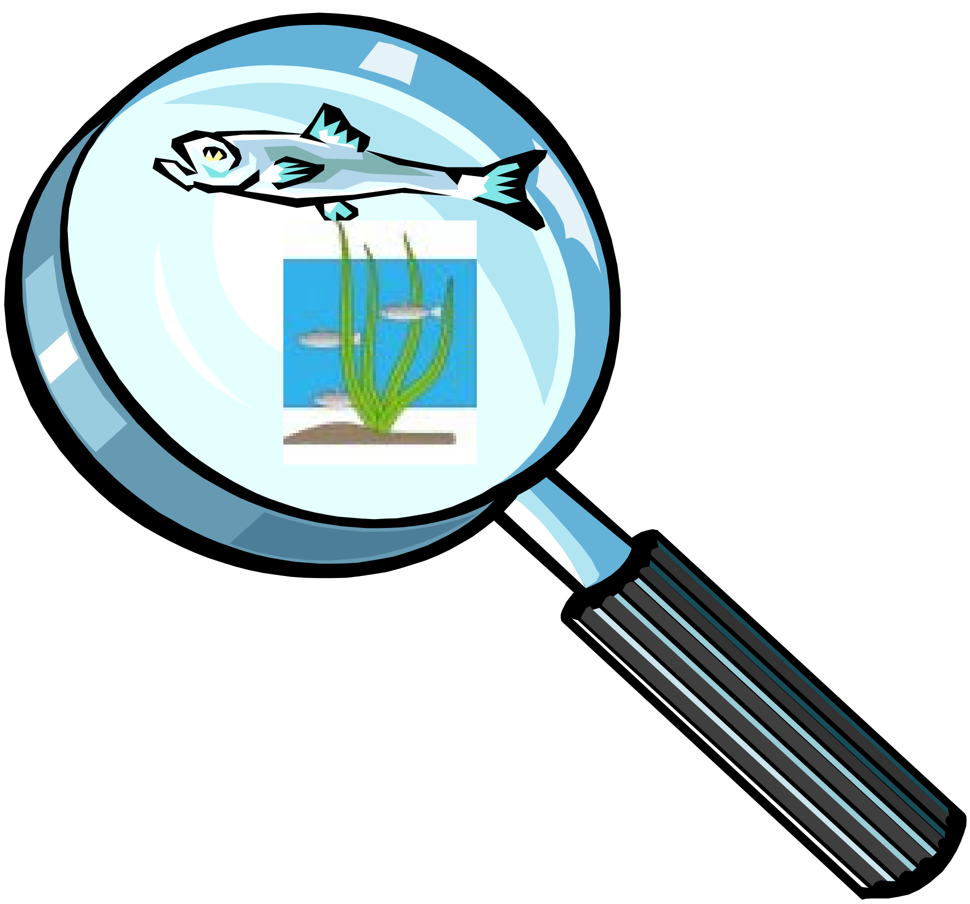
Eyes on Dissolved Oxygen



Eyes on Dissolved Oxygen

Goal

Students will understand how dissolved oxygen levels vary across the Chesapeake Bay and change with weather events and human intervention.
Students will use the Eyes on the Bay website to analyze water quality information as it relates to the Chesapeake Bay.

Learning Objectives

Students will be able to:

1. Describe factors that influence dissolved oxygen (DO) levels in the Chesapeake Bay;
2. Identify the molecular structure of dissolved oxygen in water;
3. Learn and practice using a probe to measure dissolved oxygen (older students will learn and practice titration);
4. Relate what they learned during the investigations to conditions in the Chesapeake Bay and tributaries using real-time data;
5. Describe specific things they can do to improve DO levels throughout the Bay.

Voluntary State Curriculum

Grades 6-8

Social Studies

2.0 Geography: A.1. a (using geographic tools, describe distribution of natural resources & modifications to the environment, and analyze geographic issues); A.2. a (how physical & human characteristics effect economic growth); b (how physical & human characterizes effect how people make a living). A.4. a . How humans modify their natural environment (water use; economics of modified environment); and b. (consequences of modifying the environment)

Science

1.0 Skills & Processes (all)

3.0 Life Science: E. Flow of Matter & Energy. c. (photosynthesis); e. decomposition; f. (water cycle); F. Ecology: b. (limiting factors of environment).

4.0 Chemistry: A Structure of Matter; D. Physical & Chemical Changes. 1 & 3.

6.0 Environmental Science: 1. B. How humans accelerate changes (fertilizers & wastes).

[Potential exists to meet 2.0 Earth Science: E. Interactions of Hydrosphere & Atmosphere – a. (water cycle) by including this concept in Engagement].

