WHAT IS IN THE WATER?

How our use of everyday items impact the world around us

"What is in our water" affords an opportunity for students to consider how much of an impact they have on the environment. Curiosity is piqued as students examine water samples collected from bodies of water near their homes and see micro-organisms swimming in the water. Students will become scientists as they identify the organisms. Next, they will read about some literature on everyday household items and determine which of these may be harmful to those micro-organisms. Students will take the role of environmental scientists as they setup experiments to test the effects of household items. In their final project, students will create posters to inform others of the harmful impact our everyday items have on the environment.

University of Florida Center for Precollegiate Education and Training

WHAT IS IN THE WATER

UF Center for Precollegiate Education and Training
UNIVERSITY of FLORIDA

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This curriculum was developed in the laboratory of:

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Professor
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Copper and Iron Metabolism

Copper and iron are vital nutrients with a highly conserved and interwoven metabolism that is required for the growth and development of all organisms. An overall research goal of the laboratory is to further understand copper and iron metabolism in mammals with a focus on 1) characterizing the role of the multi-copper ferroxidases (Fe (II)-> Fe(III) in iron homeostasis and 2) identifying the genetic factors that influence iron status in mammals using “in silico” QTL analysis of inbred mouse strains and collaborations to study genetic determinants of iron deficiency in zebrafish and humans.

Toxicogenomics and Green Chemistry

We are utilizing systematic functional analysis through the use of “barcoding” analysis in the budding yeast Saccharomyces cerevisiae to identify conserved toxicity pathways that may provide insight on toxicant susceptibility in people. We are currently focused on breast cancer carcinogens, mitochondrial toxicants, pesticides and emerging contaminants. Most recently we have started using whole genome CRISPR approaches in a similar approach in mammalian cell lines.

Ecotoxicogenomics

We are developing a novel approach for identifying and understanding the toxicity of xenobiotics in aquatic ecosystems by monitoring changes in global gene expression patterns in aquatic indicator species representative of different trophic levels, including DAPHNIA MAGNA (a crustacean), and PIMEPHALES PROMELAS (fathead minnow). We are assessing the sensitivity, specificity and utility of an ecotoxicogenomics approach for ecological toxicity assessment in real world environmental settings. Tools we are using include traditional microarray technologies as well as high-throughput sequencing methods.

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AUTHOR'S NOTE

I was fortunate enough during the summer of 2016 to assist in the Vulpe Lab at the University of Florida, Department of Environmental Toxicology. Dr. Chris Vulpe and his staff are studying the effects of toxins on different organisms or the effects of toxins at the cellular level. I learned so much and am very grateful for this opportunity.

One of the organisms being studied was Daphnia. Daphnia are tiny arthropods that live in fresh, slow-moving bodies of water. These little bitty organisms are able to indicate when something goes wrong in the water.

I was able to assist in the care in maintenance of these organisms. I found that these hearty creatures would be a good study for use in the classroom. In a healthy environment, they can reproduce every 24 hours. This allows you to grow a culture in your classroom. I have included helpful tips on how to establish a classroom culture.

I wanted to develop something different for use in the classroom. As I did research, I noticed laboratory experiments on the heartrate of daphnia. Daphnia are clear organisms that allow you to see the heart beat through the skin under the microscope. I also noticed experiments on the effects of detergents. I wanted more. I set out to develop a lesson that would show the students how different everyday chemicals/toxins could be harmful to the smallest organisms. Maybe this will give them a cause or reason to care. I hope it will show them how much of an impact they can have on the environment.

INTRODUCTION

Have you ever went hiking in the woods and came upon a dirty, disgusting water source? Ever wondered how the plants and animals in the area use this water source? Have you ever wondered what happens to the oil that leeches from the cars as you drive down the road? What about the runoff from our yards, where does it go? Where does the soap go after washing the car? Oil, coolant, fertilizers, pesticides, and soaps are household toxins. These toxins could get swept up in the rain and dumped into a waterway. All of these items could have a huge impact on the environment.

"What Is in My Water" focuses on the impact we make on the environment. This lesson gives students an opportunity to step-outside of their comfort zone and to think outside of their box.

Students usually never stop to think about their impact on the world around them. They take for granted every little thing. Students will examine water samples to identify organisms, read about toxins used in every household, experiment the effect of the toxins, and create a public service poster. I am hoping by the end of this curriculum the students will be concerned on what they are doing to their environment. They will care and want to make a change in the world. I hope they will be motivated to change their ways and the ways of others.

TIPS ABOUT THIS CURRICULUM

My advice is to teach this curriculum after teaching water properties. The students will also need to know the basic parts and function of the microscope.

CARE GUIDE FOR DAPHNIA: Daphnia will need to be obtained before the laboratory experiment in lesson 4. Instructions are included for the care and maintenance of the daphnia.

Lesson Plan Format: All lessons in this curriculum unit are formatted in the same manner. In each lesson you will find the following components:

ESSENTIAL QUESTION(S): Identifies key questions the lesson will explore.
OVERALL TIME ESTIMATE: Indicates total amount of time needed for the lesson, including advanced preparation.
LEARNING STYLES: Visual, auditory, and/or kinesthetic.
VOCABULARY: Lists key vocabulary terms used and defined in the lesson. Also collected in master vocabulary list.
LESSON SUMMARY: Provides a 1-2 sentence summary of what the lesson will cover and how this content will be covered. Also collected in one list.
STUDENT LEARNING OBJECTIVES: Focuses on what students will know, feel, or be able to do at the conclusion of the lesson.
STANDARDS: Specific state benchmarks addressed in the lesson. Also collected in one list.
MATERIALS: Items needed to complete the lesson. Number required for different types of grouping formats (Per class, Per group of 3-4 students, Per pair, Per student) is also indicated.
BACKGROUND INFORMATION: Provides accurate, up-to-date information from reliable sources about the lesson topic.
ADVANCE PREPARATION: This section explains what needs to be done to get ready for the lesson.
ASSESSMENT SUGGESTIONS: Formative assessment suggestions have been given. Teachers should feel free to create additional formative and summative assessment pieces.
EXTENSIONS: (ACTIVITIES/LITERATURE) There are many activities and reading sources available to augment and enhance the curriculum. They have been included. If you find additional ones that should be added, please let us know.
RESOURCES/REFERENCES: This curriculum is based heavily on primary sources. All references and resources are also collected in one list.
STUDENT PAGES: Worksheets and handouts to be copied and distributed to the students.
TEACHER MASTERS: Versions of the student pages with answers or the activity materials for preparation.

Collaborative Learning: The lessons in this curriculum have been developed to include many collaborative learning opportunities. Rather than presenting information in lecture format and teacher driven, the activities involve the students in a more engaged manner. For classrooms not accustomed to using collaborative learning strategies, have patience. It can be difficult to communicate instructions, particularly for students who are visual learners. For these students, use of visual clues such as flowcharts and graphics can help them understand how they are to move to different groups.

Groups: Most of the lessons are carried out in groups. While it isn't necessary for students to remain in the same groups the entire unit, if they work well together, it may foster students to think deeper as they are comfortable with their teammates and willing to ask questions of each other.

Inquiry-based: The lessons in the curriculum invite students to be engaged and ask questions. They work through background information in a guided fashion, but are challenged to think beyond what they have read or done. The teacher serves as the facilitator in these activities, not the deliverer of information.

Implementation notes: This curriculum should be modified and adapted to suit the needs of the teacher and students. To help make implementation easier in this first draft, notes have been included in lessons as needed.

Science Subject: Biology, Environmental Science

Grade and ability level: 9-12 students

Science concepts: environment, toxins, microscope, pollutants,

LESSON SUMMARIES

Lesson 1 – This lesson is my hook. I hope to pique the student's interest and make them wonder "What is in my Water". Students will examine a water sample under the microscope for the presence of organisms. The water sample will be a representation of what could be found in their backyard lake or pond. Students will draw what they see and write a description.

Lesson 2 - Students will be given organism cards to read and answer questions about the organisms seen under the microscope. Students should then be able to correctly identify what organisms were seen under the microscope.

Lesson 3 – A jigsaw reading will be given to the students on Environmental Toxins. The environmental toxins will be fertilizers, pesticides, surfactants, and herbicides that are found in every household. Students will work in groups to read, discuss, evaluate, and categorize the toxins readings.

Lesson 4 – students will choose one of the toxins from the day before for an experiment. Students will perform an assay with different concentrations of the toxin to determine the toxicity of the toxin. Students will be using Daphnia as a bio-indicator with their toxin. Assay will run for 24 hours. Will look for surviving daphnia to determine how toxic is their toxin.

Students will read and complete a graphic organizer about bio-indicators.

Lesson 5 – students will create a Brochure/poster to show dangers of Environmental Toxins and why we should be concerned about our impact to the Environment.

LESSON SEQUENCING GUIDE

Since the classroom teacher knows his or her students best, the teacher should decide the sequencing of lessons. Below is a suggested pacing guide that can be used when planning to use this curriculum.

