Science Nine

Module Three:

Environmental Chemistry

Name:

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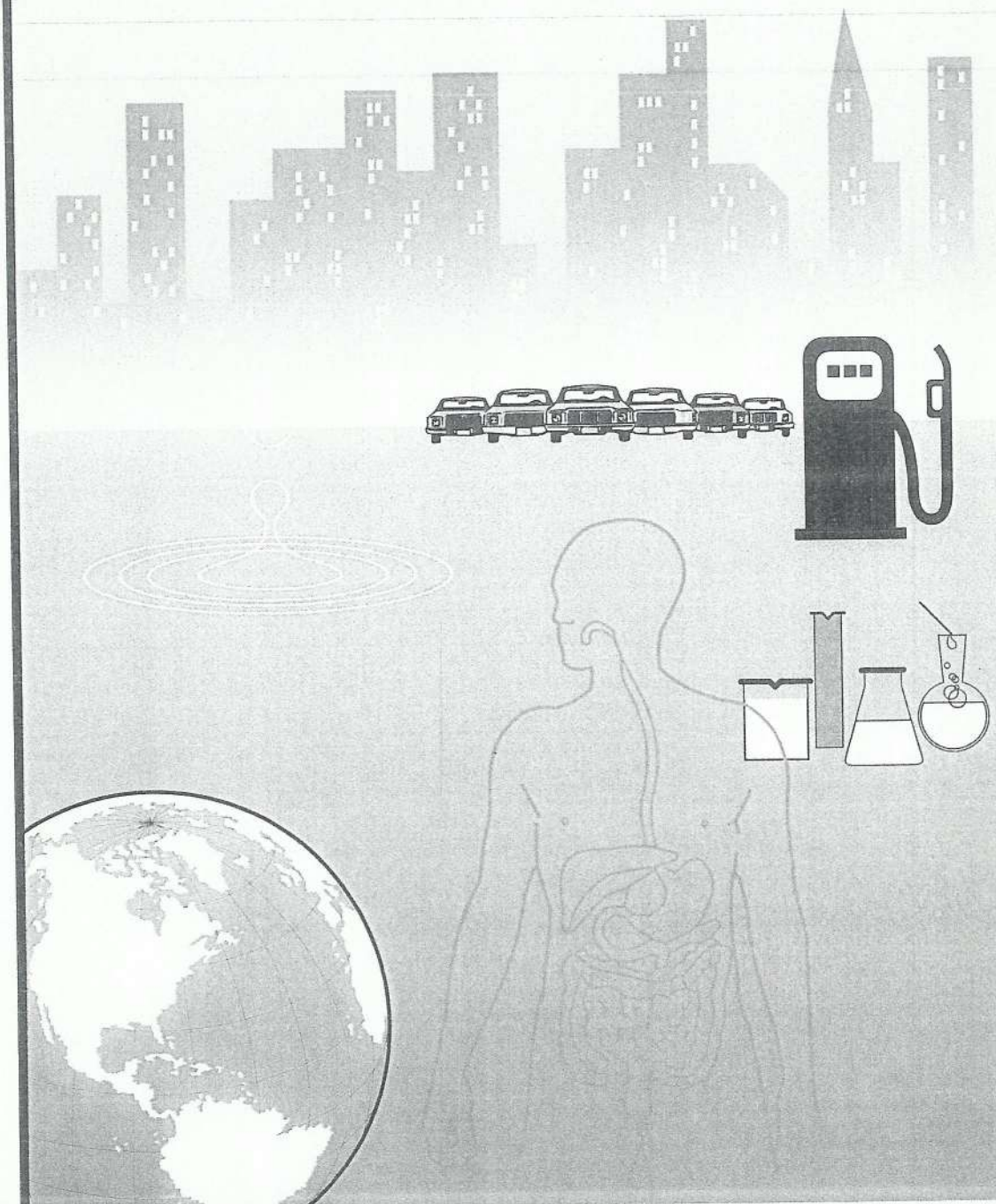


GRADE 9
TOPIC THREE

NAME

Lacombe Outreach School

Part A: Organic or inorganic?

