NO PREP

Phytoplankton

The Powerhouse of the Oceans

Includes: Student reading, case study, differentiated questions, teacher key

Name: Period: Date:

Phytoplankton: The Powerhouse of the Oceans

Phytoplankton are often called the grass of the sea because they play the same role in the ocean that plants do on land: they convert sunlight into usable energy and form the base of nearly all marine food webs. These tiny organisms drift in the sunlit layers of the ocean, using photosynthesis to transform carbon dioxide and water into glucose while releasing oxygen into the atmosphere. Even though they are microscopic, their collective impact is massive. Scientists estimate that phytoplankton produce more than half of the Earth's oxygen supply, making them critical for sustaining life not only in the oceans but also on land. Phytoplankton are incredibly diverse, with thousands of species that vary in size, shape, and ecological role. Unlike land plants, they do not have roots, stems, or leaves. Instead, their adaptations allow them to float near the ocean surface where light is available. By providing the first step of energy transfer in food webs, they support everything from tiny zooplankton to the largest whales. Without phytoplankton, marine ecosystems would collapse, and the global climate would be drastically different.

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Types of Phytoplankton

Phytoplankton can be classified into several groups, each with distinct features and ecological importance. Diatoms are among the most abundant; they have intricate silica shells called frustules that resemble glass. These shells sink to the seafloor after the diatoms die, contributing to marine sediments. Dinoflagellates are another key group, recognizable by their whip-like flagella that allow them to move through the water. Some species are bioluminescent, glowing when disturbed, while others cause harmful algal blooms. Coccolithophores are covered with tiny calcium carbonate plates that reflect light, sometimes making the ocean appear turquoise during massive blooms. Each group plays a unique role in marine environments. Diatoms dominate in nutrient-rich waters, especially in colder regions, while

dinoflagellates thrive in warmer, stratified waters. Coccolithophores contribute significantly to the global carbon cycle because their calcium plates sink and lock carbon away in sediments. These differences highlight how phytoplankton species adapt to regional conditions and together regulate ocean productivity.

Phytoplankton and the Food Web

The importance of phytoplankton extends beyond their role as producers. They serve as the primary food source for zooplankton, which in turn feed small fish, crustaceans, and eventually larger predators like tuna, sharks, and whales. In this way, phytoplankton indirectly support commercial fisheries that humans depend on for food. Their abundance or decline directly affects the health of marine populations, making them an important indicator of ecosystem stability. Phytoplankton are also sensitive to environmental changes such as nutrient availability, temperature shifts, and light conditions. When nutrients like nitrogen and phosphorus enter the water from upwelling or river runoff, phytoplankton populations can explode in growth, forming massive blooms. While these blooms often provide food for zooplankton and fish, excessive growth can sometimes lead to harmful algal blooms. The balance between phytoplankton growth and consumption is therefore central to ocean ecology.

Global Importance of Phytoplankton

Beyond their ecological role, phytoplankton influence Earth's climate. Through photosynthesis, they absorb vast amounts of carbon dioxide, helping regulate atmospheric greenhouse gases. This process, called the biological pump, transfers carbon from the atmosphere into the deep ocean, where it may remain for centuries. Without this mechanism, climate change would accelerate much faster. Scientists also use phytoplankton as indicators of environmental change. Satellite images that track chlorophyll levels reveal how ocean productivity varies seasonally and regionally. Declines in phytoplankton populations due to warming seas, acidification, or pollution could have far-reaching consequences for marine ecosystems and human societies alike. Because they lie at the intersection of biology, chemistry, and climate science, phytoplankton are among the most important organisms on Earth.

Key Information: Table: Major Groups of Phytoplankton

Group	Defining Feature	Ecological Role
Diatoms	Silica shells (frustules)	Thrive in cold, nutrient-rich waters
Dinoflagellates	Flagella for movement	Can cause harmful algal blooms
Coccolithophores	Calcium carbonate plates	Important for carbon storage

Case Study: The North Atlantic Spring Bloom

One of the most famous examples of phytoplankton dynamics is the North Atlantic spring bloom. Every year, as winter ends and sunlight increases, the cold nutrient-rich waters of the North Atlantic experience a surge in phytoplankton growth. The bloom is so massive that it can be seen from space, covering thousands of square kilometers. Researchers have studied this phenomenon for decades because it represents one of the largest transfers of carbon from the atmosphere into the ocean. During the bloom, phytoplankton populations skyrocket, feeding enormous swarms of zooplankton such as copepods. This in turn supports fish populations like herring and mackerel, which migrate to these areas to take advantage of the food supply. The North Atlantic spring bloom demonstrates the connection between plankton productivity and the marine food chain. However, it also shows how short-lived these events can be. As nutrients are consumed, the bloom quickly declines, and the balance between producers and consumers resets. The bloom is not only critical for marine life but also for global carbon cycling, as much of the carbon captured during this period sinks into the deep ocean.

1. How does the North Atlantic spring bloom affect fish populations?

2. Why is this bloom important for the global carbon cycle?

_____

_____

Multiple Choice

1. What percentage of Earth's oxygen is produced by phytoplankton?
    a) About 5%
    b) More than 50%
    c) About 10%
    d) Approximately 25% of atmospheric oxygen

2. Which phytoplankton group has glass-like silica shells?
    a) Dinoflagellates
    b) Cyanobacteria
    c) Diatoms
    d) Coccolithophores

3. What is the biological pump?
    a) The sinking of carbon from phytoplankton into the deep ocean
    b) A mechanical device scientists lower to study deep water pressure
    c) The movement of zooplankton during migration
    d) A method used by whales to feed

Matching

Write the letter of the correct definition on the line next to each term.

Term	Definition
1. ___ Dinoflagellates	A) Glass-like silica shells
2. ___ Coccolithophores	B) Produce more than half of Earth's oxygen
3. ___ Diatoms	C) Carbon storage through calcium plates
4. ___ Zooplankton	D) Flagella for movement
5. ___ Phytoplankton (general)	E) Main consumers of phytoplankton

Fill-in-the-Blank

1. Phytoplankton are often called the "_____ of the sea."

2. The North Atlantic spring bloom can be seen from _____.

3. The biological pump helps regulate Earth's _____ gases.

Short Answer

Answer each question in 2-4 complete sentences.

1. Explain why phytoplankton are considered the base of the marine food web.

_____

_____

_____

2. Describe one ecological difference between diatoms and coccolithophores.

_____

_____

_____

3. Why do scientists monitor phytoplankton from space using satellites?