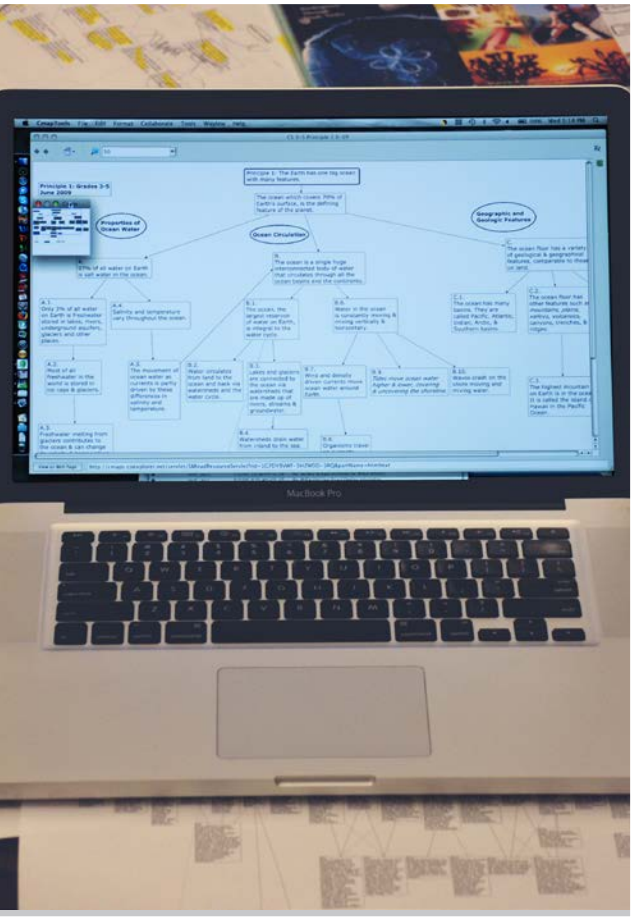


The freeware CmapTools was used in developing the conceptual flow diagrams (Photo credit: Craig Strang)

Introduction to the Ocean Literacy Scope and Sequence for Grades K through 12

The Ocean Literacy Scope and Sequence for Grades K–12 is a series of 28 conceptual flow diagrams[3] that represent and organize the ideas of the seven Ocean Literacy Principles into four grade bands—K through 2, 3 through 5, 6 through 8, and 9 through 12—effectively showing what students should know at the end of 2nd, 5th, 8th, and 12th grades. This document provides specific guidance to educators, standards committees, curriculum developers, and scientists conducting outreach. It is one part of the Ocean Literacy Framework which comprises four key documents:

- *Ocean Literacy: The Essential Principles of Ocean Sciences for Learners of All Ages*;
- *The Ocean Literacy Scope and Sequence for Grades K–12*;
- *Alignment of Ocean Literacy to the Next Generation Science Standards*; and
- *International Ocean Literacy Survey*.

The scope and sequence was developed iteratively and thoughtfully with significant and substantive participation by hundreds of scientists, science educators, and classroom teachers around the country.[4] Thus, it represents a community consensus regarding the essential ideas in ocean sciences that all students should understand by the end of Grade 12 and a road map for how to get there.

The scope and sequence conceptual flow diagrams provide specific guidance to help educators as they work to grow their learner's conceptual understanding of essential ocean concepts. Dive into the conceptual flow diagrams on the following pages.

