**Part I: How Can Water Pollution Be Detected?**

Website: <http://www.glencoe.com/sites/common_assets/science/virtual_labs/CT03/CT03.html>

Objectives:

* Define four types of water pollution
* Describe how pollution results in decreased dissolved oxygen (DO) levels, and explain the effect low DO levels can have on an ecosystem
* Describe how other factors, like temperature, can affect DO levels
* Describe what aquatic life are most and least suited to polluted environments

Background Information:

Water pollution occurs when harmful waste products, chemicals, and other substances are introduced into a body of water. Most water pollution can be classified into four main types:

1. Thermal Pollution: is caused when factories and power plants release hot water, used to cool machines in their factories, intro surrounding water. This hot water causes a higher overall water temperature, which can lead to environmental imbalances.
2. Industrial or Chemical Pollution: is the discharge of toxic substances and other industrial byproducts into bodies of water
3. Domestic Pollution: is the flow of sewage, pesticides and other waste material from farms, roads, cities and towns into bodies of water
4. Soil Pollution: occurs when erosion causes soil to flow into a body of water

One of the most devastating effects of water pollution on ecosystems is a reduction in the amount of dissolved oxygen (DO) in a body of water. Fish and other aquatic creatures extract DO from water as they breathe. As pollution cause the amount of DO to decrease, aquatic animals must move to cleaner waters or die from suffocation. However, while many species die from lack of oxygen, there are fish, invertebrates, and microorganisms that thrive in polluted conditions.

In this virtual lab, you will measure DO levels and examine the species of aquatic life that inhabit different bodies of water.

Procedure:

1. Select a river to test by clicking 1, 2 or 3
2. Click the fish net to catch a fish from the river
3. Click the pail to take a water sample from the river
4. Click the thermometer to take the temperature of the river
5. Look at the lab results to identify the samples
6. Click the fish, invertebrates, and microorganisms tabs for information about how each aquatic animal reacts to different levels of DO in the water and enter the information in the Table.
7. Click the Dissolved Oxygen tab for instructions how how to determine the Percent Saturation Value and enter the result in the Table.
8. Using the season selector, change the season. Repeat steps 1-7 for each season.
9. Click map to go to the map screen and select another site. Repeat steps 1-8 for each site.
10. Record data on table provided and use your completed table to complete the analysis questions.

Data:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Season / Site** | **Temperature ( 0C)** | **DO (ppm)** | **% Saturation Value** | **Invertebrates** | **Fish** | **Bacteria & Other Microbes** |
| Spring / Site #1 |  |  |  |  |  |  |
| Summer / Site #1 |  |  |  |  |  |  |
| Autumn / Site #1 |  |  |  |  |  |  |
| Winter / Site #1 |  |  |  |  |  |  |
| Spring / Site #2 |  |  |  |  |  |  |
| Summer / Site #2 |  |  |  |  |  |  |
| Autumn / Site #2 |  |  |  |  |  |  |
| Winter / Site #2 |  |  |  |  |  |  |
| Spring / Site #3 |  |  |  |  |  |  |
| Summer / Site #3 |  |  |  |  |  |  |
| Autumn / Site #3 |  |  |  |  |  |  |
| Winter / Site #3 |  |  |  |  |  |  |

Analysis:

1. What are four types of water pollution? Define each.
2. Which fish species are the least tolerant of water pollution? Which species are the most tolerant? How do you arrive at your conclusion?
3. Which invertebrates are the least tolerant of water pollution? Which species are the most tolerant? How do you arrive at your conclusion?
4. What might a high level of bacteria indicate about DO levels?
5. Based on the lab results, what conclusion can be drawn about each site? Which river was the most polluted? How did you arrive at your conclusion?

**Part II: When Is Water Safe To Drink?**

Website: <http://www.glencoe.com/sites/common_assets/science/virtual_labs/CT04/CT04.html>

Objectives:

* Define and determine which types of contaminants are common to lake water, city water, well water, rural water and mountain water.
* Identify treatments that remove contaminants from drinking water.

Background Information:

Suppose you were hiking along a stream or lake and became very thirsty. Do you think it would be safe to drink the water? In many cases, it wouldn't. Each source of fresh water on or beneath Earth's surface is affected by contaminants. Though the sources of these contaminants are varied, all can make water unfit to drink if they are allowed to increase beyond safe limits. The most common water contaminants are:

Acidity: The pH scale is a measure of acidity in water and other substances. Water with a pH reading of zero to six, or acidic water, is unsafe to drink and can corrode metal pipes. The most significant environmental impact of a high or low pH level is that it can magnify the effect of other contaminants.

Bacteria: Coliform bacteria and other microorganisms are found in the fecal matter of warm blooded animals and humans. This bacteria is most commonly found in lakes, rivers, and ponds, but can seep into groundwater supplies. When coliform bacteria are present in your drinking water, your risk of contracting a water-borne illness is increased.