[Potential exists to meet 4.0 Chemistry: C. States of Matter by including HEAT as a variable/factor influencing DO levels].

Grade 9-12

Government/ History

Government 1.3 (pollution issues); & 3.1 (environmental issues); Government 3.1.2 (environmental issues).

U.S. History 6.2.1 (impact of urban sprawl).

[Potential exists to meet U.S. History 5.2 (Clean Water Act; regulations by the Environmental Protection Agency.]

Science

Goal 1 Skills & Processes (all)

Goal 2 Earth Science 2.1.1 Current technology to study the atmosphere, land

and oceans; 2.5 Connect prior understanding & new experiences to evaluate natural cycles (all).

Goal 3 Biology 3.1.1 (chemistry's effect on living systems); 3.5 interdependence); 3.6 (investigate a biological issue).

Goal 4 Chemistry 4.2.1 (structure of matter); 4.3.4 (temperature's affect on gas – dissolved oxygen); 4.4.1 (chemical formulas); 4.4.2 (chemical reactions);

4.4.3 (balancing equations).

Time

- 3 50-minute periods

Materials

Per Group

- Dissolved oxygen probe or DO testing kit
- Four 1000 mL beakers
- Water of different temperatures (very cold, cold, room temperature, hot).
- Ice (to make the water very cold).
- Thermometer or temperature probe.
- Computer with Internet connection.
- Stirring stick

Per Student

- Student Sheets: Investigating Dissolved Oxygen, Getting to Know DO, DO and the Bay

Overview

In this investigation, students will learn about dissolved oxygen (DO) and factors that influence the levels of DO in a river or estuarine system. They will learn how to measure DO using either probes or a dissolved oxygen chemical testing kit. Most chemical testing kits use the Winkler Titration Method[1]. Older students can balance the equations of the chemical reactions that take place using the Winkler Titration Method. They will then use real-time data to look at current DO levels in the Chesapeake Bay.

Science Understanding For Teachers

What is DO and what factors affect levels of DO?

Dissolved oxygen (DO) refers to the concentration of molecular oxygen (O_2) dissolved in water. Aquatic animals need oxygen to breathe and live, but they cannot use the oxygen in a water molecule (H_2O) because it is bonded too strongly to the hydrogen atoms (2H).

Dissolved oxygen is essential for the survival of aquatic organisms. Animals such as fish and some macroinvertebrates (oysters and clams) use their gills to extract oxygen from the water. However, some organisms can tolerate lower amounts of dissolved oxygen than others. Consequently, the concentration of oxygen strongly influences which organisms can survive in a particular area of water.

Most of the molecular oxygen enters the water from mixing with the atmosphere. Wind and riffles (very small waves) facilitate this process. The amount of dissolved oxygen that can be contained in water is largely dependent on the temperature and physical conditions of the water. Cold water can hold more dissolved oxygen than warm water. Because of the contact with the atmosphere, white-water areas such as cascades and riffles have higher concentrations of dissolved oxygen than slowly moving or still water, such as pools and glides.