To access online versions of the Framework documents, please visit www.marine-ed.org/ocean-literacy/overview

3 See "Developing the Ideas of Ocean Literacy Using Conceptual Flow Diagrams" in this handbook.

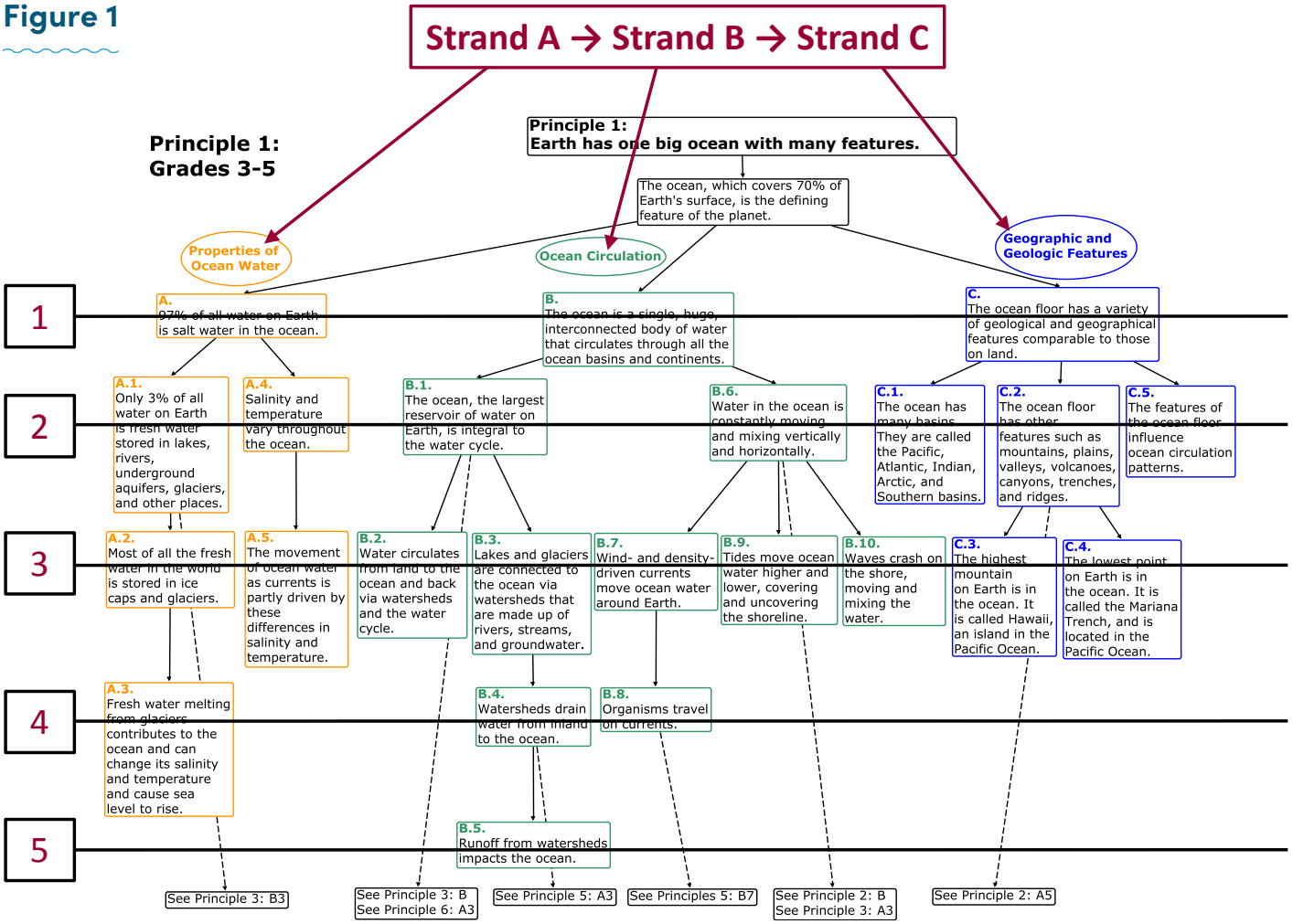
4 A more complete history is provided in the introduction to this handbook.

The Ocean Literacy Scope and Sequence comprises 28 conceptual flow diagrams (hereafter referred to as flows). There is one flow for each principle for each grade band (K through 2, 3 through 5, 6 through 8, and 9 through 12). Each flow is read from top to bottom and left to right and represents one possible way of breaking down and organizing the major concepts and supporting ideas for each principle for a grade band.

The essential principle as well as the grade level are listed at the top of the page. The diagram shows three sets of text boxes (called strands) cascading down the page. Each strand represents a topic related to the essential principle and includes concepts and supporting subconcepts focused on the topic.

Conceptual flow diagrams can be used as a suggested instructional sequence, organizer of ideas, and/or indicator of learning progression.

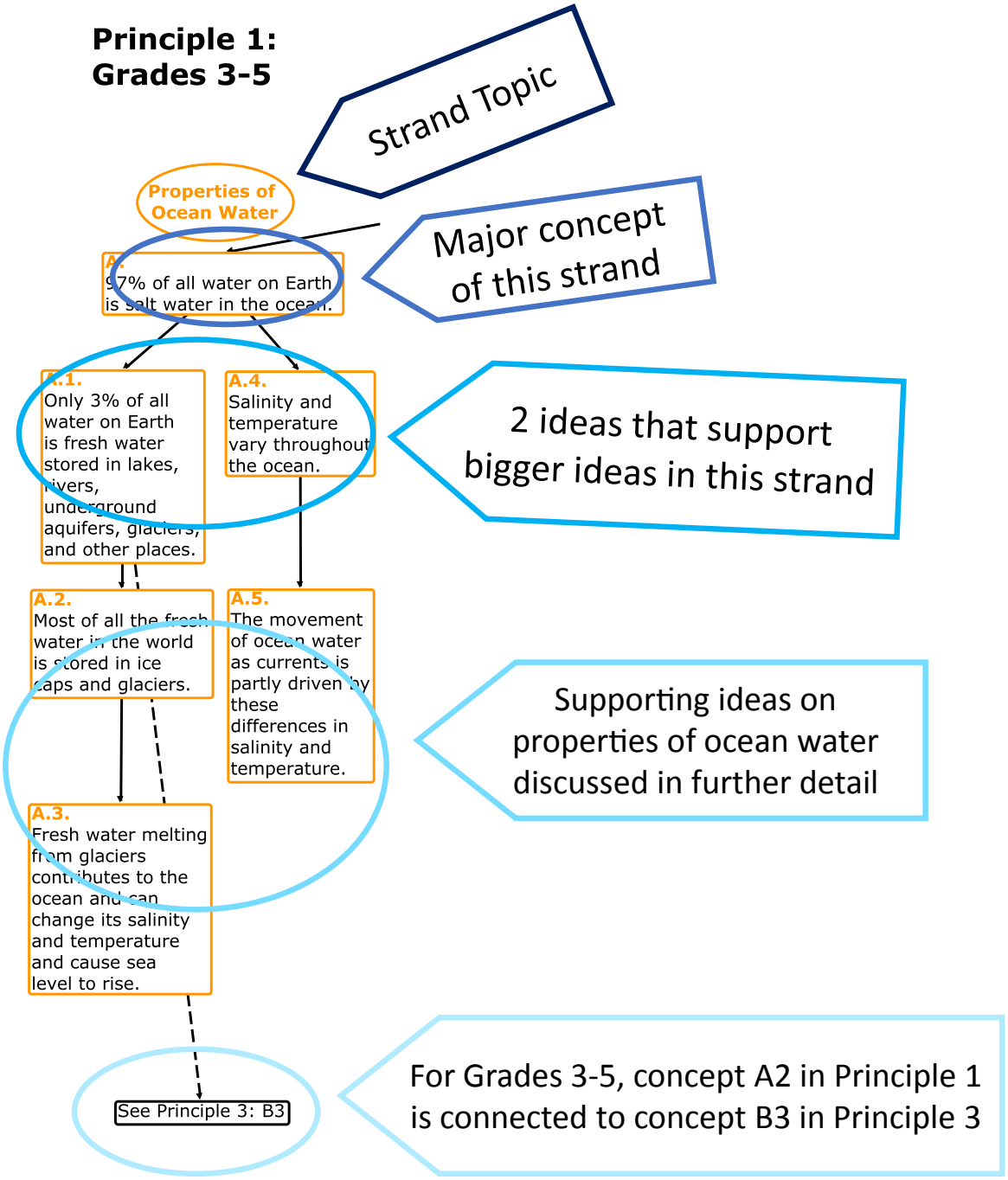
Figure 1



Dashed lines lead to cross-referenced concept statements in other essential principles.