45 minute periods

	Day 1	Day 2	Day 3	Day 4	Day 5
Week 1	Lesson 1 Micro-critters in the water (45 minutes)	Lesson 2 ID Micro-critters from the water (45 minutes)	Lesson 3 Introduction to Environmental Toxins (45 minutes)	Lesson 4 Environmental Toxins Lab Experiment (45 minutes)	Lesson 4 Bioindicators reading Lab results (45 minutes)
Week 2	Lesson 5 Environmental Toxins Poster (45 minutes)	Lesson 5 Environmental Toxins Poster (45 minutes)			

VOCABULARY

Autotrophic – organism that is able to capture energy from sunlight and use it to produce food

Cilia – short, hair-like structures that propel organisms

Daphnia – tiny, transparent crustaceans referred to as water flea

Ecosystem – all the biotic parts interacting with the abiotic parts of an environment

Ecotoxicology – study how toxicants affect the environment and organisms within the environment

Environment – The sum of all external conditions affecting the life, development, and survival of an organism

Eukaryote – organism whose cells contain a nucleus

Eyepiece – lens closest to the eye when looking through the device

Fertilizers – a substance added to soil to help with the growth of plants

Flagellum – long, whip-like structures that propel organisms

Heterotrophic – organisms that obtains food by consuming other organisms

Magnification – process of enlarging; eyepiece power times the objective lens power

Microscope – an optical instrument having a magnifying lens for inspecting objects too small to be seen or too small to see details by the naked eye

Multicellular – many cells

Objective lens – lens closet to the object that first receives rays from the object to form image in the eyepiece

Pesticides – substance used to attract, seduce, and destroy any pest

Pollutant – a waste material that contaminates the soil, air, or water

Pseudopod – a false foot used to propel organisms

Resolution – minimum and maximum magnification necessary for details of object; shortest distance between two points on a specimen that can still be distinguished by the observer

Stage – place where slide is placed for observation

Surfactants – surface-active substances used in cleaning applications; soften the water, so it can wet the fibers and surfaces, loosen and encapsulates the dirt and prevents re-deposition of dirt on the surface

Toxins – A poisonous or harmful non-biological substance, such as a pollutant

Unicellular – one cell

NEXT GENERATION SUNSHINE STATE STANDARDS – SCIENCE

Benchmark	1	2	3	4	5
SC.912.L.14.6 Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health.			X	X	X
SC.912.L.17.2 Explain the general distribution of life in aquatic systems.	X	X			
SC.912.L.17.8 Recognize the consequences of the losses of biodiversity due to human activity			X	X	X
SC.912.L.17.11 Evaluate the costs and benefits of renewable and nonrenewable resources such as water. .			X	X	X
SC.912.L.17.16 Discuss the large-scale environmental impacts resulting from human activity			X	X	X
SC.912.L.17.20 Predict the impact of individuals on environmental systems and examine how human lifestyles affect sustainability				X	X
SC.912.N.1.1 Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following: 1. pose questions about the natural world, 2. conduct systematic observations, 3. examine books and other sources of information to see what is already known, 4. review what is known in light of empirical evidence, 5. plan investigations, 6. use tools to gather, analyze, and interpret data, 7. pose answers, explanations, or descriptions of events, 8. generate explanations that explicate or describe natural phenomena (inferences), 9. use appropriate evidence and reasoning to justify these explanations to others, 10. communicate results of scientific investigations, and 11. evaluate the merits of the explanations produced by others.	X	X	X	X	
SC.912.N.1.2 Describe and explain what characterizes science and its methods.	X	X	X	X	X
SC.912.N.1.3 Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depends on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented.		X	X		X
SC.912.N.1.4 Identify sources of information and assess their reliability according to the strict standards of scientific investigation.			X		
SC.912.N.1.5 Describe and provide examples of how similar investigations conducted in many parts of the world result in the same outcome.		X	X		
SC.912.N.1.6 Describe how scientific inferences are drawn from scientific observations and provide examples from the content being studied.	X			X	X
SC.912.N.1.7		X		X	X

Benchmark	1	2	3	4	5
Recognize the role of creativity in constructing scientific questions, methods and explanations.					
SC.912.N.2.4 Explain that scientific knowledge is both durable and robust and open to change. Scientific knowledge can change because it is often examined and re-examined by new investigations and scientific argumentation. Because of these frequent examinations, scientific knowledge becomes stronger, leading to its durability.		**X**	**X**		**X**
SC.912.N.4.1 Explain how scientific knowledge and reasoning provide an empirically-based perspective to inform society's decision making.					**X**
SC.912.N.4.2 Weigh the merits of alternative strategies for solving a specific societal problem by comparing a number of different costs and benefits, such as human, economic, and environmental.				**X**	**X**

BACKGROUND INFORMATION

General background information is given here. More detail is provided in the individual lessons as needed as well in the student information in lesson one.

The environment is the immediate world that surrounds each of us. It includes our home, our work, where we play, where we get our food, and our water sources. Our environment supplies us with food, water, sun, renewable and nonrenewable resources. Examples like oil and gas are nonrenewable resources. Eventually, these resources will be used up. Renewable resources are resources that keeps replenishing themselves within a healthy environment. To keep using the supplies our environment gives us, we need to be aware of our impact to the environment.

Our environment supplies us with food. Most of our food comes from the ground – corn, wheat, rice, garden vegetables, apple trees, etc. To obtain enough food, the soil needs to be healthy. This requires the soil to be maintained with organic matter and nutrients. One way to achieve this is with the use of fertilizers. Healthy maintained soil can be a renewable resource.

Another renewable resource is freshwater. Freshwater resources are our lakes, ponds, and streams. These freshwater resources have many uses. One of the favorite uses is recreational use. Swimming, water skiing, and fishing are a few of these fun activities. Farms can use freshwater to irrigate their crops plus serve as drinking reservoirs for the animals. Households use freshwater for bathing, cleaning, washing, and drinking. Our bodies need water. Other uses of freshwater are transportation, industry, or waste disposal. To keep our waterways healthy, we need to be aware of what is ending up in our waterways.

A healthy water environment will have a variety of micro-critters as well as macro-invertebrates present. These critters range from microorganisms such as simple bacteria, protists, and daphnia to macro-invertebrates such as snails, crawfish, or dragonflies. This lesson will concentrate on the microorganisms. Bacteria are helpful to the quality of water by limiting algae buildup. Protist organisms are the food source for many aquatic organisms, provide oxygen for oceans and lakes, and may be used as thickener in ice cream, soups, and puddings. Daphnia are also used as a food source for larger organisms like fish. A loss of any of these organisms especially in large quantities would be an indicator that something else is happening. We need to take a closer look at the water.

Protist organisms are the organisms that do not fit anywhere else. The characteristics of protist are either unicellular or multicellular, either autotrophic or heterotrophic, and all are Eukaryote. Protist maybe plantlike also called algae, maybe animal-like also called protozoa or maybe fungus-like. They are classified by how they move and obtain nutrition. Another organism found in our water sample is daphnia. Daphnia are clear, tiny arthropods. Daphnia are also used as a food source for larger organisms like fish. A loss of any of these organisms especially in large quantities would be an indicator that something else is happening

Humans impact the environment by the use of environmental toxins. Environmental toxins include fertilizers, surfactants, sediment, pesticides, and chlorine. Runoff from yards, oil from cars on the road, detergents from cleansers, and pesticides sprayed on crops are being washed away into waterways. Huge amounts of phosphorus and nitrogen are being channeled into our waterways from farms and industry. Construction site sediment leeches into the water. Sewage treatment plants dump potable water into waterways. The waterways become polluted. This pollution could lead to disruption of ecosystems, which can be damaging to the plant and animal life depending on the water source for survival.

Environmental toxins are toxicants from everyday use and how it affects the environment and the organisms within the environment. This study is called ecotoxicology. An ecosystem can be impacted by a slight change in the community. Environmental Toxins do not recognize political or national boundaries.

A way to detect pollution in our water sources is by the use of Bio-indicators are organisms that can be used to determine the health on an environment. Lichens live on trees. Their survival depends on healthy nutrients found in clean air. Fish may develop an increase in liver enzymes. Worms experience nervous system function changes in unhealthy soil. Frogs may have mutations or even death. Microorganisms develop stress proteins. Daphnia die. All of these organisms are examples of bio-indicators.

This curriculum will concentrate on Daphnia as the bio-indicators. Daphnia are tiny, transparent crustaceans, (arthropods), also called water fleas. These critters live in slow-moving fresh water sources. Daphnia feed on algae, bacteria, and other protozoans that live in the water sources. These guys are easy to care for and can be cultured for use in the study of toxins that enter the waterway. In a healthy environment, daphnia can reproduce every 24 hours. All members in a culture will be female. When the waterway becomes polluted, daphnia will die. Daphnia will be exposed to different toxins and will measure how toxicity of the toxins.

LESSON ONE: MICRO-CRITTERS IN THE WATER

Lesson 1: Micro-critters in the water

Essential Questions: How do you operate a microscope?
What are the functions of the microscope components?
What are the organisms found under the microscope?
What is the general distribution of life in an aquatic ecosystem?

Learning styles: visual and kinesthetic

Estimated time frame: 45 minutes

Vocabulary:

Autotrophic – organism that is able to capture energy from sunlight and use it to produce food

Heterotrophic – organisms that obtains food by consuming other organisms

Unicellular – one cell

Multicellular – many cells

Eukaryote – organism whose cells contain a nucleus

Microscope – an optical instrument having a magnifying lens for inspecting objects too small to be seen or too small to see details by the naked eye

Stage – place where slide is placed for observation

Objective lens – lens closet to the object that first receives rays from the object to form image in the eyepiece

Eyepiece – lens closest to the eye when looking through the device

Magnification – process of enlarging; eyepiece power times the objective lens power

Resolution – minimum and maximum magnification necessary for details of object; shortest distance between two points on a specimen that can still be distinguished by the observer

Lesson summary: What a way to capture the student's attention than to show them living organisms found in a water sample, a water sample that they swim and play in. This lesson is my hook. I hope to pique the student's interest and make them wonder "What is in my Water". Students will examine a water sample under the microscope for the presence of organisms. The water sample will be a representation of what could be found in their backyard lake or pond. Students will draw what they see and write a description.

Student Learning Objectives:

The student will be able to…

1. Track and follow an organism as it moves on the microscope slide
2. Identify the organisms seen in the microscope
3. Understand the functions of the microscope components
4. Describe the distribution of life in an aquatic ecosystem

Standards:
SC.912.L.14.4
SC.912.L.17.2
SC.912.N.1.1

Materials:

- Microscopes
- Microscope slides
- Cover slips
- Disposable pipettes or medicine droppers
- Water sample(s)
- 1 copy of teacher page
- 1 copy of student directions for every student

Background information: A healthy water environment will have a variety of micro-critters as well as macro-invertebrates present. These critters range from microorganisms such as simple bacteria, protists, and daphnia to macro-invertebrates such as snails, crawfish, or dragonflies. This lesson will concentrate on the microorganisms. Bacteria are helpful to the quality of water by limiting algae buildup. Protist organisms are the food source for many aquatic organisms, provide oxygen for oceans and lakes, and may be used as thickener in ice cream, soups, and puddings. Daphnia are also used as a food source for larger organisms like fish. A loss of any of these organisms especially in large quantities would be an indicator that something else is happening. We need to take a closer look at the water.

Advance Preparation:

1. Make copies of student directions
2. Need microscope slides and cover slips.
3. Collect water sample.

Assessment Suggestions:
Student worksheet can be checked for completion

Extensions:
Water samples can be tested for water quality

Teacher page:

Laboratory is student driven. I have some helpful hints that may help you with setup and answering questions as students move through the lab.

Water sample is best collected from slow-moving fresh water supply (ditch, a pond, creek or lake). You can use a water bottle to collect in or baby food jars, just about anything will work. Collect a little bit of the algae seen in the water sample. You can have your students collect the sample from a body of water near their house. My students have found that the horse or cow water supply gave us the best results.