Chemicals in Our Bodies

The nutrients (chemicals) that travel through our bloodstream and are used by our bodies to live, grow and reproduce. Nutrients are divided into two categories: organic and inorganic.

Organic

Organic substances are those that contain carbon— the element that is the basis of all life. Organic nutrients are used to build carbohydrates, proteins, lipids (fats) and vitamins.

Inorganic

Inorganic substances don't contain carbon. Inorganic substances that aren't destroyed by cooking are called "minerals." Minerals are an important part of special protein molecules (enzymes) in our bones and they work together with vitamins to help the special proteins do their job.

Nutrients are produced by plants and modified (changed) by animals. This means a plant provides nutrients for an animal and that animal provides nutrients for us when we eat it.

Once nutrients are inside our bodies, they are transformed (changed and added to other substances) to make the complex chemical substances that we need to survive—carbohydrates, proteins, lipids and vitamins.

Use the words in the passage above to help you fill in the blanks in these sentences.

1. The _____ (1) in our bodies help us to live, grow and reproduce.

2. The substance that all organic nutrients contain that inorganic nutrients do not is _____ (2).

3. Nutrients are produced by _____ (3) and modified by _____ (4).

4. The chemical substances we need to survive are _____ (5), _____ (6), _____ (7) and _____ (8).

This chart shows where you get the organic nutrient molecules you need to survive and how your body uses each type of nutrient. Use the information to help you answer the questions below.

Type of Organic Molecule	How Our Bodies Use It	Where It Comes From
Carbohydrates	Source of energy.	rice grains potatoes fruits
Proteins	Build structures in the body and helps with chemical reactions.	meat eggs dairy products beans and legumes nuts
Lipids	Store unused energy.	vegetable oils nut oils dairy products

1. How are carbohydrates and lipids similar and different?

_____

_____

2. How are proteins and lipids similar and different?

_____

_____

3. What does the information in this chart tell you about choosing the foods you eat each day?

_____

_____

All living things need nutrients to survive. Read the information about nutrients in the chart below.

Type of Nutrient	How it is Needed in Plants	How it is Needed in Humans
Calcium	Calcium helps to build cell walls and helps in cell division.	Calcium helps to build strong bones and teeth, helps blood clot (form scabs) and helps muscles and nerves work properly.
Nitrogen	Nitrogen is in plant protein and chlorophyll (for photosynthesis) and helps stems and leaves to grow.	Nitrogen is in protein and helps our bodies grow and repair tissues.
Sulfur	Sulfur helps plants produce fruit and grain (seeds) for reproduction.	Sulfur is in protein and helps to detoxify (remove harmful chemicals from) our bodies.

What is the most surprising piece of information in the chart? Explain why you think so.

_____

_____

_____

_____

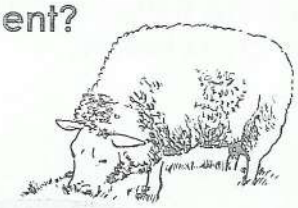
_____

Independent Research!

Choose one of the following topics to research:

- What foods give us calcium, nitrogen and sulfur?
- How do potassium and magnesium help plants and animals survive?

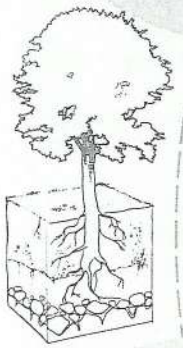
Part B: How do chemicals move around in our environment?



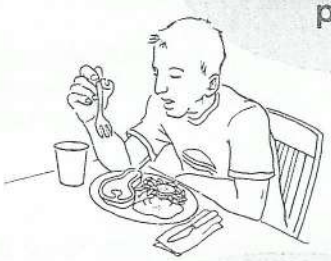
Plants use the minerals and nutrients to help them grow and reproduce.

Animals eat plants and other animals.

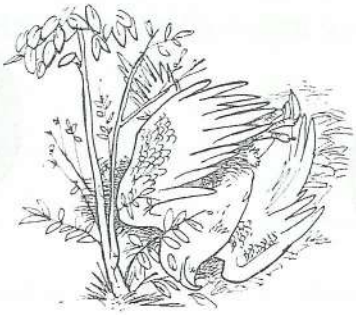
Plants take in minerals and nutrients through osmosis and diffusion.



