PHYTOPLANKTON

Phytoplankton are tiny plants and algae that live throughout the global ocean in the upper sunlit layer. They serve as the base of the marine food web and produce oxygen vital to life. When there are large amount of phytoplankton in the ocean, they change the colour of the water. The colour we see depends on the type of phytoplankton suspended in the water.

By monitoring global phytoplankton communities and abundance with unprecedented detail using PACE , which carries NASA's most advanced colour sensor, we get a better understanding of the complex systems that drive ocean ecology and the health.

INTRODUCTION

The word 'phytoplankton' is derived from the Greek words Phyto (plant) and plankton (made to wander or drift).

- These are microscopic organisms that live in watery environments, bot salty and fresh.
- Most phytoplankton are single-celled plants while some are bacteria or protists (simple eukaryotic organisms that are neither plants nor animals or fungi).
- Among the common kinds are cyanobacteria(photosynthesizing bacteria), silica-encased diatoms (plant-like), dinoflagellates, green algae and chalk-coated coccolithophores.

When conditions are right, phytoplankton population can grow explosively, a phenomenon known as bloom.

Blooms in the ocean may cover hundreds of square kilometres and are easily visible in satellite images.

A bloom may last several weeks, but the life span of any individual phytoplankton is rarely more than a few days.

SURVIVAL OF PHYTOPLANKTON

Phytoplankton growth depends on the availability of sunlight, CO_2 and nutrients like nitrate, phosphate, silicate and calcium at various levels depending on the species. Due to this reason, they live in the surface waters of the ocean.

All phytoplankton photosynthesize, but some get additional energy by consuming other organisms. Whenever the supply of surface waters diminishes due to the photosynthesis process, it is replenished from the atmosphere above.

The major limiting factor regulating phytoplankton growth is the availability of nutrients. This is the reason of more abundance of phytoplankton in some areas of the ocean compared to others. Nutrients can also be supplied by following sources:

- Since most nutrients are found in colder depth of the ocean, whenever those water are bought near the surface, upwelling, the oceans are essentially fertilized and the plankton bloom.
- High chlorophyll concentrations line the coasts where nutrients wash into the

ocean from the land. This runoff may carry fertilizers and other nutrients applied to agricultural fields, providing phytoplankton the nutrients needed to thrive and bloom.

- Dust can contain soluble iron, which is an essential nutrient for phytoplankton growth and development.

Other factors, like water temperature and salinity, water depth, wind and what kind of predators are grazing, also influence phytoplankton growth.

INTERACTION WTH OTHER SPHERES

BIOSPHERE

Phytoplankton, responsible for nearly half of the planet's primary production, covert carbon dioxide, sunlight and nutrients into organic matter.

They are the foundation of the aquatic food web, the primary producers, which means the entire marine food chain depends on the supply of phytoplankton. If the plankton disappear, the chain is broken and eventually, the animals will suffer.

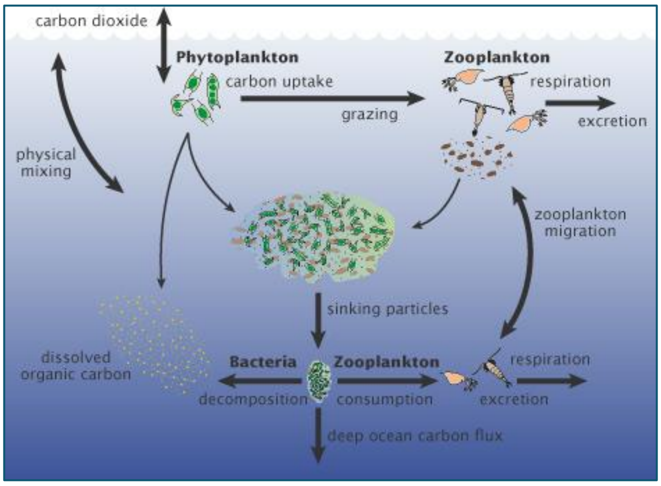
They are such important sources of food for many marine animals that waters rich in phytoplankton usually support a thriving, diverse marine ecosystem.