Microscopes (best if each student has their own or at least 2 students share). Use what you have. Students can work in groups of 4 if you only have 6.

Procedure:
Students will need a place to keep the slides and water samples.
Have the students make the slide and take the slide back to their microscope.
The students should not have the water sample next to their microscope.
Slides can be rinsed in the sink and reused or placed on a towel to dry.
You can buy pre-made slides from any supply company (Fisher scientific, Frey scientific, Carolina)
You can buy water cultures with the micro-organisms from these companies also

Students may need help finding organisms in the water. Lots of time the sample is not in focus or they forget to bring the stage up. If they cannot find an organism within a few minutes have them remake the slide.

Student Lab procedures:

Observing Micro-critters in the microscope

Objectives: Track and follow an organism as it moves on the microscope slide
Identify the organisms seen in the microscope
Understand the functions of the microscope components

Introduction: Today, you will be a student scientist using the microscope to look for the presence of a micro-critter in a water sample. The water sample will be a representation of what can be found in your backyard or your neighborhood. Most of these micro-critters are known as protists. Protists may be unicellular or multicellular, autotrophic or heterotrophic, and eukaryotic. They are beneficial as a food source for higher aquatic organisms. We may know be familiar with these as they can be used as thickeners in ice cream. Another organism that may be spotted is the small arthropod, Daphnia. Daphnia are also a food source for aquatic organisms like fish.

Materials: microscope, microscope slide, coverslip, water sample

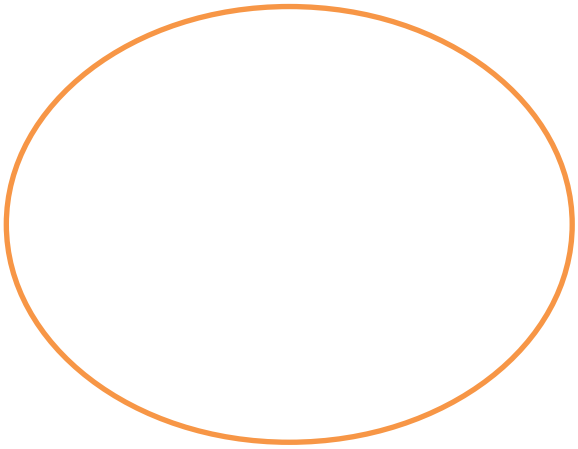
Procedure:

1. Obtain a microscope from the microscope cart, carefully carry it to your station.
2. Plug in the microscope. Place the cord behind the microscope.
3. Make a wet mount slide
    a. Take a clean slide. Wipe off with a paper towel.
    b. Take a pipette or dropper. Squeeze the bulb removing the air. Dip it into the water sample. Release the bulb to draw up some water sample.
    c. Expel 1 to 2 drops of water onto your slide
    d. Gently place the cover slip over the water drop by placing one side of the coverslip onto the slide, lower the coverslip until it is over the water drop.
4. Examine the slide under the microscope.
    a. Always start with the stage of the microscope at the lowest point and the low power objective lens in place.
    b. Place your slide on the stage
    c. Slowly raise the stage until you see debris in the microscope
    d. Use the coarse adjustment knob to bring the debris into focus
    e. Change objective lens to the next (medium) power
5. Look for movement. May need to move your slide around to find something.
6. Draw what you see. Describe the movement of the organism. Write a description of what it looks like. Give the magnification.
7. Repeat step 6 for 3 more micro-critters.

Student name: _____ Date: _____

Data Collection:

Draw what you see. Write a description of what it looks like. Describe the movement of the organism. Give the magnification.



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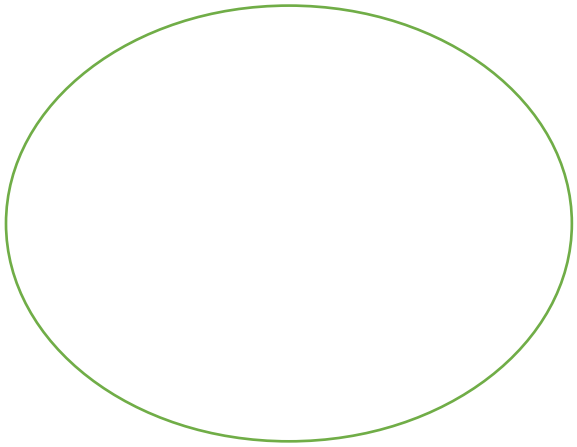

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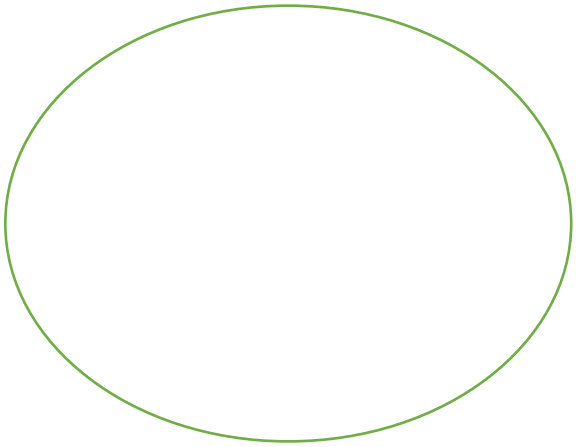

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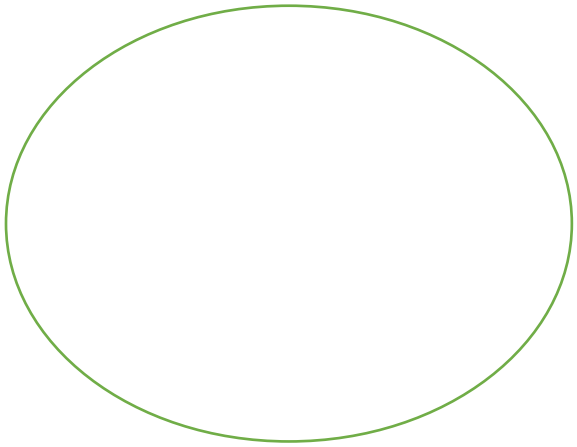

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LESSON TWO: ID THE MICRO-CRITTERS

Lesson 2: Id the Micro-critters from the water

Essential Questions:

What are the organisms found under the microscope?
What is the general distribution of life in an aquatic ecosystem?

Learning styles: visual and auditory

Vocabulary:
Autotrophic – organism that is able to capture energy from sunlight and use it to produce food

Heterotrophic – organisms that obtains food by consuming other organisms

Unicellular – one cell

Multicellular – many cells

Eukaryote – organism whose cells contain a nucleus

Pseudopod – a false foot used to propel organisms

Cilia – short, hair-like structures that propel organisms

Flagellum – long, whip-like structures that propel organisms

Estimated time frame: 50 minutes

Lesson summary: Students will be given organism cards to read and answer questions about the organisms seen under the microscope. Students should then be able to correctly identify what organisms were seen under the microscope.

Student Learning Objectives:
The student will be able to…
1. Describe the distribution of life in an aquatic ecosystem

Standards:
SC.912.L.17.2
SC.912.N.1.1

Materials:
- 1 copy of teacher page
- 1 copy of student directions for every student

Background information: A healthy water environment will have a variety of micro-critters as well as macro-invertebrates present. From the lab yesterday, this lesson will concentrate on the microorganisms Protist and Daphnia. Protist organisms are the organisms that do not fit anywhere else. The characteristics of protist are either unicellular or multicellular, either autotrophic or heterotrophic, and all are Eukaryote. Protist maybe plantlike also called algae, maybe animal-like also called protozoa or maybe fungus-like. They are classified by how they move and obtain nutrition. Protists are the food source for many aquatic organisms, provide oxygen for oceans and lakes, and may be used as thickener in ice cream, soups, and puddings. Another organism found in our water sample is daphnia. Daphnia are clear, tiny arthropods. Daphnia are also used as a food source for larger organisms like fish. A loss of any of these organisms especially in large quantities would be an indicator that something else is happening.

Advance Preparation:

Make copies

ASSESSMENT SUGGESTIONS:

Student data collection worksheet for lab can be checked to determine if organisms are correctly identified.

References: available in reference list

Teacher page:

Students will be reading about the different organisms that they could have possibly seen in the Micro-critter lab. Students will need to complete the student worksheet for each organism and then compare that to their laboratory results. Students should be able to correctly identify the organisms seen.

Purpose is to make identification cards. Hand the cards out to each student as they walk in the door. Students will find their partner by finding the student that has the same organism.

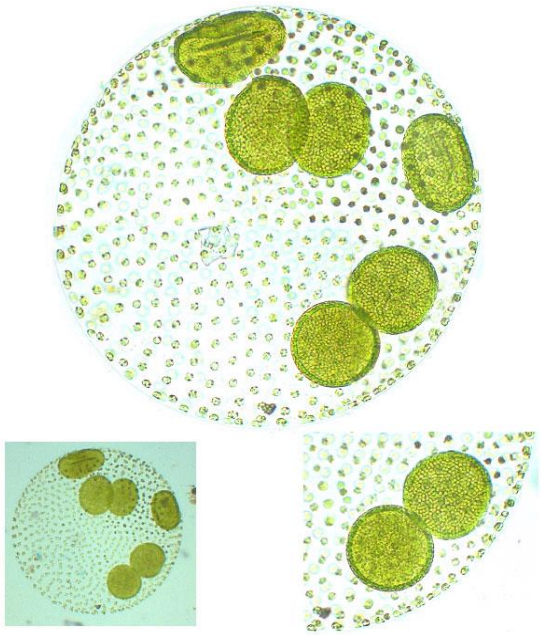
How to make the identification cards:
Cards are meant to be matched image on one side and description on the back. The cards are labeled below. I have the pages listed as identification image 1, 2, or 3, and description 1, 2, or 3. Copies of these cards need to be made as follows: 1 should be copied with 1, 2 with 2, and 3 with 3. Cards may be laminated and reused. You will need to cut out the cards. There are four cards per page. This will give you a set of 12 cards.

How to pass the cards around:
Students can share out their information for the others to fill in their charts
they can change cards with another group of students
Make partners join another partnership to make four students. They can then share.
Students can number themselves 1 or 2. All 1's can form a bigger group and all 2's can form a bigger group. Each person then shares with the group.
Do what works best for your class.