Humans eat animals and plants.



Mineral and nutrient filled soil covers the ground where plants grow.



Animals and humans use the minerals and nutrients to grow and reproduce.

Living things die and decay and the minerals and nutrients go back into the soil.

Consider: If chemicals move around in our environment so easily, what happens when dangerous chemicals are introduced to the environment?

Pesticides

Pesticides are chemicals that are used to control insect populations. This "control" usually comes in the form of killing the adult insects or their young.

Consider the information in the chart below about pond life in an area where a chemical pesticide called DDT was sprayed for years. Naturalists then noticed that bird populations were dying out because the birds weren't able to reproduce anymore.

Sample	Amount of DDT Found
Water	1 ppm*
Green Plant	2 ppm*
Minnow	4 ppm*
Adult Fish	8 ppm*
Small Bird	12 ppm*
Large Bird	30 ppm*

* ppm stands for "parts per million" which is approximately the same as saying how many milligrams of the pesticide you would find in every 10 litres of water.

The information in the chart above is an example of biomagnification through food chains. Based on the information in the chart and on the previous page, try to come up with a definition for biomagnification. Check your answer in a textbook, encyclopedia or online.

Biomagnification is . . .

_____

_____

Read the passage and then answer the questions below based on the information you have learned so far.

Mercury occurs naturally in the earth's crust but it is also a pollutant created by industry (e.g., factories). When mercury gets into our water (lakes, streams and oceans), tiny bacteria turn it into a more dangerous form called methylmercury that is absorbed by aquatic (water) plants.

Small fish that feed mainly on tiny green plants are known to have small amounts of methylmercury inside them. Larger fish that feed on smaller fish are know to have much higher percentages of methylmercury in them.

Over time, as people eat more and more fish, scientists and health care professionals are beginning to worry about toxic levels of mercury building up in their systems.

This is an example of how biomagnification can affect humans.

1. Why do smaller animals have a lower percentage of toxins in them than the larger animals in a food chain?

_____

_____

_____

2. What have you learned that tells you that there are some chemicals that plants and animals have a hard time breaking down and getting out of their bodies?

_____

_____

_____

3. Which of the following questions are important for scientists to answer before people are allowed to dump chemicals into the environment. Put a check beside the questions you think are most important.

a. ____ Is the chemical cheap and easy to use?

b. ____ Does the chemical already exist in nature?

c. ____ Is the chemical there for a reason that is more important than its effects on plants and animals in the environment?

d. ____ Will changing the levels of the chemical in nature affect plants?

e. ____ Will changing the levels of the chemical in nature affect animals and micro-organisms?

f. ____ How much of the chemical can be added to the environment before there is a concern?

g. ____ Will animals be able to break down and get rid of the chemical when it enters their bodies or will it build up inside them?

h. ____ Is there another chemical that could be used instead?

4. Which of the questions above do you think is most important? Explain why you think so.

Part C: Substrate or nutrient?

Substrate
The substrate is the material on which an organism lives or moves.

Nutrient
A nutrient is a source of food or energy.

Read each of the following sentences and then identify the substrate and the nutrient in each example.

1. Sea anemones live their lives attached to rocks and let the ocean water wash over them. They catch small marine animals as they float by.

   substrate: _____ nutrient: _____

2. Bread mould breaks down bread into simple sugars that its cells can absorb.

   substrate: _____ nutrient: _____

3. Lichen plants are a combination of fungi and algae that grows on rocks. The algae is green and can make simple sugars from sunlight. The fungi eats as well.

   substrate: _____ nutrient: _____

4. Red algae covers sections of snow in the Arctic. The algae makes its own simple sugars through photosynthesis.

   substrate: _____ nutrient: _____

5. Remoras are fish that travel around with sharks, often attaching themselves to their bodies. The shark lets them because they get rid of all of the insects on their skin.

   substrate: _____ nutrient: _____

Part D: What is good quality?

