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.

Diversity of Life

C. The diversity of ocean ecosystems allows for many lifeforms and adaptations of ocean organisms.

Phyletic Diversity

C.1. The diversity of phyla is greater in the ocean than on land, and includes a range of organisms, from the smallest living things (microbes) to the largest animal on Earth (blue whales).

C.2. The first forms of life started in the ocean and evolved into the phyla seen today.

C.3. The first vertebrates to evolve were fish. Fish are the most numerous vertebrates in terms of species and individuals.

C.4. Some major groups left the ocean and evolved further on land. Some members of those groups later returned to the ocean, such as mammals, reptiles, birds, and flowering plants.

C.5. The majority of phyla that exist on Earth are still found exclusively in the ocean. These include seaweeds, echinoderms,ctenophores, urochordates (tunicates), and most sponges and cnidaria. There is only one phylum that exists uniquely on land.

C.6. All major groups of invertebrates have marine representatives, and many only live in marine environments. Except for the insects, most invertebrate species and thus most animals, are marine. At least 97% of all species of animals are invertebrates.

C.7. Seaweeds are eukaryotes, multicellular, photosynthetic organisms that have no seeds, and lack true roots and leaves. There are three phyla of seaweeds: green, brown and red.

C.8. Most of the organisms and biomass in the ocean are small prokaryote and eukaryote microbes, which are the basis of all ocean food webs

C.9. Prokaryote microbes are the most numerous ocean organisms.

C.10. Some bacteria and archaea are chemosynthetic primary producers, and make their own food from chemical compounds, such as hydrogen sulfide at hydrothermal vents.

C.11. Most marine bacteria are heterotrophs that break down detritus and recycle essential nutrients back into the environment. Some symbiotic bacteria are responsible for the bioluminescence of some deep sea fish and squid.

C.12. Photosynthetic bacteria, called cyanobacteria, are thought to have made most of the oxygen in the atmosphere. Cyanobacteria were the first photosynthetic organisms, and still produce much of Earth's oxygen.

C.13. There are many diverse groups of eukaryote microbes including unicellular algae (phytoplankton) and fungi.

C.14. Dinoflagellates are phytoplankton that have animal-like features, such as flagella, and can ingest food as heterotrophs. Some of these organisms cause red tides and bioluminescence. Some, called zooxanthellae, have symbiotic relationships with organisms such as corals.

C.15. Coastal pollution can cause an increase in the numbers of some dinoflagellates, leading to disease in humans and marine organisms.

C.16. Diatoms are phytoplankton that produce a huge amount of the carbon and oxygen produced on Earth. Diatoms have cell walls made of glass-like silica. The ocean floor is covered by vast deposits of these siliceous sediments.

C.17. Some diatoms are harmful, including those that produce domoic acid, which accumulates in shellfish and fish and may lead to death in mammals that eat them.

C.18. There are many species of marine fungi and they are mostly microbes. Most of these are decomposers.

C.19. The ocean supports larger animals than on land due to its unique physical and biological characteristics.

C.20. Seawater is denser than air, and thus support animals with much greater mass.

C.21. The great productivity of particular places in the ocean, such as upwelling zones and polar regions, can support organisms larger than those that can exist on land.

Diverse Adaptations to Environmental Factors

C.22. Organisms in the ocean exhibit a wide variety of adaptations to survive in a watery environment.

C.23. There are varying levels of light in the ocean. Some ocean organisms have adaptations that allow them to stay near the sunlit surface. These adaptations allow some to photosynthesize (e.g., phytoplankton, kelp) and others to stay near their food source (e.g., zooplankton).

C.24. Plankton have features, such as oil droplets, spines, cilia, flagella, and/or a large surface area to volume ratio.

C.25. The ocean acts as a filter, and allows different wavelengths of light to penetrate to different depths: red, yellow, and orange wavelengths are filtered out in shallow water; green and blue light penetrate the deepest. The color of some organisms is a feature that allows them to be camouflaged at different depths.

C.26. Even in relatively shallow water, many red organisms appear gray and are camouflaged.

C.27. Since sound travels through the ocean further and faster than light does, many marine animals, from shrimp to whales, rely on sound to communicate, find prey and mates, and sense their environments.

C.28. Many large whales use low frequency sound to communicate across entire ocean basins. Many toothed whales use echolocation to find and/or capture prey. Pistol shrimps use blasts of sound to shock prey.

C.29. Some ocean organisms have adaptations for living in or diving to the deep ocean.

C.30. Some marine mammals have many adaptations for deep diving, such as breath holding, slowing their heart rate, reducing blood flow to non-vital organs, and increasing oxygen storage. Many organisms use bioluminescence to find or attract prey and mates, and escape predators.

C.31. Marine organisms have adaptations that allow them to osmoregulate in a saltwater environment.

C.32. The body fluids of many marine organisms, including most fish, are more dilute than the surrounding seawater, so they tend to lose water by osmosis. To compensate, fish drink drink seawater and excrete salt through their gills and urine. Other organisms change the amount of ions in their body to match the salinity in the environment, e.g., sharks regulate urea in their blood to match the ocean's salinity.

C.33. Marine organisms are adapted to live within particular ecosystems in a relatively stable ocean where there are only small fluctuations in pH and temperature.

C.34. Small changes in temperature and pH due to human activities can affect organisms' survival and biological diversity, (e.g., coral bleaching due to increased temperature and inhibition of shell formation due to ocean acidification).

C.35. Shelled organisms use CaCO3 to construct shells and skeletons, relying on the abundant carbonate ions usually available in ocean water. As ocean pH decreases, the concentration of available carbonate ions also decreases and carbonate from the shells dissolves into the ocean water, leading to thinning shells.

C.36. Small increases in temperature can lead to coral bleaching as the symbiotic algae (zooxanthellae) living inside the coral polyp leave resulting in the death of the coral.

See Principle 4: A1
See Principle 6: D18
See Principle 3: C4
See Principle 6: C36