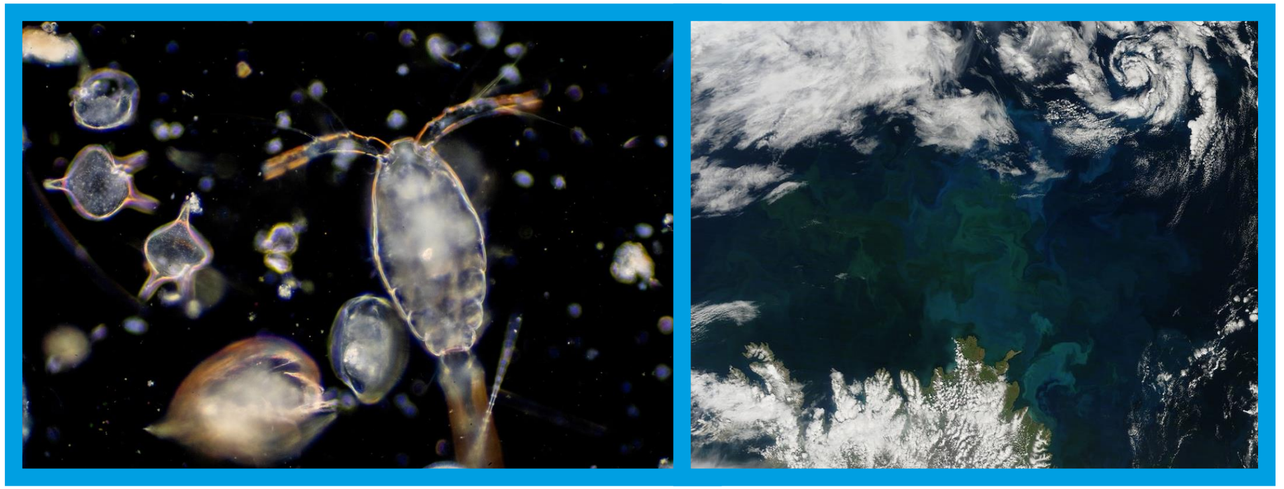
NASA SPOTLITE

Science for students by students

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Middle School Lesson



This material is based upon work supported by the National Aeronautics and Space Administration under award No. NNX16AB91A. Any opinions, findings, and conclusions or recommendations expressed are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration (NASA).

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What are NASA Spotlites?

NASA Spotlites are 90-120 second student-produced video segments that address common science misconceptions as determined by reputable assessment sources such as the National Assessment of Educational Progress (NAEP), National Science Foundation (NSF) Factual Knowledge Questions, and the Misconceptions-Oriented Standards-based Assessment Resources for Teachers (MOSART).

NASA Spotlites are designed to increase scientific literacy in a standards-based classroom. By producing Spotlite videos, students gain production experience, as well as deepen their understanding of science content. Approved NASA Spotlites can be found at the NASA eClips website. https://nasaeclips.arc.nasa.gov/

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5E Lesson Model

NASA eClips™ Guides use the 5E constructivist model developed by Biological Sciences Curriculum Study. Constructivism is an educational philosophy that promotes student-centered learning where students build their own understanding of new ideas. The 5E instructional model consists of five stages for teaching and learning: Engage, Explore, Explain, Extend (or Elaborate), and Evaluate.

Click to play this video.
This video is a collection of images with text read aloud and set to music.

The video is also located on the NASA eClips website linked here.

Table of Contents

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Lesson Overview

Science Misconceptions

Phytoplankton are only found in oceans.

Standards

Next Generation Science Standards

MS-LS1-6: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

Objective

As a result of watching Spotlite videos, learning vocabulary collaboratively, and completing investigations and activities, learners will be able to explain the importance of monitoring the growth and distribution of phytoplankton in aquatic ecosystems.

Safety

- Review digital citizenship before learners use online resources.
- Have learners wear safety goggles to protect their eyes and gloves to protect their hands.
- Use caution and monitor learners when using tools and equipment like scissors and microscopes.

Target Vocabulary

plankton	population
phytoplankton	climate
zooplankton	energy transfer
photosynthesis	nutrients
food web	bloom
producer	carbon dioxide
consumer	oxygen
microscopic	ecosystem

Time Frame

Between two and five 45-minute class periods (depending on the activities conducted):

Day 1 - Engage and Explore*

(*optional data collection over a week or more)

Day 2 - Explain and Elaborate/Extend

Day 3 - Evaluate

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Lesson Overview

Materials

Assessment

Per student:

- copy of pretest and posttest
- Frayer Model Activity

Per classroom:

- chart paper for posting final vocabulary definitions

Per small group:

- copy of a digital Frayer Model (alternatively, this can be printed)

Explore

For each group of students:

Activity 1 - What are phytoplankton?

- compound and/or stereo microscopes
- prepared slides of phytoplankton and zooplankton or live samples
- labels for slides (to identify organisms)
- handout or guide with images of plankton for reference
- gloves and goggles (if using live water samples)
- optional: methyl cellulose and cotton fibers (to slow down live specimen)

Activity 2 - How are phytoplankton distributed?

- large, clear plastic bin or aquarium
- water
- food coloring (blue and green)
- small lightweight items to represent phytoplankton (e.g., paper confetti, foam pieces)
- handheld cordless fan (to simulate wind)
- ice cubes (to simulate temperature changes)

Materials Continued

Activity 3 - What affects phytoplankton growth?

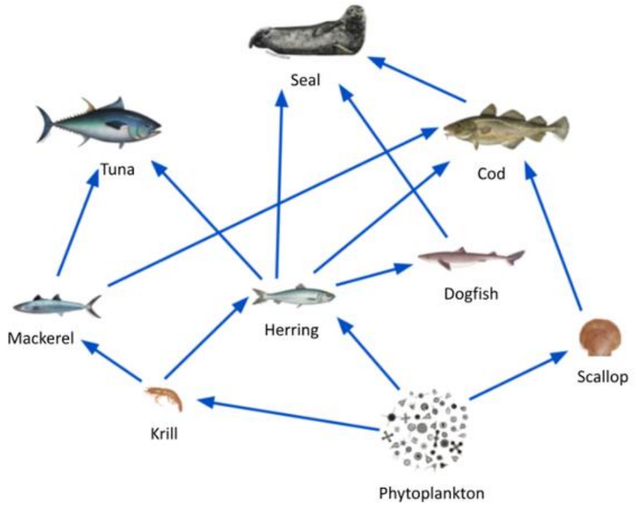
- 3 clear plastic containers or jars (baby food jars)
- water (room temperature, warm, and cold)
- liquid chlorophyll solution (or green food coloring as a substitute)
- droppers or pipettes
- light source (e.g., desk lamp)
- ruler (for measuring light penetration depth)
- thermometers
- data recording sheet

Activity 4 - What are algal blooms?

- one algal bloom data table (provided)
- optional:
  - graph paper or digital graph tool
  - calculator

Lesson Big Ideas

- Phytoplankton are microscopic, primary producers that form the base of most aquatic food webs.
- Phytoplankton capture solar energy through photosynthesis and convert it into chemical energy stored in sugars, which fuels aquatic ecosystems.
- Environmental factors such as temperature, sunlight availability, nutrient concentrations, pH, and water circulation patterns influence the distribution and abundance of phytoplankton.
- Because phytoplankton play a critical role in aquatic food webs, oxygen production, and carbon sequestration, scientists monitor them to better understand changes in Earth's interconnected systems.



NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Background Information

Plankton is the term for organisms found in marine and freshwater. This includes certain algae, bacteria, protozoans, crustaceans, mollusks, and coelenterates. Most exist in a drifting state because they are nonmotile or too small or weak to swim against the current. The word comes from:

- phyto = plant
- plankton = drifting organism

Although they are not plants in the traditional sense, phytoplankton function like plants because they:

- contain chlorophyll
- use sunlight, carbon dioxide, and nutrients to carry out photosynthesis

Plankton can be categorized into two main groups.

1. Phytoplankton: plant-like plankton that carry out photosynthesis to produce food.
2. Zooplankton: animal-like plankton that feed on phytoplankton and other zooplankton.

Phytoplankton Facts

- microscopic, plant-like organisms found in aquatic environments.
- many exist in a drifting state because they are nonmotile or too small or weak to swim.
- use sunlight, water, and carbon dioxide to perform photosynthesis, resulting in the production of glucose (food) and oxygen as a byproduct.
- float or drift in the sunlit upper layer of water called the photic zone, where enough light is available for photosynthesis.
- base and primary producers in aquatic ecosystems and food webs, supporting a wide range of organisms, from tiny zooplankton to large marine mammals.

- Average size of a phytoplankton varies widely depending on the species, but most phytoplankton are microscopic, typically ranging from 0.2 microns to 200 microns in size. A micron (or micrometer) is one-millionth of a meter or one-thousandth of a millimeter.
  - May be grouped this way:
    - Picoplankton: 0.2 to 2 microns (e.g., Prochlorococcus).
    - Nanoplankton: 2 to 20 microns (e.g., small diatoms and flagellates).
    - Microplankton: 20 to 200 microns (e.g., larger diatoms and dinoflagellates).
- The average size of common phytoplankton like diatoms and dinoflagellates is around 10 to 50 microns.

A copepod (shown here) is a type of zooplankton, a planktonic crustacean distantly related to shrimp and crabs. Copepods are one of the most common and easily recognized types of zooplankton, found in almost every ocean, sea, and freshwater habitat, even in underground caverns. Image credit: NASA

Krill are often pinkish and opaque and feed on phytoplankton. Photo: Sophie Webb/NOAA/Point Blue

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Background Information

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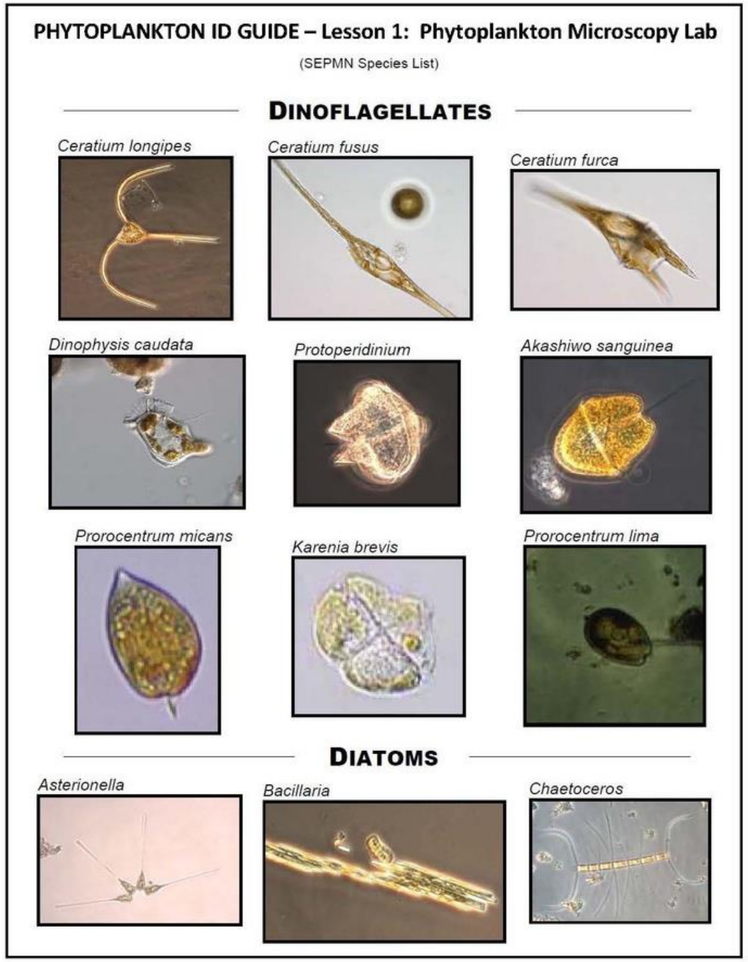

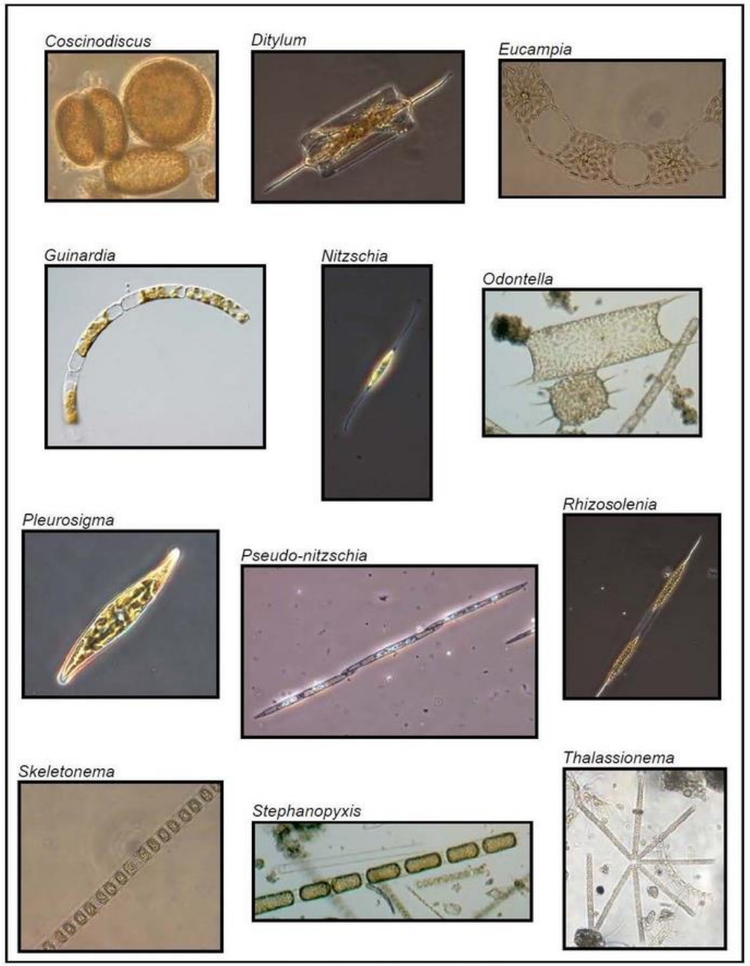

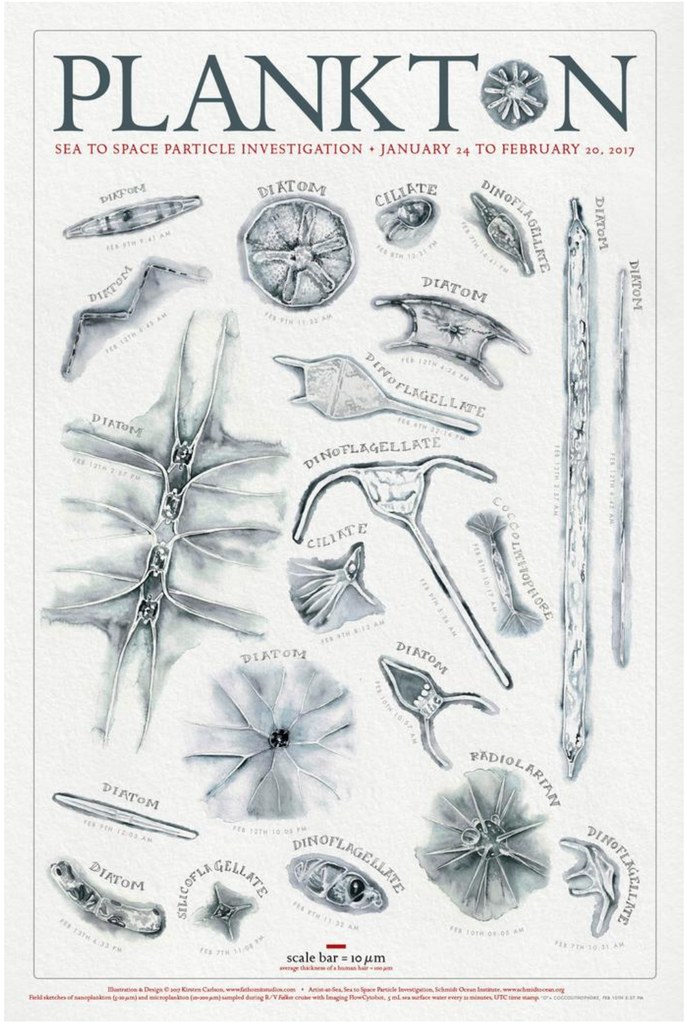

Image Credit
https://pace.oceansciences.org/images/Plankton-Poster-Kirsten-Carlson.jpg