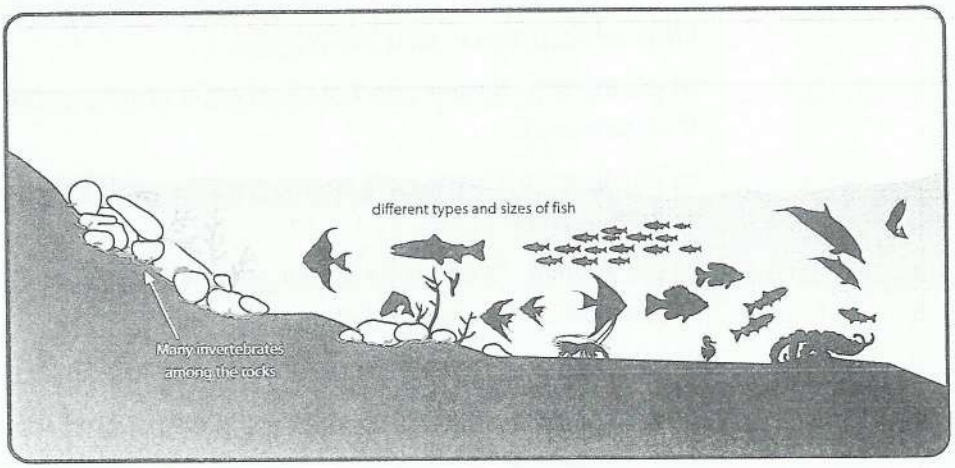
Biological Indicators

Biological indicators are the changes in living organisms that prove whether water is healthy or not.

Chemical Indicators

Chemical indicators are the levels of certain chemicals that are measured to determine whether water is healthy or not.

A.



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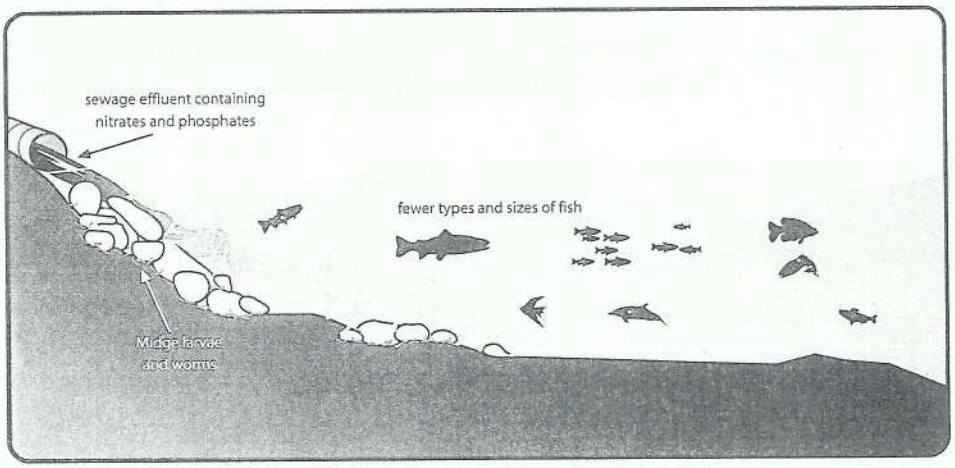
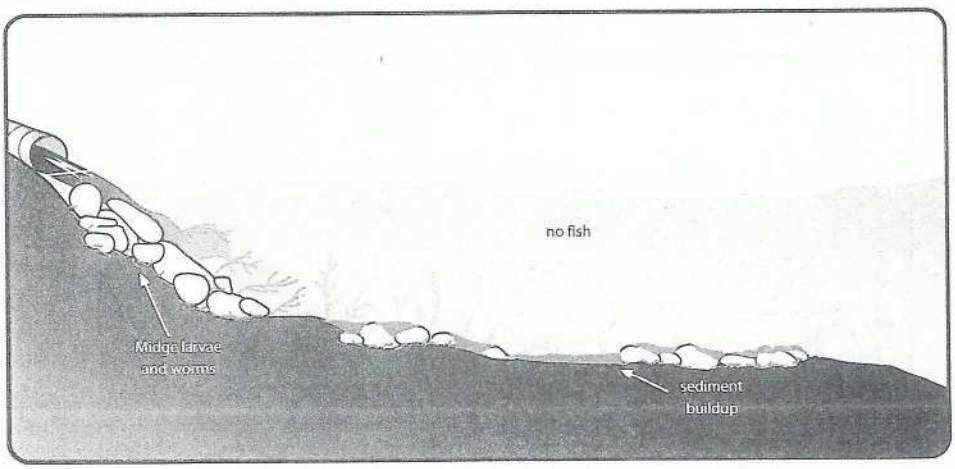


C.