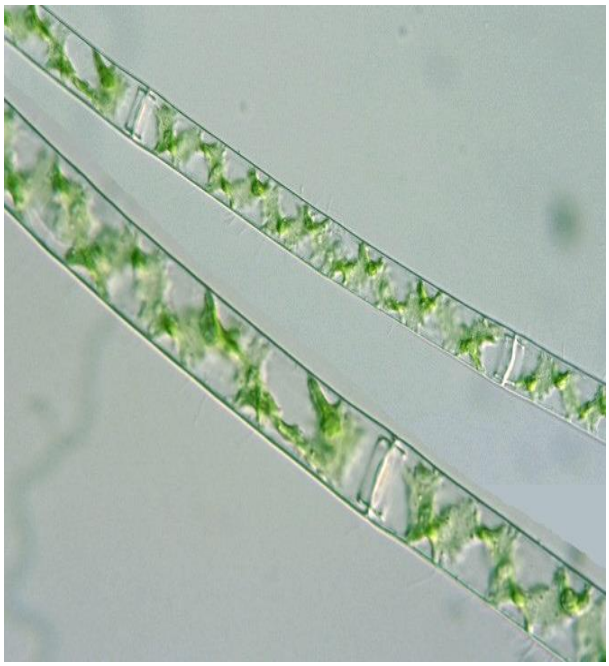
Identification image cards 1

Amoeba

Paramecium



Volvox



Spirogyra

Identification description cards 1

Paramecium	Amoeba
Kingdom Protist Phylum Ciliophora 100-350um long Elongated ciliated bodies Move by cilia Feeds on bacteria, yeasts, algae, protozoa Could eat 5000 bacteria a day	Kingdom Protist Phylum Sacrodina 500-100um long Changes shape Extends and retracts pseudopods to move Looks like a blob Feeds on algae, bacteria, protozoa
Spirogyra	**Volvox**
Kingdom Protist Phylum Chlorophyta 10-100um Long thread-like structure Move by rolling and stretching towards sunlight, contains cilia Autotrophic Named for the spiral shape of the chloroplast	Kingdom Protist Phylum Chlorophyta 100-6000 um Round shape Move by rotating cilia Autotrophic Green color

Identification image cards 2

Cyclops

Hydra

Rotifer

Vorticella

Identification description cards 2

Hydra	Cyclops
Kingdom Animalia Phylum Cnidaria 5mm long Thin, translucent tube with tentacles Spend most of time attached in one place but may somersault its body Feed on Daphnia and Cyclops Belong to same phylum as jellyfish	Kingdom Animalia Phylum Arthropoda 2-3mm long Black or red eye, 5 legs, divided tail Swims freely Feed on algae Related to lobsters and shrimp
Vorticella	**Rotifer**
Kingdom Protist Phylum Ciliophora 1mm stalk, 150um bell Bell shape attached to a stalk Attached in one spot with the bell waving around Feed on bacteria and small protozoa	Kingdom Animalia Phylum Rotifera 100-500um long Cylindrical-like shape with ciliated tufts around the mouth Swim freely Feed on algae, bacteria, protozoa

Identification image cards 3

Daphnia

Chlamydomonas

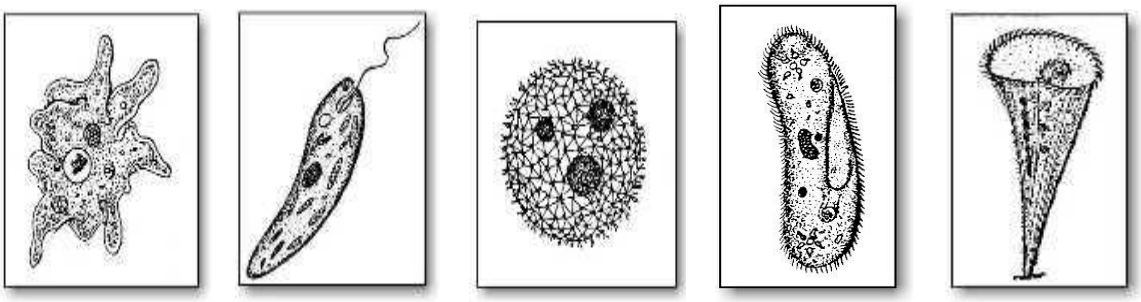
Euglena

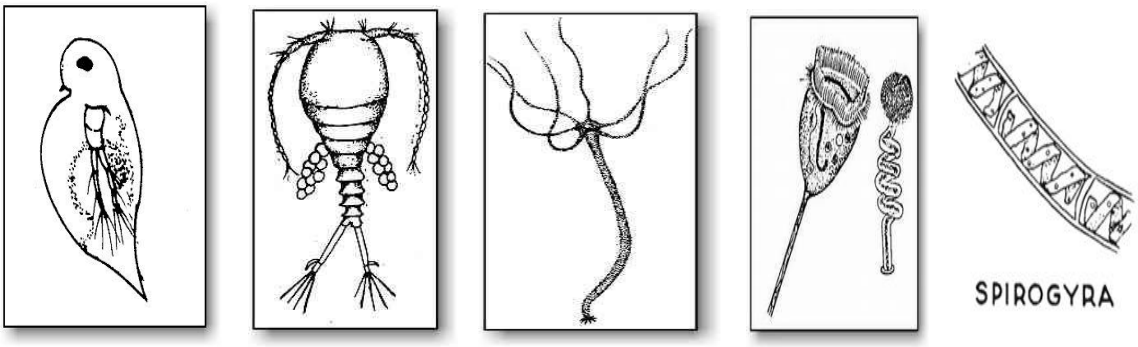
Stentor

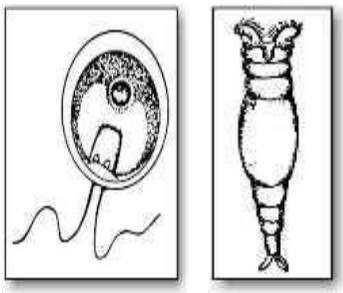
Identification description cards 3

Chlamydomonas	Daphnia
Kingdom Protist Phylum Mastigophora 10-30um Round ball shape with two flagellum Move by flagellum Autotrophic	Kingdom Animalia Phylum Arthropoda 1-5mm Clear bodies, oval shape with antennae on head Move by swimming in a hopping motion Feed on algae
Stentor	**Euglena**
Kingdom Protist Phylum Ciliophora 500-2000um long Horn-like shape Contract into a ball or swim freely by cilia Feeds on bacteria or algae Blue to blue-green ciliates	Kingdom Protist Phylum Mastigophora 35-55um long Oval shaped with long flagellum; red eye spot Move by flagellum Feed on green algae, amoebas, parameciums, and rotifiers

Black and white images if you need better copies







Student worksheet

Student Name: _____ Date: _____

Directions: Partner up with another student that contains the same organism as you. Read and discuss your organism. Complete the chart below. Change cards with another group. Use this information to identify organisms from yesterday's lab

Organism name	Size	Shape	Movement	Feed

Teacher Master worksheet

Student Name: _____ Date: _____

Directions: Partner up with another student that contains the same organism as you. Read and discuss your organism. Complete the chart below. Use this information to identify organisms from yesterday's lab

Organism name	Size	Shape	Movement	Feed
Stentor	500-2000um	Horn-like	Cilia	Bacteria or algae
Euglena	35-55um	Oval shape with long flagellum	Flagellum	Green algae, amoebas, parameciums,
Daphnia	1-5mm	Clear bodies with antennae on head	Swimming in a hopping motion	Algae
Chlamydomonas	10-30um	Round ball shape with 2 flagellum	Flagellum	autrotrophic
Rotifer	100-500um	Cylindrical-like shape with ciliated tufts	Cilia	Algae, bacteria, protozoa
Vorticella	1mm stalk, 150um bell	Bell shape attached to a stalk	Attached	Bacteria, small protozoa
Cyclops	2-3mm	Black or red eye, 5 legs, divided tail	Swim freely	Algae
Hydra	5mm	Thin, translucent tube with tentacles	somersault	Daphnia and cyclops
Spirogyra	10-100um	Long, thread-like structure	Rolls and stretches, cilia	Autotrophic
Volvox	100-6000um	round	Rotating cilia	autrotrophic
Paramecium	100-350um	Elongate ciliated body	Cilia	Bacteria, yeasts, algae, protozoa
Amoeba	500-1000um	Changes shape	Extends and retracts pseudopods	Algae, bacteria, protozoa

LESSON THREE: INTRODUCTION TO ENVIRONMENTAL TOXINS

Lesson 3
Title: Environmental Toxins – Jigsaw reading

Essential Questions: What are Environmental Toxins?
How do Environmental Toxins enter the environment?
How do we contribute to these toxins entering the environment?

Learning Styles: Visual and Auditory

Estimated Time Frame: 50 minutes

Vocabulary:
Environment – The sum of all external conditions affecting the life, development, and survival of an organism

Toxins – A poisonous or harmful nonbiological substance, such as a pollutant

Pollutant – a waste material that contaminates the soil, air, or water

Ecosystem – all the biotic parts interacting with the abiotic parts of an environment

Surfactants – surface-active substances used in cleaning applications; soften the water, so it can wet the fibers and surfaces, loosen and encapsulates the dirt and prevents re-deposition of dirt on the surface

Ecotoxicology – study how toxicants affect the environment and organisms within the environment

Fertilizers – a substance added to soil to help with the growth of plants

Pesticides – substance used to attract, seduce, and destroy any pest

Lesson summary: – A jigsaw reading will be given to the students on Environmental Toxins. The environmental toxins will be fertilizers, pesticides, surfactants, and motor oil that are found in every household. Students will work in groups to read, discuss, evaluate, and categorize the toxins readings.

Student Learning Objectives:
Students should be able to …

1) Predict the impact of environmental toxins on an environment
2) Discuss the large-scale environmental impact from human activity
3) Describe the positive and negative consequences of human activity to an ecosystem's biodiversity.

Standards:

SC.912.L.17.20
SC.912.L.17.11
SC.912.L.17.16
SC.912.L.17.8

Materials:

- Copy of Environmental Toxins readings pages 1 to 4
- Section name cards

- Clips for readings
- Copy of student worksheet, 1 per student

Background information:

Environmental toxins are toxicants from everyday use and how it affects the environment and the organisms within the environment. This study is called ecotoxicology. Humans impact the environment by the use of environmental toxins. Environmental toxins include fertilizers, surfactants, heavy metals, sediment, pesticides, and chlorine. Runoff from yards, oil from cars on the road, detergents from cleansers, and pesticides sprayed on crops are being washed away into waterways. Huge amounts of phosphorus and nitrogen are being channeled into our waterways from farms and industry. Construction site sediment leeches into the water. Sewage treatment plants dump potable water into waterways. The waterways become polluted. This pollution could lead to disruption of ecosystems, which can be damaging to the plant and animal life depending on the water source for survival. An ecosystem can be impacted by a slight change in the community.
Environmental Toxins do not recognize political or national boundaries.