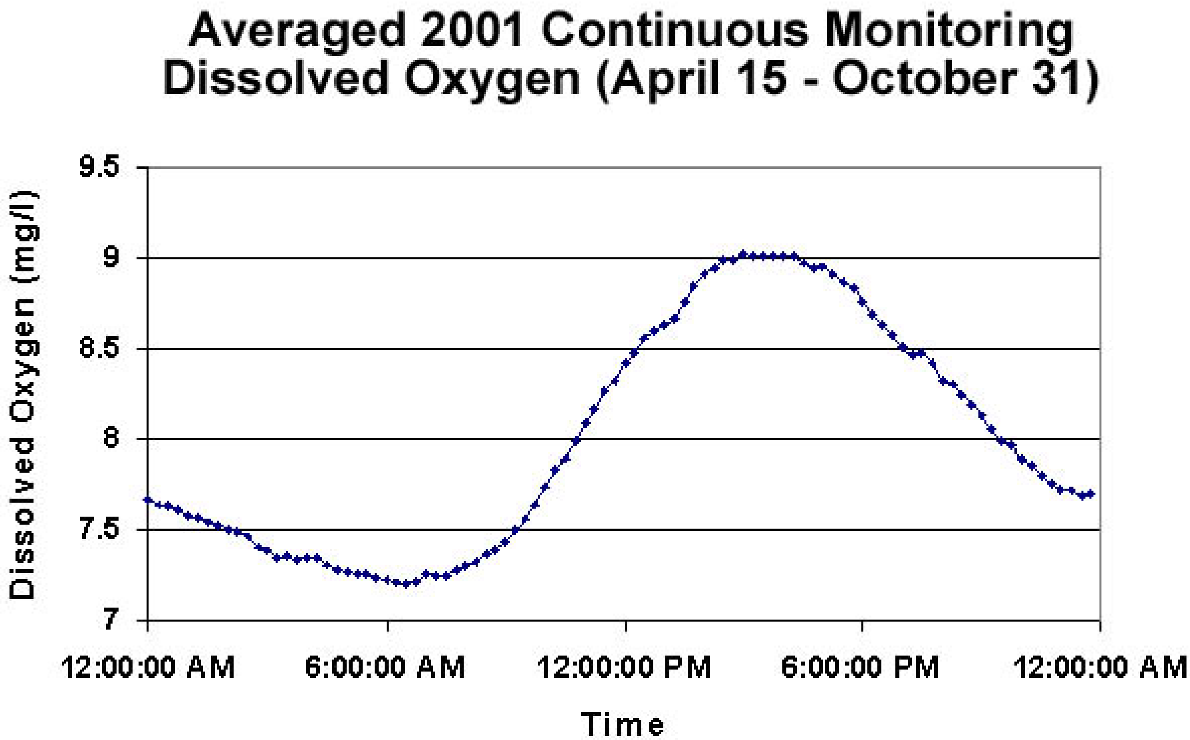
Macroscopic plants, such as bay grasses, and microscopic plants, such as phytoplankton, also oxygenate the water as a product of photosynthesis. Large daily fluctuations in DO are characteristic of areas that have extensive plant growth. As a result of photosynthesis, DO levels rise throughout the day, reaching a peak in mid-afternoon. Since photosynthesis stops at night, but organisms continue to respire, DO levels are lowest just before dawn.

One of the main factors that affect DO levels is a buildup of organic waste. This includes everything that was once part of a living plant or animal such as food, leaves, feces, etc. Additionally, organic wastes can enter a water body through runoff, sewage, or the discharge of food processing plants and other industrial and agricultural sources. In the Chesapeake Bay region, one major contributor to the buildup of organic wastes is fertilizer. As you know, fertilizer stimulates plant growth. Algal blooms may result, covering a large area of water with excess phytoplankton. Because of photosynthesis, an initial increase in DO may result. As these plants die, dissolved oxygen will decrease as aerobic bacteria consume the oxygen in the process of decomposition.

Sampling Procedures

If you are going to test samples from a body of water, keep in mind that DO varies according to time of year, time of day, weather, and temperature (see graph below). The tests should be run during the same period if you want to make yearly comparisons. Also be aware that deep bodies of water have little mixing between the bottom and upper layers, causing differences in DO measurements through the water column. For detailed sampling procedures, see the Mitchell/Stapp book in the Resources section.

[1] Depending on which DO kit you use, you may use a variation of this method.



Eyes on the Bay continuous monitoring sampling sites are monitoring shallow areas that have been historically under-sampled by traditional monitoring programs. It is in these shallow areas where fish kills most often occur. A primary reason for these fish kills is a decline in dissolved oxygen levels. Because these waters are shallow, declines in dissolved oxygen tend to occur throughout the entire water column, leaving fish with no vertical escape and often trapping them in even shallower waters as they move further upstream.

Engage

Part I: Getting to Know DO

1. Engage students in a class discussion – record answers on the board or have students take notes.

- What are some variables that influence water quality?
- What are some animals that live in a river or estuary?
- What are the essentials for animals to live in the water?
- How do animals breathe in the water?
- What do animals breathe in the water?
- How does oxygen get in the water for animals to use?

2. Reading for Understanding

Either individually or in pairs, have students read background information on dissolved oxygen found on the Eyes on the Bay website:

- Visit http://www.eyesonthebay.net
- Go to "Our Monitoring Explained" and read the sections on dissolved oxygen, harmful algal blooms, and turbidity.
- As students read, they should answer the following questions on their student worksheet:

1. Why is dissolved oxygen (DO) so important to the Chesapeake Bay? *Because without oxygen, the living resources would die.*
2. At what level of dissolved oxygen do many organisms become stressed? *<5 mg/L*
3. Name 3 things that affect DO levels? *Temperature, time of year, time of day, depth, plant growth.*
4. When are DO levels the highest? Lowest? *During the day; during the night/pre-dawn*
5. What causes algal blooms? *Excess of nutrients that stimulate plant growth*. Why are algal blooms harmful? *Because eventually the algae will begin to die. Bacteria feeding on the dead algae use DO from the water.*

6. Are all algae found in waters harmful? *No. Algae is a normal part of a water community. It is only when blooms occur that they are problematic.*

7. How does turbidity affect DO levels? *Turbidity decreases photosynthesis, which in turn decreases DO.*

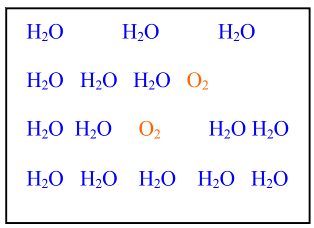
3. As a class, go over the answers. Note any areas where there was confusion over the concepts of dissolved oxygen and variables that affect DO levels.

