Backyard STEM

Where's all the O_2???

An experiment about Biochemical Oxygen Demand

Project Area: Environmental Science

Skill Level: Intermediate

Learner Outcomes:

⇒ Be able to describe biochemical oxygen demand.

⇒ Be able to link organic matter pollution with oxygen depletion.

⇒ Be able to compare a demonstration to a real world scenario.

⇒ Be able to create a mathematical relationship.

Tennessee Science Curriculum Standard GLEs:

Science Skills: Create an active model, observe, reflect

Life Skills: Observing, Reasoning

Tags: water quality, biochemical oxygen demand

Materials:

⇒ Timer (60 second)

⇒ Calculator

⇒ White board

The purpose of this activity is to introduce the concept of biochemical oxygen demand in waterways and relate that measurement to our own bodies oxygen consumption patterns.

Ask your students:

⇒ How often do you think about breathing? Why do we get out of breath when we are exercising or doing work? Do you think all animals need oxygen? What happens when microbes and invertebrates in streams and wetlands "breathe?" Where does that oxygen come from?

Introduce Key Concepts:

The air we breathe is made of approximately 78% nitrogen, 21% oxygen and small amounts of other gases like argon and carbon dioxide. There is plenty of oxygen in the air we breathe to provide our bodies with an amount that supports our bodies through activities. We are not in short supply.

But, in the water is a different case. Dissolved oxygen in water is vital for fish and aquatic invertebrates. These organisms are bound within the water, so when oxygen is pulled from the water, there may not be enough to support biodiversity in the aquatic environment. But what pulls oxygen out of water?

Just as we pull oxygen out of the air when as we live (whether is just sitting and reading a book or being active), microbes use oxygen when they are active, which is usually when they are breaking down organic materials. In the water, the amount of oxygen that is utilized during the decomposition and utilization of organic matter is called biochemical oxygen demand, or BOD. BOD is typically measured in mass per volume, or commonly miligrams per liter (mg/L). This is a common measurement of water to describe the amount of organic matter in water. Organic matter can be a pollutant in water if there is too much of it. Organic matter and other substances that reduce oxygen from the water due to BOD can come from many sources. Common sources include land uses of agriculture, urban development, golf courses and roadways.

We are going to explore oxygen demand by using our own body as a demonstration. The oxygen uptake rate of our bodies can be measured by our oxygen consumption, or VO_2 rate. Just as microbes doing work to break down organic matter utilize oxygen from the water, we utilize oxygen from the atmosphere when we exercise. As our work or exercise increases, our VO_2 rate increases.

Credits: Andrea Ludwig and Jennifer DeBruyn

Activity: Exploring Oxygen Demand

The goal of this activity to explore oxygen demand and draw a parallel between our bodies doing work and consuming oxygen and microbes doing work to break down organic pollutants and utilizing oxygen in the stream.

Materials:

- Calculator, timer, white board

Methods:

- Ask students to work in pairs or small groups.
- Ask students to set the timer for a minute and count how many breaths they take in resting minute.
- Record their answers.
- Ask students to set the timer for 30 seconds and perform an exercise like jumping jacks, jump rope or high-knees in place. Then ask them to record their breaths for a minute immediately afterwards.
- Ask students to again do the exercise, but this time count their breaths for during the exercise for a complete minute.
- Combine all students data on breaths and calculated oxygen uptake rate. Explore the linear relationship between breaths and oxygen consumption and discuss the range of consumption that varies based on the amount of work being done.

Reflection

Make the connection between our own oxygen utilization and that of microbes in stream water doing work to break down organic matter. Talk about what would happen if too much organic matter made its way into streams.

Add up all the students' oxygen consumption to determine the "community" consumption for both resting and exercising scenarios. Draw a conclusion from this analogy that the resting rate oxygen uptake is lower and represents a stream in a healthy state with a natural BOD. Compare this to the sum of the exercising oxygen update rate of the class and describe how this represents a stream that has had organic pollution occur and the decomposer community is working hard to breakdown the food source.