Advance Preparation:

1. Make copies of student worksheets for each student
2. Make section cards: *Teacher Pages: Section Name Cards*, laminate if desired, and cut into individual cards.

Assessment Suggestions:
Check student discussion questions for completion

Teacher Directions:
Jigsaw readings

1) Have students assemble into groups of 4. This is their home group, so encourage them to remember the members of their home group. For a class with extra students, have them join to make groups of 5 rather than have a group without a member which would put extra burden on the smaller group to read more.

2) Once settled, give each member a card with one of the following section names: Fertilizers, Pesticides, Surfactants, or Motor Oil. *See Teacher Pages: Section Name Cards.*

3) Ask students to regroup according to their section name, forming four large groups.

4) Distribute information packets to each section.

5) Distribute *Student Worksheet* to each student.

6) Have students remove and equally distribute the information slips from the envelope or clip, read their slip(s), and share with the other members of their section. Encourage students to answer questions 1-4 on their toxin to share back in their home group. Move around the groups to ensure understanding.

7) Ask students to put their information slips back in the envelope or clip. Have one member return the envelope to the front of the room while the groups redistribute back to their home group.

8) Once back in their home groups, the students should each take a turn sharing what they learned about Environmental Toxins in their section group. Again, move around the groups to ensure understanding. They can use the *Student Worksheet* (discussion questions) to guide their discussion.

Student worksheet (Discussion Questions) answers may vary

Section Name Cards
Copy and cut. Distribute one card per student. (Laminate for repeated use)

FERTILIZER	FERTILIZER
FERTILIZER	FERTILIZER
FERTILIZER	FERTILIZER
FERTILIZER	FERTILIZER

PESTICIDE	PESTICIDE
PESTICIDE	PESTICIDE
PESTICIDE	PESTICIDE
PESTICIDE	PESTICIDE

SURFACTANT	SURFACTANT
SURFACTANT	SURFACTANT
SURFACTANT	SURFACTANT
SURFACTANT	SURFACTANT

MOTOR OIL	MOTOR OIL
MOTOR OIL	MOTOR OIL
MOTOR OIL	MOTOR OIL
MOTOR OIL	MOTOR OIL

Environmental Toxin Reading 1

Fertilizer:
Plants are autotrophic, living organisms that need essential nutrients to help them grow and thrive. Fertilizers supply the nutrients needed by the plant to help them build amino acids, make cell membranes, and help with metabolism. The main components in fertilizers are Nitrogen, Phosphorus, and Potassium. Usually the plant is able to obtain these elements from dead, decaying plants. When that is not available, then the plants need help. Fertilizers help.

Nitrogen is the main component in most fertilizers. Nitrogen makes up 78% of the Earth's atmosphere. Our bodies need nitrogen for building proteins and it is a component of our DNA.
What happens when too much nitrogen is used? Extensive use of fertilizers increases the nitrogen concentration in water. This can lead to changes in a species composition. An example of nitrogen overuse is algal blooms. One type of fertilizer is Scott's Liquid Turf Builder. This can be applied to lawns to help grass grow. Statistics are listed below for

Scott's Liquid Turf Builder:
Lawn food 29-0-3

Total Nitrogen 29%
Soluble Potash 3%
Derived from Triazone, Urea, Potassium Chloride

Acute toxicity
Product/ingredient name Result Species Dose Exposure
LD50 Oral Rat > 5,000 mg/kg
LC50 Inhalation Rat > 5 mg/l 4 h
LD50 Dermal Rat > 5,000 mg/kg -
Conclusion/Summary : No known significant effects or critical hazards.

Information from scotts.com/smg/goprod/scotts-liquid-turf-builder/prod100024

Environmental Toxin Reading 2

Pesticide:
An annoying, troublesome, invasive, noxious, destructive living organism is called a pest. Pests can destroy buildings, feast on crops, or infect humans. Pesticides are used to control or eliminate the pests. How do Pesticides work? By biologically, chemically, or physically disrupting the organism's metabolism or behavior is one way they work. Some pesticides kill the annoying organisms, while others repel the pests. Some pesticides inhibit the reproductive ability of the pest. It all depends on the pesticide and what you need it to do.

Cyfluthrin is a main ingredient in some pesticides. It is a synthetic chemical used to control chewing and sucking insects. The insect takes the poison either by contact or by eating. The poison attacks the nervous system resulting in swift debilitation. The insects stop feeding and usually die of starvation. Most applications of Cyfluthrin are by spraying where you need the pesticide. It is hydrophobic and does not penetrate into plant tissues. This pesticide can be used around your house for a protection against pest. Statistics for this is listed below.

Bayer Advanced – Carpenter Ant & Termite Killer Plus

Acute oral toxicity	Male rat: LD50: 3,084mg/kg Female rat LD50: 1,733mg/kg
Acute Dermal Toxicity	Male/Female rat: LD50: > 2,000 mg/kg
Acute Inhalation Toxicity	Male/Female rat: LC50: 4hr exposure to dust > 1.18mg/l Male/Female rat: 1 hour exposure to dust from 4hr lc50 > 4.72mg/l

Environmental Hazards
This product is highly toxic to fish and aquatic invertebrates. This product is highly toxic to bees. Do not apply when bees are active. To protect the environment, do not allow pesticide to enter or run off into storm drains, drainage ditches, gutters or surface waters. Applying this product in calm weather when rain is not predicted for the next 24 hours will help to ensure that wind or rain does not blow or wash pesticide off the treatment area. Rinsing application equipment over the treated area will help avoid run off to water bodies or drainage systems.
Kills: termites, ants, carpenter ants, spiders, ticks, fleas, and stink bugs

Active ingredient:
<Cyfluthrin . . . . . 2.5% OTHER INGREDIENTS . . . . . 97.5% TOTAL
100.0%
EPA Reg. No. 72155-58 EPA Est. No. indicated by 3rd and 4th digits of the batch number on this package. (65) = 432-TX-1 (39) = 58996-MO-1 (68) = 67572 - GA-1 (57) = 071106-GA-003 ß-cyfluthrin is the chemical name for Tempo® Ultra.

Information from: cdpr.ca.gov/docs/emon/pubs/fatememo/cyflthrn.pdf and Bayeradvanced.com
Environmental Toxin Reading 3

Surfactants:
Surfactants are surface-active substances used in cleaning applications. They soften the water, so it can wet the fibers and surfaces, loosen and encapsulates the dirt and prevents re-deposition of dirt on the surface. Surfactants are used every day when we wash our hands, clean the dishes, wash our hair or wash clothes. It works by getting under the dirt and grime allowing water to carry the dirt and grime away. Another use of surfactants is lubrication as with shaving cream. Shaving cream allows you to run your razor next to your skin to remove unwanted hair. Surfactants are also found in fabric softeners, anti-fogging liquids, and sanitizing products.

Dawn dish soap is a surfactant. Some of the ingredients that are found in Dawn dish soap include methylisothiazolinone and sodium laureth sulfate. Methylisothiazolinone is used to control microbial growth. Sodium Laureth sulfate makes the soap foam. Most households use it to wash dishes. Other uses of Dawn dish soap take us into nature. More than 75,000 wild animals have been saved after an oil spill thanks to Dawn dish soap. The makers of Dawn want to educate and inspire others to do their share. The statistics of Dawn are listed below.

Toxicological Information Components	Test Results
ETHANOL (64-17-5)	Acute Inhalation LC50 Mouse: 0.039 mg/l 4 Hours Acute Inhalation LC50 Rat: 20000 mg/l 10 Hours Acute Oral LD50 Dog: 5.5 g/kg Acute Oral LD50 Guinea pig: 5.6 g/kg Acute Oral LD50 Mouse: 3450 mg/kg Acute Oral LD50 Rat: 7060 mg/kg Acute Oral LD50 Rat: 6.2 g/kg Acute Other LD50 Mouse: 933 mg/kg Acute Other LD50 Rat: 1440 mg/kg
ALCOHOL ETHOXYSULFATE, SALT (68585-34-2)	Acute Oral Rat: 1.85 g/kg
ALCOHOL SULFATES, SODIUM SALT (68585-47-7)	Acute Oral LD50 Rat: >= 2000 mg/kg
AMINES	Acute Oral LD50 Rat: 1330 mg/kg

Msds information obtained from
http://www.pg.com/productsafety/msds/professional_line/professional_line/Dawn_Professional_Dish_Detergent.pdf

Environmental Toxin Reading 4

Motor Oil:
Have you ever pulled out of the yard and seen black fluid on the driveway? Motor oil has leaked from the car. Motor oil acts as a lubricant for engine. Engines have moving parts and some of these components need to keep moving. Oil helps to reduce the friction between the moving parts. Motor oil is mostly a refined crude oil called base oil. This process removes wax, Sulphur, and nitrogen and extracts unsaturated hydrocarbons to keep it stable. Other components are detergents, rust inhibitors, corrosion inhibitors, and antioxidants. Each of these components help motor oil maintain its smooth flow. The statistics listed below.

PRODUCT: PENNZOIL™ Multi-Grade Motor Oil - All Grades
MSDS NUMBER: 612978LU – 3

INGREDIENTS	CAS#	CONCENTRATION
Multigrade Motor Oil	Mixture	90 - 99 %weight
Highly refined petroleum oils		
Proprietary additives (<1% zinc)	Mixture	1 - 3 %weight

Acute Toxicity

TEST	Result	OSHA	Material Tested Classification
Dermal	LD50 >5.0 g/kg(Rabbit)	Non-Toxic	Based on components(s)
Oral	LD50 >5.0 g/kg(Rat)	Non-Toxic	Based on components(s)

Ecological INFORMATION
Environmental Impact Summary: There is no ecological data available for this product. However, this product is an oil. It is persistent and does not readily biodegrade. However, it does not bioaccumulate.

http://ehsrms.uaa.alaska.edu/CMS/Laboratory/MSDS/MSDS%20by%20Vendor/Pennzoil%20Co/Motor%20Oil%20Multigrade.pdf

Environmental Toxin Readings Discussion Questions

Student name: _____ Date: _____
Home group members: _____

Directions: Use the guiding questions 1-5 below as you share information about your environmental toxin in your home group. Answer as thoroughly as possible. Include illustrations as needed.

