

PRINCIPLE 1: GRADES 6-8

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

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

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

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.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.

See Principle 7: A2

See Principle 2: A19

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.

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.

Properties of Ocean Water

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

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

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

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

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

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

Ocean Circulation

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.

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

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

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

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.

See Principle 3: A1

See Principle 5: A8

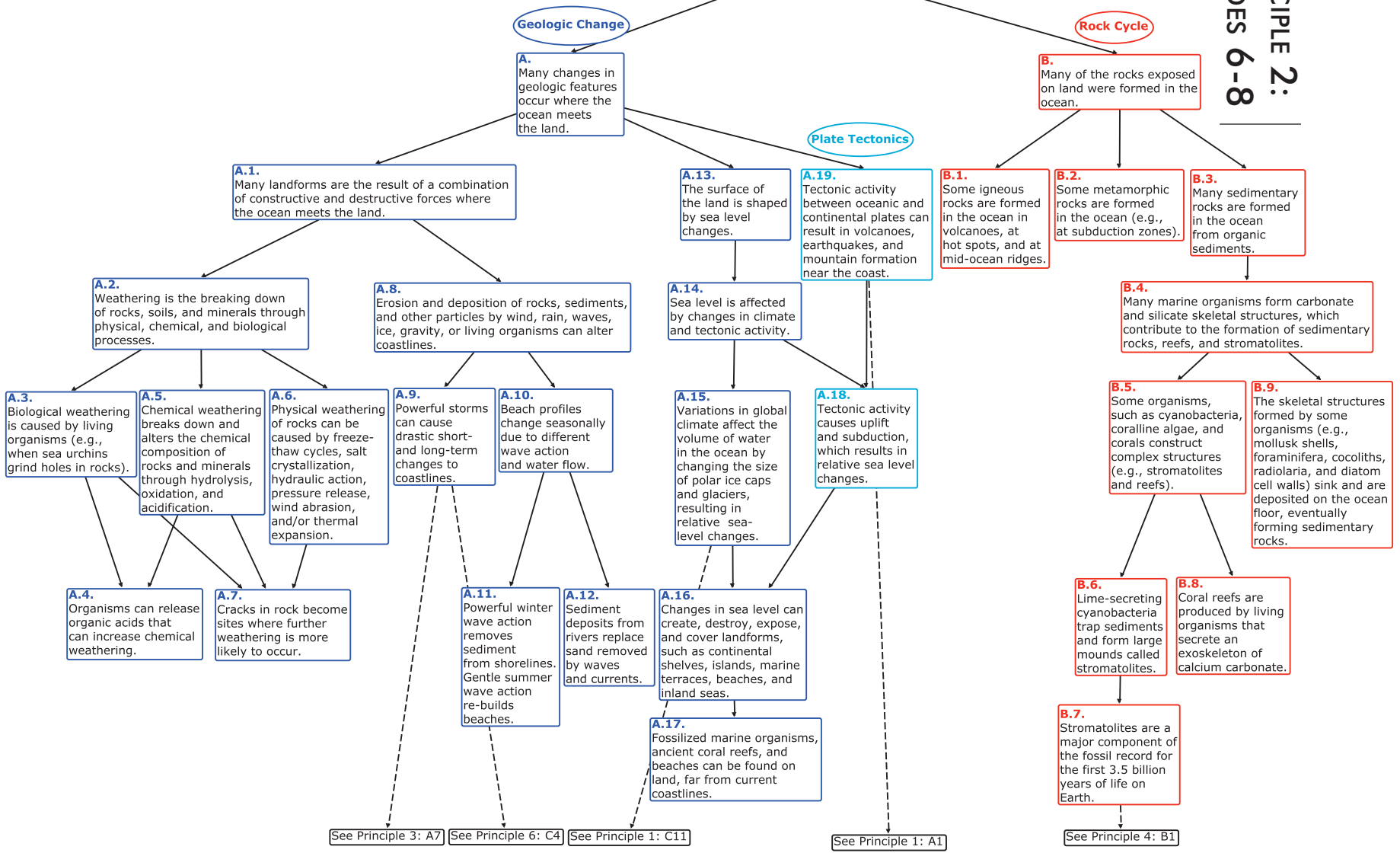
See Principle 5: B11

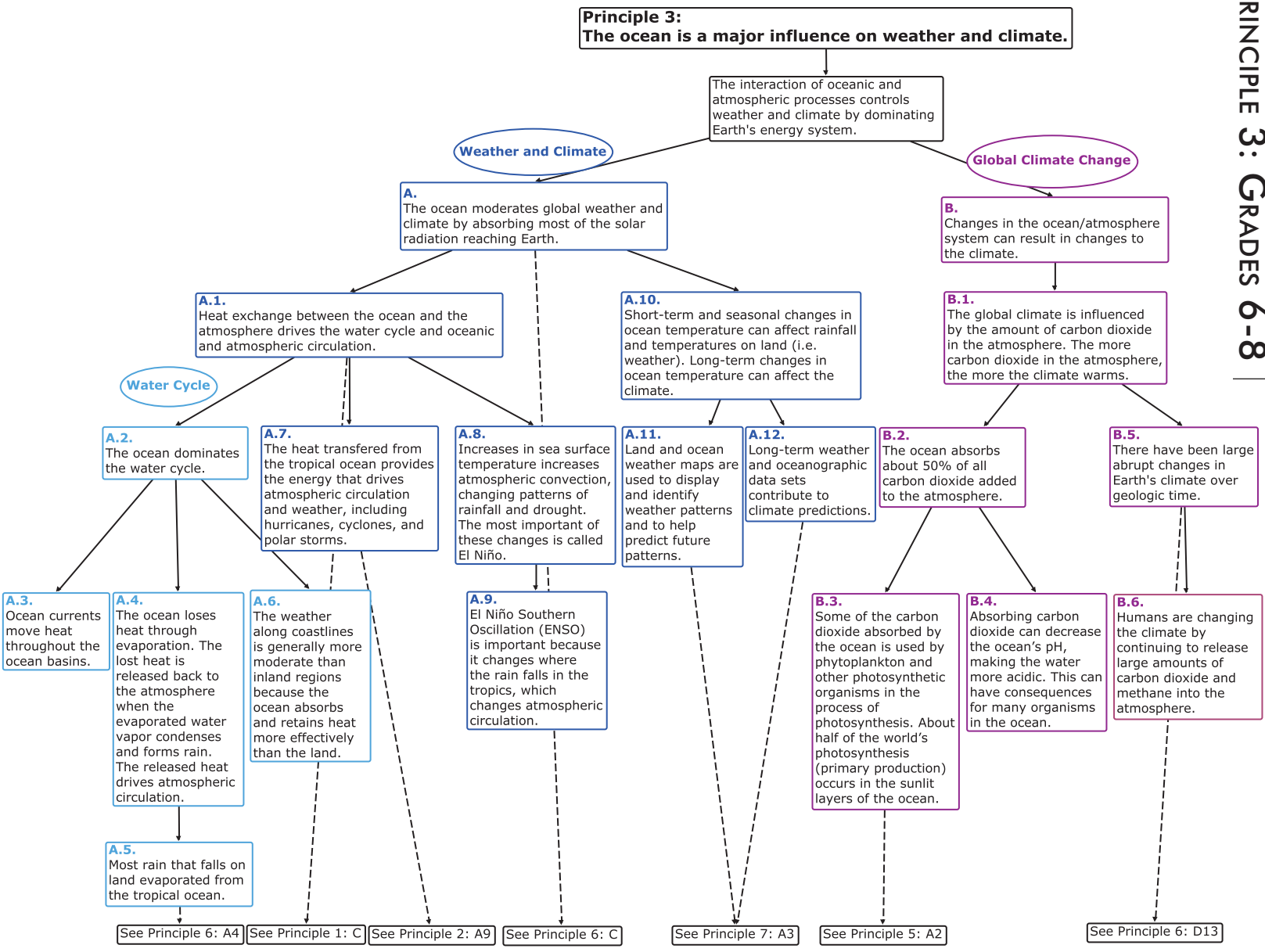
See Principle 6: D17

See Principle 2: A15

**PRINCIPLE 2:
GRADES 6-8**

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





PRINCIPLE 4: GRADES 6-8

**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 5: GRADES 6-8

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

The ocean provides vast living space and unique ecosystems from the surface through the water column to the sea floor.

Diversity of Ecosystem

Diversity of Life

A. Ocean ecosystems vary widely, based on the variety of environmental factors and the community of organisms living there.

B.. The diversity of ocean ecosystems allows for many unique lifeforms with many unique adaptations.

Primary Productivity

A.1. Ocean ecosystems with the greatest abundance of life occur where environmental conditions and/or adaptations allow for high levels of productivity.

A.15. Differences in light, temperature, pressure, density, and chemical makeup of this fluid environment lead to distinct vertically and horizontally distributed ecosystems.

A.21. Ocean ecosystems are connected to each other via a series of food webs.

B.1. The diversity of phyla is greater in the ocean than on land.

B.3. The ocean supports a range of animals from the smallest living thing to the largest animal on Earth.

B5.. Organisms in the ocean exhibit an amazing variety of adaptations to sound, density, pressure, patchy food distribution, and other environmental factors.

A.2. Most primary productivity in the ocean takes place at the surface where there is plentiful sunlight for photosynthesis and nutrients to support growth.

A.5. Some ecosystems function independent of sunlight energy.

A.8. There are six places in the ocean, all on west coasts, with the right environmental conditions to create the most productive areas. These are the coastal upwelling zones.

A.11. Coral reefs occur where the water is warm and there are not many nutrients in the water, and yet they are very productive ecosystems.

A.13. Environmental conditions in estuaries (e.g., shallow, brackish water) and in mangroves (lots of decaying organisms) result in highly productive nursery areas for a great many ocean organisms.

A.14. At the poles, nutrients flowing into the ocean from melting glaciers, combined with long, sunny days in the summer, result in productivity, and abundance unequalled anywhere else in the world.

A.16. Ecosystems exist in layers of habitats and microhabitats due to gradients in specific environmental factors, such as temperature, salinity, and oxygen within the water column.

A.22. The diversity of phyla and life history strategies of ocean organisms create complex, interconnected food webs, often with many more levels than in terrestrial ecosystems.

A.23. Any change in an ecosystem or an organism in the community may have an adverse affect on many other ecosystems.

B.2. Many major groups (phyla and classes) of organisms, such as echinoderms, cephalopods, comb jellies, and many types of worms are found exclusively in the ocean.

B.4. Most of the biomass in the ocean is made up of microscopic microbes.

B.6. Different ocean organisms have different life history strategies. Some drift with the currents (plankton), some swim (nekton), and some live on the bottom (benthos).

B.7. In the tropical ocean where there are fewer nutrients, diversity of life is higher and abundance of life is lower. In the polar regions where there are comparatively more nutrients, there is less diversity of life and more abundance of life.

B.8. Some ocean organisms, such as phytoplankton, have adaptations (e.g., oil droplets, spines, and a large surface area), which allow them to stay near the sunlit surface where photosynthesis can occur.

B.9. Many marine animals, from shrimp to whales, rely on sound to communicate, find prey and mates, and sense their environments. Sound travels through the ocean much better than light does.

B.10. Some ocean organisms have adaptations for living in or diving to the deep ocean. For example, elephant seals spend most of their life diving in the deep ocean to depths at which most mammals could not survive. Other organisms have bioluminescent lures to capture prey, or huge mouths and stomachs to take advantage of the scarce prey in the deep.

B.11. Organisms in the ocean exhibit an amazing variety of life cycles. Some have planktonic stages that help colonize new areas, some undergo long seasonal migrations to mate and have young, and others change sex as they mature or as the dominance hierarchy in the community changes.

A.3. Microbes (photosynthetic algae and bacteria) are important primary producers and support a huge abundance of life.

A.6. Ecosystems, such as deep sea vents and cold water seeps, depend on chemosynthesis—a process similar to photosynthesis, but with a different energy source—for primary productivity.

A.9. Coastal upwelling occurs when wind and the Coriolis effect push surface water offshore, allowing for cold, nutrient rich water from deeper down to rise to the surface.

A.10. Kelp forests and other coastal ocean ecosystems in upwelling zones have abundant sunlight, cold water, and nutrients, making them some of the most productive ecosystems in the world.

A.12. A symbiotic relationship between corals and the algae living inside them allows the corals to thrive, even though the environmental conditions do not seem conducive to supporting life.