Metals: Copper and Iron are two of the more common metal contaminants found in water supplies. An overabundance of copper and iron can cause water to be discolored and foul-tasting. Liver damage can also be traced to unsafe levels of metallic contaminants in water. Most copper and iron contaminants enter the water supply through rusty and corroded pipes. However, metallic contaminants can also enter groundwater through erosion as the water travels through layers of rock and minerals.

Nitrates: Nitrates are a form of nitrogen found in animal wastes, chemical fertilizers and food preservatives. Found in both surface water and groundwater, nitrates enter the water supply through surface runoff from farms and from leaking household septic tanks. Nitrates pose little threat to humans, but an overabundance of nitrate can kill fish and other aquatic creatures.

Pesticides: Pesticides and herbicides are manufactured chemicals that are used to kill weeds, molds and insects. Carbofuran and Alachlor are examples of common herbicides used in agriculture. Surface runoff can introduce pesticides and herbicides into the water supply. In concentrated amounts, these substance

Procedure:

1. Click the right and left arrows to select a body of water to analyze.
2. Click Test to test the water sample.
3. Look at the results of the water analysis. Identify the “Safe Range” for each category and record in the data table.
4. Identify which contaminants exceed the safe range.
5. Click the tabs to find information on how to treat each contaminant.
6. Enter the contaminant and treatment information in your data table.
7. Click Go To Treatment to go to the treatment screen.
8. Use the information in the table and click the wheels on the valves to add chemicals or additives to the water sample.
9. Click the Treatment Switch to start treating the water. The Safe/Unsafe Sign will indicate whether the water is safe to drink.
10. If the water is safe to drink, use Return to Lab to go to the lab screen and test another water sample.
11. If the water is unsafe to drink, check your information and treat the water sample again.
12. When you have tested and treated all the water samples, use your completed table to complete the analysis questions.

Data:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **Acidity (pH)** | **Metals (mg/L)** | **Coliform Bacteria (ml)** | **Pesticides/Herbicides (mg/L)** | **Nitrates** | **Type of Contamination** | **Treatment Performed** |
| **Safe Range** |  |  |  |  |  |  |  |
| **City** |  |  |  |  |  |  |  |
| **Lake** |  |  |  |  |  |  |  |
| **Mountain** |  |  |  |  |  |  |  |
| **Rural** |  |  |  |  |  |  |  |
| **Well** |  |  |  |  |  |  |  |

Analysis:

1. What contaminants were found in the surface water samples? What contaminants were found in the groundwater samples?
2. Why might groundwater and surface water have different contaminants?
3. Generally, farmers do not farm on the sides of mountains or in remote areas. Industries also do not build factories in these areas. These areas are usually not highly populated by people. What might explain the high nitrate level in the mountain water in this activity?
4. What is pH level, what are its characteristics, and how does it contribute to pollution? What chemicals are used in treating low pH levels?
5. Water in an old building tested recently, showed high copper and iron content, and low pH levels. A water reading taken 20 years before, showed low pH levels and only minimal traces of copper and iron. If none of the new buildings on the same street showed signs of metallic contaminants, but all reported lower than normal pH readings, how might these readings be explained?

**Part III: Using Invertebrates to Assess Water Quality**

Website: <http://www.mhhe.com/biosci/genbio/virtual_labs/BL_09/BL_09.html>

Objectives:

* Investigate the effects of acid rain on different species of aquatic invertebrates.

Background Information:

On the screen you will see three aquatic invertebrates in the aquarium. The pH level indicator on the aquarium shows the current pH level. Note: The specimens are not drawn to scale. The computer randomly chooses three specimens at a time from the following: aquatic earthworms, snails, tubifex worms, clams, leeches, sideswimmers, dragonfly nymphs, crayfish, fairy shrimps, and stonefly nymphs.

Acid rain results from the release of pollutants in the air. The pollutants come from fossil fuels such as gasoline, oil and coal being burned by automobiles, factories, and power plants. When the fossil fuels are burned, they release sulfur dioxide and nitrous oxides as byproducts. These pollutants can combine with water and other chemicals to form nitric acid and sulfuric acid in the atmosphere. When the water falls to Earth as rain, snow, sleet, fog or dew, it is called acid precipitation (acid rain). The carbonic acid used in this investigation represents acid rain.

The strength of acid rain is determined by reading a pH scale. The pH is a measurement of how acidic or basic a solution is. The pH scale ranges from 0 to 14. The lower the pH, the more acidic the solution. The higher the pH, the more basic the solution. On the pH scale, a change of one unit is actually a ten-fold change. For example, pure distilled water is neural at pH 7. A solution at pH 6 is ten times more acidic than pure water, and a solution at pH 5 is 100 times more acidic than pure water. Thus, a pH change of one or two units can seriously affect a great number of organisms in an ecosystem.