In this flow for Principle 1, Grades 3 through 5, there are three strands of topics and five levels of ideas. Read the flow from top to bottom and left to right, from Strand A (A1 to A5) to Strand B (B1 to B10) to Strand C (C1 to C5). Some of the concepts cross-reference other concepts in other principles within that same grade band. These cross-references are connections between principles.

Figure 2

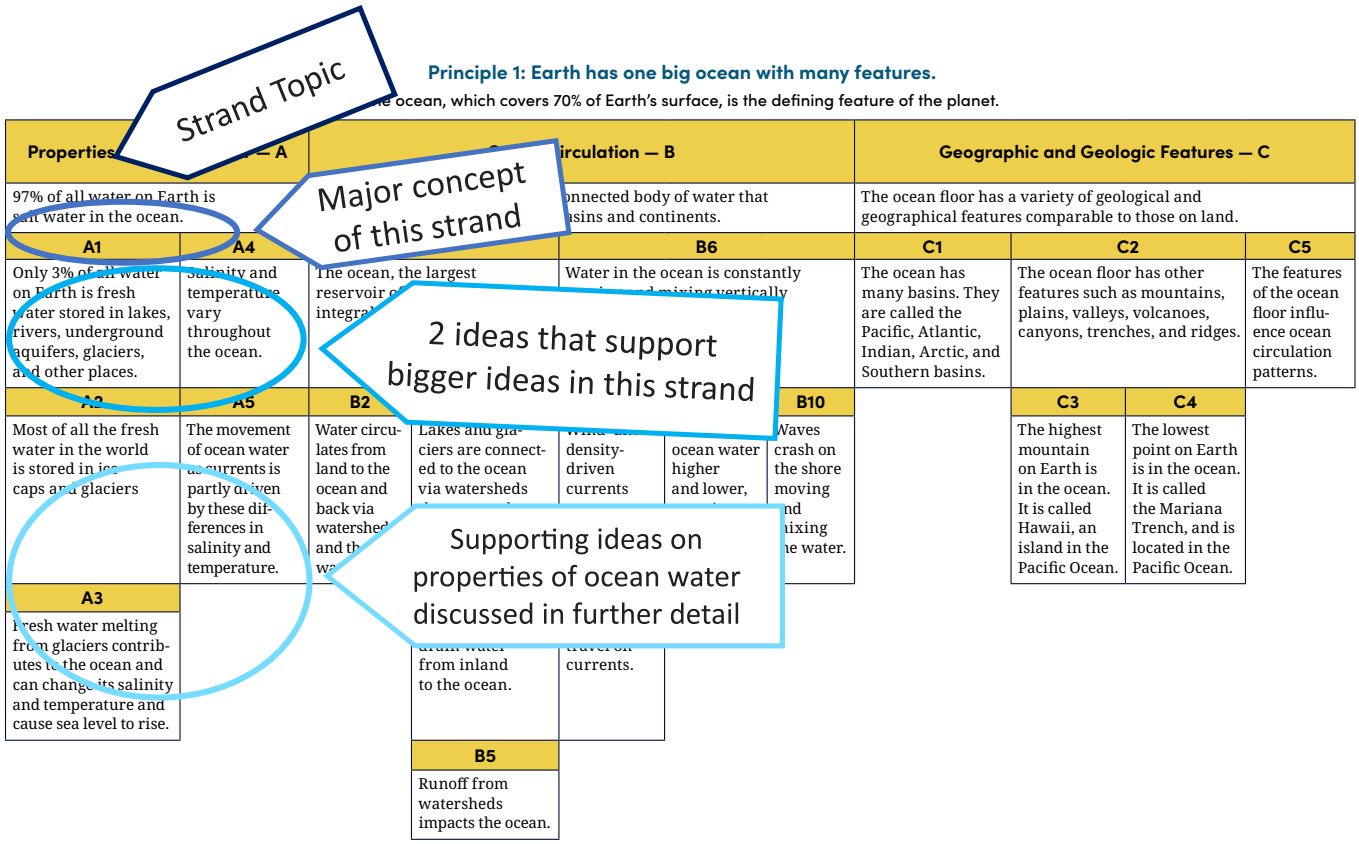


Strand A of conceptual flow diagram of Principle 1 for Grades 3 to 5. Here is a breakdown of the components in a strand. The strand is identified by topic for easy reference. The strand begins with a major concept and then nested below are two levels of ideas that support the bigger idea. Supporting ideas can be examples, but not always.

How to Use the Alternative Form of the Conceptual Flow Diagrams

In addition to the conceptual flow diagrams of the *Ocean Literacy Scope and Sequence for Grades K–12*, we also present the concepts in a tabular format. This helps convey the connections and relationships between concepts, without relying on visual cues.

Strands of connected ideas are organized under a topic title and brief description. Instead of using arrows to convey connections between individual concepts, concepts are stacked in columns in the order in which they should be presented (i.e., top to bottom, then left to right). This means some concepts are repeated under each higher level concept to convey the connections among them. As users of assistive technology navigate the tables, the concepts become more and more specific.



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

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

Properties ... — A		...irculation — B				Geographic and Geologic Features — C			