Teacher preparation...

- *Visit the Eyes on the Bay website to see if there are any specific dissolved oxygen stories you want your students to read.*
- *Review the following concepts: molecules, photosynthesis, food webs*

Part II: Take a closer look at dissolved oxygen

- Ask students for the formula of water. H_2O
- What is the formula for molecular oxygen? O_2
- Dissolved oxygen are molecules of oxygen surrounded by many water molecules.
- Have students draw what this looks like. Their drawings should look something like the one below:
- Point out that there are actual molecules of oxygen in the water. This is the oxygen that organisms use to breathe.
- Have students come up with their own definition of dissolved oxygen and share it with the class. Allow them to modify their definition based on what they heard classmates say.



Note: This is a very simplified drawing. There are many other dissolved gases and chemical compounds that can be found in any sample of water.

Note: At this point, high school students can work out the equations for the Winkler titration method either by balancing the equations or writing the product. See Chemistry section.

Explore

Part II: Investigation #1

How does aeration affect dissolved oxygen?

Conducting an Investigation

1. Have students examine a 1500 mL sample collected from a local stream or pond under a microscope or hand lens. Have them record any organisms they see in the space provided on their worksheet.
2. Have students test the dissolved oxygen levels of the water sample. Have students record their data on their student worksheet (number 2).

Vocabulary

Decomposition -- The breakdown or decay of organic matter through the digestive process of microorganisms, macroinvertebrates, and scavengers.

Dissolved oxygen -- Amount of oxygen gas dissolved in a given quantity of water at a given temperature and atmospheric pressure. It is usually expressed as a concentration in parts per million or as a percentage of saturation.

Organic waste -- Waste materials that are derived from living organisms.

Photosynthesis -- The process through which green plants produce simple sugars by combining carbon dioxide and water using light as an energy source and producing oxygen as a by-product.

Phytoplankton -- microscopic plants that live in the ocean.

3. In three beakers or jars, divide the water sample into 3 equal parts, approximately 500 mL each. Label the beakers as follows:

Beaker #1: control -- no aeration
Beaker #2: slight aeration
Beaker #3: most aeration

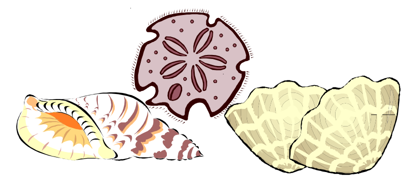
4. Place Beaker #1 in an area where it will not be disturbed for at least 24 hours. Place Beaker #2 and #3 next to each other.

5. Set up the aeration device and place one hose in each of the beakers. To reduce the aeration in Beaker #2, crimp the hose with a clip or use a regulator. Plug in the aerator and let sit for 24 hours.

6. Have students **predict** how they think the DO levels will change after 24 hours and record their predication on the student worksheet (number 5). What will happen to the organisms?

7. After 24 hours have passed, have students **observe** what happened to each of the beakers. Have students use the probe or DO test kit to measure the DO levels in each of the tubes and record it in the data in a table (number 6).

8. Have students look at each sample under the microscope or with a hand lens. Record observations on the worksheet (number 7).



Did You Know...

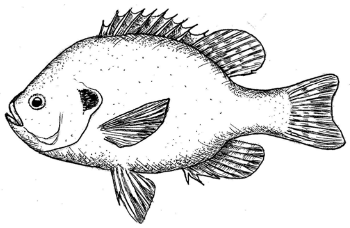
Fish must use a special system for removing oxygen from the water. This takes place in the gills, where the blood picks up oxygen from the surrounding water. The blood flows in the opposite direction of the water, resulting in a gradient that causes the water to have more available oxygen than the blood. This allows oxygen diffusion to continue to take place after the blood has acquired more than 50% of the water's oxygen content. The countercurrent exchange system gives fish an 80-90% efficiency in acquiring oxygen.

Explain

9. Facilitate a discussion about the results of this investigation. Have students explain their results on their worksheet (number 8). Have students draw some conclusions: Why did you see what you did? Did your results differ from your prediction?