A.17. Ocean organisms are adapted to live in a relatively stable ocean. They are often adapted to tolerate very specific environmental conditions. For example, corals can only live within specific temperature ranges, and some larval fish can only live in very narrow layers of water with particular salinity and temperature.

A.18. Adaptations to specific environmental conditions can result in vertical and horizontal zonation patterns. For example, in intertidal areas, organisms are adapted to crashing waves and the cycle of the tides, while in the open ocean, many organisms are adapted to a specific temperature and salinity level. Different organisms are found in different density layers.

A.19. Humans have changed environmental conditions in the ocean, which has had a generally negative impact on organisms adapted to the previous conditions.

A.20. Changes to the climate will cause further changes to environmental conditions, which will likely have major impacts on many different ocean organisms.

B.12. Some of these life cycles are unique to ocean organisms, such as those of seahorses, corals, many fish, and kelp.

See Principle 3: B3

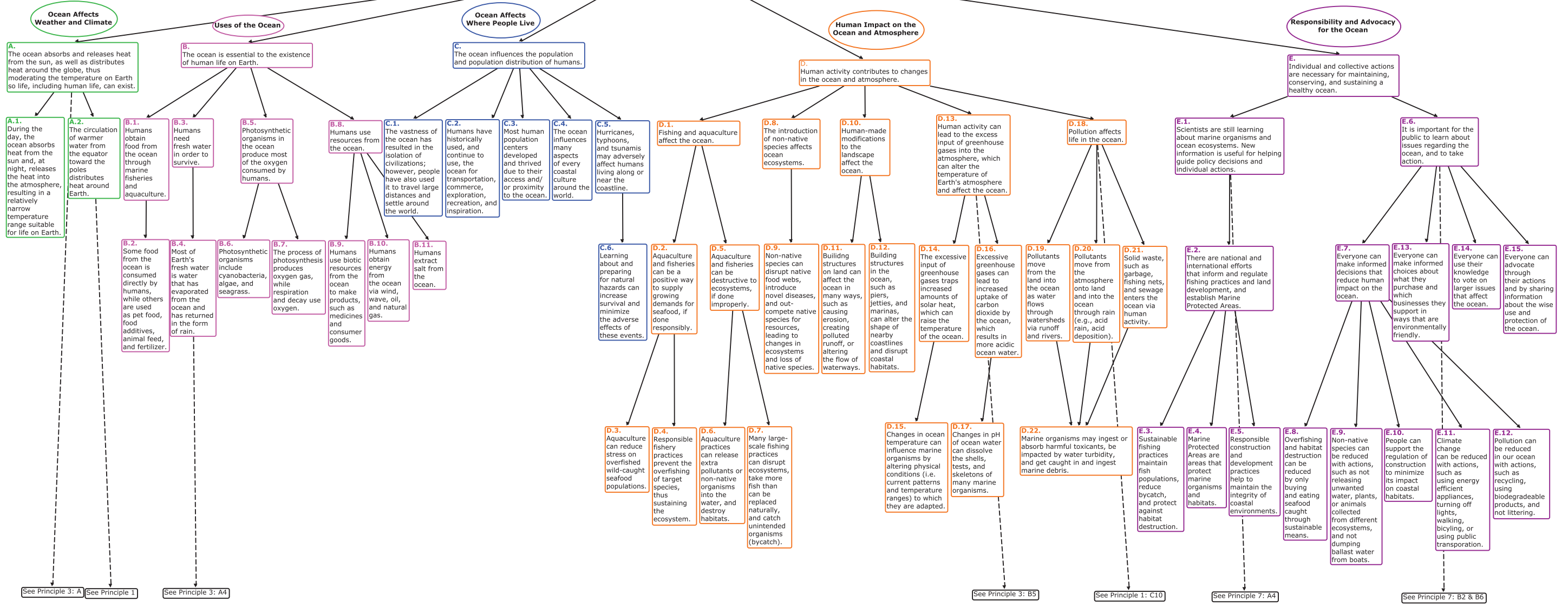
See Principle 1: C7

See Principle 7: C

See Principle 1: C8

PRINCIPLE 6: GRADES 6-8

Principle 6: The ocean and humans are inextricably interconnected.



PRINCIPLE 7: GRADES 6-8

Principle 7: The ocean is largely unexplored.