ATMOSPHERE

(Oxygen Production)

During photosynthesis, phytoplankton capture and store solar energy, where they remove carbon dioxide from seawater and release oxygen as a by-product.

Some of the carbon dioxide is carried to the depth ocean floor when a phytoplankton die. The carbon is soon covered by other material sinking to the ocean bottom while some is transferred to different layers of the ocean as phytoplankton are eaten by other creatures, which themselves reproduce, generate waste and die.



There are trillions of phytoplankton in the sea which together convert huge quantities of carbon dioxide into living matter. In that process, they release a major percentage of the world's oxygen into the atmosphere.

Scientists estimate that at least 50 percent of the oxygen in our atmosphere has been produced by phytoplankton.

They are also responsible for drawing down significant portions of CO_2 from the air. This allows the oceans to absorb additional CO_2 form the atmosphere. A decline in phytoplankton populations would result in higher levels of CO2 in the atmosphere.

Therefore, even small changes in the growth of phytoplankton may effect atmospheric CO_2 concentrations, which would feed back to global surface temperature.

GEOSPHERE

(Short and Long term Carbon Cycle)

Phytoplankton, responsible for around 50% of Earth's photosynthesis, play a key role in regulating atmospheric carbon, with over 99.9% of carbon dioxide incorporated into living things over time buried in marine sediments.

Coccolithophores, a type of phytoplankton, contribute to this process by storing carbon in their scales, which can sink to the ocean floor and become a long-term carbon sink.

CRYOSPHERE

(Melting Sea Ice)

Phytoplankton are influenced by Earth's cryosphere. As global temperatures rise and sea ice melts, it impacts these organisms. Phytoplankton thrive in the ocean's surface (top) layer, relying on sunlight for growth. With less ice, more sunlight penetrates the water, promoting their growth.

CYCLING OF ENERGY & MATTER

The patterns of distribution of phytoplankton that we spot are related to both physical and biological processes. NASA scientists have observed that rising sea surface temperatures lead to a global decline in phytoplankton productivity. This is because warmer waters reduce vertical mixing between nutrient-rich deep (denser) waters and surface (less dense) waters, where phytoplankton grow. As surface water warms, layering increases, further limiting nutrient transfer, which in turn decreases phytoplankton growth. Conversely, cooler temperatures promote better mixing and higher productivity.

MEASURING PHYTOPLANKTON

The ocean, covering 70% of Earth, is home to vast amounts of microscopic life, particularly phytoplankton, which far outnumber larger marine organisms. Phytoplankton blooms, rich in chlorophyll and pigments, change ocean colours visible from space, allowing satellites to track their abundance.

Over the past 30 years, NASA satellites have monitored ocean colour changes, using chlorophyll levels to estimate phytoplankton concentrations. For example,

- The water may turn greenish, reddish or brownish due to presence of chlorophyll.
- The chalky-scaled coccolithophores, which are made of calcium carbonate, are very reflective and often gives the water a bright, turquoise glow.
- Sea water changes from blue to green as the abundance of phytoplankton in the water increases.
- Land is represented by dark Gray colour while light Gray colour represents ice, polar darkness or clouds.

These observations, coming grom the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite, provide insights into the ocean's health and its role in the global carbon cycle.

Satellite data, combined with ocean samples, help scientists understand phytoplankton distribution and carbon absorption in the world's oceans.

IMPACTS OF BLOOMS

Phytoplankton are crucial for marine ecosystems, but excessive nutrient pollution can trigger harmful phytoplankton blooms.

These dense blooms block sunlight, harming submerged aquatic vegetation (SAV) and disrupting fish nurseries.

As dead phytoplankton decompose, they deplete oxygen, creating "Dead Zones" where marine life suffocates.

`Some phytoplankton species also produce biotoxins, leading to harmful algal blooms (HABs), which can kill marine life, cause irritation, and make seafood dangerous to eat.