Phytoplankton

The effects of abiotic factors on their growth and diversity

By Melissa Duhaime, PhD and Heather Vingsness

Museum Program Type	Science for Tomorrow
Content Area	Biology
Grade Level	Middle School, Grades 6-8
Big Idea/Unit	Phytoplankton growth depends on abiotic factors
Pre-Existing Knowledge	
Time Required	30 minutes
Cost (for a group of 30)	$
Safety	Take care with glass microscope slides and coverslips

Flasks are filled with river water and monitored to see and measure the effects of light and nutrients. Students will view a standardized set of phytoplankton under the microscope. Then, students will examine water from their local watershed under the microscope to compare its phytoplankton to the standardized set. They will compare local river water (e.g., Detroit River, Huron River) and discuss how light and nutrients affect phytoplankton growth.

BACKGROUND INFORMATION

Vocabulary:

Plankton - the diverse collection of organisms found in water that are unable to propel themselves against a current. Includes bacteria, archaebacteria, protists, and drifting animals (including things like jellyfish).

Phytoplankton - the autotrophic (photosynthesizing) components of the plankton community and a key part of ocean and freshwater ecosystems. Includes diatoms, cyanobacteria and dinoflagellates.

Pre-Required Knowledge:

Phytoplankton are microscopic organisms that live in saltwater and freshwater. The group is made up of bacteria and protists. They grow quickly in environments with light and nutrients.

“Phytoplankton are the foundation of the aquatic food web, the primary producers, feeding everything from microscopic, animal-like zooplankton to multi-ton whales. Small fish and invertebrates also graze on the plant-like organisms, and then those smaller animals are eaten by bigger ones.”[1]

MATERIALS

Presentation Duhaime Lesson Phytoplankton
500-1000mL Flasks (6)
River water from Local Water Source
Hydroponic Plant Fertilizer
Lamp
Glass beakers, 500mL, 3
Spring water
Standardized culture of phytoplankton, such as Mixed Marine Diatoms and Dinoflagellates (link)
Bucket of soapy water

[1] https://earthobservatory.nasa.gov/features/Phytoplankton

Microscope Slide - 2 per student
Cover Slip - 2 per student
Microscope - 1 for every 2 students
Pipets - 2 per table
Smaller 2oz condiment cups, 2 per table
Paper towel, 1 piece per student

SAFETY

If a slide or cover glass is broken, dispose of it in a labeled cardboard box to prevent anyone from being cut.

SET UP

Room Requirements/Floorplan

Microscopes evenly distributed around the room. Tape down cords if needed to avoid tripping hazards.
Tables should be arranged with four microscopes each and seating for two students per microscope.

3 Weeks in Advance

Three Weeks In Advance

Collect river water from a local water source. Divide into three glass beakers (diatoms require a source of silica to grow, which it can pull from the glass).
Flask 1: Under a light source or lamp (control)
Flask 2: Under a light source or lamp, with fertilizer, according to fertilizer package instructions
Flask 3: In the dark.
If the water level drops, top off with spring water. Every day, use a pipet to squirt air into the river water.

Day Of

- Pour small amounts (about 10-20mL) of prepared phytoplankton into smaller containers, one for each table
- At each station, place

    - A microscope; small container of phytoplankton; small container of river water; and paper towel
- At the front of the room, place
    - A container of soapy water
    - A sample of diatomaceous Earth
    - Container of phytoplankton

CONDUCTING THE LESSON

Slides are highlighted in green. Recommended tasks for staff are highlighted yellow.

Engage

Slide 2
Professor Duhaime studies Antarctic phytoplankton.

Slide 3
Phytoplankton are tiny floating plant-like organisms. There are four kinds - cyanobacteria, diatoms, dinoflagellates, and algae.

Floating plants can grow in the open ocean where it is too deep for plants that need to attach to the ground.

Algae look a lot like plants, but are technically not like plants. It's probably what you imagine when you think of seaweed. It can be one cell big or it can be huge. Diatoms are a common type of phytoplankton. You have probably seen it in a fish tank or lake. It forms a brown scummy layer on plants, rocks, and fish tanks. Diatoms have hard shells made of silica.

Slide 4
Cyanobacteria are a type of bacteria that get their energy from photosynthesis.
Cyanobacteria blooms can turn water a bright green.
Dinoflagellate blooms can turn water a bright red.
Both of these phytoplankton can release toxins that make the water deadly for drinking and can kill fish.