10. As a class, or as a writing assignment, have students answer the following questions:

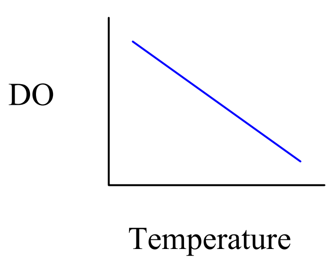
- How did each sample change based on the dissolved oxygen levels?
- How does this experiment relate to the Chesapeake Bay ecosystem?

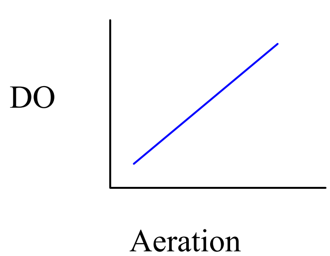


Try It!

Design your own experiment
Investigate dissolved oxygen further by having students design their own experiment. Some questions they could investigate include:

- *How does submerged aquatic vegetation (SAV) affect DO levels?*
- *Do different types of SAV affect DO levels differently?*
- *How do increases or decreases in DO levels affect respiration rates in goldfish?*
- *How do increases or decreases in DO affect the quantity or variety of biota found in a pond?*





Part II: Investigation #2
How does temperature affect dissolved oxygen?

Conducting the Investigation:

1. Let each of the samples sit overnight. Have students re-label the beakers to read as follows:

   Beaker #1: control — room temperature

   Beaker #2: cool water

   Beaker #3: hot water

2. Have students make a predication about which beaker you think will have the most dissolved oxygen. Which will have the least? Record predictions on their student worksheet (number 2).

3. Have students place several ice cubes in Beaker #2 and heat Beaker #3 on a hot plate. Make sure students wear proper safety gear.

4. Have students use the probes or the DO test kit to determine DO level of each beaker. Have students draw a table and record their observations.

5. Have students explain their observations. They may use the Eyes on the Bay website as a reference.

6. Have students answer the question: How do these demonstrations relate to an actual river or estuary?

Explain

7. Have students finish the following sentences on their student worksheet:
   - As temperature increases, dissolved oxygen ______. *(decreases)*
   - As contact with the atmosphere (aeration) increases, dissolved oxygen _________. *(increases)*
8. On their worksheet, have students draw a line graph relating 1) DO and temperature and 2) DO and aeration. *See example in side bar.*

9. Facilitate a class discussion about what students have learned about dissolved oxygen. Ask the following questions (students can summarize their findings in the space provided on their worksheet).
   - How do temperature and mixing affect DO?
   - How would you classify water that has a low DO level? Why?
   - Where does the oxygen come from?
   - How can we use DO to help determine water quality?

Extend - Try It!

1. Design your own experiment

Investigate dissolved oxygen further by having students design their own experiment. Some questions they could investigate include:

- How does submerged aquatic vegetation (SAV) affect DO levels?
- Do different types of SAV affect DO levels differently?
- How do increases or decreases in DO levels affect respiration rates in goldfish?
- How do increases or decreases in DO affect the quantity or variety of biota found in a pond?

2. We suggest using the following activities to extend this lesson: " Water Quality Windows (Healthy Water, Healthy People)

Explore

Part III – Dissolved Oxygen and the Bay

Relating student learning to real-time data illustrating what's happening with regard to dissolved oxygen in the Bay.

Introduction

- Introduce students to http://www.eyesonthebay.net
- Have students read the background information on Continuous Monitoring and Long Term Fixed Monthly Monitoring on Eyes on the Bay.

Investigating the Bay

1. Have students visit http://www.eyesonthebay.net and read the "Isle of Wight Fish Kill Cause

Determined with Continuous Monitoring Data".
They should be able to answer the following questions:
- What caused the low dissolved oxygen levels?
- When was chlorophyll production the highest? When did the fish kill occur?
- How did the continuous monitoring help scientists?
- How do you think this information helped the general public?

2. Working in pairs, students should choose a site (either continuous or monthly monitoring) from the main station map, then find that station's data on the data and charts page for either Continuous Monitoring or Long Term Monthly Monitoring.
3. Have students query for and look at the dissolved oxygen data for one year. When are DO concentrations the lowest? When are they the highest? Why?
4. Visit www.cbos.org to get current and historical weather information.
5. Look at the DO concentration levels at some of the continuous monitoring sites. Do you see any significant changes? Postulate why these changes occurred.
6. Find out the extended weather forecast. Make a prediction as to what you think the DO levels will be next week and why. What other factors might influence the DO levels?

