NO PREP

Diatoms, Dinoflagellates, and Coccolithophores Explained

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

Name: Period: Date:

Diatoms, Dinoflagellates, and Coccolithophores Explained

When you look out over the ocean, it may appear vast and empty, but beneath the surface, there are trillions of microscopic organisms shaping life as we know it. Among the most important of these are diatoms, dinoflagellates, and coccolithophores. These organisms are all types of phytoplankton, tiny producers that perform photosynthesis in the sunlit waters of the ocean. Each group has distinct features, adaptations, and ecological roles, making them critical to both the marine food web and the regulation of Earth's climate.

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Diatoms: Nature's Glass Houses

Diatoms are among the most abundant phytoplankton in the world, particularly in colder and nutrient-rich waters. Their most defining characteristic is their silica-based cell walls, called frustules, which resemble glass. These frustules come in a variety of beautiful and intricate shapes, almost like microscopic works of art. Because they are heavy, diatom shells often sink after death, carrying carbon with them to the seafloor. This makes diatoms important players in the biological pump, which helps regulate Earth's climate by storing carbon in deep-sea sediments. In addition to their ecological role, diatoms are highly efficient at photosynthesis, producing an estimated 20–25% of the world's oxygen. Their ability to bloom quickly when nutrients are abundant supports huge populations of zooplankton, fish, and larger predators. This rapid growth and high productivity mean that diatoms are

often considered the backbone of the marine food web in colder regions such as the North Atlantic and the Southern Ocean. Without them, much of the ocean's biodiversity would struggle to survive.

Dinoflagellates: The Movers and Shakers

While diatoms drift passively, dinoflagellates are unique because they can move through the water using whip-like structures called flagella. This mobility allows them to adjust their depth in the water column to find light or nutrients. Dinoflagellates are most common in warm, stratified waters where they often thrive under stable conditions. Dinoflagellates are also famous for their diversity of behaviors. Some are photosynthetic, while others are mixotrophic, meaning they can both photosynthesize and consume other organisms for food. A few are bioluminescent, glowing with light when disturbed by waves or swimming fish, creating shimmering displays sometimes called "sea sparkle." However, dinoflagellates can also cause ecological problems. Certain species form harmful algal blooms, producing toxins that kill fish, shellfish, and even affect human health. These events, often referred to as red tides, disrupt ecosystems and damage coastal economies. Despite their dangerous side, dinoflagellates are crucial in tropical and subtropical waters, fueling marine ecosystems where diatoms are less dominant.

Coccolithophores: The Ocean's Carbon Guardians

Unlike diatoms and dinoflagellates, coccolithophores are covered with microscopic calcium carbonate plates known as coccoliths. When viewed under a microscope, these plates look like tiny shields, giving coccolithophores a distinctive and elegant appearance. Coccolithophores are particularly important for the carbon cycle because they use calcium carbonate to build their plates, locking away carbon in the process. When these organisms die, their coccoliths sink and accumulate on the ocean floor, forming chalk and limestone deposits over geological time. Large blooms of coccolithophores can sometimes be seen from space, turning parts of the ocean a bright turquoise due to the way sunlight reflects off their calcium plates. These blooms play a major role in balancing carbon between the atmosphere and the ocean. At the same time, coccolithophores are sensitive to ocean acidification, which makes it harder for them to build their plates. Their vulnerability to changing pH levels

raises concerns about how future climate shifts may affect their survival and the global carbon cycle.

Comparing the Three Groups

Although diatoms, dinoflagellates, and coccolithophores are all phytoplankton, their differences are key to understanding how the ocean works. Diatoms dominate in cold, nutrient-rich regions, dinoflagellates excel in warmer and stable waters, and coccolithophores specialize in balancing the carbon cycle through their calcium carbonate plates. Together, these three groups create a dynamic system where productivity shifts depending on environmental conditions. Their combined actions ensure that marine ecosystems remain productive and that carbon is constantly cycled between the atmosphere and the ocean. However, modern threats such as climate change, warming waters, and acidification may alter the balance between them. Studying these organisms is essential not only for protecting ocean health but also for understanding how the Earth's climate may change in the coming decades.

Key Information: Table: Comparing Phytoplankton Groups

Group	Unique Feature	Ecological Importance
Diatoms	Silica frustules	Store carbon and support cold-water food webs
Dinoflagellates	Motile with flagella	Thrive in warm waters; can cause red tides
Coccolithophores	Calcium carbonate plates	Major role in carbon storage and climate regulation

Case Study: The Coccolithophore Bloom in the Bering Sea

In the summer of 1997, satellite imagery revealed a massive coccolithophore bloom in the Bering Sea. The bloom stretched over an area of more than 250,000 square kilometers, making the water appear an unusual bright turquoise color. Scientists quickly began studying the bloom, intrigued by its scale and its impact on the marine ecosystem. Unlike many blooms dominated by diatoms, this event was almost entirely driven by coccolithophores. The bloom had significant ecological consequences. Zooplankton that typically fed on diatoms struggled to consume the smaller, harder coccolithophores, reducing food availability for fish populations. This, in turn, caused cascading effects throughout the food web, from seabirds to marine mammals. At the same time, the massive bloom increased the amount of carbon being locked into the ocean floor through sinking coccoliths. The event highlighted both the strengths and vulnerabilities of coccolithophores. While they are vital in capturing carbon, their dominance can sometimes disrupt established food web dynamics.

1. How did the 1997 coccolithophore bloom affect fish and zooplankton in the Bering Sea?

2. Why was this bloom significant for the carbon cycle?

Multiple Choice

1. What makes diatoms especially important for carbon storage?

    a) Their silica shells that sink after death

    b) Their ability to move through water with flagella

    c) Their ability to cause harmful blooms

    d) Their bioluminescent properties

2. Which phytoplankton group is most associated with red tides?

    a) Coccolithophores

    b) Dinoflagellates

    c) Diatoms

    d) Cyanobacteria

3. Why are coccolithophores vulnerable to ocean acidification?

    a) Acidification disrupts silica production

    b) They require significantly more oxygen during acidification

    c) Acidification makes calcium carbonate harder to build

    d) They cannot move to avoid low pH zones

Matching

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

Term	Definition
1. ___ Diatoms	A) Cause harmful algal blooms and red tides
2. ___ Dinoflagellates	B) Glowing light some plankton give off when disturbed
3. ___ Coccolithophores	C) Form silica shells that sink with carbon
4. ___ Phytoplankton (general)	D) Bright turquoise blooms visible from space
5. ___ Sea sparkle	E) Serve as base of marine food webs

Fill-in-the-Blank

1. Dinoflagellates move using structures called _____.

2. Coccolithophores produce protective plates made of _____.

3. Diatom shells, known as _____, resemble glass.

Short Answer

Answer each question in 2-4 complete sentences.

1. Explain one way coccolithophore blooms affect marine food webs.

_____

_____

_____

2. How do diatoms contribute to the biological pump?

_____

_____

_____

3. What adaptation allows dinoflagellates to adjust their position in the water column?

_____

_____

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