All rain naturally has some amount of acid in it. Unpolluted rain has a pH of 5.0-5.6. By contrast, acid rain has a pH range of 4.0-5.0. In highly industrialized regions, acid rain can be extremely acidic. With pH readings below 4.0, the acid rain in these areas can be as strong as vinegar (3.3.) and sometimes even as strong as lemon juice (2.30). When acid rain falls, it can produce many problems for the environment, particularly for forest and aquatic habitats. All organisms are adapted to survive within particular pH ranges. Most freshwater fish, for example, survive best within a pH range of 5.0-6.0. When acid precipitation falls into a lake, it lowers the pH of the water, thus killing many aquatic organisms.

Indicator species are particular aquatic invertebrates that alert us to pollution problems in an environment. The populations of these organisms change rapidly in response to changes in ecological variables, such as food availability, water, temperature, amount of dissolved water in the water, pH levels, and other factors.

Procedure:

1. Click on the Population Bar Graph on the computer to see the population data for the three species at the present pH level.
2. Click the Table button to open the TABLE and record the population data and the current pH level on your data table.
3. Click the PIPETTE to dispense three drops of carbonic acid (acid rain) into the aquarium.
4. Click the Population Bar Graph to see the new data and record the population data and the current pH level on your table.
5. Continue to add Carbonic Acid and record the resulting population data and pH levels until you have completed the table.
6. Collect Data for each invertebrate (Sideswimmer, Stonefly Nymph, Aquatic Earthworm, Fairy Shrimp, Dragonfly Nymph, Snail, Leech, Tubifex Worm, Crayfish, Clam) Remember: the computer randomly chooses three specimens at a time, so you will need to click Reset to select the invertebrates.

Data:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Effects of Carbonic Acid on Water pH and Population Size of Aquatic Invertebrates** | | | | | | | | | | | | | | | |
| **Species** | **Population Size** | | | | | | | | | | | | | | |
| **2.8** | **3.1** | **3.4** | **3.7** | **4.0** | **4.3** | **4.6** | **4.9** | **5.2** | **5.5** | **5.8** | **6.1** | **6.4** | **6.7** | **7.0** |
| **Sideswimmer** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Stonefly Nymph** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Earthworm** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Fairy Shrimp** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Dragonfly Nymph** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Snail** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Leech** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Tubifex Worm** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Crayfish** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Clam** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Analysis:

1. How does acid rain affect ecosystems?
2. Which species of aquatic invertebrate was most tolerant to changes in pH? Which was least tolerant? How do you know?
3. Do you think it is necessary to start with a higher pH level? Explain
4. What is an indicator species? How are indicator species used to assess pollution levels?
5. Which of the species that you investigated is most likely an indicator species?
6. What are some sources of error in this experiment? How would you improve it?
7. What type of experiment would you perform to determine the effect of acid rain on plant species?

Part I: How Can Water Pollution Be Detected?

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Season / Site** | **Temperature ( 0C)** | **DO (ppm)** | **% Saturation Value** | **Invertebrates** | **Fish** | **Bacteria & Other Microbes** |
| Spring / Site #1 |  |  |  |  |  |  |
| Summer / Site #1 |  |  |  |  |  |  |
| Autumn / Site #1 |  |  |  |  |  |  |
| Winter / Site #1 |  |  |  |  |  |  |
| Spring / Site #2 |  |  |  |  |  |  |
| Summer / Site #2 |  |  |  |  |  |  |
| Autumn / Site #2 |  |  |  |  |  |  |
| Winter / Site #2 |  |  |  |  |  |  |
| Spring / Site #3 |  |  |  |  |  |  |
| Summer / Site #3 |  |  |  |  |  |  |
| Autumn / Site #3 |  |  |  |  |  |  |
| Winter / Site #3 |  |  |  |  |  |  |

Part II: When Is Water Safe To Drink?

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sample** | **Acidity (pH)** | **Metals (mg/L)** | **Coliform Bacteria (ml)** | **Pesticides/Herbicides (mg/L)** | **Nitrates** | **Type of Contamination** | **Treatment Performed** |
| **Safe Range** |  |  |  |  |  |  |  |
| **City** |  |  |  |  |  |  |  |
| **Lake** |  |  |  |  |  |  |  |
| **Mountain** |  |  |  |  |  |  |  |
| **Rural** |  |  |  |  |  |  |  |
| **Well** |  |  |  |  |  |  |  |

Part III: Using Invertebrates to Assess Water Quality

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Effects of Carbonic Acid on Water pH and Population Size of Aquatic Invertebrates** | | | | | | | | | | | | | | | |
| **Species** | **Population Size** | | | | | | | | | | | | | | |
| **2.8** | **3.1** | **3.4** | **3.7** | **4.0** | **4.3** | **4.6** | **4.9** | **5.2** | **5.5** | **5.8** | **6.1** | **6.4** | **6.7** | **7.0** |
| **Sideswimmer** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Stonefly Nymph** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Earthworm** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Fairy Shrimp** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Dragonfly Nymph** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Snail** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Leech** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Tubifex Worm** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Crayfish** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Clam** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |