

**Principle 1:  
Earth has one big ocean with many features.**

The ocean, which covers 70% of Earth's surface, is the defining feature of the planet.

**Geologic Features**

**Properties of Ocean Water**

**Ocean Circulation**

**A.** The size and shape of the ocean has changed over geologic time and continues to move and change.

**B.** 97% of all water on Earth is ocean water, which has unique chemical and physical properties.

**C.** The ocean is one interconnected body of water that is integral to the water cycle; and is in constant motion in a global circulation system.

**A.1.** Motion along the margins of lithospheric plates creates physical features on the ocean floor and land.

**A.7.** During various times in Earth's geologic history, all of the continents have been joined into one "super continent." A giant ocean circulated around the supercontinent.

**B.1.** Salts enter the ocean via erosion from land, volcanic emissions, reactions at the sea floor, and atmospheric deposition.

**B.3.** Density differences between masses of water can cause currents.

**C.1.** A global ocean circulation system is generated from tides and different types of currents moving the water.

**C.6.** Currents transport heat, nutrients, and organisms throughout the ocean.

**C.9.** All major watersheds, from the Amazon River to melting glaciers, mix fresh and salt water when they meet the ocean, which contributes to the density differences that set ocean currents in motion.

**A.2.** Many of the physical features on the ocean floor are the result of the constant motion of the lithospheric plates that make up Earth's crust.

**A.8.** The supercontinent broke apart along rift valleys to create new, smaller continents and ocean basins now known as the Pacific Ocean, Atlantic Ocean, etc.

**B.2.** The freezing point of ocean water decreases as salinity increases; the pH of ocean water is more basic than fresh water.

**B.4.** The density of ocean water increases as salinity (amount of dissolved salts) increases and as temperature decreases.

**C.2.** Deep ocean currents are driven by density differences between masses of ocean water.

**C.3.** The wind, combined with Earth's rotation (Coriolis effect), drives surface currents in circular gyres in each ocean basin; clockwise in the Northern Hemisphere and counter-clockwise in the Southern Hemisphere.

**C.4.** Tides are mainly caused by the gravitational interaction between Earth, the moon and the sun.

**C.7.** Upwelling, which occurs mostly on west coasts, brings nutrients from deep water to the sunlit surface zone where photosynthetic primary producers grow.

**C.8.** Currents are especially important in moving young organisms (larvae and juveniles) to populate new areas.

**C.10.** As water travels through the watersheds, it collects nutrients, salts, sediments and pollutants and carries them into the ocean.

**C.11.** Sea level rises as glaciers melt.

**A.3.** New lithospheric crust is generated at spreading centers while older, denser crust is recycled into the Earth's interior at subduction zones, creating various physical features.

**A.4.** Plate movement is primarily caused by the convection of hot fluids below Earth's crust.

**A.5.** Features on the ocean floor are highly varied, and include trenches, rift valleys, mid-ocean ridges, seamounts, islands, and continental shelves.

**A.9.** The continents are still in motion today.

**B.5.** The salinity of ocean water can change due to adding or removing water (e.g., evaporation, melting glaciers, or inflow from rivers, streams, and rainfall).

**B.6.** The temperature of ocean water can change due to warming and cooling (e.g., heat from the sun or contact with ice).