97% of all water on Earth is ... salt water in the ocean.		...onnected body of water that ...asins and continents.				The ocean floor has a variety of geological and geographical features comparable to those on land.			
A1	**A4**		**B6**			**C1**	**C2**		**C5**
Only 3% of all water on Earth is fresh water stored in lakes, rivers, underground aquifers, glaciers, and other places.	Salinity and temperature vary throughout the ocean.	The ocean, the largest reservoir ... integral	Water in the ocean is constantly ... and mixing vertically			The ocean has many basins. They are called the Pacific, Atlantic, Indian, Arctic, and Southern basins.	The ocean floor has other features such as mountains, plains, valleys, volcanoes, canyons, trenches, and ridges.		The features of the ocean floor influence ocean circulation patterns.
A2	**A5**	**B2**			**B10**		**C3**	**C4**	
Most of all the fresh water in the world is stored in ice caps and glaciers	The movement of ocean water as currents is partly driven by these differences in salinity and temperature.	Water circulates from land to the ocean and back via watershed... and th... wa...	Lakes and glaciers are connected to the ocean via watersheds ...	Wind-... density-driven currents ...	ocean water higher and lower, ...	Waves crash on the shore moving ... and ...ixing ...e water.	The highest mountain on Earth is in the ocean. It is called Hawaii, an island in the Pacific Ocean.	The lowest point on Earth is in the ocean. It is called the Mariana Trench, and is located in the Pacific Ocean.	
A3			... drain water from inland to the ocean.	... travel on currents.					
Fresh water melting from glaciers contributes to the ocean and can change its salinity and temperature and cause sea level to rise.			**B5**						
			Runoff from watersheds impacts the ocean.						