Images taken with a compound microscope. Credit: National Science Foundation-sponsored Center for Microbial Oceanography: Research and Education (C-MORE) https://pace.oceansciences.org/images/Plankton-Poster-Kirsten-Carlson.jpg

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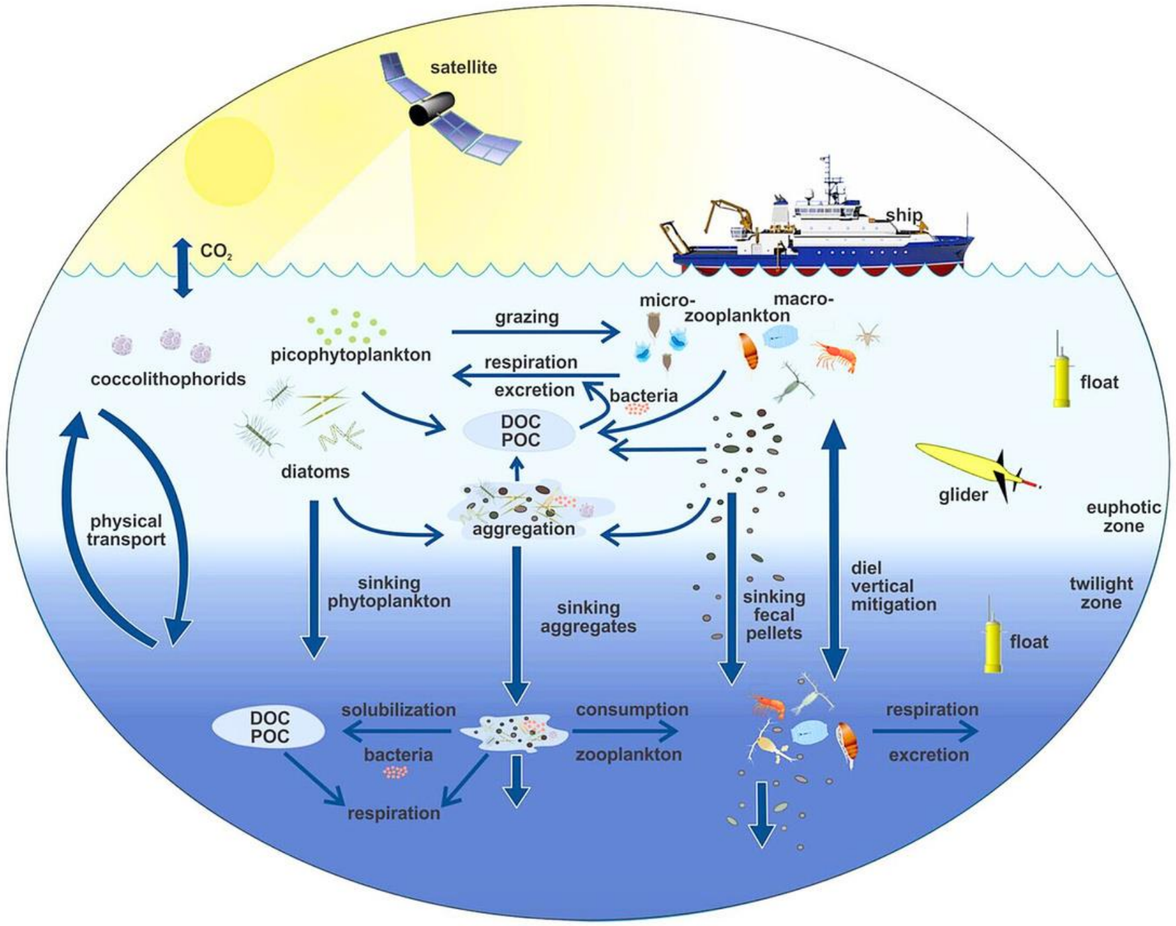
Background Information



This diagram shows how NASA scientists use satellites and underwater tools to track what happens to phytoplankton.

EXPORTS (EXport Processes in the Ocean from Remote Sensing) is a NASA research project that combines satellite images with ocean tools to collect data over time, helping scientists learn how the ocean stores carbon and supports life on Earth.

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Background Information

Role of Phytoplankton in Photosynthesis and Energy Flow

Phytoplankton are primary producers in aquatic food webs. This means they:

- convert light energy into chemical energy through photosynthesis
- transform carbon dioxide and water into glucose and oxygen
- form the base of nearly all aquatic food chains

Why phytoplankton matter so much:

- They produce over 50% of Earth's oxygen
- They drive the movement of energy through aquatic ecosystems
- They support all higher trophic levels, including:
  - zooplankton
  - small fish
  - predatory fish
  - mammals

Without phytoplankton, aquatic ecosystems would collapse due to a lack of energy at the base of the food web.

Phytoplankton and the Cycling of Matter

Phytoplankton play a central role in biogeochemical cycles, especially the carbon cycle, oxygen cycle, and nutrient cycles. Below is a short description of these cycles. You'll find more in-depth background information about the cycles on p. 8 - 12.

Carbon Cycle

- They remove carbon dioxide from the atmosphere during photosynthesis.
- When they die, the carbon they contain can:
  - be consumed by other organisms.
  - sink to the floor of the water body.
  - be stored long-term in sediment.
  - help regulate Earth's climate (it's called the biological carbon pump).

Oxygen Cycle

Oxygen released during photosynthesis enters:

  - the water for aquatic life.
  - the atmosphere for terrestrial life.

Nutrient Cycles (Nitrogen & Phosphorus)

- Phytoplankton absorb nutrients from the water.
- Nutrients move through the food web as organisms eat one another.
- Decomposition returns the nutrients to the environment.

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Background Information

Carbon Cycle:

The carbon cycle is the natural process through which carbon moves between the atmosphere, land, water, and living things. This continuous cycle ensures carbon is reused and redistributed throughout Earth's systems, maintaining balance in the environment. Here are the main steps:

1. Carbon in the Atmosphere
   - Carbon exists in the atmosphere as carbon dioxide (CO_2).
2. Photosynthesis
   - Plants and phytoplankton absorb CO_2 from the air or water.
   - They use sunlight to convert CO_2 and water into food (sugars) and release oxygen.
3. Carbon in Living Organisms
   - Animals eat plants or other animals, transferring carbon into their bodies.
   - Carbon becomes part of their tissues (muscles, bones, etc.).
4. Cellular Respiration
   - Plants, animals, and even microorganisms release CO_2 back into the atmosphere through respiration.
5. Decomposition
   - When plants and animals die, decomposers like bacteria and fungi break down their bodies.
   - Some of the carbon is released as CO_2 into the atmosphere, while some is stored in the soil.
6. Carbon in the Oceans
   - CO_2 dissolves in the ocean and is used by marine organisms, including phytoplankton, to grow.
   - When these organisms die, some carbon sinks to the ocean floor and is stored in sediments.
7. Carbon Storage in Fossil Fuels
   - Over millions of years, carbon from dead plants and animals can become fossil fuels (like coal, oil, and natural gas) after being put under high pressure and heat.
8. Release of Stored Carbon
   - Burning fossil fuels or natural events like volcanic eruptions release stored carbon back into the atmosphere as CO_2.

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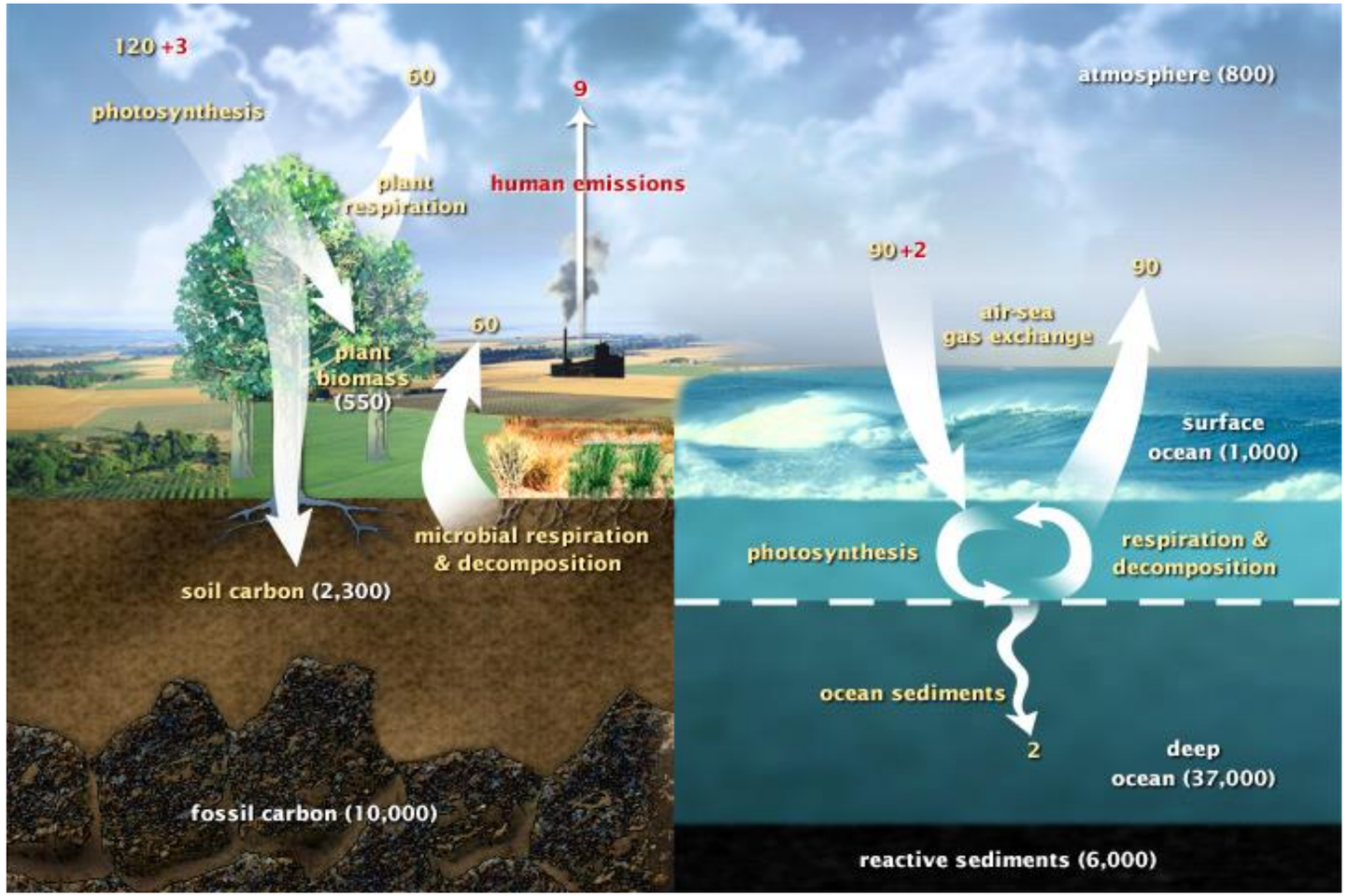
Background Information



This diagram of the fast carbon cycle shows the movement of carbon between land, atmosphere, and oceans. Yellow numbers are natural fluxes, and red are human contributions in gigatons of carbon per year. White numbers indicate stored carbon. Image Credit: The Earth Observatory https://earthobservatory.nasa.gov/features/CarbonCycle

Carbon is the fourth most common element in the universe and is essential for life. Most of the carbon on Earth is locked inside rocks. The carbon on Earth is also found stored in other places that we call reservoirs: atmosphere, ocean, plants, soil, and fossil fuels. The carbon cycle is the movement of carbon between these reservoirs.

When carbon leaves one reservoir, it builds up somewhere else. Sometimes the movement of carbon happens slowly, and other times more quickly.

Over long periods of time, the carbon cycle seems to stay in balance. This balance helps keep Earth's temperature fairly steady. Any event/activity that results in more carbon gases moving into the atmosphere, such as the 9 gigatons (in red) humans are adding through emissions, can result in Earth's temperatures rising.

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Background Information

Nitrogen Cycle:

Nitrogen is essential for building:

- proteins
- DNA
- chlorophyll

However, most living things cannot use nitrogen gas (N_2) directly, even though it makes up ~78% of Earth's atmosphere. The nitrogen cycle is how nitrogen moves between the atmosphere, water, organisms, and sediments — with phytoplankton playing a central role in aquatic systems. Here are the main steps:

1. Nitrogen Fixation
   - Atmospheric nitrogen (N_2) cannot be used directly by most organisms.
   - Certain cyanobacteria (nitrogen-fixing phytoplankton) convert N_2 into ammonium (NH_4^+).
   - Lightning also converts N_2 into nitrates that enter aquatic systems through rain and runoff, adding new usable nitrogen into the systems.