**C.5.** Ocean circulation is influenced by the position of basins, continents, and other geologic features.

See Principle 2: A19

See Principle 7: A2

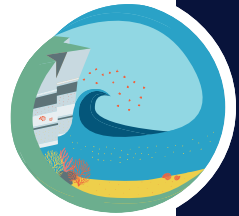
See Principle 3: A1

See Principle 5: A8

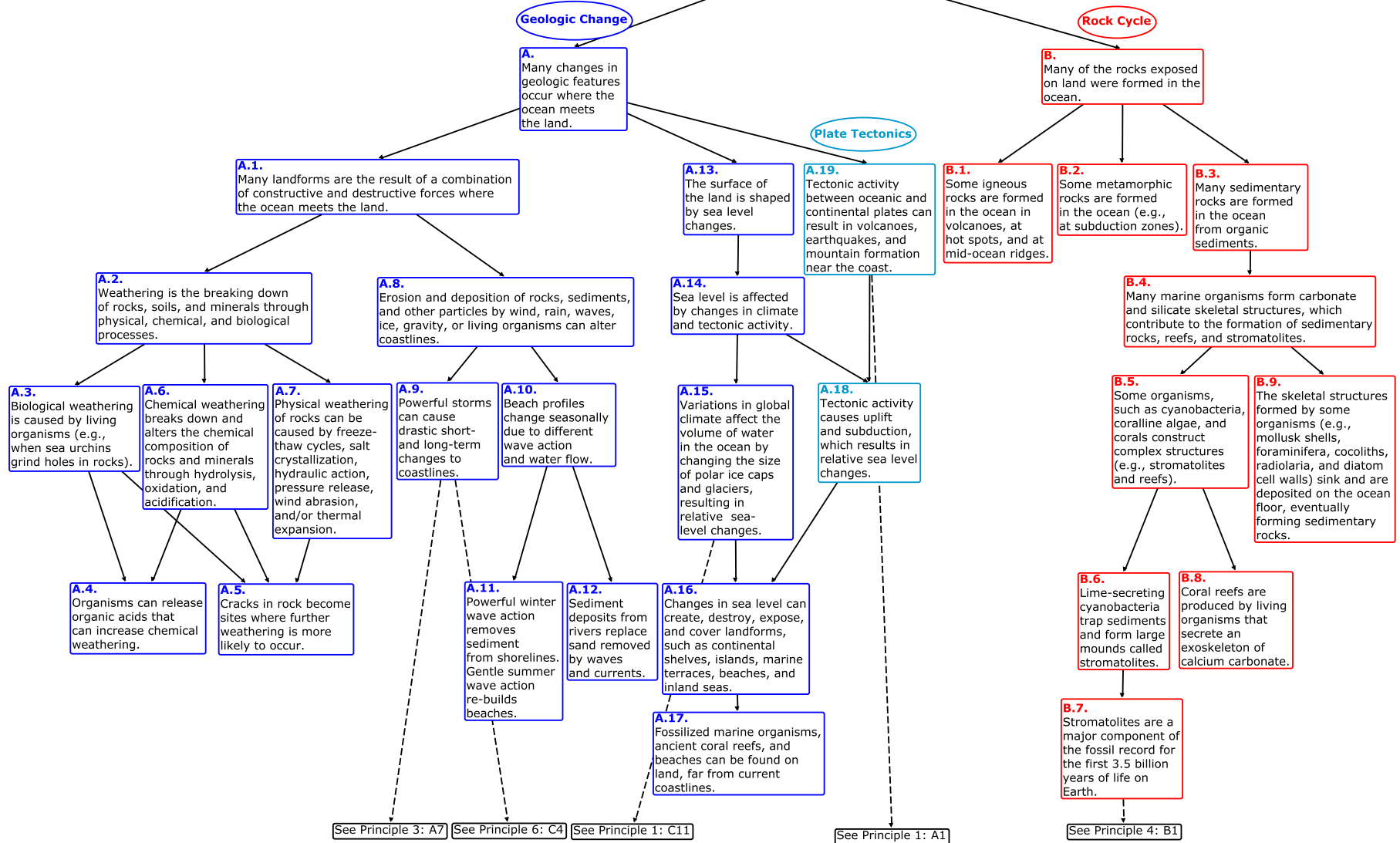
See Principle 5: B11

See Principle 6: D17

See Principle 2: A15

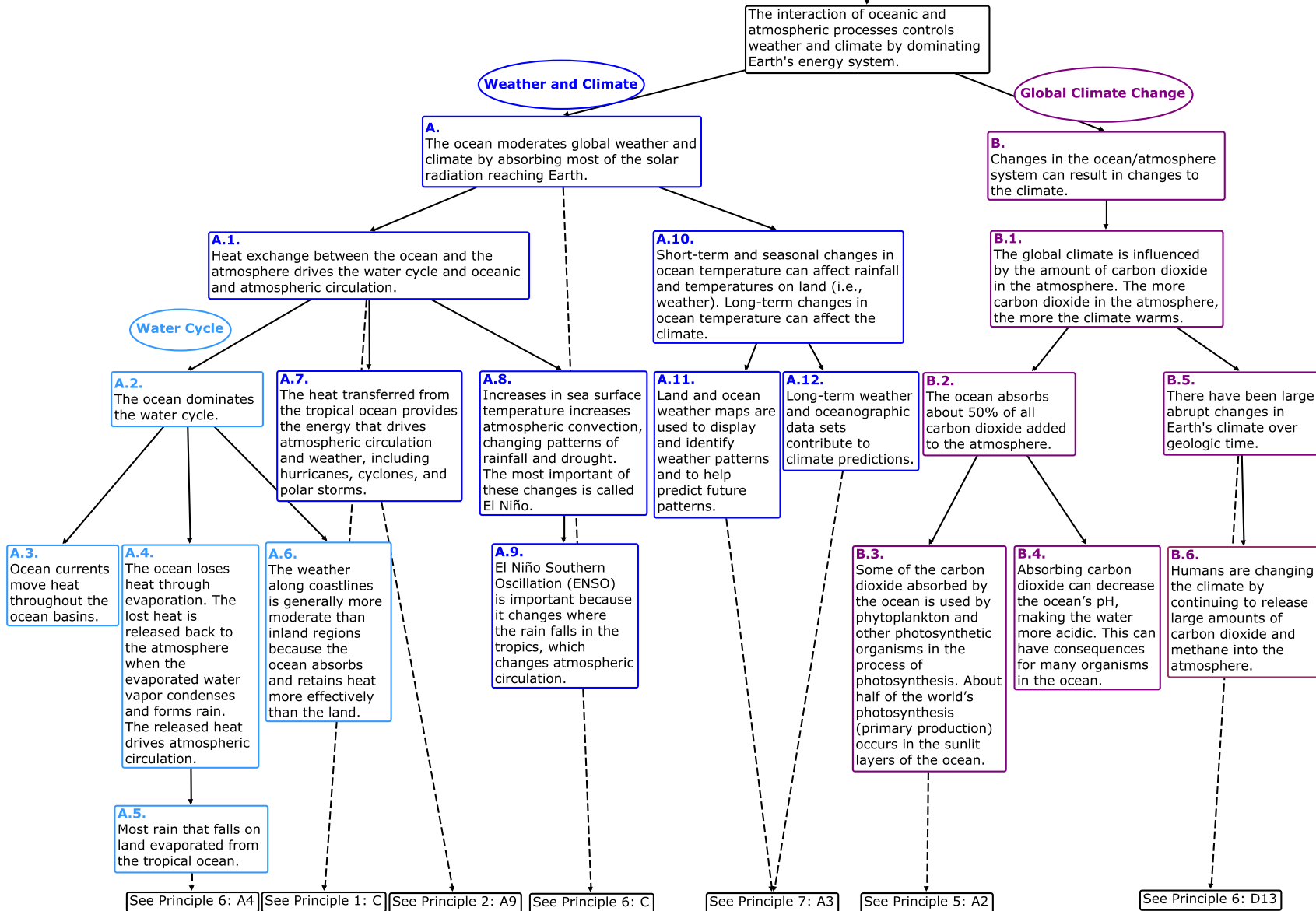


**Principle 2:  
The ocean and life in the ocean shape the features of Earth.**





**Principle 3:  
The ocean is a major influence on weather and climate.**





**Principle 4:  
The ocean makes Earth habitable.**

**Oxygen Production**

**Origins of Life**

**A.**  
Originally, all oxygen in the atmosphere came from photosynthetic organisms in the ocean.

**B.**  
Life started in the ocean, and the earliest evidence of life is found in ancient ocean sediments.

**A.1.**  
Earth originally had an atmosphere containing gases toxic to most organisms; there was no life on land until oxygen became common in the atmosphere.

**A.5.**  
Most of the oxygen consumed by organisms living on land and in the water is produced by photosynthetic organisms in the ocean.

**B.1.**  
The fossil record of ancient lifeforms provides evidence for the theory of evolution and the important role that the ocean played in the evolution of life on Earth.

**A.2.**  
Cyanobacteria (blue-green algae) living in the ocean generated oxygen in Earth's atmosphere through the process of photosynthesis, over many millions of years.

**A.6.**  
The process of photosynthesis produces oxygen gas, while respiration and decay use oxygen.

**B.2.**  
Cyanobacteria (blue-green algae), the ancestors of all plants and algae, are among the oldest fossils currently known on Earth. These 3 billion-year-old organisms evolved in the ocean, and are found in ancient ocean sediments.

