Principle 5:
Grades 9-12

Principle 5:
The ocean supports a greatdiversity of life and ecosystems.

The ocean provides a vast, interconnected living space with diverse and unique ecosystems from the surface through the water column and down to the sea floor.

Primary Productivity

A.
Microbes, such as cyanobacteria and phytoplankton, are the most abundant lifeforms, and the most important primary producers in the ocean. They are the base of most of the food chains in the ocean.

A.1.
Primary production is the net gain in organic matter that occurs when producers make more organic matter than they use in respiration.

A.2.
Nutrients, such as minerals and vitamins, are needed to convert glucose into other organic material used to grow and reproduce. Some of the most important nutrients for producers in the ocean include: nitrogen (especially nitrate), phosphate, silicate and iron. Nitrogen is often the nutrient in shortest supply.

A.3.
Most of the nutrients needed for primary productivity come from nutrient recycling. Nitrogen, phosphorous and other nutrients in organic molecules, such as proteins and nucleic acids, are released when organisms die are decomposed by bacteria.

A.4.
Some of the organic matter produced by primary producers sinks below the sunlit surface zone, carrying nutrients to the deep.

A.5.
There is a direct relationship between primary productivity, current patterns, and upwelling. The highest levels of primary productivity are near the polar regions and in upwelling zones where there are high levels of nutrients and sunshine.

See Principle 2: B1

See Principle 1: C5

A.6.
Organisms that do not make their own food (heterotrophs) are dependent on the primary producers (autotrophs) to get the energy and matter they need to survive.

A.7.
Chlorophyll, the green pigment found in microbes, algae, and other photosynthetic organisms, absorbs energy from sunlight; and together with carbon dioxide (inorganic carbon) and water, converts and stores chemical energy in the form of glucose (organic carbon).

See Principle 2: B4

Ecosystem Diversity

B.
Ocean ecosystems are defined by environmental factors and the community of organisms living there.

B.1.
Ocean life is not evenly distributed through time or space due to differences in abiotic factors such as oxygen, salinity, temperature, pH, light, nutrients, pressure, substrate, and circulation.
A few regions of the ocean support the most abundant life on Earth, while the vast majority of the ocean does not support much life.

B.2.
Ocean ecosystems with the greatest abundance of life occur where environmental conditions and/or adaptations allow for high levels of productivity.

B.3.
Coastal habitats, such as estuaries and kelp forests, support a great diversity and number of organisms, which is due in part to: abundant sunlight and current patterns (e.g., upwelling, which brings nutrients to the surface, and nutrients flowing into the ocean from rivers).

B.4.
There are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms. Hydrothermal vents, submarine hot springs and methane cold seeps rely only on chemical energy and chemosynthetic organisms to support life.

See Principle 1: C12
See Principle 2: B1

B.5.
Coral reefs, one of the most diverse ecosystems on Earth, thrive in nutrient-poor, warm waters because of a symbiotic relationship between corals and zooxanthellae, a type of dinoflagellate. This relationship enables corals to grow, forming substrates that are the foundation of complex reef ecosystems.

B.7.
Ocean ecosystems are often composed of habitats and microhabitats that exist in distinct, vertically distributed zones. Vertical zonation exists as distinct horizontal layers or bands on the coastline and throughout the water column.

B.8.
Zonation patterns occur in part because ocean organisms are adapted to live within specific environmental conditions.

B.9.
Many intertidal organisms are adapted to survive in zones defined by tidal cycles (amount of time exposed to air), crashing waves, predation, or substrate.

See Principle 1: C17

B.10.
Many open ocean organisms are adapted to live only within distinct density layers or in zones defined by pressure or light levels.

B.11.
Ocean ecosystems are connected to each other in a macro food web. Over time, organisms move from one ecosystem to another as they grow, migrate and die. Changes in an ecosystem or an organism may have unpredictable effects on other ecosystems.

B.12.
Ocean ecosystems support a large number of niches–the range of environmental conditions, including physical (e.g., temperature, depth) and biological (e.g., competitors, predators) under which an organism can live, and its role in the ecosystem (e.g., what it does and what it eats).

B.13.
Niches in the ocean are in a very dynamic environment, contributing to the high diversity seen in this ecosystem, e.g. sudden upwelling events create an environment conducive to the survival of a different set of organisms than were present prior to the influx of nutrient-rich water.