Conceptual Flow Diagrams

Principle 1

Principle 2

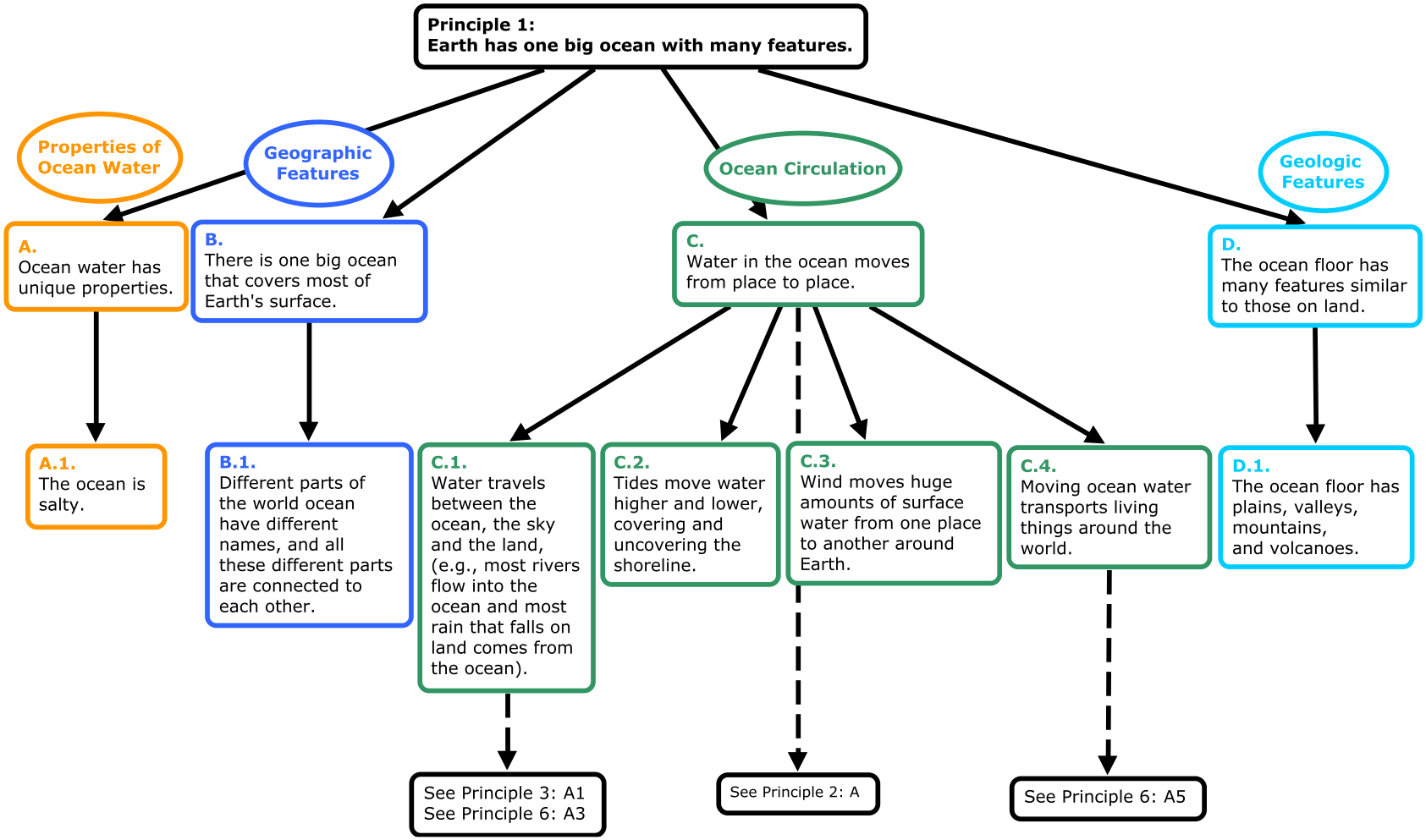
Principle 3

Principle 4

Principle 5

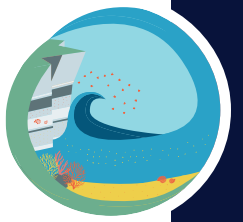
Principle 6

Principle 7


Principle 1:
Earth has one big ocean with many features.
Properties of Ocean Water
Geographic Features
Ocean Circulation
Geologic Features
A.
Ocean water has unique properties.
B.
There is one big ocean that covers most of Earth's surface.
C.
Water in the ocean moves from place to place.
D.
The ocean floor has many features similar to those on land.
A.1.
The ocean is salty.
B.1.
Different parts of the world ocean have different names, and all these different parts are connected to each other.
C.1.
Water travels between the ocean, the sky and the land, (e.g., most rivers flow into the ocean and most rain that falls on land comes from the ocean).
C.2.
Tides move water higher and lower, covering and uncovering the shoreline.
C.3.
Wind moves huge amounts of surface water from one place to another around Earth.
C.4.
Moving ocean water transports living things around the world.
D.1.
The ocean floor has plains, valleys, mountains, and volcanoes.
See Principle 3: A1
See Principle 6: A3
See Principle 2: A
See Principle 6: A5

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

Properties of Ocean Water — A	Geographic Features — B	Ocean Circulation — C				Geologic Features — D
Ocean water has unique properties.	There is one big ocean that covers most of Earth's surface.	Water in the ocean moves from place to place.				The ocean floor has many features similar to those on land.
A1	**B1**	**C1**	**C2**	**C3**	**C4**	**D1**
The ocean is salty.	Different parts of the world ocean have different names, and all these different parts are connected to each other.	Water travels between the ocean, the sky and the land, (e.g., most rivers flow into the ocean and most rain that falls on land comes from the ocean).	Tides move water higher and lower, covering and uncovering the shoreline.	Wind moves huge amounts of surface water from one place to another around Earth.	Moving ocean water transports living things around the world.	The ocean floor has plains, valleys, mountains, and volcanoes.



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

Erosion and Changing Coastlines

A.
Moving water can cause coastal build up and erosion, carrying earth materials from one place to another and shaping the shoreline.