Slide 5

Phytoplankton get their energy from the sun, just like plants, but they are not technically plants. Phytoplankton are missing a few really important structures that all plants have. What do you think that is?

Answer: Roots, stems, leaves

Explore

Slide 6

They aren't supported by stems - the water holds them up.

Ask: Why can't phytoplankton have roots?

Answer: Since phytoplankton grow on the water's surface, it is usually too deep to attach to the ground securely with all of the movement of waves and currents. Some species of algae, like kelp, have structures that hold them to the ground, but are not technically "true" roots.

Slide 7

Let's see what phytoplankton look like up close!

Hold up Mixed Phytoplankton culture.

Watch me make a slide, and then everyone will make their own slide.

Everyone will need a slide and a coverslip. Hold up slide and coverslip

Use the pipet to place one drop of phytoplankton on the slide. Cover the slide with a coverslip. Demonstrate.

Now you try.

Pass out pipettes - one per table. Have students create slides. Make sure they know which container is the Mixed Phytoplankton culture.

Slide 8

Next, we will turn to the microscope. Watch me, and then you'll use the microscope yourself.

1. Make sure the microscope is plugged in.

2. Use the big knob to move the stage all the way down.
3. Turn on the light
4. Center the object above the light. Most microscopes have a twisty thing to move the slide back and forth or up and down.
5. Clip the slide to the stage

Slide 9
6. Turn the objective lenses so that the shortest lens (usually the red one) is pointing down towards the stage.
7. Look through the eyepiece. While looking, adjust the big knob (coarse adjustment) until the object comes into focus. Only use the big knob at this low magnification.
8. If you want to see it closer, turn the objective lenses so the second shortest lens (usually yellow) is pointing down.
9. Focus using only the little knob (fine adjustment) at medium or high power.
Have students view through the microscope. Repeat the steps if necessary to guide students along, since they will inevitably forget steps.
Walk around and help students with their microscopes.

Explain

Slide 10
Here's a picture of what species you'll see in this special mixture: Amphidinium, Cyclotella and Thalassiosira. How many can you find?

Slide 11
You don't need to go to a store or the Antarctic or anywhere fancy to find phytoplankton. You can find them in your local waterways.

Local waterways have much more biodiversity than the little jar of phytoplankton from the store. You're going to see many more types of phytoplankton in your local waterway than from a "pre-packaged" jar.

When I visited your school a few weeks ago, I went to your local river and collected a water sample. I have kept it here at the museum and grown it for you. Let's see how different it looks.

Slide 12

Elaborate

Slide 13

Slide 14

Slide 15

Slide 16

Phytoplankton might increase in population and fight against climate change if they are allowed to grow with exposure to light and nutrients

Evaluate

Students will recognize that phytoplankton growth is not just related to light and nutrients; it can also be affected by humidity, genetics, predation, etc.

CLEAN UP

Put used microscope slides in a bucket of soapy water

CONCLUSION

COMMON QUESTIONS

TIPS AND TROUBLESHOOTING

EXTENSIONS

SCALING

REFERENCES

SUPPLEMENTAL FILES

NEXT GENERATION SCIENCE STANDARDS

MS-LS1 From Molecules to Organisms: Structures and Processes

The chart below makes one set of connections between the instruction outlined in this lesson and the NGSS. Other valid connections are likely; however, space restrictions prevent us from listing all possibilities. The materials, lessons, and activities outlined in the article are just one step toward reaching the performance expectations listed below.

Dimensions	Classroom Connections
Science and Engineering Practices	
Constructing Explanations and Designing Solutions Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	• Students will explain how phytoplankton might increase in population and fight against climate change if they are allowed to grow with exposure to light and nutrients
Disciplinary Core Ideas	

LS1.B: Growth and Development of Organisms Genetic factors as well as local conditions affect the growth of the adult plant.	• Students will compare the pond water grown under different environments (light and nutrients; light and no nutrients; no light no nutrients) for their effects on the growth of the phytoplankton
Crosscutting Concepts	
Cause and Effect Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.	• Students will recognize that phytoplankton growth is not just related to light and nutrients; it can also be affected by humidity, genetics, predation, etc.

Performance Expectation

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

[Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.]

[Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]

Connections to the Common Core State Standards (NGAC and CCSSO 2010)

ELA

Optional. Include any ELA CCSS connections that are strongly evident in the lesson

Mathematics

Optional. Include any Mathematics CCSS connections that are strongly evident in the lesson

CREDITS

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