Healthy

Unhealthy

1. Read each of the following descriptions of what is happening in the pictures on the previous page and identify whether each is an example of a **biological** or **chemical** indicator.

a. _____ In picture A, there are a number of different types and sizes of fish.

b. _____ In picture A, there is very little bacteria in the water.

c. _____ In picture A, the water has a lot of oxygen and a little phosphorus and nitrogen.

d. _____ In picture B, there are less fish and many worms on the ground.

e. _____ In picture B, there are more plants and bacteria in the water.

f. _____ In picture B, there is less oxygen and more nitrogen and phosphorus.

g. _____ In picture C, there are no fish but a lot of plants.

h. _____ In picture C, there are a lot of worms and muck on the ground.

i. _____ In picture C, there is very little oxygen in the water and a lot of phosphorus and nitrogen.

2. What are some characteristics of healthy water?

_____

_____

3. What are some characteristics of unhealthy water?

_____

_____

What is healthy soil?

Soil is made up of both organic (living) and inorganic (non-living) things. Bacteria, yeast and other living organisms make up the living part of soil. Too many living organisms in the soil can harm plant growth, but a certain number of these organisms can help plants grow by breaking down nutrients in the soil and making them easier for the plants to absorb.

Most of the non-living substances in soil are made of minerals. Things like clay, silt and sand change the density of the soil and affect how much air is in the soil and how well water can drain through it. Healthy soil is well oxygenated (lots of air in it) and water can drain through it easily.

The pH level of soil (how acidic it is) is important because some plants grow well in acidic soils but others do not. A good pH level is not the only thing that is important in healthy soil; it must also have many different nutrients dissolved in it. Plants need nitrogen for their leaves and stems, phosphorus for their roots, and potassium for their flowers.

4. What are some characteristics of healthy soil?

_____

_____

_____

5. What are some characteristics of unhealthy soil?

_____

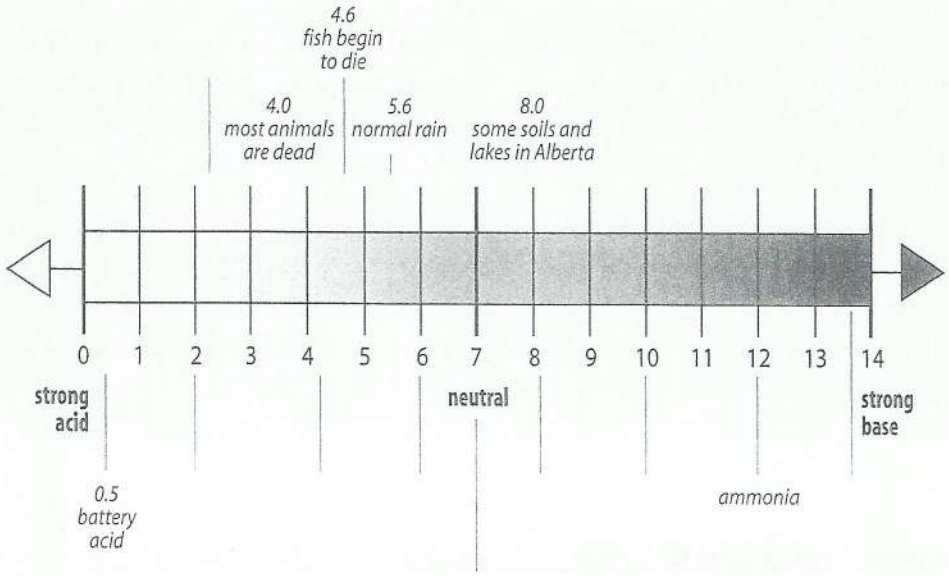
_____

_____

Part E: What is pH?

pH

pH is the concentration of hydrogen ions in a solution. Solutions with a low pH are **acids** and solutions with a high pH are **bases**. The pH scale goes from 0 to 14. Solutions in the middle (around 7) are called neutral because they are neither basic nor acidic.