1) Summarize your Toxin.

2) Predict the impact of your environmental toxins on an environment

3) Describe the positive and negative consequences of your toxin

4) Discuss the large-scale environmental impact from using these toxins resulting from human activity

Directions: Now that you have a shared understanding of your Environmental toxins, answer the questions below 5-8 with your home group.

5) Rank the toxins in your group from lowest risk to highest risk.

6) What is an environmental toxin?

7) What does LC50 and LD50 mean?

8) Graph your groups LC50 an LD50.

LESSON FOUR: ENVIRONMENTAL TOXINS LAB EXPERIMENT

Lesson 4
Title: Environmental Toxins lab experiment

Helpful Hint: Need to order Daphnia or maintain your own culture in the classroom before doing this experiment. You will need 30 Daphnia for each toxin.

Essential Questions: What are Environmental Toxins?
How do Environmental Toxins enter the environment?
How do we contribute to these toxins entering the environment?

Learning Styles: Visual and Kinesthetic Auditory

Estimated Time Frame: 100 minutes, 2 class periods

Vocabulary:
Environment – The sum of all external conditions affecting the life, development, and survival of an organism

Toxins – A poisonous or harmful non-biological substance, such as a pollutant

Pollutant – a waste material that contaminates the soil, air, or water

Ecosystem – all the biotic parts interacting with the abiotic parts of an environment

Surfactants – surface-active substances used in cleaning applications; soften the water, so it can wet the fibers and surfaces, loosen and encapsulates the dirt and prevents re-deposition of dirt on the surface

Ecotoxicology – study how toxicants affect the environment and organisms within the environment

Fertilizers – a substance added to soil to help with the growth of plants

Pesticides – substance used to attract, seduce, and destroy any pest

Daphnia – tiny, transparent crustaceans referred to as water flea

Lesson summary: – students will choose one of the toxins from the day before for an experiment. Students will perform an assay with different concentrations of the toxin to determine the toxicity of the toxin. Students will be using Daphnia as a bio-indicator with their toxin. Assay will run for 24 hours. Will look for surviving daphnia to determine how toxic is their toxin.

Students will read and complete a graphic organizer about bio-indicators.

Student Learning Objectives:
Students should be able to …

1) Predict the impact of environmental toxins on an environment
2) Discuss the large-scale environmental impact from human activity

3) Describe the positive and negative consequences of human activity to an ecosystem's biodiversity.
4) Develop, design, and incorporate an experiment using the scientific method
5) Analyze data

Standards:
SC.912.L.17.20
SC.912.L.17.11
SC.912.L.17.16
SC.912.L.17.8
SC.912.N.1.1

Materials:

- 1 Copy of Daphnia Quick Care Guide
- Daphnia – 30 for each toxin (180 per class)
- Glass jar, small aquarium, plastic/Nalgene jug, or stainless steel bucket to house / culture the daphnia
- 6 Toxins – Dawn dish soap, motor oil, pesticide, fertilizer, shampoo, coolant
- 6 small beakers or small cups for 6 groups
- Pipettes disposable and mechanical
- Graduated cylinder
- Thermometer
- pH indicator
- Copy of student worksheet
- 6 gallons of distilled water
- Media for daphnia

Background information:

Environmental toxins are toxicants from everyday use and how it affects the environment and the organisms within the environment. This study is called ecotoxicology. Humans impact the environment by the use of environmental toxins. Environmental toxins include fertilizers, surfactants, heavy metals, sediment, pesticides, and chlorine. Runoff from yards, oil from cars on the road, detergents from cleansers, and pesticides sprayed on crops are being washed away into waterways. Huge amounts of phosphorus and nitrogen are being channeled into our waterways from farms and industry. Construction site sediment leeches into the water. Sewage treatment plants dump potable water into waterways. The waterways become polluted. This pollution could lead to disruption of ecosystems, which can be damaging to the plant and animal life depending on the water source for survival. An ecosystem can be impacted by a slight change in the community.
Environmental Toxins do not recognize political or national boundaries.

Extensions:
Give students an unknown toxin and have them experiment to determine identity of toxin

Teacher Directions:
Daphnia Quick Care Guide
Everything you need to know to keep daphnia!
Written by Danielle Ivey
Dr. Vulpe's Lab
Center for Environmental and Human Toxicology
University of Florida
Gainesville, Florida

Daphnia are tiny, transparent crustaceans, (arthropods), also called water fleas. These organisms live in slow-moving fresh water sources. Daphnia feed on mostly algae, but also bacteria, and other protozoans that live in the water sources. Sometimes the algae can be seen as green in their digestive tracks. These guys are easy to care for and can be cultured for use in the study of toxins that enter the waterway. In a healthy environment, daphnia can reproduce every 24 hours. All members in a culture will be female. These babies are easily seen in the brood pouch before they are released. These characteristics make daphnia a great tool to study in the classroom.

Containers:

- Glass Jar
- Small Aquarium
- Plastic / Nalgene Jug (be careful of Leachates)
- Stainless Steel Bucket

Light

- 12-16 hours of light and 8-12 hours of dark
- Classroom light, or natural light next to a window is also okay

Media

- Clean lake water
- Aged tap water: tap water contains chlorine, but aging will allow it to dissipate
- Perrier water
- Old fish tank water
- Distilled water with added minerals: Put lettuce, potato skins or other raw veggie peels in a container of tap water and place in indirect sunlight for a few days to add minerals and dechlorinate

Mineral Salts

- $NaHCO_3$ – Sodium Bicarbonate (baking soda) 96mg/l
- $CaSO_4$ – Calcium Sulfate (gypsum or baking soda) 60mg/l
- $MgSO_4$ – Magnesium Sulfate (Epsom salt) 60mg/l
- KCl – Potassium Chloride 4mg/l
- Unnecessary if using lake or pond water, green water, or if aging water with veggies

Food

- Green algae (main diet): 12 mls per liter of media Monday, Wednesday, and Friday
- Powdered Yeast: a pinch once or twice per week in conjunction with algae
- Broken-up trout chow: a pinch once or twice per week in conjunction with algae
- Invertebrate food is available at fish hobbyist stores
- *Phyto Feast Live* is a good option for live algae food (found in most pet stores)

Care and Crowding

- 15 adults per every 2 liters of media
- Daphnia have a lot of babies so changing their water is crucial
- Remove 30% of their media and replace with fresh once per week or Transfer all adults to new container of fresh media once per week
- Babies can be used to start a new tank or poured down the drain

Temperature

- 64 – 72 degrees Fahrenheit
- 18 – 25 degrees Celsius

Dissolved Oxygen

- Should not aerate with Daphnia in the water. Bubbles get trapped in their carapaces.
- Large water surface to air ratio for good gas exchange find a container with a wide opening
- Can aerate new media prior to addition of the daphnia
- You can tell the daphnia need more DO in their media when they turn a reddish color. Daphnids produce hemoglobin in low oxygen conditions.

Teacher notes:
Advanced preparation:
Daphnia may be purchased from
Carolina Biological Supply Company catalog #142330 $9.50

You may buy feeder Daphnia at some pet stores

Live Algae to feed the Daphnia may also be purchased at pet stores

Students will be doing a serial dilution

1) Label beakers or small cups as follows:
   A (100%), B (50%), C (25%), D (12.5%), E (6.25%), F control
2) Add 25ml of media to each cup, except for F control and A -100%.
3) Add 50ml of media to control. Set control aside
4) Add 50ml of toxin to cup A. Mix well.
5) Take 25ml from cup A and add it to cup B. Mix well.
6) Take 25 ml from cup B and add it to cup C. Mix well.
7) Take 25 ml from cup C and add it to cup D. Mix well
8) Take 25 ml from cup D and add it to cup E. Mix well.
9) Remove 25 ml from cup E and dispose of it according to teacher's direction.
   *Total volume will be 25 mls in each cup. *
10) pH and temperature needs to be taken of each solution.
11) Add 5 daphnia to each cup.

You will need to make media for the students to use in the experiment. They will need 25 mls for each dilution of toxin except for solution A (no media) and 50 mls for control (150 mls per group). It would probably be best (easier) to use a gallon of distilled water with the salts added. See care instructions above

I am using chemicals from around my household
Scott's Turf Builder
Bayer Advanced termite & carpenter ant killer
Dawn Dish soap
Penzoil motor oil
Prestone antifreeze / coolant
laundry detergent

I tried to include two from inside the house, two from outside the house and two from the car.

To determine stock solution of toxin is based on the LD50 amount. You will need to look up the MSDS for your toxin. My toxins are listed below.

Fertilizer: LD50 >5000mg/kg
Pesticide: LD50 >3084mg/kg
Surfactant, Dawn: LD50 > 7060mg/kg
Surfactant, Tide: LD50 > 2000mg/kg
Motor Oil: LD50> 5.0 g/kg
Coolant: LD50 > 4700mg/kg

To make a stock solution Use the following table to determine how much toxin to add to

Table 2. Toxicity Rating Scale and Labeling Requirements for Pesticides.

Category	Signal word required on label	LD50 oral mg/kg(ppm)	LD50 dermal mg/kg(ppm)	Probable oral lethal dose
I highly toxic	DANGER-POISON (skull and crossbones)	less than 50	less than 200	a few drops to a teaspoon
II moderately toxic	WARNING	51 to 500	200 to 2,000	over 1 teaspoon to 1 ounce
III slightly toxic	CAUTION	over 500	over 2,000	over 1 ounce

1 gallon = 3.79 liters
3.79 liters = 3790mls

Tables from:
http://pmep.cce.cornell.edu/profiles/extoxnet/TIB/dose-response.html

I will be adding my toxin to a gallon of distilled water based on table 2 listed above.

Environmental Toxin Exposure experiment

Objective: To determine how toxic household products may be to the environment

Background: Environmental toxins are toxicants from everyday use and how it affects the environment and the organisms within the environment. This study is called ecotoxicology. Humans impact the environment by the use of environmental toxins. Environmental toxins include fertilizers, surfactants, heavy metals, sediment, pesticides, and chlorine. The waterways become polluted. This pollution could lead to disruption of ecosystems, which can be damaging to the plant and animal life depending on the water source for survival. An ecosystem can be impacted by a slight change in the community.

Directions: Daphnia will be exposed to a dilution of toxicants. We will measure the survival rate of the Daphnia.