2. Assimilation
   - Phytoplankton absorb ammonium (NH_4^+) and nitrate (NO_3^-) from the water.
   - They use nitrogen to make proteins, DNA, enzymes, and chlorophyll.
   - Nitrogen becomes part of living biomass and enters the food web.

3. Consumption and Food Web Transfer
   - Nitrogen moves from phytoplankton → zooplankton → fish → larger predators.
   - At each trophic level, nitrogen is used for growth and metabolism, linking the nitrogen cycle to energy flow in ecosystems.

4. Ammonification (Excretion and Decomposition)
   - When organisms excrete waste or die, decomposer bacteria break down organic nitrogen.
   - Organic nitrogen is converted into ammonium (NH_4^+).
   - This returns nitrogen to the water for reuse.

5. Nitrification
   - In oxygen-rich water, bacteria convert:
   - $NH_4^+ \rightarrow NO_2^-$ (nitrite)
   - $NO_2^- \rightarrow NO_3^-$ (nitrate)
   - This produces nitrate, the most common nitrogen form used by phytoplankton.

6. Denitrification
   - In low-oxygen environments (sediments, deep water, dead zones), bacteria convert:
   - $NO_3^- \rightarrow N_2$ (gas)
   - Nitrogen is returned to the atmosphere.
   - This is the only step that permanently removes nitrogen from aquatic ecosystems.

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Background Information

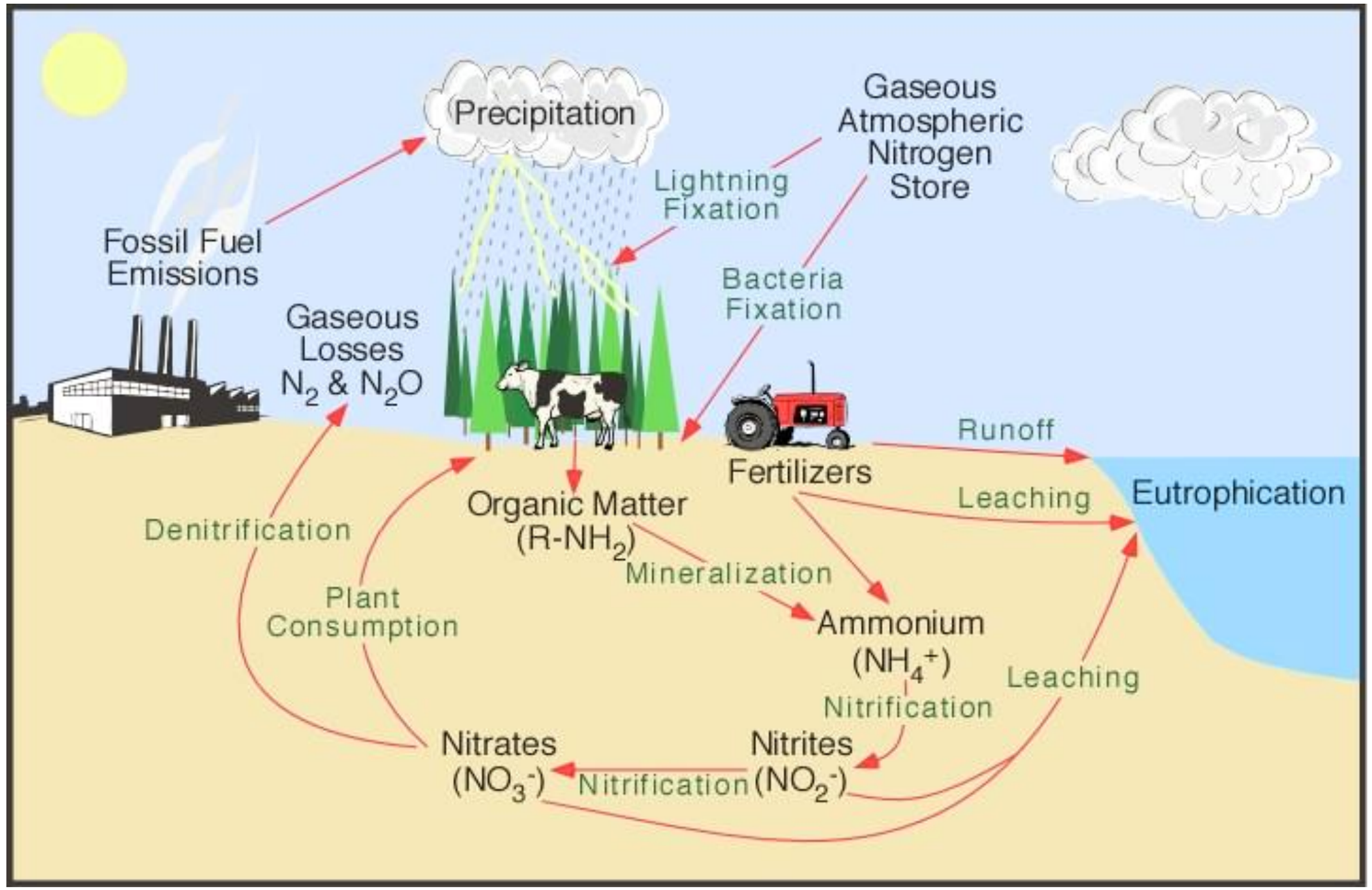

Diagram showing parts of the Nitrogen Cycle Processes
Image Credit: Climate Program Office - NOAA

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Background Information

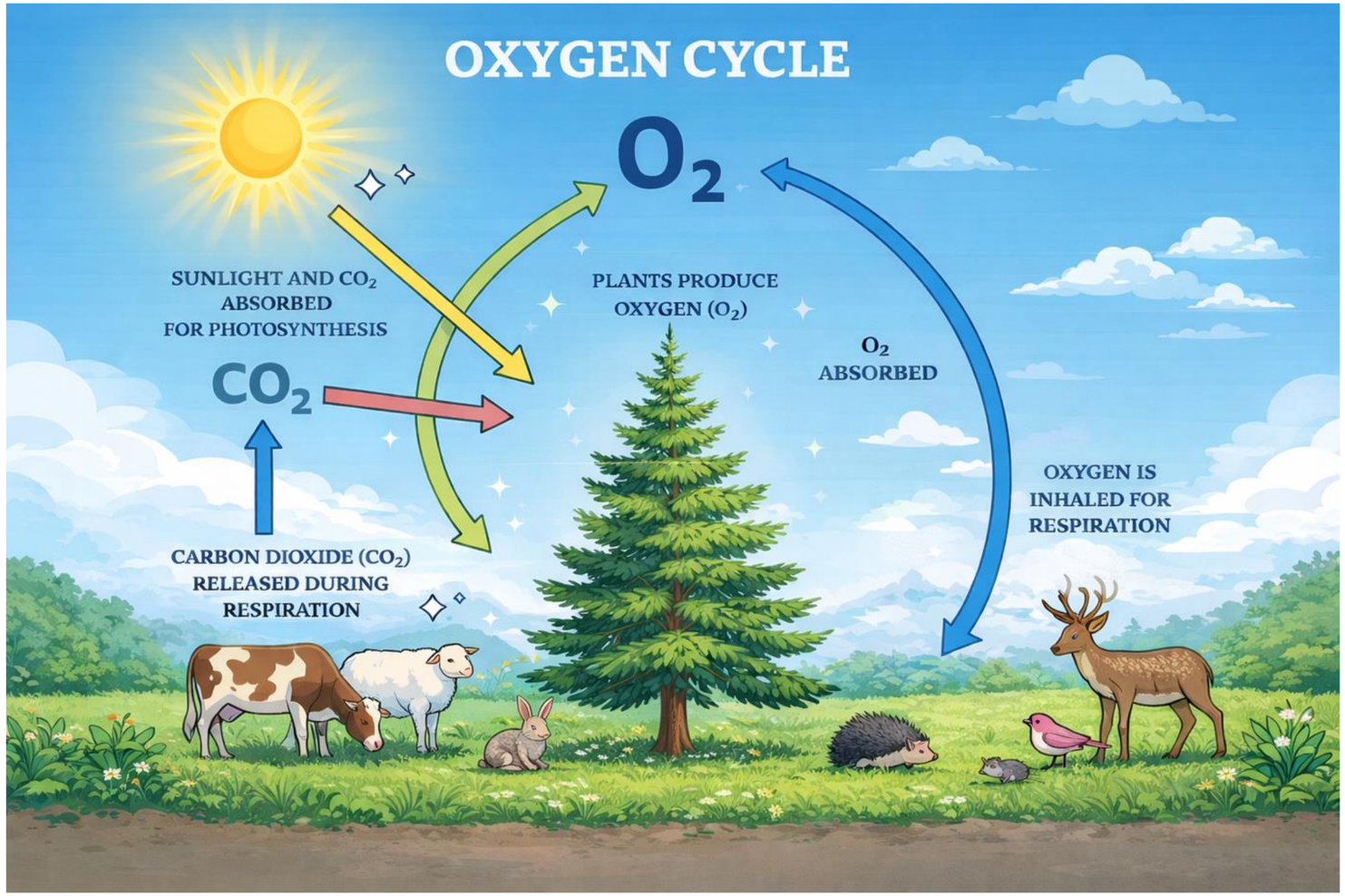

Diagram showing parts of the Oxygen Cycle.

Citation: Oxygen CycleOriginal digital illustration created with assistance from ChatGPT (OpenAI), 2026.

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Background Information

Oxygen Cycle:

The oxygen cycle describes how oxygen moves between the atmosphere, water, living organisms, and Earth's surface. In aquatic ecosystems, phytoplankton are the main producers of oxygen, making this cycle closely tied to photosynthesis, respiration, and decomposition. Here are the main steps:

1. Photosynthesis – Oxygen Is Produced

Photosynthesis is the main process that adds oxygen to the Earth's system. In oceans, lakes, and rivers, phytoplankton use sunlight, carbon dioxide (CO_2), and water (H_2O) to make glucose (food) and release oxygen (O_2).

- occurs in the photic (sunlit) zone of water
- produces oxygen as a byproduct
- supplies oxygen for both aquatic and terrestrial life

2. Oxygen Dissolves and Circulates in Water

After oxygen is produced, it dissolves into the surrounding water and moves through aquatic systems by mixing and circulation.

- carried by currents, waves, and wind-driven mixing
- highest dissolved oxygen levels are near the surface
- lower oxygen levels are in deep or stagnant waters
- essential for fish, invertebrates, and aerobic microbes

3. Cellular Respiration – Oxygen Is Used by Organisms

All living organisms use oxygen during cellular respiration to release energy from food.

- used by phytoplankton, zooplankton, fish, plants, animals, and bacteria
- oxygen reacts with glucose to release energy (ATP)
- produces carbon dioxide and water as byproducts
- returns CO_2 to the system for photosynthesis

4. Decomposition – Decomposers Use Oxygen

When organisms die, decomposer bacteria break down organic matter, using oxygen in the process.

- occurs in water and sediments
- uses large amounts of dissolved oxygen
- can cause low-oxygen (hypoxic) conditions
- excess decomposition can lead to dead zones

5. Diffusion Between Water and the Atmosphere

Oxygen constantly moves between the water and air through diffusion.

- oxygen moves from areas of high concentration to low concentration
- wind and waves increase the rate of exchange
- helps replenish oxygen in surface waters
- maintains balance between aquatic ecosystems and atmosphere oxygen levels

6. Long-Term Storage and Chemical Use

Some oxygen becomes stored or used in chemical reactions over long periods of time.

- trapped in sediments and ocean-floor minerals
- used in oxidation reactions (such as rusting)
- locked into fossil fuels and rocks
- affects atmospheric oxygen over millions of years

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Engage

Pre-assessment

Probe for students' prior knowledge using the pre-assessment.

1. Pretest items are located **at this link.**
2. Essential questions
3. Discussion questions

Essential Question(s)

- What are phytoplankton?
- Where can phytoplankton be found?
- What environmental factors affect the growth and distribution of phytoplankton?

Today's Lesson

In today’s lesson, you will identify the characteristics of phytoplankton. After watching the Spotlight videos, learning the vocabulary collaboratively, and exploring the factors that affect phytoplankton populations, you will explain the importance of monitoring the growth and distribution of phytoplankton in aquatic ecosystems.

True or False?

Phytoplankton are only found in oceans.

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Engage

NASA Spotlite Videos: Confronting Science Misconceptions

As you watch this video, look for how a misconception about phytoplankton is confronted.

Spotlite: Where can you find phytoplankton?

NASA Spotlite: Where Do We Find Phytoplankton?
Link - https://science.nasa.gov/eclips/videos/where-can-you-find-phytoplankton/

Science Misconceptions

Phytoplankton are only found in oceans.

Class Discussion

- How do phytoplankton support aquatic ecosystems, and why are they considered the foundation of the aquatic food webs?
- In what ways does the presence of phytoplankton influence the Earth's oxygen and carbon cycles?
- How might changes in the environment impact global ecosystems?
- How do scientists study phytoplankton, and what can we learn from their work?

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Explore

Activities

You will complete some activities to observe and explore plankton.

Safety:

- **Wear goggles to protect your eyes.**
- **Wear gloves and long sleeves to protect your skin.**
- **Get permission and adult supervision before collecting the mud, plants, and water samples.**

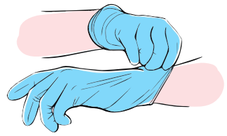
NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explore

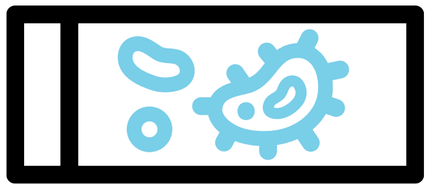
Activities

Activity 1 - Plankton Observations. Observe phytoplankton and zooplankton through prepared slides or live samples.