1. Write the names of the following household products where they belong on the pH scale using the pH numbers provided.

   - lemon juice 2.0
   - vinegar 2.2
   - toothpaste 10
   - drain cleaner 14
   - milk 6.6
   - tomatoes 4.2
   - baking soda 8.2
   - bottled water 7

2. Which of the substances is a strong acid? _____

3. Which of the substances is a strong base? _____

4. Which of the substances is neutral? _____

Acid Rain

Acid rain is a type of air pollution caused mainly by power plants and manufacturing plants that burn fossil fuels (e.g., natural gas, coal, oil) and pump sulfur dioxide and nitrogen oxide out of their smoke stacks. These chemicals mix with moisture in the air to form sulfuric acid and nitric acid that falls to Earth as acid rain.

Damage from acid rain is found around the world. Acid rain drains nutrients from soils, slows down the growth of trees, and ruins lakes so fish and other wildlife can't survive. In cities, acid rain corrodes (eats away at) vehicles, buildings and statues. Acids in the air also mix together with other chemicals to form smog, a thick, hazy form of air pollution that damages peoples' lungs making them very sick.

5. What are the two main acids in acid rain?

_____

_____

6. How does acid rain affect plants?

_____

_____

7. How does acid rain affect animals?

_____

_____

8. How does acid rain affect structures in cities?

_____

_____

9. How does acid rain affect peoples' health?

_____

_____

10. What do you think should be done to stop acid rain?

_____

_____

Acids and Bases

Consider: What happens when you mix acids and bases?

Hypothesis: (check the one you agree with)

☐ when acids and bases are mixed, the pH becomes more neutral

☐ when acids and bases are mixed, the pH becomes more acidic

Materials:

- litmus paper
- hair conditioner
- lemon juice
- plastic containers and stir sticks

Procedure: (glue the pieces of used litmus paper in the box)

1. Use the litmus paper to test the acidity of the lemon juice.
2. Use the litmus paper to test the acidity of the conditioner.
3. Mix the lemon juice with the conditioner and use the litmus paper to test the acidity of the mixture.

Analysis/Conclusion:

1. Now, answer the original question using evidence/examples from your investigation OR prove why your hypothesis was correct.

Part F: How do chemicals move around in air, water and soil?

Moving Around in the Air and Water

Pollutants in the air move through our environment in two main ways:

Dispersion is when pollution in the air gets spread around. This happens because of diffusion and wind.

Deposition is when pollutants in the air are spread to the ground by rain and snow.

If there is very little wind, pollutants don't spread far from the source but if winds are strong, pollutants can be carried for long distances. If it rains or snows around the source of the pollution, the pollutants are usually kept close to the source. The problem is that they are more concentrated (stronger) if they are all in one area.

Pollutants get into our water in many ways; rainwater, runoff from farm fields and industrial sites, and the overflow from storm sewers and sewage treatment plants.

Pollutants in our water fall into two main categories.

Groundwater Pollutants

Groundwater pollutants are dangerous (or at least unpleasant) chemicals that find their way into our groundwater. This is the water underground that fills up the spaces in the soil and is called the water table. The problem with pollutants getting into this water is that they can become concentrated (stronger) because the water doesn't flow (move around) it just sits underground. This can make the ground around it unsafe for animals and plants or for any humans that might want to dig a well in that area.

Surface Water Pollutants

Surface water pollutants are dangerous (or at least unpleasant) chemicals that find their way into our rivers, lakes and oceans. These chemicals are diluted (made weaker) because the water flows around and the pollutants get spread out. Some pollutants fall to the bottom and become sediment (muck) on the bottom of rivers and lakes. The problem with pollutants getting into surface water is that they start to affect a much larger area. Most drinking water comes from surface water so pollution can become a problem for human health, not to mention its effects on plants and animals.

Use the information on the previous page to help you answer the questions below.