Materials:

- 6 beakers or small cups
- Choice of toxin
- Pipette disposable and mechanical
- Daphnia (5 for each toxin)
- Media (150 mls)
- Graduated cylinder
- Thermometer
- pH indicator

Divide the work among the members of the group.

1 person will obtain the materials and label the beakers or cups
1 person will measure and pour the media
1 person take pH, temperature and record the information
1 person to collect daphnia

Procedure:

1) Label beakers or small cups as follows:
   A (100%), B (50%), C (25%), D (12.5%), E (6.25%), F control
   Note: cup will be used for rest of directions instead of beakers or cups
2) Add 25ml of media to each cup, except for F control and A -100%.
3) Add 50ml of media to control. Set control aside
4) Add 50ml of toxin to beaker or cup A. Mix well.
5) Take 25ml from cup A and add it to cup B. Mix well.
6) Take 25 ml from cup B and add it to cup C. Mix well.
7) Take 25 ml from cup C and add it to cup D. Mix well
8) Take 25 ml from cup D and add it to cup E. Mix well.
9) Remove 25 ml from cup E and dispose of it according to teacher's direction.
   Total volume will be 25 mls in each cup
10) Measure the temperature of each solution. Record your results
11) Measure the pH of each solution. Record your results.
12) Add 5 daphnia to each beaker or cup using the pipette.

Experiment will run for 24 hours. We will count survival rate of the daphnia.

Data collection:

	pH before	Temp before	Survival/dead	pH after	Temp after

Toxin name: _____

Hypothesis: _____

Conclusion: _____

Lab Questions:

1) What is an environmental toxin?

2) What are Daphnia?

3) Describe the purpose of a control.

4) Why are Daphnia considered a bio-indicator for the environment?

5) Was your toxin harmful to the environment? Why or why not?

6) Compare your results to the other toxins and other periods. Let's graph the data

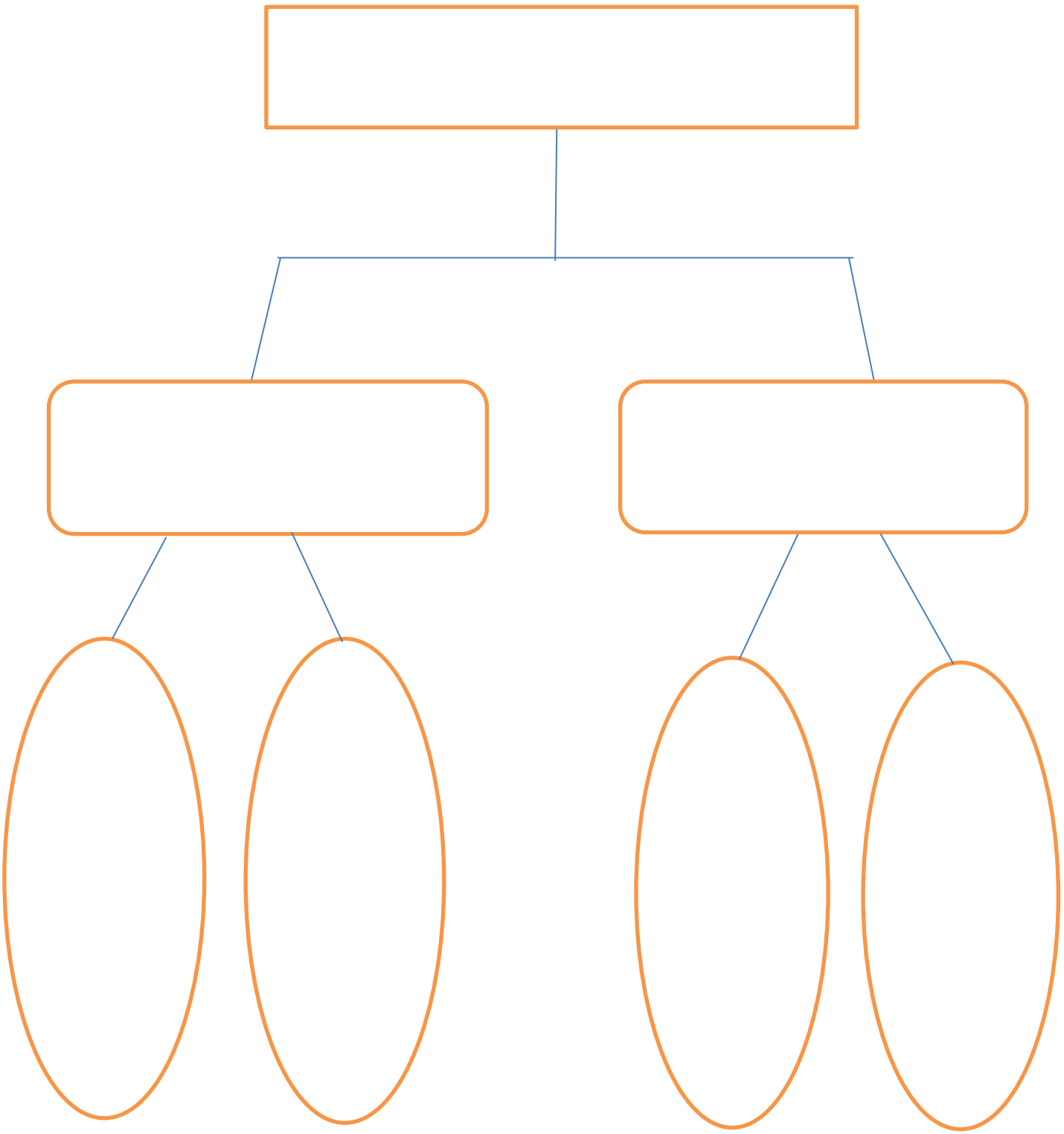
Bioindicators Reading

The following website contains an article on bioindicators. Pull up reading on Overhead and read to class out loud. Have students complete the graphic organizer on the article.

www.sciencelearn.org.nz/contexts/Enviro-imprints/scienceideas-concepts/bioindicators. Jan 8, 2009

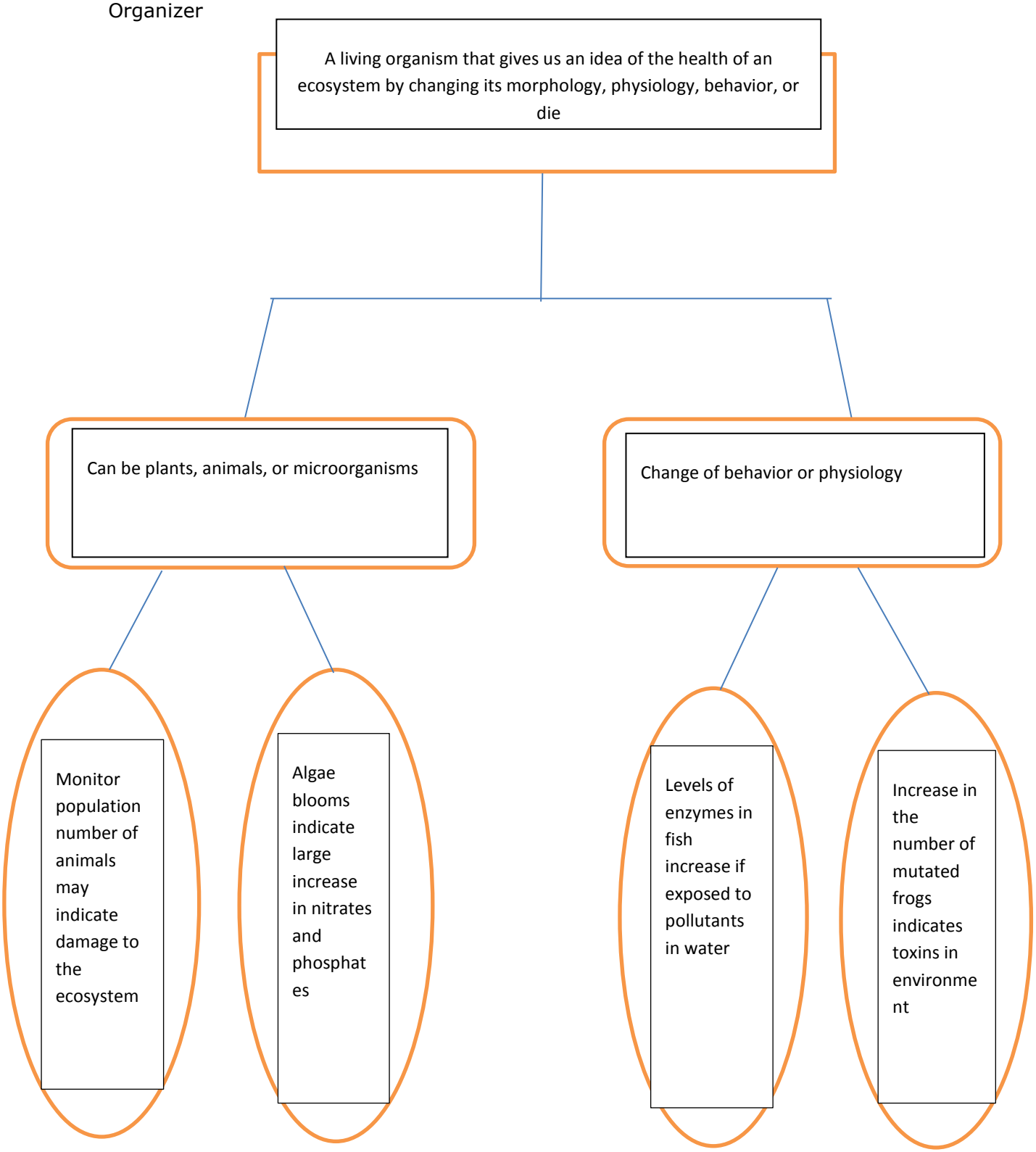
Student Name: _____ Date: _____

Bio-indicators Graphic Organizer



Student Name: _____ Date: _____

Bio-indicators Graphic Organizer



LESSON FIVE: ENVIRONMENTAL TOXIN POSTER

Lesson 5
Title: Environmental Toxins Poster

Essential Questions: What is the impact of Environmental Toxins on the environment?
What are positive and negative consequences of Environmental Toxins to the environment?