Explain

- Have each pair of students discuss their findings.
- Based on what they have learned about dissolved oxygen, what are some specific things they can do to improve DO levels throughout the Bay?

*Extend**

One of the reasons algal blooms are such a problem in the Chesapeake Bay is because, when they die, massive amounts of decomposers respire and use up the dissolved oxygen. This extension helps students understand the relationship between organic waste and dissolved oxygen in water. Students should wear safety gear.

*Adapted from Kristina Rogers (July 2002). Loyalsock Township High School. Renewable Natural Resource Extension. The Pennsylvania State University. University Park, PA 16802. 814-863-0401.

- 2 beakers
- 2 mL dry yeast
- 10 mL graduated cylinder
- 3 test tubes in rack
- stirring stick
- 5 mL pipet or eye dropper
- Methylene blue solution
- milk

1. Fill a beaker half full.
2. Label 3 test tubes: 1, 2, 3
3. Using the pipet, or eye dropper, add the amount of materials to each test tube, as shown below (15 drops approximately equals 1 mL).

Test Tube	Milk (mL) or Drops		Water (mL) or Drops	
1	2.5	37	0	0
2	1.0	15	1.5	22
3	0.2	3	2.3	35

4. Check the height of the liquid — it should be the same in all three tubes.
5. Add three drops of methylene blue to each test tube. The meth-ylene blue is an "indicator" solution. It will change from blue to white when the oxygen in the tube is consumed.
6. Mix each tube by putting your thumb over the top and inverting it quickly 4 times.
7. Mix 1/2 teaspoon of dry yeast to 20 mL of warm water in a beaker. Mix the yeast and water thoroughly with the stirring stick.
8. Next, you will mix the yeast and milk solutions. Follow the directions carefully:
   - Mix the yeast solution vigorously with the tip of the pipet or eyedropper.
   - Carefully put exactly 2.0 mL (30 drops) of yeast solution into test tube 1. Mix by inverting 4 times. Record the exact time.
   - Repeat that procedure for test tubes 2 and 3. Record the exact time that the yeast is added to the milk mixture.

Resources

Healthy Water, Healthy People
Cindy Etgen, Maryland State Coordinator. Maryland DNR.
410-260-8716
cindy.etgen@maryland.gov
http://dnr.maryland.gov/education
Lesson plan resources on Eyes on the Bay

Mitchell, Mark K. and William B. Stapp. *Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools. Eleventh Edition. Kendall/Hunt Publishing Company. Dubuque, IA. 1996.*

Sustainable Forestry Teacher Resource Center
The Pennsylvania State University
University Park, PA 16802
(814) 863-0401
http://sftrc.cas.psu.edu

Earth Force
1908 Mount Vernon, Second Floor
Alexandria, VA 22301
Ph: 703-299-9400
Fax: 703-299-9485
earthforce@earthforce.org
http://www.green.org/

Hach Company
P.O. Box 389
Loveland, CO 80539-0389
Ph: 800-227-4224
Fax: 970-669-2932
orders@hach.com
http://www.h2ou.com

Imagiworks(Probes to use with handheld PDAs)
http://www.imagiworks.com/
Ph: 877-373-0300

LaMotte Environmental and Outdoor Monitoring
P.O. Box 329
802 Washington Ave.
Chestertown, MD 21620
Ph: 800-344-3100
Fax: 410-778-6394

9. Watch until each tube's color changes from blue to white (it should take about 15 minutes). Note: the surface of each tube always remains blue. Why?

Test Tube	Time Mixing (A)	Time When Tube Changes Color (B)	Total Time for Color Change to Occur (B-A)
1			
2			
3			

Wrap Up

- Shake one of the test tubes that turned white. What happens to the color? Why?
- Where do microorganisms living in the water get the oxygen they need to live?
- Which test tube contained the most oxygen? Which test tube contained the least oxygen?
- What did the yeast represent?
- What did the milk represent?
- Have students graph their data and explain the relationship between the amount of waste and oxygen in the water.
- How does this relate to dissolved oxygen in the Chesapeake Bay?

Evaluation

- Have students draw a molecular view of dissolved oxygen.
- Have students draw a graph relating temperature and DO and atmospheric mixing and DO.
- Did students provide thorough explanations during the POE activity?
- During the on-line lesson, did students answer questions and provide explanations that demonstrate their understanding?

Chemistry Reactions for the Winkler Titration Method[1]

If you chose to review the chemical process with your students, there are several options:

1. Have students balance the equations.
2. Have them underline the reactants once and the products twice.
3. Give them the description and have them write word equations.
4. Have them calculate the products.