1. What are two ways that pollutants are spread around in the air?

_____

_____

2. What do still (unmoving) air and rain do to the spread of pollutants?

_____

_____

3. What happens to pollutants in surface water that doesn't happen to pollutants in ground- water?

_____

_____

4. What happens when pollutants don't disperse?

_____

_____

_____

Optional Challenge!

Draw a diagram to illustrate an effective strategy for pollutant control based on what you learned on the previous page.

Part G: How does nature clean up?

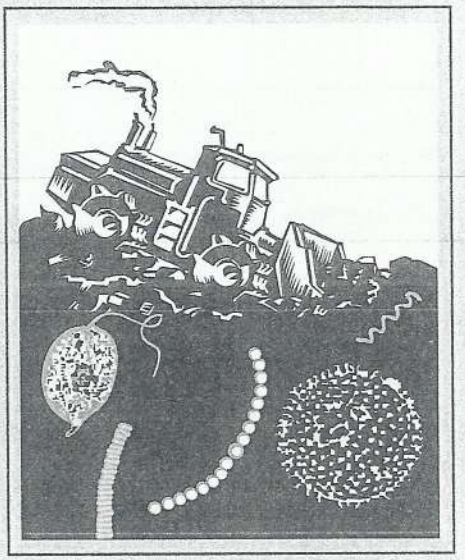
Biodegradation

Biodegradation comes from the words "bio" (meaning living things) and "degrade" (meaning to break things down). Biodegradation is the term used to describe how living things break down the harmful things in our environment. In this way, nature can sometimes act as a pollution recycler.

Micro-organisms (living things that can only be seen with a microscope) play a major role in biodegradation. Algae, bacteria, fungi and protozoa that live in soil and water often use pollutants as a food source.

Once scientists realized that this was possible, they began adding liquids to pollution sites (like landfills) that made the micro-organisms even healthier so they could break down the waste materials even faster.

Unfortunately, in Canada, biodegradation only has a short season because the micro-organisms hibernate in the winter.



Create a web to summarize the information above.

Part H: How should we care for hazardous chemicals?

Read each of the rules for caring for hazardous household chemicals and then, for each one, think of an example of what might happen if the rule was not followed.

1. Chemicals should always be kept in their original containers with clear labels.

2. Containers should be kept in good shape with lids on tightly.

3. Chemicals should be kept where children and dogs can't get to them.

4. Chemical containers should always be kept upright during storage or when they are being transported (e.g., brought home from the store).

5. Containers with dangerous substances in them should not be kept together.

6. Don't pour dangerous substances down the drain or put them in the garbage. Leftover chemicals should go to a hazardous waste collection site (like an Ecostation).

7. If containers are damaged or leaking, put them inside another larger container to transport them.

Industry Regulations

To avoid dangerous accidents that can happen when chemicals are used, stored or transported incorrectly, there are rules companies must follow. They must clearly communicate each of these things to the people who might buy and use the products.

- What the product is supposed to be used for.
- What the physical and chemical properties or "active" ingredients are.
- Instructions for how to use the product.
- Instructions for how to safely store the product.
- Safety precautions, health or environmental effects and first aid instructions.

Under the supervision of a parent or teacher, examine the product information found on the packaging of a hazardous chemical (cleaning product, etc.). Try to identify information that fits with each of the rules above.

Product: _____

What it is used for: _____

_____

What its ingredients are: _____

_____

How it is supposed to be used: _____

_____

How it should be stored: _____

_____

Other safety precautions: _____

_____

_____

Final Project

Choose one of the projects below to complete alone or with a partner, and then share your work with your class.

1. Research an issue related to the disposal of hazardous chemicals. This may include groups of citizens who live near industrial sites or environmentalists who have noticed changes in an environment caused by pollution. Research both sides of the issue and present the information to your class.

2. The Prestige oil spill was one of the most publicized oil spills in recent history. Research and learn about what happened, who was involved and how local wildlife was affected. You may even want to go further and find out if new laws or regulations were put in place as a result of this and other oil spill disasters.

3. Look on the local city Web site and/or contact the environmental department and ask about studies that have been conducted regarding how spraying for mosquitoes affects other animal populations (e.g., birds). Find out if the results of those studies have brought about changes in how pesticides are used in your city.