1. Gather materials :
   - Compound and stereo microscopes
   - Prepared slides of phytoplankton and zooplankton or live samples
   - Optional: methyl cellulose and cotton fibers (to slow down live specimens)
   - Labels for slides (to identify organisms)
   - A handout or guide with images of plankton for reference
   - Gloves and goggles (if using live water samples)



2. Use the microscope to observe plankton and make observations of their shapes and features. Record observations.



3. Match your observations to the handout or guide. Which plankton did you identify?

4. How many were phytoplankton? How many were zooplankton?

5. Wait 10 minutes and repeat steps 2, 3 and 4.

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Explore

Activities

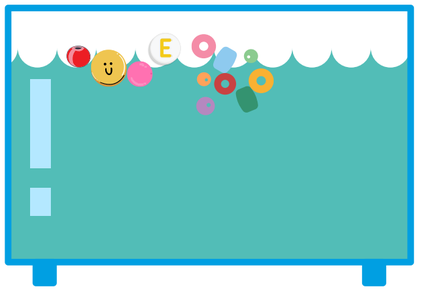
Activity 2 - Simulating Ocean Currents and Phytoplankton Blooms - Investigate how ocean currents distribute phytoplankton and nutrients.

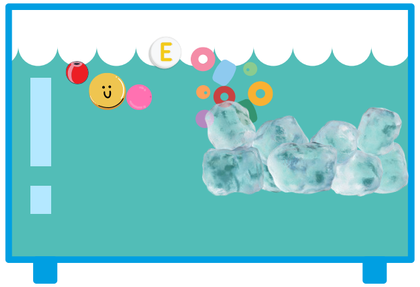
1. Gather materials :
   - Large clear plastic bin or aquarium
   - Water
   - Food coloring (blue and green)
   - Small lightweight items to represent phytoplankton (e.g., paper confetti, foam pieces)
   - Handheld cordless fan (to simulate wind)
   - Ice cubes (to simulate temperature changes)

2. Fill the bin with water and add a few drops of blue and green food coloring to represent nutrient-rich water.

3. Scatter the lightweight items on the surface to simulate phytoplankton.

4. Use the fan to create “currents” on the water surface. Observe how the “currents” move the phytoplankton horizontally. Record observations.





5. Add ice cubes to one end of the bin and observe how colder, denser water sinks, creating upwelling that mixes the colored water vertically and moves the "phytoplankton."

6. Discuss how upwelling zones increase nutrient availability, leading to phytoplankton blooms.

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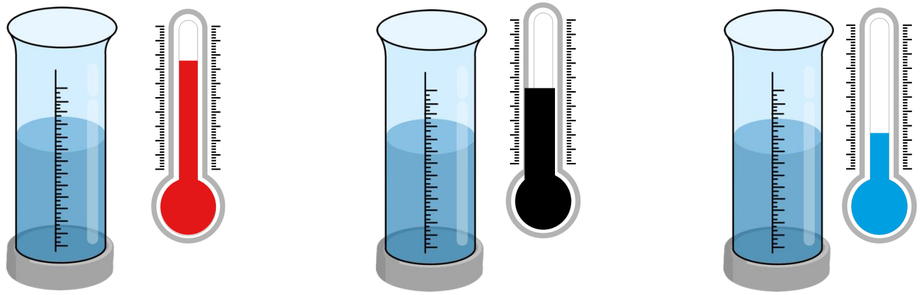
Explore

Activities

Activity 3 - Investigating the Impact of Water Temperature on Phytoplankton Growth - Use observations and data to construct an argument about how changes in water temperature affect phytoplankton populations.

1. Gather materials :
   - 3 clear plastic containers or jars (baby food jars)
   - Water (room temperature, warm, and cold)
   - Liquid chlorophyll solution (or green food coloring as a substitute)
   - Droppers or pipettes
   - Light source (e.g., desk lamp)
   - Ruler (for measuring light penetration depth)
   - Thermometers
   - Data recording sheet

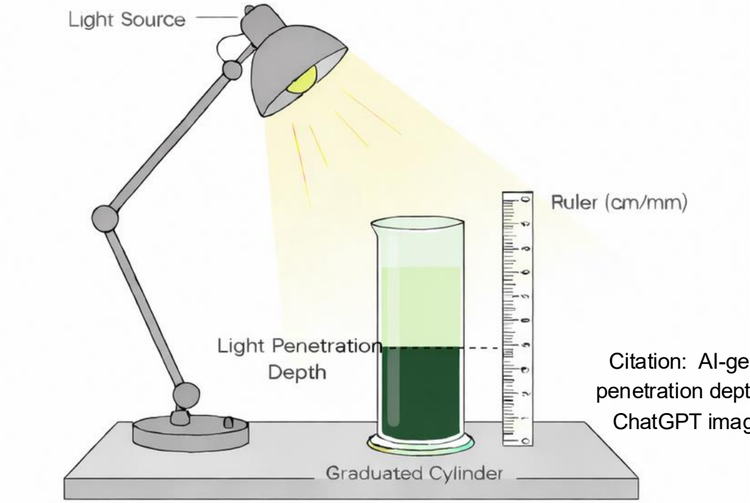
2. Fill three containers with water: one with room temperature, one with warm, and one with cold water.



3. Add the same amount of liquid chlorophyll (or green food coloring) to each container.

4. Place the containers under a light source to simulate sunlight.

5. Use a ruler to measure how far light penetrates into each container. Record data.



Citation: AI-generated illustration of light penetration depth experiment. Created with ChatGPT image generation tools, 2026.

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Explore

Activities

Activity 3 - Investigating the Impact of Water Temperature on Phytoplankton Growth - Use observations and data to construct an argument about how changes in water temperature affect phytoplankton populations.

6. After 10 minutes have elapsed, use a ruler to measure again how far light penetrates each container. Record data.

Container	Temperature (°C)	Light Penetration Depth (cm) – 10 min	Color Intensity (1=faint – 5=very dark) – 30 min	Notes
Cold Water				
Room Temp				
Warm Water				

- Record the actual water temperature using a thermometer.
- Measure how far light penetrates before being completely diffused.
- Rate color intensity as an indicator of chlorophyll concentration.
- Note any observations (e.g., “Warm water looks cloudier,” “Color faded,” etc.).

7. After 30 minutes, observe changes in the "phytoplankton" dispersion or concentration. Measure light penetration again to assess changes in the density of the chlorophyll solution.

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explore

Activities

Activity 4 - Analyzing Data: Phytoplankton Bloom Investigation

1. Gather materials :
   - One algal bloom data table (provided below)
   - Optional:
     - Graph paper or digital graph tool
     - Calculator

Energy Flow Data Table - Aquatic Ecosystem

Day	Water Temp (°C)	Nitrate (mg/L)	Chlorophyll-a (µg/L)	Dissolved Oxygen (mg/L)
1	18	0.4	3.2	9.5
4	20	1.2	9.8	8.1
7	23	2.4	21.6	6
10	26	3.1	32.4	4.2
13	25	0.8	10.1	7.6

2. Use the following questions to help analyze the data to discover how nutrients and temperature affect phytoplankton populations and predict how these changes impact the food webs and the amount of oxygen available.
   - What patterns do you see between changes in nutrient levels (nitrates) and dissolved oxygen?
   - What patterns do you see between water temperature and dissolved oxygen?
   - The amount of chlorophyll-A indicates the amount of phytoplankton. What patterns do you see between the environmental factors and phytoplankton?
   - How might you use this chart to create an argument for ways to protect phytoplankton?

3. Optional: Work with a group to graph the data. You might create:
   - A graph of Nitrate vs. Chlorophyll
   - A graph of Chlorophyll vs. Dissolved Oxygen

Discuss how visualizing the data in a graph helps the viewer see trends and patterns more easily.

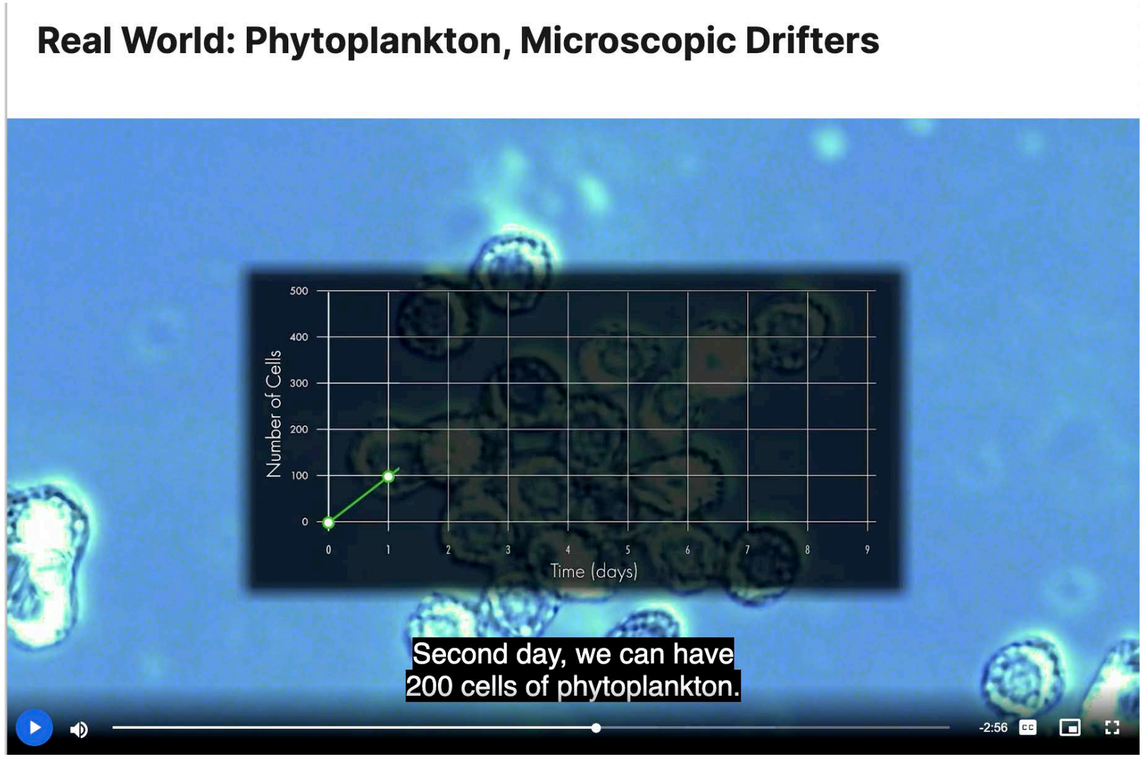
NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explain

Explain Resources

During the “explain” of a 5E lesson, students share their findings from the “engage” and “explore” experiences. Teachers listen for students’ understanding of the key concepts and use this opportunity to clarify concepts, introduce formal terminology, and reinforce and connect students’ experiences to scientific principles.

Share this video with students to help reinforce key concepts.



Real World: Phytoplankton, Microscopic Drifters
https://science.nasa.gov/eclips/videos/phytoplankton-microscopic-drifters/

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explain

Explain Resources

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Below you will find some key concepts you may reinforce after students share their experiences from the “explore” activities.

Activity 1 - Plankton Observations - Observe the plankton in prepared slides or live samples.

- If you’re observing live specimens, you might notice tiny creatures moving around. Some learners may think all microscopic organisms are plants. Remember, phytoplankton are plant-like producers, while zooplankton are animal-like organisms that eat phytoplankton and other zooplankton. Not all small things in the water are the same.
- Energy flows from producers (phytoplankton) to consumers (zooplankton and larger animals). If there are fewer phytoplankton, there will be less food for zooplankton, which in turn affects the whole food web.
- Phytoplankton are the base of the aquatic food web, supporting higher levels in the web.

Activity 2 - Simulating Ocean Currents and Phytoplankton Blooms - Investigate how ocean currents distribute phytoplankton and nutrients.

- Phytoplankton need sunlight and nutrients, and currents move these nutrients around. Blooms happen where conditions are right, not just randomly.
- The moving water spreads phytoplankton. This is how nutrients and organisms are transported in real oceans.
- Ocean currents control nutrient distribution, which affects where phytoplankton can thrive.

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explain

Explain Resources

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Activity 3 - Investigating the Impact of Water Temperature on Phytoplankton Growth - Use observations and data to construct an argument about how changes in water temperature affect phytoplankton populations.

- Warmer water does not always lead to more growth. Each species has an optimal temperature range. Temperatures that are too hot or too cold can inhibit growth.
- This activity shows how environmental changes outside of “normal” ranges – like those caused by climate change – can disrupt ecosystems.
- Temperature affects the metabolism and growth of phytoplankton, which in turn impacts the food web.

Activity 4 - Analyzing Data: Phytoplankton Bloom Investigation

- A large bloom is not always ‘good.’ Massive blooms can lead to problems such as oxygen depletion in the water, harming other marine life.
- When you look at your data, do nutrient levels, light, and temperature patterns explain the bloom size? Data helps us understand the causes and effects of blooms.
- Multiple factors influence phytoplankton blooms, and their effects can be both positive and negative for the ecosystem.

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

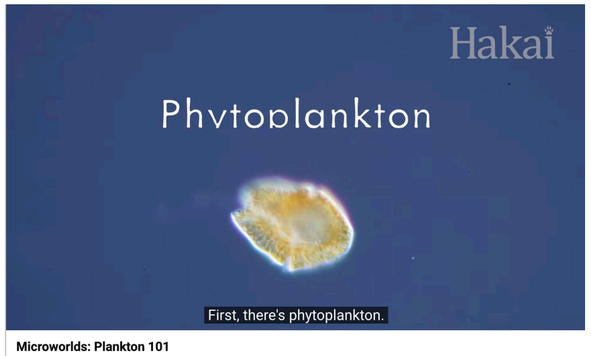
Explain

Explain Resources

During the “explain” of a 5E lesson, students share their findings from the “engage” and “explore” experiences. Teachers listen for students’ understanding of the key concepts and use this opportunity to clarify key concepts, introduce formal terminology, and reinforce and connect students’ experiences to scientific principles.

Share these videos and articles with students to help reinforce key concepts.

From Drifter to Dynamo: The Story of Plankton | Deep Look



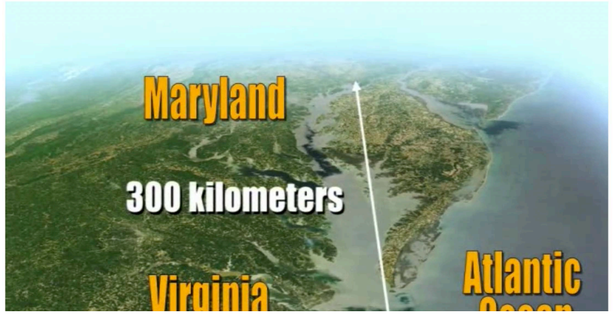
Microworlds: Plankton 101

The power of plankton: Advancing our understanding of the role and value of plankton as marine natural capital (online article)

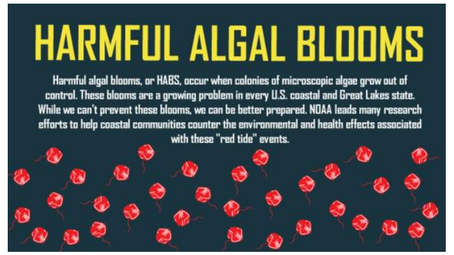
Eutrophication:
Excessive amounts of organic matter provide the nutrients algae need to grow. When the algae uses up the nutrients, they begin to die. As bacteria use oxygen to break down the dead algae, dissolved oxygen is removed from the aquatic ecosystem. This is harmful to aquatic life.