Learning Styles: Visual, Kinesthetic, Auditory

Estimated Time Frame: 50 minutes

Vocabulary:
Environment – The sum of all external conditions affecting the life, development, and survival of an organism

Toxins – A poisonous or harmful nonbiological substance, such as a pollutant

Pollutant – a waste material that contaminates the soil, air, or water

Ecosystem – all the biotic parts interacting with the abiotic parts of an environment

Surfactants – surface-active substances used in cleaning applications; soften the water, so it can wet the fibers and surfaces, loosen and encapsulates the dirt and prevents re-deposition of dirt on the surface

Ecotoxicology – study how toxicants affect the environment and organisms within the environment

Fertilizers – a substance added to soil to help with the growth of plants

Pesticides – substance used to attract, seduce, and destroy any pest

Daphnia – tiny, transparent crustaceans referred to as water flea

Lesson summary: – students will create a Brochure/poster to show dangers of Environmental Toxins and why we should be concerned about our impact to the Environment.

Student Learning Objectives:
Students should be able to …

6) Predict the impact of environmental toxins on an environment
7) Discuss the large-scale environmental impact from human activity
8) Describe the positive and negative consequences of human activity to an ecosystem's biodiversity.

Standards:

SC.912.L.17.20
SC.912.L.17.11
SC.912.L.17.16
SC.912.L.17.8

Materials:

- Copy of student worksheet
- Copy of Rubric
- Copy paper or construction paper
- Crayons, colored pencils, or markers

Background information:

Environmental toxins are toxicants from everyday use and how it affects the environment and the organisms within the environment. This study is called ecotoxicology. Humans impact the environment by the use of environmental toxins. Environmental toxins include fertilizers, surfactants, heavy metals, sediment, pesticides, and chlorine. Runoff from yards, oil from cars on the road, detergents from cleansers, and pesticides sprayed on crops are being washed away into waterways. Huge amounts of phosphorus and nitrogen are being channeled into our waterways from farms and industry. Construction site sediment leeches into the water. Sewage treatment plants dump potable water into waterways. The waterways become polluted. This pollution could lead to disruption of ecosystems, which can be damaging to the plant and animal life depending on the water source for survival. An ecosystem can be impacted by a slight change in the community.
Environmental Toxins do not recognize political or national boundaries.

Advance Preparation:

- Make copies of student directions, 1 per student or a class set to reuse each period
- Copies of rubric for each student

Assessment Suggestions:
Grade poster based on rubric provided

Teacher Directions:
Students will create a poster exposing the dangers of an Environmental Toxin to Daphnia and how this should be a concern of us

Monitor student's as they work. Make sure that they are not copying another student's work.

Environmental Toxin Poster

Objective: to create a poster exposing the dangers of an Environmental Toxin to Daphnia and how this should be a concern of us

Background: Environmental toxins are toxicants from everyday use and how it affects the environment and the organisms within the environment. This study is called ecotoxicology. Humans impact the environment by the use of environmental toxins. Environmental toxins include fertilizers, surfactants, heavy metals, sediment, pesticides, and chlorine. The waterways become polluted. This pollution could lead to disruption of ecosystems, which can be damaging to the plant and animal life depending on the water source for survival. An ecosystem can be impacted by a slight change in the community

Directions:

Create a poster that indicates the negative consequences of toxins to the environment.
Address these questions in the poster

1) What is your toxin?
2) How harmful your toxin is?
3) Why should we be concerned about Daphnia's exposure to your toxin?
4) Is there a way to reduce our impact to the environment? How? Why?

Have a slogan or saying to reduce the impact.
Include pictures.
Needs to have color
Be prepared to present
Keep it neat.
Have Fun and Be creative.

Posters will be graded based on the rubric guidelines.

Criteria	1 (10 points)	2 (15points)	3 (20 points)	4 (25 points)
Content and Participation	Majority of content is missing, incomplete, or inaccurate < 50% activities completed	Content shows basic understanding 50% of activities completed	Content is mostly accurate and shows a basic understanding of key ideas 75% of activities completed	Content is accurate, thorough. Gives appropriate explanation and examples All activities completed
Organization	Clutter, no definitive sections Not all sections present	Hard to follow Missing parts	All present but unclear Must reread for clarity Some evidence of refinement	Defined sections and headings Easy to read Finished product
Creativity	Bland No use of color Boring to look at and read Interest, motivation, effort, and time absent	Very little use of color holds attention Shows little evidence of originality	Some use of color and diagrams Catches attention and engages people Shows originality	Interesting and engaging Appealing use of color, diagrams and text Clear ownership of idea Information is visually engaging
Presentation	1 minute or less.	Less than 3 minutes.	3 to 4 minutes. Thoughts clear, easy to understand	4 to 5 minutes. Very creative presentation.

ENVIRONMENTAL TOXIN POSTER RUBRIC

References:

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Pollution Sources. 2016. www.sjrwmd.com/waterbodies/pollutionsources.html

The Pompe Predicament. Julie Bokor. Center for Precollegiate Education and Training. University of Florida. Gainesville, Florida.

Pond Water Critters That You Can See With A Microscope: Protozoans and Small Animals. 2016. www.microscope-microscope.org/applications/pond-critters/pond-critters.htm

Protist Lab Exercise. 2016. Stuyvesant High School.stuy.enschool.org/pdf/bio-lab/first_semester//Lab4

http://disc.gsfc.nasa.gov

Scotts Liquid Turf Builder. 2016. www.scotts.com/smg/goprod/scotts-liquid-turf-builder/prod100024

CONTENT AREA EXPERT EVALUATION

Thank you for reviewing *What Is In The Water* curriculum. Please review the entire curriculum and then complete the questions below. You are welcome to insert comments directly in the manual as well as in the section provided below. Comments and suggestions are greatly appreciated!

Reviewer name: _____

Date reviewed: _____ Email: _____

Employer: _____ Department/Division: _____

Job title: _____

Part I: For each item below, please indicate your response to each question as it relates to the curriculum **overall** by circling Yes (Y), No (N), or Undecided (U).

Is the science content in the curriculum accurate?	Y	N	U
Is the science content in the curriculum current?	Y	N	U
Is the science content in the curriculum important for science literacy?	Y	N	U
Is the content in the curriculum related to major biological concepts? (e.g., molecular genetics)	Y	N	U
Is the content coverage in the curriculum thorough and complete?	Y	N	U
Are potential misconceptions adequately addressed?	Y	N	U
Is the content in the curriculum properly sequenced for a novice?	Y	N	U
Are there additional concepts that should be included? (If yes, please elaborate below.)	Y	N	U

Part II: Please include below any comments or suggestions about the curriculum.

1. GENERAL COMMENTS ABOUT THE OVERALL CURRICULUM _____

2. COMMENTS REGARDING INDIVIDUAL LESSONS

Lesson 1: Micro-critters Lab	
Lesson 2: ID Micro-critters	
Lesson 3:	

Introduction to Environmental Toxins	
Lesson 4: Environmental Toxins Lab	
Lesson 5: Environmental Toxins Poster	

TEACHER FEEDBACK FORM

Thank you for reviewing *What Is In The Water* curriculum. Please review the entire curriculum and then complete the questions below. You are welcome to insert comments directly in the manual as well as in the section provided below. Comments and suggestions are greatly appreciated!

Teacher name: _____

Subjects taught: _____ Grade levels taught: _____

School: _____ Email: _____

Part I: Evaluation of the entire curriculum

Section A: For each item below, please indicate your response to each question as it relates to the curriculum **overall** by marking Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D), or Strongly Disagree (SD).

	SA	A	U	D	SD
1. Are the experimental procedures appropriate for your students?					
2. Are the topics addressed important for your course objectives?					
3. Are the topics addressed relevant to your students' lives?					
4. Are the topics addressed interesting to your students?					
5. Is the depth of coverage of topics appropriate?					
6. Is the overall quality of the curriculum satisfactory?					
7. Is the content in the curriculum properly sequenced?					
8. Is the content in the curriculum adaptable for a range of student ability levels?					

Section B: Please provide additional comments pertaining to the laboratory manual **overall**.

1. Are there any topics/sections that should be added to/deleted from the curriculum? If so, please explain. _____

_____

_____

_____

2. Additional comments _____

_____

_____

_____

Part II: Evaluation of individual lessons - Section A: For each question below, please indicate your response for each **specific lesson** by marking High, Moderate, Low, or Not Applicable (NA).

	Lesson 1:				**Lesson 2:**				**Lesson 3:**				**Lesson 4:**			
	High	Mod-erate	Low	NA	High	Mod-erate	Low	NA	High	Mod-erate	Low	NA	High	Mod-erate	Low	NA
1. Is the amount of teacher background information sufficient?																
2. Do the time estimates seem reasonable?																
3. Is the amount of advance preparation reasonable?																
4. Is the procedure clearly stated?																
5. Is the suggested assessment sufficient?																

	Lesson 5:															
	High	Mod-erate	Low	NA												
1. Is the amount of teacher background information sufficient?																
2. Do the time estimates seem reasonable?																
3. Is the amount of advance preparation reasonable?																
4. Is the procedure clearly stated?																
5. Is the suggested assessment sufficient?																

Section B: Please provide additional comments pertaining to each specific lesson.

Lesson	Are there any topics, sections, or resources that should be added or deleted? If so, please explain.	Additional comments
Lesson 1:		
Lesson 2:		
Lesson 3:		
Lesson 4:		
Lesson 5:		

STUDENT FEEDBACK FORM

Student name: _____ Date: _____ Student grade level: _____ Circle one: Male Female

School name: _____ Teacher's name: _____ Subject: _____

Section A: Evaluation of individual lessons- For each question below, please indicate your response for each **specific lesson** by marking High, Moderate, Low, or Not Applicable (NA).

	Lesson 1: Micro-critters lab				**Lesson 2: ID micro-critters**				**Lesson 3: Toxin reading**				**Lesson 4: Toxin Lab**			
	High	Mod-erate	Low	NA	High	Mod-erate	Low	NA	High	Mod-erate	Low	NA	High	Mod-erate	Low	NA
1. Is the amount of background information sufficient?																
2. Do you feel you were provided adequate advance instruction?																
3. Were you provided enough time to complete the lesson?																
4. Is the procedure clearly written?																

	Lesson 5: Poster															
	High	Mod-erate	Low	NA	High											
1. Is the amount of background information sufficient?																
2. Do you feel you were provided adequate advance instruction?																
3. Were you provided enough time to complete the lesson?																
4. Is the procedure clearly written?																

Section B: Please provide additional comments pertaining to each specific lesson.

Lesson	Are there any topics, sections, or resources that should be added or deleted? If so, please explain.	Additional comments
Lesson 1:		
Lesson 2:		
Lesson 3:		
Lesson 4:		
Lesson 5:		