The first step in a DO titration is adding Manganous Sulfate solution and Alkaline Potassium Iodide Azide Solution. These reagents react to form a white precipitate, or floc, of manganous hydroxide, $Mn(OH)_2$.

$$MnSO_4 + 2KOH \longrightarrow Mn(OH)_2 + K_2SO_4$$

Manganous Sulfate + Potassium Hydroxide → Manganous Hydroxide + Potassium Sulfate

When the precipitate has formed, oxygen in the water oxidizes the manganous hydroxide to a brown color, manganic hydroxide. For every molecule of oxygen in the water, four molecule of manganous hydroxide is converted to manganic hydroxide.

$$4Mn(OH)_2 + O_2 + 2H_2O \longrightarrow 4Mn(OH)_3$$

Manganous Hydroxide + Oxygen + Water → Manganic Hydroxide

After the brown precipitate is formed, a strong acid, such as sulfuric Acid, is added to the sample. The acid converts the manganic hydroxide to manganic sulfate. The sample is now "fixed".

$$2Mn(SO_4)_3 + 3H_2SO_4 \longrightarrow Mn_2(SO_4)_3 + 6H_2O$$

Manganic Hydroxide + Sulfuric Acid → Manganic Sulfate + Water

Iodine from the potassium iodide in the Alkaline Potassium Iodide Azide Solution is oxidized by manganic sulfate, releasing free iodine into the water. Since the manganic sulfate comes from the reaction between the manganous hydroxide and oxygen, the amount of iodine released is proportional to the amount of oxygen present in the original sample. This release of free iodine is indicated by a yellow-brown color.

$$Mn_2(SO_4)_3 + 2KI \longrightarrow 2MnSO_4 + K_2SO_4 + I_2$$

Manganic Sulfate + Potassium Iodide → Manganic Sulfate +Potassium Sulfate + Iodine

The final addition to this process is the sodium thiosulfate. It reacts with the free iodine to produce sodium iodide. When all the iodine has been converted, the sample becomes colorless. A starch indicator is added to enhance the final endpoint.

$$2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2NaI$$

Sodium Thiosulfate + Iodine → Sodium Tetrathionate + sodium Iodide

Name___________________

Investigating Dissolved Oxygen

During this series of activities, you will learn about how dissolved oxygen, its effects on fish and plant communities, and factors that can change dissolved oxygen levels.

Background

Dissolved oxygen (DO) refers to the concentration of molecular oxygen (O_2) dissolved in water. Aquatic animals need oxygen to breathe and live, but they cannot use the oxygen in a water molecule (H_2O) because it is bonded too strongly to the hydrogen atoms (2H).

Dissolved oxygen is essential for the survival of aquatic organisms. Animals such as fish and some macroinvertebrates (oysters and clams) use their gills to extract oxygen from the water. However, some organisms can tolerate lower amounts of dissolved oxygen than others. Consequently, the concentration of oxygen strongly influences which organisms can survive in a particular area of water.

Most of the molecular oxygen enters the water from mixing with the atmosphere. Wind and riffles (very small waves) facilitate this process. Cool water can hold more dissolved oxygen than warm waters. Because of contact with the atmosphere, white-water areas such as cascades and riffles have higher concentrations of dissolved oxygen than slowly moving or still water, such as pools and glides.

One of the main factors that affect DO levels is a buildup of organic waste. This includes everything that was once part of a living plant or animal such as food, leaves, feces, etc. Additionally, organic wastes can enter a water body through runoff, sewage, or the discharge of food processing plants and other industrial and agricultural sources. In the Chesapeake Bay region, one major contributor to the buildup of organic wastes is fertilizer. As you know, fertilizer stimulates plant growth. Algal blooms may result, covering a large area of water with excess phytoplankton. Because of photosynthesis, an initial increase in DO may result. As these plants die, dissolved oxygen will decrease as aerobic bacteria consume the oxygen in the process of decomposition.

Part I: Getting to Know DO

Visit http://www.eyesonthebay.net. Go to "What does it all mean?" and read the sections on dissolved oxygen, harmful algal blooms, and turbidity. As you read, try to answer the following questions:

1. Why is DO so important to the Chesapeake Bay?
2. At what level of DO do many organisms become stressed?
3. Name 3 things that affect DO levels?
4. When are DO levels the highest? Lowest?
5. What causes algal blooms? Why are algal blooms harmful?
6. Are all algae found in waters harmful?
7. How does turbidity affect DO levels?

Part II: Take a Closer Look at Dissolved Oxygen

In the space below, draw a simplified model of dissolved oxygen. Then, write your own definition.