What is a Micron?

Real World: NASA and the Chesapeake Bay



Real World: NASA and the Chesapeake Bay



What is a harmful algal bloom? (online article)

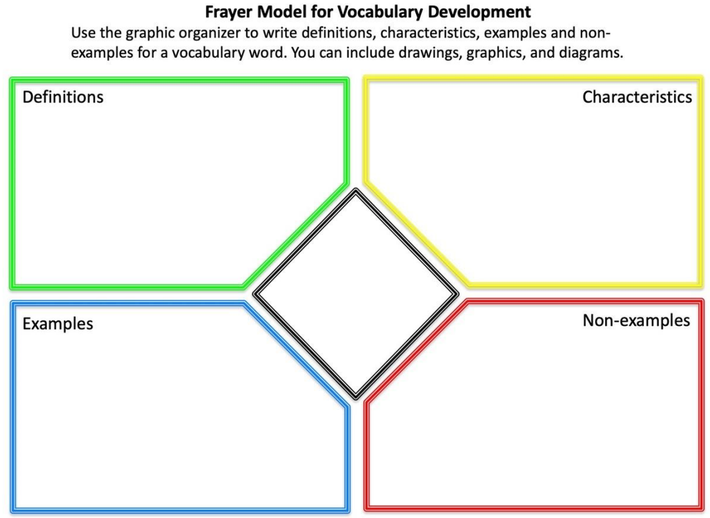
NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explain

Vocabulary Development

It's almost impossible to learn science concepts without also learning vocabulary words. Vocabulary words help people discuss science concepts, so they're important. However, knowing vocabulary words is not the same as understanding science concepts. This section is designed to help your students do more than memorize definitions as they connect the vocabulary to the science concepts that they have explored.

1. Place the term "aquatic" in the center of the graphic organizer. (Link to a fillable Frayer Model) Facilitate a discussion with students exploring why this word is key vocabulary to this study.
2. Ask students to brainstorm ***characteristics*** of "aquatic" and add responses to the area with the corresponding heading on the graphic organizer.
3. Ask students to continue their exploration as they research the topic using a variety of resources, including their textbook and notes.
4. Next, ask students to add ***examples*** and ***non-examples*** in the Frayer Model. Emphasize the higher-level thinking skill of comparing and contrasting. How are the examples alike/different than the non-examples?
5. Using the information provided, ask students to develop their own ***definition*** of the term "aquatic" that is clear and concise.
6. After completing the example together, assign a new vocabulary word to each group of students to work on collaboratively. The group will complete the Frayer Model graphic organizer using their assigned word.
7. Groups will share their Frayer Models and lead discussions to check for understanding of each vocabulary word. Refer to definitions in the Explain section. (Link to Definitions)
8. Compile and post final definitions so all students have access for later reference.



NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explain

Vocabulary Development

It's almost impossible to learn science concepts without also learning vocabulary words. Vocabulary words help people discuss science concepts.

Start

Place the assigned word in the center of the graphic organizer.

Brainstorm characteristics of the word and add responses (words and pictures).

Next, add examples and non-examples in the Frayer Model.

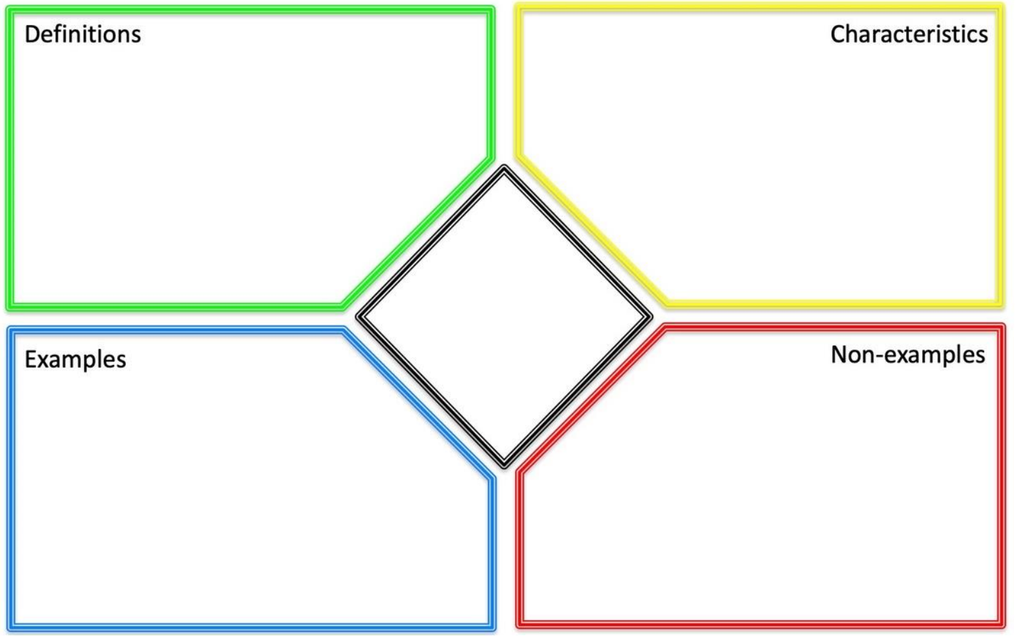
How are the examples alike and different than the non-examples?

Develop a definition of the word that is clear and concise.

Complete a Frayer Model with your group using your assigned word and fill in the graphic organizer. We will share some as a class.

Frayer Model for Vocabulary Development

Use the graphic organizer to write definitions, characteristics, examples and non-examples for a vocabulary word. You can include drawings, graphics, and diagrams.



NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Evaluate

Post-Assessment

Check students' understanding with these activities.

1. Identify misconception
2. Discussion questions
3. Vocabulary Review
4. Post test items are **located here.**

Identify Additional Misconceptions

What are common misconceptions people have about phytoplankton? How can you correct those misconceptions?

Discussion Question(s)

1. What are phytoplankton?
2. Where can phytoplankton be found?
3. What environmental factors affect the growth and distribution of phytoplankton?

NASA Spotlite Videos

Carefully re-watch the NASA Spotlite video about phytoplankton.

Spotlite: Where can you find phytoplankton?

NASA Spotlite: Where is Phytoplankton?
Link - https://science.nasa.gov/eclips/videos/where-can-you-find-phytoplankton/

Vocabulary Review

Use your new vocabulary words to respond to this prompt:

You are a scientist on a mission. You have been tasked with determining why all the phytoplankton in a body of water have suddenly vanished!

Write or draw to explain what happens next.

How does this affect ocean life, the air we breathe, and people in your community?

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Evaluate

Pretest & Posttest

1. **What are phytoplankton?**
A. Microscopic animals in the ocean
B. Microscopic plant-like organisms that perform photosynthesis***
C. Large algae found on the ocean floor
D. Tiny rocks that drift in the water

2. Where are phytoplankton most commonly found?
A. Deep ocean trenches
B. Near the surface of the ocean where sunlight is available***
C. On the ocean floor
D. In frozen glaciers

3. What process do phytoplankton use to make their own food?
A. Respiration
B. Fermentation
C. Decomposition
D. Photosynthesis***

4. Which molecule do phytoplankton produce during photosynthesis that is essential for animals to survive?
A. Carbon dioxide
B. Nitrogen
C. Oxygen ***
D. Ammonium

5. Why is it important for scientists to monitor water temperature in oceans when studying phytoplankton?
A. Because temperature does not affect phytoplankton at all
B. Because temperature can influence growth, reproduction, and distribution of phytoplankton ***
C. Because only large fish respond to temperature changes
D. Because phytoplankton are unaffected by nutrients

6. What role do phytoplankton play in the carbon cycle?
A. They release carbon dioxide into the atmosphere
B. They use carbon dioxide during photosynthesis***
C. They prevent carbon from entering the ocean
D. They turn carbon into rock

7. Which of these factors affects phytoplankton growth?
A. Availability of sunlight
B. Temperature of the water
C. Nutrient levels in the water
D. All of the above***

8. What are harmful algal blooms?
A. Excessive phytoplankton growth that produces toxins that can harm aquatic life***
B. Excessive phytoplankton growth that clean the water
C. Excessive phytoplankton growth that builds coral reefs
D. Excessive phytoplankton growth that forms when the ocean is too cold

9. What tool does NASA use to monitor phytoplankton?
A. Telescopes
B. Satellites***
C. Submarines
D. Buoys

10. If phytoplankton populations decrease significantly, what would most likely happen to the ecosystem?
A. Oxygen levels would drop and food availability for fish would decrease***
B. Nitrogen levels would increase automatically
C. Dead zones would disappear
D. Water temperature would rise

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Evaluate

Pretest & Posttest

11. **Which of the following best describes the relationship between phytoplankton and zooplankton?**
A. Phytoplankton eat zooplankton for energy
B. Zooplankton eat phytoplankton for energy ***
C. Zooplankton and phytoplankton compete for the same food
D. Phytoplankton and zooplankton do not interact

12. Energy in a marine food web flows from:
A. Zooplankton → Phytoplankton → Fish
B. Phytoplankton → Zooplankton → Fsh ***
C. Fish → Zooplankton → Phytoplankton
D. Phytoplankton → Fish → Zooplankton

13. How do ocean currents affect phytoplankton blooms?
A. Currents prevent phytoplankton from growing anywhere
B. Currents do not affect phytoplankton distribution
C. Currents increase water temperature, killing phytoplankton
D. **Currents move nutrients, helping phytoplankton grow in new areas *****

14. How can a change in water temperature affect phytoplankton growth?
A, It may speed up or slow down phytoplankton growth depending on species***
B. It only affects large fish, not phytoplankton
C. Phytoplankton always die if temperature changes
D. Temperature has no effect on phytoplankton

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Engineering Challenge

Clear the Green
An engineering design challenge can not only assess learners' understanding of phytoplankton and algal blooms, but it can also strengthen problem-solving, collaboration, and scientific reasoning as learners build and test solutions. It increases engagement by giving learners ownership of a real-world problem, while providing multiple entry points for diverse learners to demonstrate understanding. This approach also reinforces the engineering design process and builds awareness of how humans can mitigate environmental challenges.

Design Challenge Scenario
Scientists found that a pond turned green and cloudy due to excessive algae growth. Algal blooms can turn water green and cloudy, block sunlight, and harm fish and people. Fish are struggling because there is less light and oxygen.

Today, you are going to be environmental engineers. Use the engineering design process to design and create a tool that makes the water clearer by removing or reducing the green color in the water.

Criteria (What It Must Do)
- Make the green water clearer than before
- Let water pass through it
- Stay together while being used
- Be able to be tested by pouring water on it or into it

Building Materials (examples)
- Plastic cup filled with green water
- Coffee filters
- Paper towels
- Sponge pieces
- Cotton balls
- Rubber bands
- Plastic spoon or craft stick

Testing Materials
- 1 clear plastic cup (250 mL / 1 cup) per group
- ¼ teaspoon green powdered drink mix, spirulina powder, or powdered food coloring
- 1 small spoon for stirring
- white paper
- paper towels
- safety goggles

Cyanobacteria (a blue-green algae) covered over half of the surface of Florida's largest freshwater lake in mid-June 2023.

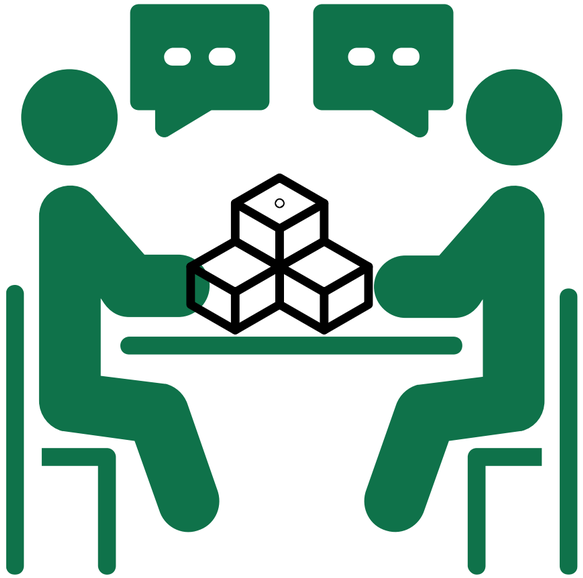
Image Credit: NASA Earth Observatory

Testing station set up
1. Fill cups with water
2. Use ¼ teaspoon (about 1 gram) of powdered drink mix per 250 mL (1 cup) of water
3. Stir

The checklist below is a quick way for learners to collect data.

How does the water look before and after testing the created solution:
Before:
☐ **Very Green** ☐ **Medium Green** ☐ **Light Green**
After:
☐ **Very Green** ☐ **Medium Green** ☐ **Light Green**

Learner Pages



NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explore

Activities

You will complete some activities to observe and explore plankton.

- **Be sure to wear eye and skin protection as needed.**
- Use caution when exploring plants. Make sure the kinds of plants used are safe to touch. Some plants can be poisonous.
- Adult supervision is needed when using cutting tools.

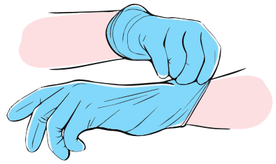
NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explore

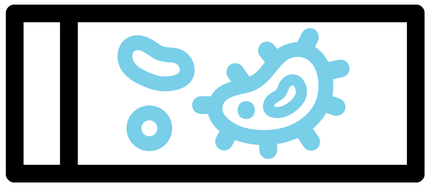
Activities

Activity 1 - Plankton Observations. Observe phytoplankton and zooplankton through prepared slides or live samples.

