used as drinking water, the toxic pollutants can become a health hazard.

The movement of groundwater is affected by pores in the soil. Permeable soil has larger pores and more space between particles. It is easier for pollutants to flow and spread through permeable soil.

Soil pollution by hydrocarbons takes place as a result of the use of fossil fuels in vehicles and industries. These hydrocarbons do not dissolve in water; they cling to the soil particles, changing the soil properties. Most hydrocarbons are toxic to both plants and animals.

C3.2 describe mechanisms for biodegradation, and interpret information on the biodegradability of different materials

Biodegradation

The concentration of pollutants in the environment can be decreased naturally. Certain organisms, such as bacteria, fungi and earthworms, can decompose pollutants in the soil. These organisms break down complex organic molecules into simpler substances in a process called **biodegradation**. Bacteria are especially important in this process. Some bacteria require oxygen to carry out biodegradation. When this process needs oxygen, the process is referred to as **aerobic biodegradation**.

Other bacteria can only survive under conditions with no oxygen. These bacteria decompose organic material in **anaerobic biodegradation**.

The process of biodegradation is affected by the availability of nutrients, pH, temperature, soil moisture, and oxygen supply. An environment that is too cold or too dry is unfavourable for microorganisms to decompose matter.

Bioreactors have been built to increase the rate of biodegradation. Bioreactors are designed to provide the optimal conditions for biodegradation at all times. A sewage treatment plant has bioreactors to speed up the decomposition of sewage.

The rate of biodegradation can also be increased by planting vegetation in the area. Bacteria and fungi are more likely to inhabit soil where plants are present.

C3.3 comprehend information on the biological impacts of hazardous chemicals on local and global environments, by:

- ***interpreting evidence for environmental changes in the vicinity of a substance release***
- ***interpreting LD₅₀ data and other information on toxicity [Note: LD₅₀ refers to the amount of a substance found to be lethal to 50% of a population, if ingested.]***
- ***identifying concerns with the disposal of domestic wastes, such as paints and oils, and industrial wastes***

Impacts of Hazardous Chemicals

It is important to properly dispose of hazardous chemicals. Even a small amount of chemical released into the environment can have detrimental effects. The harmful effects of a toxin or hazardous chemical often increase through biomagnification as it moves through the food chain. For example, if a small quantity of mercury leaked into a lake, it would be absorbed by phytoplankton. Small fish that feed on the phytoplankton might absorb some toxins from the water, but they would also take in all the mercury that the phytoplankton had absorbed. Since one fish would eat many phytoplankton, the mercury concentration would be many times higher in the fish than in the phytoplankton. The mercury level would be magnified again when larger fish eat the smaller fish. An orprey that then eats the larger fish would have the highest concentration of mercury.

Certain chemical substances, such as household cleaners, fertilizers, pesticides, paints, and automotive fuels, are hazardous to your health. If not handled properly, they can be toxic.

The use of pesticides and the combination of pesticides can produce poisoning effects. This is referred to as the chemical's **toxicity**. Toxicity describes how poisonous a substance is.

To compare the toxicity of certain chemicals, scientists use a measurement called the **median lethal dose** or LD₅₀. The LD₅₀ is the dose of a toxic substance required to kill half the members of a tested population after a specified test duration.

For example, the LD₅₀ dosage of DDT in rats is 87 mg/kg. Half the rats in a population would die if given a dosage of 87 mg/kg of DDT.

C3.4 investigate and evaluate potential risks resulting from consumer practices and industrial processes, and identify processes used in providing information and setting standards to manage these risks (e.g., interpret and explain the significance of manufacturer's information on how wood preservatives can be safely applied; recognize that some individuals may have greater sensitivity to particular chemical substances than do others in the general population)

Transport, Storage, and Disposal of Hazardous Chemicals

Students working in laboratories must be familiar with the Workplace Hazardous Material Information System (**WHMIS**). WHMIS labels on containers specify the type of hazardous chemicals in the containers. The barrels in the illustration contain flammable chemicals.

Material Safety Data Sheets (**MSDS**) give detailed descriptions of chemical products. An MSDS contains information about the composition, physical properties, and chemical features of the chemical product. It describes the precautions to be taken while handling, storing, transporting, or disposing of that product.

Chemicals are not just found in a laboratory. Many chemicals are found at home. Cleaners, fertilizers, pesticides, paints, and automotive fuels are hazardous to human health and they can be toxic if not handled properly.

When storing hazardous chemicals, be sure to take the following precautions:

- Leave products in their original containers with their labels intact.
- Keep the chemicals out of the reach of children.
- Keep containers tightly closed with a lid.
- Store chemicals in a cool, dry place.
- Do not store flammable liquids in glass containers.
- Store corrosive, flammable, reactive, and poisonous chemicals separately.
- Keep oxidizers (such as hydrogen peroxide, $H_2O_{2(l)}$) away from flammable chemicals.
- Return chemicals to their proper locations after use.
- Safely discard hazardous chemicals if they have expired.

Hazardous chemicals should not be poured down the drain, into sewers, into septic systems, or into the soil. Do not throw chemicals in the garbage. There are hazardous waste collection sites where wastes such as oil, paints, and household cleaners can be disposed of. It is very important to transport, store, and dispose of hazardous chemicals properly.

C3.5 identify and evaluate information and evidence related to an issue in which environmental chemistry plays a major role (e.g., evaluate evidence that the use of insecticides to control mosquitoes has an effect/has no effect on bird populations)

Environmental Chemistry

Environmental chemistry is the study of the chemical processes in an environment. Environmental chemists study which chemicals are present naturally in an ecosystem, their concentrations, and their effects on the natural environment. Understanding environmental chemistry is an important first step towards understanding how a clean environment works and how pollutants change things.

Environmental chemistry is used by Environment Canada and environmental research bodies around the world in order to identify the source of pollutants and their potential polluting impacts on the environment.