Part II. Investigation #1

How does aeration affect dissolved oxygen?

Investigation Instructions:

1. Examine a 1500 mL sample of water collected from a local stream or pond under a microscope or hand lens. Record your observations below:

2. Test the dissolved oxygen level of the water sample.
Dissolved oxygen: ______________ mL

3. In three beakers or jars, divide the water sample into 3 equal parts, approximately 500 mL each. Label the beakers as follows:

Beaker #1: control - - no aeration
Beaker #2: slight aeration
Beaker #3: most aeration

- Place Beaker #1 in an area where it will not be disturbed for at least 24 hours.
- Place Beaker #2 and #3 next to each other on your table.

4. Set up the aeration device and place one hose in each beaker. Reduce the aeration in Beaker #2 by crimping the hose with a clip. Plug in the aerator and let sit for 24 hours.

5. Predict what the DO levels will be for each of the beakers after 24 hours:

Prediction: Beaker #1:

Prediction: Beaker #2:

Prediction: Beaker #3:

6. After 24 hours have passed, measure the DO levels in each beaker using a probe or test kit. Create a table below to record your data:

7. Examine the sample with a microscope or hand lens. Compare your observations with what you saw before you started the aeration. Did you notice any differences? Record any changes in the organisms you found in the sample:

8. Explain why there were changes in DO levels or aquatic life. Did the results differ from your prediction?

Part II. Investigation #2

How does temperature affect dissolved oxygen?

Investigation Instructions:

1. Label each of three beakers:
   Beaker #1 (control)
   Beaker #2 (cool water)
   Beaker #3 (hot water).

2. Predict which beaker will have the most dissolved oxygen, and which one will have the least.
   Most:
   Least:

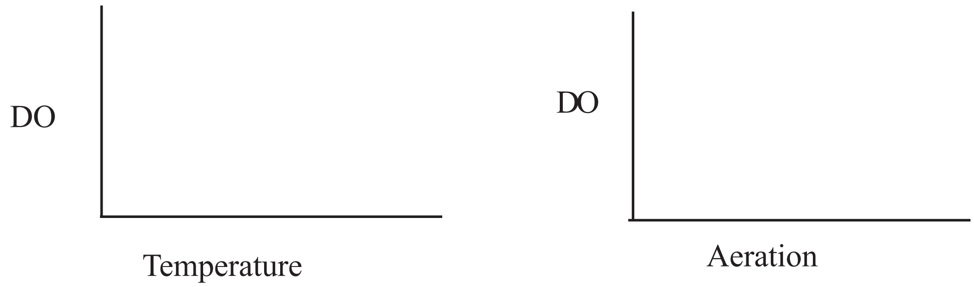
3. (Put on your safety gear) Put several ice cubes in Beaker #2 and heat Beaker #3 on a hot plate until it is just about to boil.

4. Remove the beaker from the hot plate and using a probe or test kit, measure the DO levels of all three beakers. Record your observations and data below.

5. Explain your observations. How do these investigations relate to an actual river or estuary?

Finish the following sentences:
a. As temperature increases, dissolved oxygen _______________.
b. As aeration increases, dissolved oxygen _______________.

6. Draw a line graph relating 1) DO and temperature, and 2) DO and aeration.



7. (With class discussion) How do temperature and mixing affect DO?

8. How would you classify water that has a low DO level? Why?

9. Where does the oxygen come from?

10. How can we use DO to help determine water quality?

Part III: Dissolved Oxygen and the Bay

1. Visit http://www.eyesonthebay.net.
Read the "Isle of Wight Fish Kill Cause Determined with Continuous Monitoring Data". Try to answer the following questions:

   a. What caused the low dissolved oxygen levels?

   b. When was chlorophyll production the highest?
   When did the fish kill occur?

   c. How did the continuous monitoring help scientists?

   d. How do you think this information helped the general public?

2. Choose a station (either continuous or long term monthly monitoring) from the main map. Next, find this station's data on the data page for either Continuous Monitoring or Long Term Monthly Monitoring.
Look at the dissolved oxygen data for one year.

   a. When are DO concentrations the lowest? When are they the highest? Why?

3. Visit www.cbos.org to get current and historical weather information.

4. Look at the DO concentration levels at some of the continuous monitoring sites.

· Do you see any significant changes? Postulate why these changes occurred.

5. Find out the extended weather forecast. Make a prediction as to what you think the DO levels will be next week and why. What other factors might influence the DO levels?

Prediction:

Factors:

6. Discuss your findings with your partner. Based on what you have learned about dissolved oxygen, what are some specific things you can do to improve DO levels throughout the Bay?