1. Gather materials :
   - compound and stereo microscopes
   - prepared slides of phytoplankton and zooplankton or live samples
   - optional: methyl cellulose and cotton fibers (to slow down live specimen)
   - labels for slides (to identify organisms)
   - handout or guide with images of plankton for reference
   - gloves and goggles (if using live water samples)



2. Use the microscope to observe plankton and make observations of their shapes and features. Record observations.



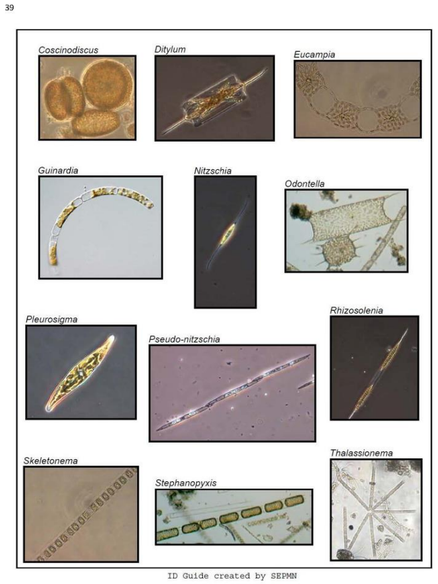
NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

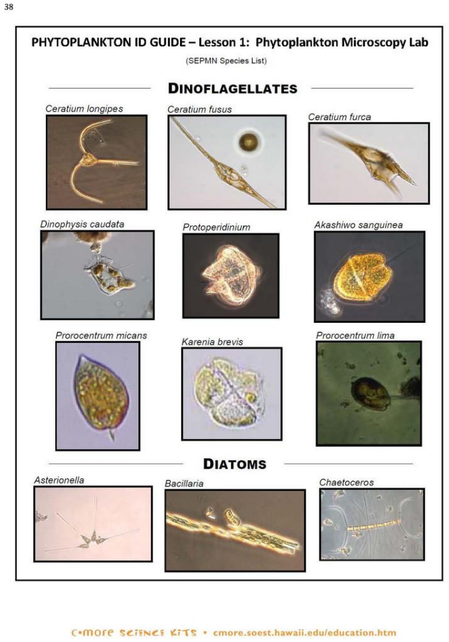
Explore

Activities

Activity 1 - Plankton Observations. Observe phytoplankton and zooplankton through prepared slides or live samples.

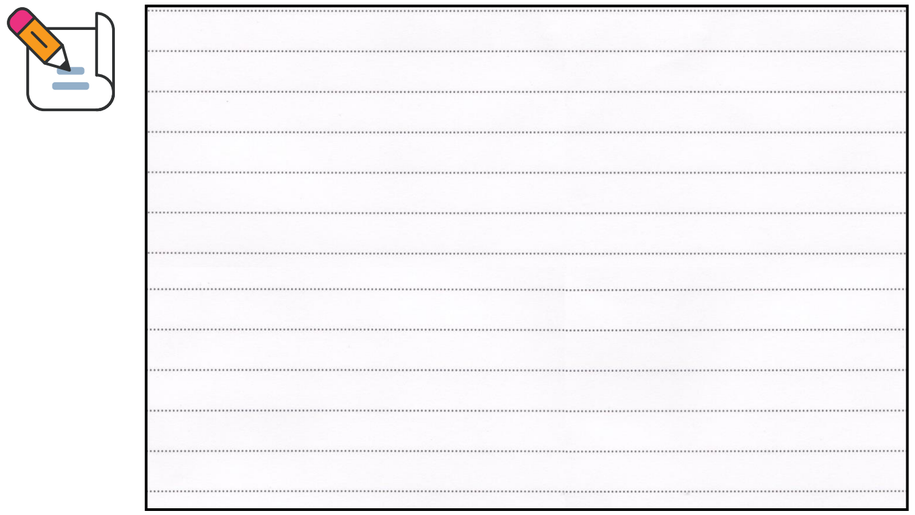
3. Match your observations to the chart. Which plankton did you identify?





Link to full size charts

4. How many were phytoplankton? How many were zooplankton?



5. Wait 10 minutes and repeat steps 2, 3 and 4.

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explore

Activities

Activity 2 - Simulating Ocean Currents and Phytoplankton Blooms - Investigate how ocean currents distribute phytoplankton and nutrients.

1. Gather materials :
   - large clear plastic bin or aquarium
   - water
   - food coloring (blue and green)
   - small lightweight items to represent phytoplankton (e.g., paper confetti, foam pieces)
   - handheld fan (to simulate wind)
   - ice cubes (to simulate temperature changes)

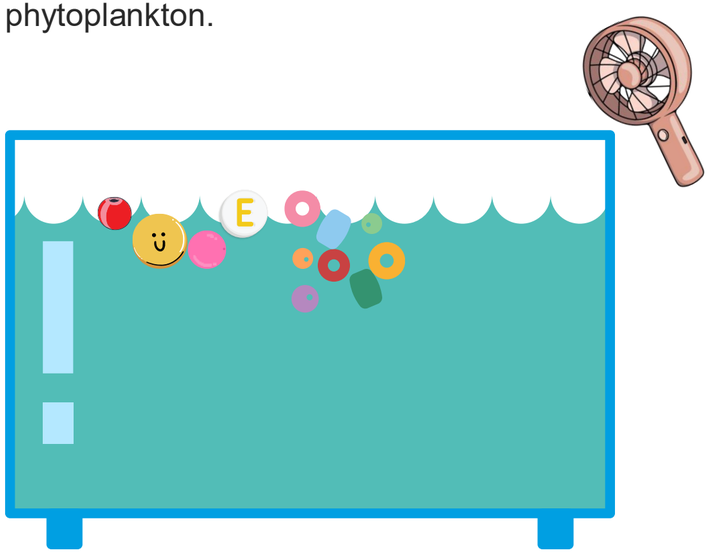
2. Fill the bin with water and add a few drops of blue and green food coloring to represent nutrient-rich water.

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explore

Activity 2 - Simulating Ocean Currents and Phytoplankton Blooms - Investigate how ocean currents distribute phytoplankton and nutrients.

3. Scatter the lightweight items on the surface to simulate phytoplankton.



4. Use the hairdryer or fan to create “currents” on the water surface. Observe how the “currents” move the phytoplankton horizontally. Record observations.

5. Add ice cubes to one end of the bin and observe how colder, denser water sinks, creating upwelling that mixes the colored water vertically and moves the "phytoplankton."

6. Discuss how upwelling zones increase nutrient availability, leading to phytoplankton blooms.

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

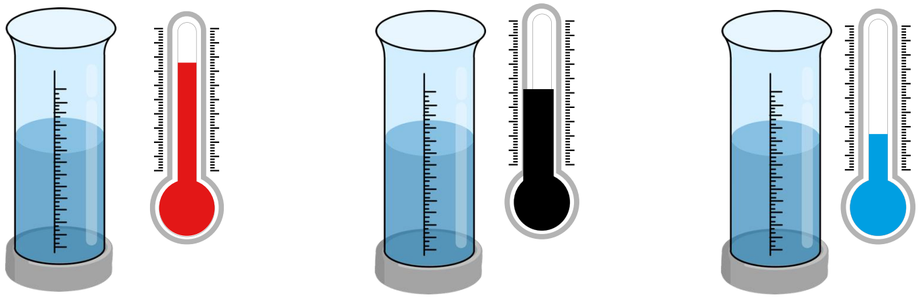
Explore

Activities

Activity 3 - Investigating the Impact of Water Temperature on Phytoplankton Growth - Use observations and data to construct an argument about how changes in water temperature affect phytoplankton populations.

1. Gather materials :
   - 3 clear plastic containers or jars (baby food jars)
   - water (room temperature, warm, and cold)
   - liquid chlorophyll solution (or green food coloring as a substitute)
   - droppers or pipettes
   - light source (e.g., desk lamp)
   - ruler (for measuring light penetration depth)
   - thermometers
   - data recording sheet

2. Fill three containers with water: one with room temperature, one with warm water, and one with cold water.



3. Add the same amount of liquid chlorophyll (or green food coloring) to each container.

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

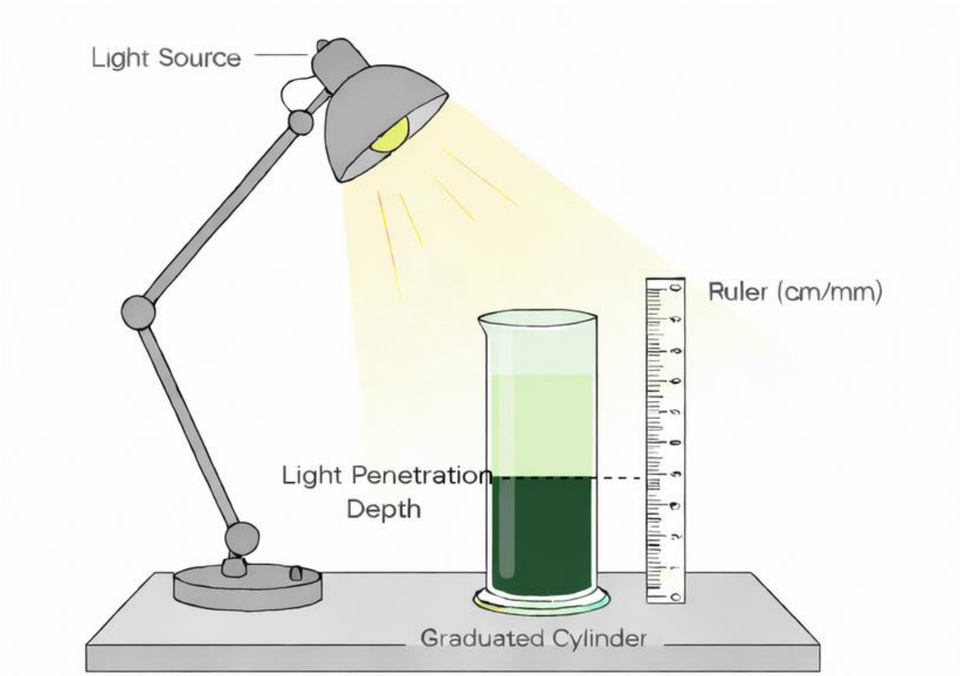
Explore

Activity 3 - Investigating the Impact of Water Temperature on Phytoplankton Growth - Use observations and data to construct an argument about how changes in water temperature affect phytoplankton populations.

4. Place the containers under a light source to simulate sunlight.

5. Use a ruler to measure how far light penetrates into each container. Record data.

10 min



Citation: AI-generated illustration of light penetration depth experiment. Created with ChatGPT image generation tools, 2026.

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explore

Activity 3 - Investigating the Impact of Water Temperature on Phytoplankton Growth - Use observations and data to construct an argument about how changes in water temperature affect phytoplankton populations.

6. After 10 minutes, use a ruler to measure how far light penetrates into each container. Record data.

Container	Temperature (°C)	Light Penetration Depth (cm) – 10 min	Color Intensity (1=faint – 5=very dark) – 30 min	Notes
Cold Water				
Room Temp				
Warm Water				

- Record the actual water temperature using a thermometer.
- Measure how far light penetrates before being completely diffused.
- Rate color intensity as an indicator of chlorophyll concentration.
- Note any observations (e.g., “Warm water looks more cloudy,” “Color faded,” etc.).

7. After 30 minutes, observe changes in the "phytoplankton" dispersion or concentration.
Measure light penetration again to assess changes in the density of the chlorophyll solution.

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explore

Activities

Activity 4 - Analyzing Data: Phytoplankton Bloom Investigation

1. Gather materials :
   - one algal bloom data table (provided below)
   - optional:
     - graph paper or digital graph tool
     - calculator

2. Analyze the data to discover how nutrients and temperature affect phytoplankton populations and predict how these changes impact food webs and the amount of oxygen available.

Energy Flow Data Table - Aquatic Ecosystem

Day	Water Temp (°C)	Nitrate (mg/L)	Chlorophyll-a (µg/L)	Dissolved Oxygen (mg/L)
1	18	0.4	3.2	9.5
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NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explain

Vocabulary Development

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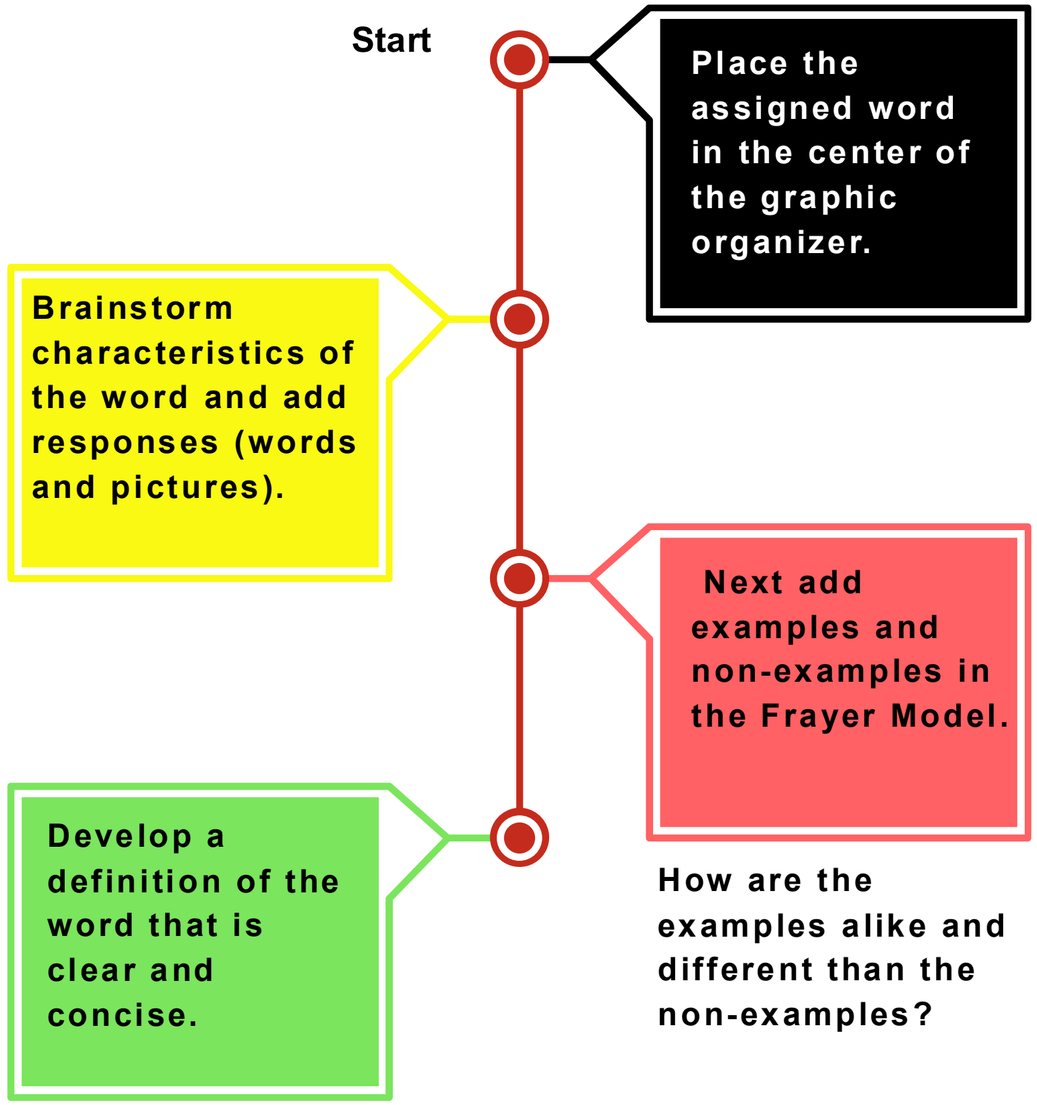


NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

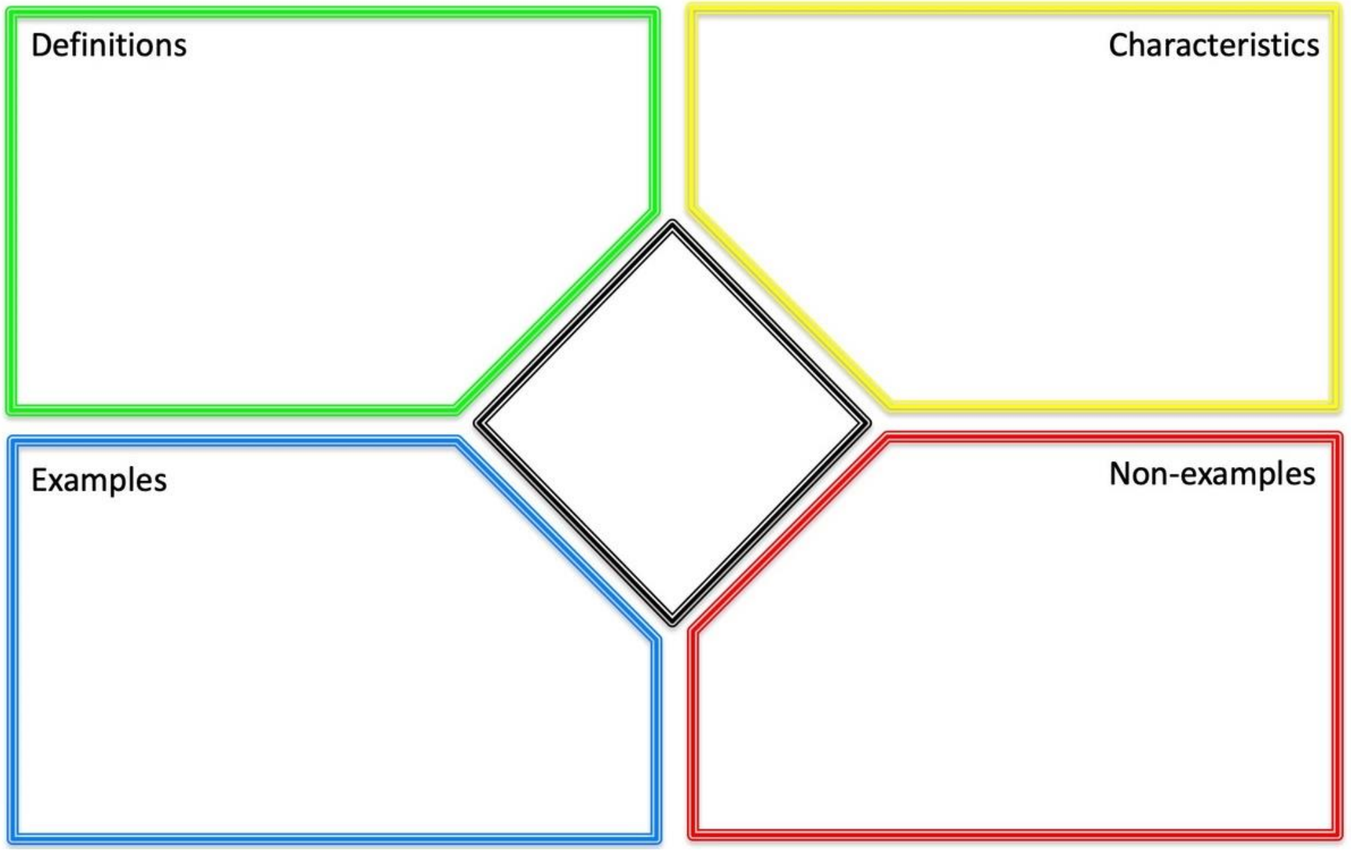
Explain

Vocabulary Development

Complete a Frayer Model with your group using your assigned word and fill in the graphic organizer. We will share some as a class.

Frayer Model for Vocabulary Development

Use the graphic organizer to write definitions, characteristics, examples and non-examples for a vocabulary word. You can include drawings, graphics, and diagrams.



NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explain

Vocabulary Words

bloom - is a rapid increase in the number of plankton in water.

Image credit: NASA.gov
https://www.nagwa.com/en/explainers/434109472654/

carbon dioxide - is a gas used by plants during photosynthesis.

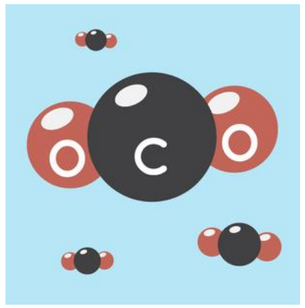


Image credit: NASA

climate - is the long-term weather pattern of an area, including temperature, precipitation, and wind.

Image credit: NASA Space Place

consumer - is a living thing that eats other organisms for energy.

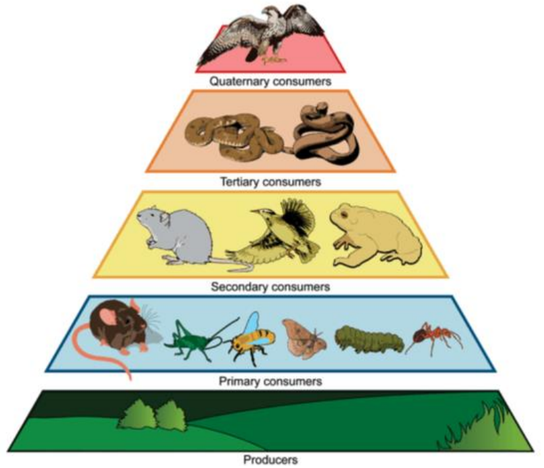


Image credit: NOAA

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explain

Vocabulary Words

food web - is a system of connected food chains showing how energy moves through an ecosystem.

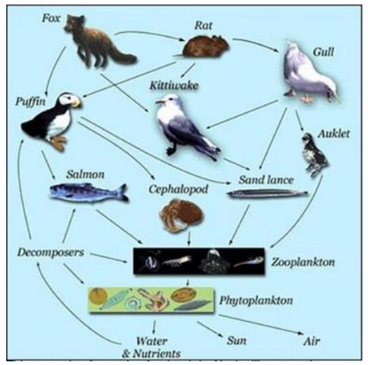


Image credit: NASA Earthdata

energy transfer - is the movement of energy from one organism to another in a food chain or food web.

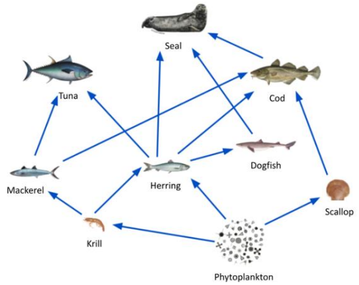


Image credit: NOAA

microscopic - refers to something so small it can only be seen with a microscope.

Image credit: NASA

oxygen - is a gas found in air that cells need to live (represented by O2)

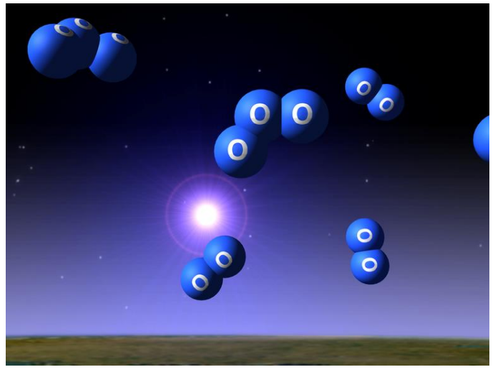


Image credit: NASA SVS

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Explain

Vocabulary Words

photosynthesis- is the process in green plants and certain other organisms that uses energy from sunlight, water, and carbon dioxide to make food (a sugar called glucose).

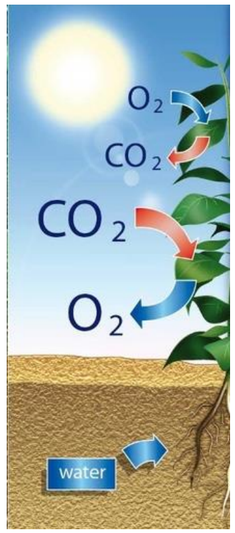


Image credit: NASA JLP Earth Science

plankton – are tiny living organisms that float or drift in water.

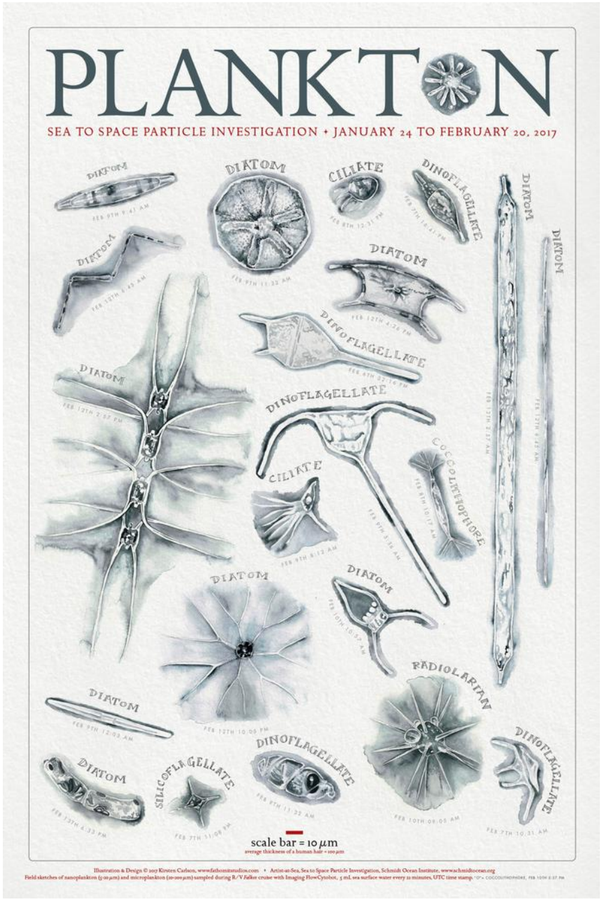


Image credit: NASA PACE

phytoplankton- is the plant-like plankton that make their own food through photosynthesis.

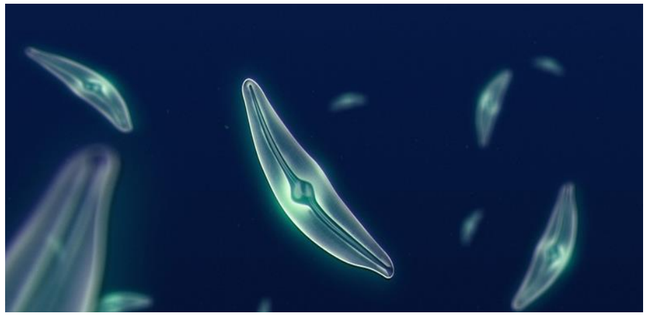


Image credit: NASA PACE

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Vocabulary Words

producer – is a living thing that makes its own food (like phytoplankton).

Peppers harvested from the Plant Habitat-04 experiment are set aside for the astronauts to eat. Twelve other peppers harvested from the experiment will return to Earth for analysis.
Credits: NASA

Image credit: NASA PACE

zooplankton – is animal-like plankton that eat phytoplankton and other organisms.

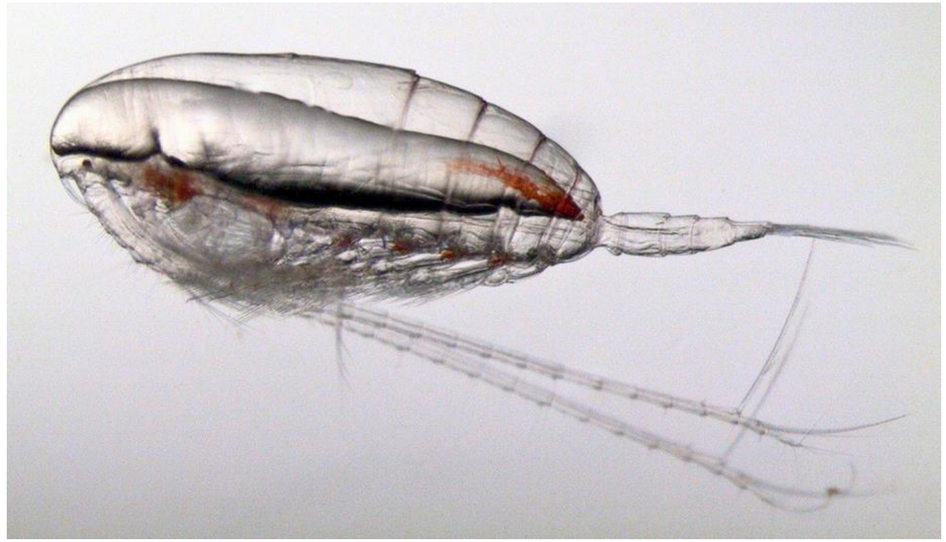


Image credit: NASA PACE

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Extend

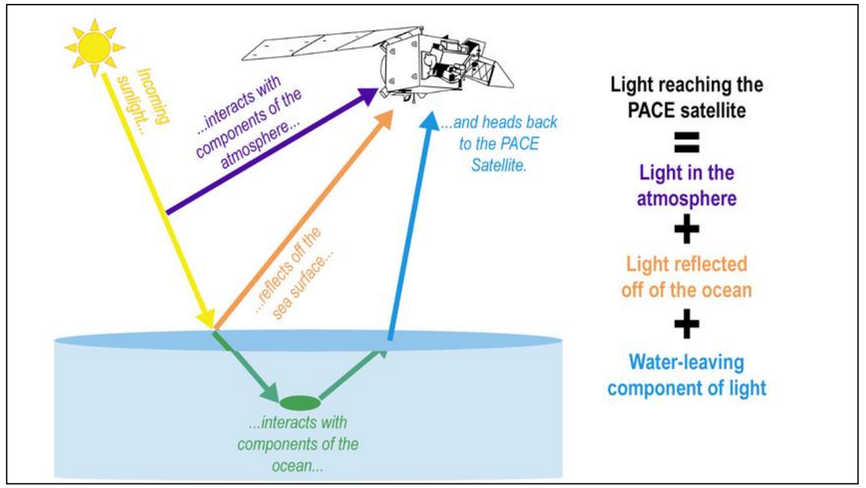
NASA Connection

Visit the PACE interactive website page to learn how a photon of light from the sun is used to help us learn about Earth's oceans and atmosphere. Respond to one of the prompts.