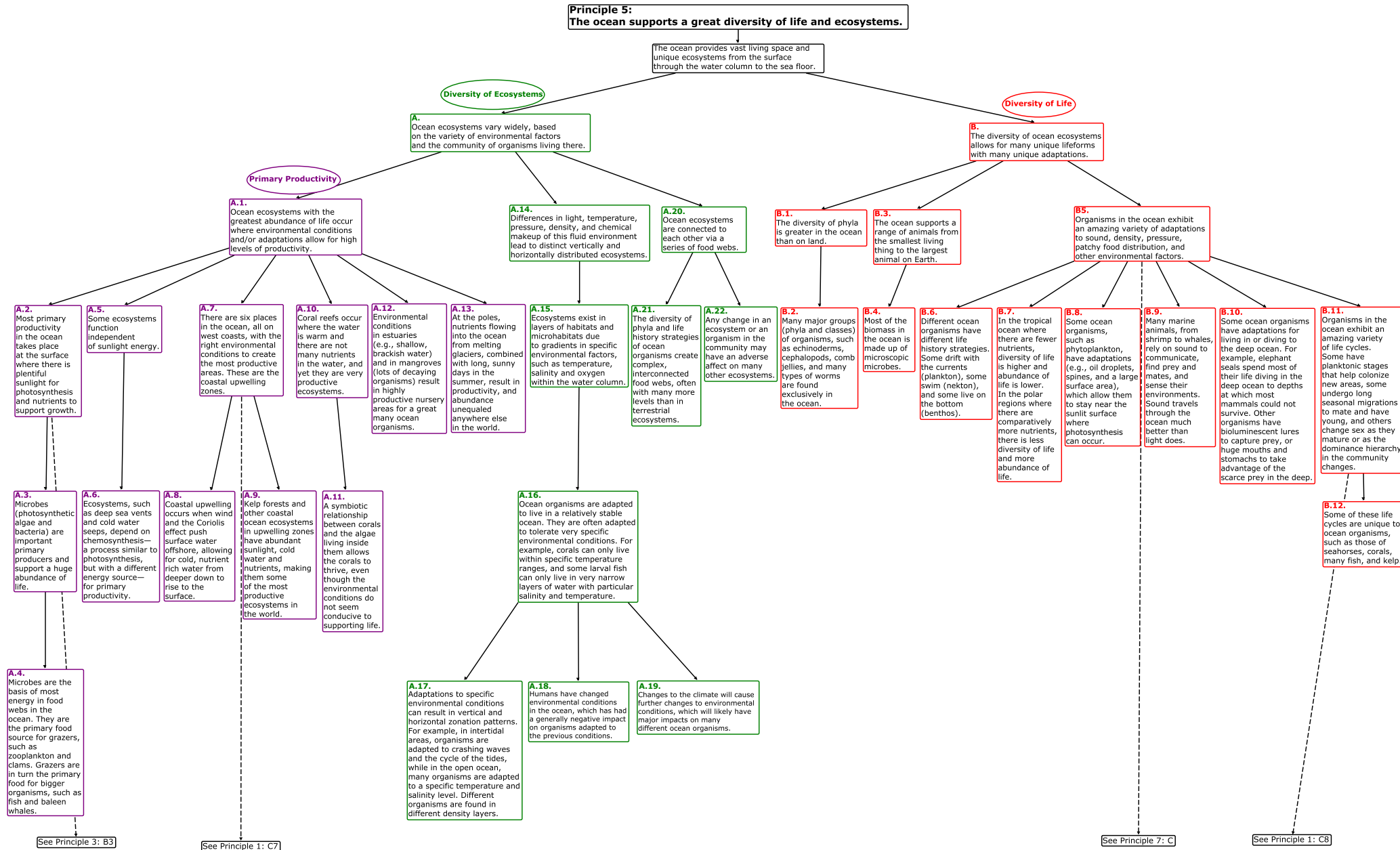
**B.4.**  
The millions of different species of organisms on Earth today are related by descent from common ancestors that evolved in the ocean and continue to evolve today.

**A.3.**  
The oxygen produced by cyanobacteria through photosynthesis first accumulated in the ocean, and then escaped into the atmosphere, where it formed ozone that blocked much UV radiation from reaching Earth's surface.

**B.3.**  
The chloroplast, which plants use to make food for themselves through photosynthesis, is a remnant of cyanobacteria.

**A.4.**  
By 550 million years ago, oxygen and ozone levels in the atmosphere were high enough that terrestrial organisms could develop and survive.

See Principle 2: B7





**Principle 6:  
The ocean and humans are inextricably interconnected.**