Link to webpage -https://pace.oceansciences.org/pace_eq_intro.htm

Describe one way scientists use measurements of light to learn about what is happening in the ocean or atmosphere. Why is breaking down the light (by wavelength or color) important to scientists?

Draw a diagram showing how light changes as it passes through water. Include arrows to show light being absorbed, scattered out of the path, and scattered into the path.



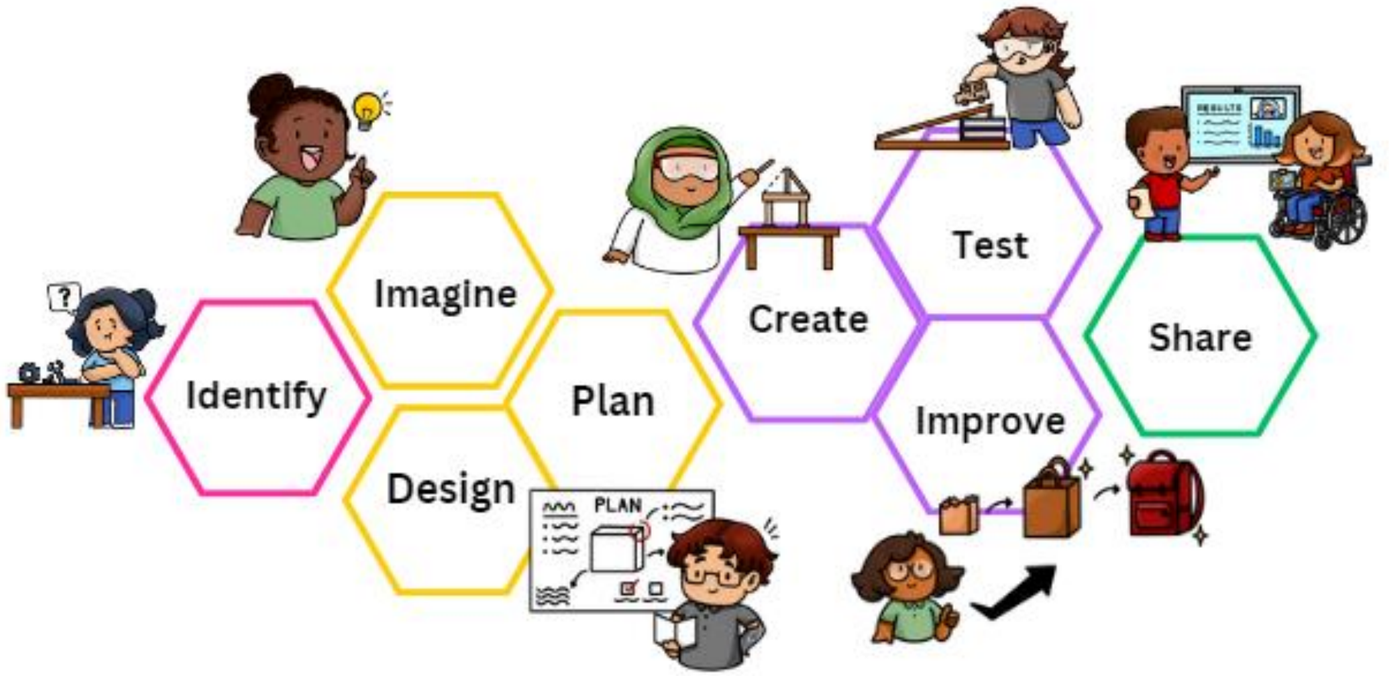
NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Extend

NASA Connection

Engineering Design Challenge

Use your new knowledge to design a tool that makes the water clearer.



Use this link to download a copy of the engineering design packet to complete this challenge.

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Extend

Engineering Challenge

Clear the Green

An engineering design challenge can not only assess learners' understanding of phytoplankton and algal blooms, but it can also strengthen problem-solving, collaboration, and scientific reasoning as learners build and test solutions. It increases engagement by giving learners ownership of a real-world problem, while providing multiple entry points for diverse learners to demonstrate understanding. This approach also reinforces the engineering design process and builds awareness of how humans can mitigate environmental challenges.

Design Challenge Scenario

Scientists found that a pond turned green and cloudy due to excessive algae growth. Algal blooms can turn water green and cloudy, block sunlight, and harm fish and people. Fish are struggling because there is less light and oxygen.

Today, you are going to be environmental engineers. Use the engineering design process to design and create a tool that makes the water clearer by removing or reducing the green color in the water.

Cyanobacteria (blue-green algae) covered over half of the surface of Florida's largest freshwater lake in mid-June 2023.

Image Credit: NASA Earth Observatory

Criteria (What It Must Do)

- Make the green water clearer than before
- Let water pass through it
- Stay together while being used
- Be able to be tested by pouring water on it or into it

Building Materials (examples)

- Plastic cup filled with green water
- Coffee filters
- Paper towels
- Sponge pieces
- Cotton balls
- Rubber bands
- Plastic spoon or craft stick

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Evaluate

Identify Additional Misconceptions

What are common misconceptions people have about phytoplankton? How can you correct these misconceptions?

NASA Spotlite Videos

Carefully re-watch the NASA Spotlite videos about phytoplankton.

Spotlite: Where can you find phytoplankton?

NASA Spotlite: Where Do We Find Phytoplankton?
Link - https://science.nasa.gov/eclips/videos/where-can-you-find-phytoplankton/

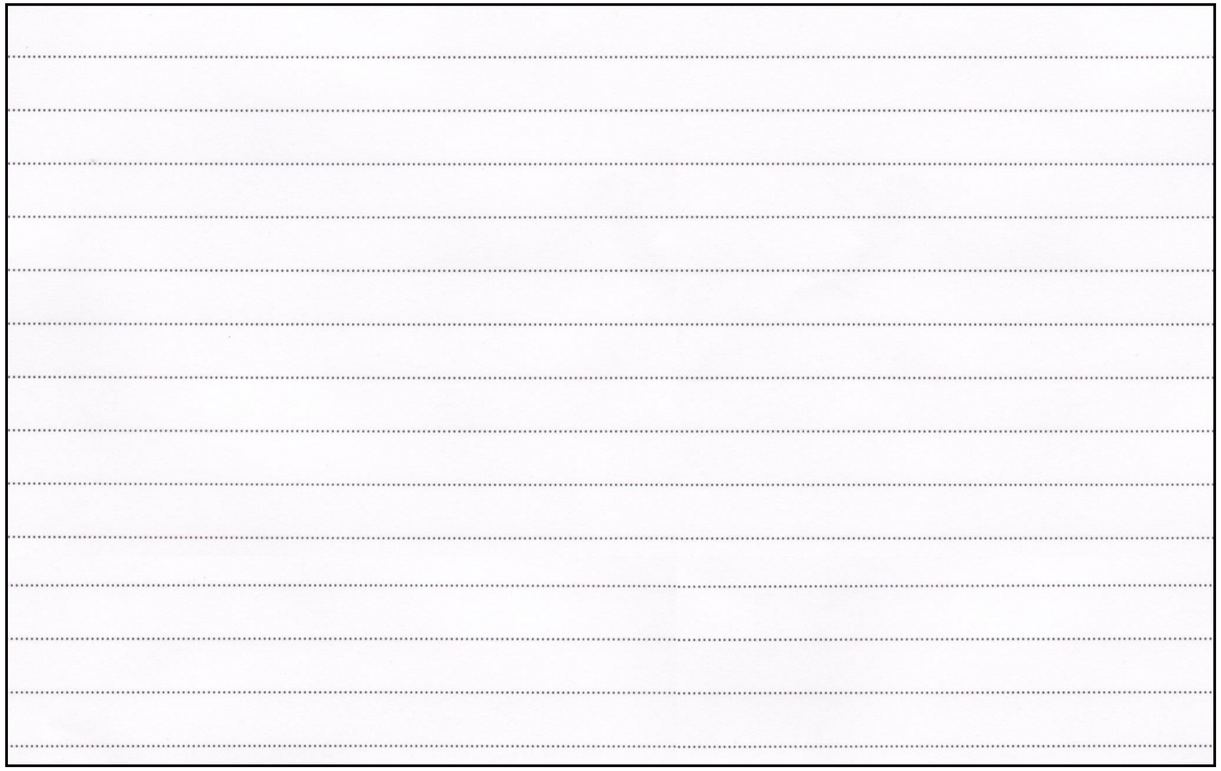
NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

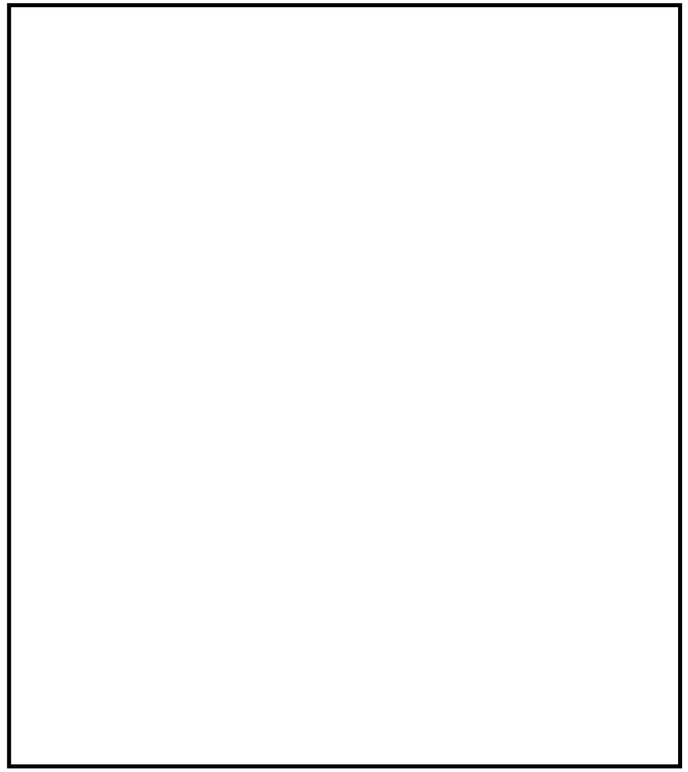
Evaluate

Vocabulary Review

Use your new vocabulary words to respond to this prompt. Add drawings or images to support your response.

Prompt:You are a scientist on a mission. You have been tasked with determining why all the phytoplankton in a body of water have suddenly vanished! Write or draw to explain what happens next. How does this affect ocean life, the air we breathe, and people in your community?





NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Evaluate

Pretest & Posttest

1. **What are phytoplankton?**
A. Microscopic animals in the ocean
B. Microscopic plant-like organisms that perform photosynthesis
C. Large algae found on the ocean floor
D. Tiny rocks that drift in the water

2. Where are phytoplankton most commonly found?
A. Deep ocean trenches
B. Near the surface of the ocean where sunlight is available
C. On the ocean floor
D. In frozen glaciers

3. What process do phytoplankton use to make their own food?
A. Respiration
B. Fermentation
C. Decomposition
D. Photosynthesis

4. Which molecule do phytoplankton produce during photosynthesis that is essential for animals to survive?
A. Carbon dioxide
B. Nitrogen
C. Oxygen
D. Ammonium

5. Why is it important for scientists to monitor water temperature in oceans when studying phytoplankton?
A. Because temperature does not affect phytoplankton at all
B. Because temperature can influence growth, reproduction, and distribution of phytoplankton
C. Because only large fish respond to temperature changes
D. Because phytoplankton are unaffected by nutrients

6. What role do phytoplankton play in the carbon cycle?
A. They release carbon dioxide into the atmosphere
B. They use carbon dioxide during photosynthesis
C. They prevent carbon from entering the ocean
D. They turn carbon into rock

7. Which of these factors affect phytoplankton growth?
A. Availability of sunlight
B. Temperature of the water
C. Nutrient levels in the water
D. All of the above

8. What are harmful algal blooms?
A. Excessive phytoplankton growth that produces toxins that can harm aquatic life
B. Excessive phytoplankton growth that clean the water
C. Excessive phytoplankton growth that builds coral reefs
D. Excessive phytoplankton growth that forms when the ocean is too cold

9. What tool does NASA use to monitor phytoplankton?
A. Telescopes
B. Satellites
C. Submarines
D. Buoys

10. If phytoplankton populations decrease significantly, what would most likely happen to the ecosystem?
A. Oxygen levels would drop and food availability for fish would decrease
B. Nitrogen levels would increase automatically
C. Dead zones would disappear
D. Water temperature would rise

NASA Spotlite Interactive Lesson: Why Are Phytoplankton Important?

Evaluate

Pretest & Posttest

11. **Which of the following best describes the relationship between phytoplankton and zooplankton?**
A. Phytoplankton eat zooplankton for energy
B. Zooplankton eat phytoplankton for energy
C. Zooplankton and phytoplankton compete for the same food
D. Phytoplankton and zooplankton do not interact

12. **Energy in a marine food web flows from:**
A. Zooplankton → Phytoplankton → Fish
B. Phytoplankton → Zooplankton → Fish
C. Fish → Zooplankton → Phytoplankton
D. Phytoplankton → Fish → Zooplankton

13. **How do ocean currents affect phytoplankton blooms?**
A. Currents prevent phytoplankton from growing anywhere
B. Currents do not affect phytoplankton distribution
C. Currents increase water temperature, killing phytoplankton
D. Currents move nutrients, helping phytoplankton grow in new areas

14. **How can a change in water temperature affect phytoplankton growth?**
A. It may speed up or slow down phytoplankton growth depending on species
B. It only affects large fish, not phytoplankton
C. Phytoplankton always die if temperature changes
D. Temperature has no effect on phytoplankton