A.1.
Shorelines are built up by earth materials brought to the shore by rivers and waves.

A.2.
Some earth materials from the ocean, such as sand, shells, corals, and rocks, are carried to the shore by waves.

A.3.
Some earth materials from the land, such as rocks, sand, and soils, are carried to the shore by rivers.

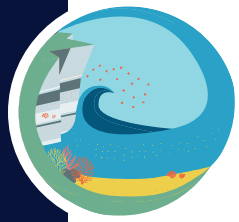
A.4.
Erosion is the wearing away of rocks, soil, shells, and other earth materials and features.

A.5.
Waves can break down and wear away cliffs, beaches, and materials brought to the shore, changing the shape of the shoreline.

A.6.
Rocks, shells, corals, plants, and other materials can be broken down into sand.

See Principle 6: C2

See Principle 1: C



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

<table>
<tr><th colspan="3">Erosion and Changing Coastlines — A</th></tr>
<tr><td colspan="3">Moving water can cause coastal build up and erosion, carrying earth materials from one place to another and shaping the shoreline.</td></tr>
<tr><th colspan="2">A1</th><th>A4</th></tr>
<tr><td colspan="2">Shorelines are built up by earth materials brought to the shore by rivers and waves.</td><td>Erosion is the wearing away of rocks, soil, shells, and other earth materials and features.</td></tr>
<tr><th>A2</th><th>A3</th><th>A5</th></tr>
<tr><td>Some earth materials from the ocean, such as sand, shells, corals, and rocks, are carried to the shore by waves.</td><td>Some earth materials from the land, such as rocks, sand, and soils, are carried to the shore by rivers.</td><td>Waves can break down and wear away cliffs, beaches, and materials brought to the shore, changing the shape of the shoreline.</td></tr>
<tr><td></td><td></td><th>A6</th></tr>
<tr><td></td><td></td><td>Rocks, shells, corals, plants, and other materials can be broken down into sand.</td></tr>
</table>

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

Weather and Water Cycle

A.
Local weather, including precipitation, fog, and wind, can be caused by the ocean—no matter where you live.

A.1.
Most precipitation on Earth comes from water that evaporated from the ocean.

A.2.
When water evaporates and condenses, clouds form, which can lead to precipitation.

A.3.
Most of the water in lakes, ponds, rivers, and the ground comes from water that evaporated from the ocean and fell to the land as precipitation.

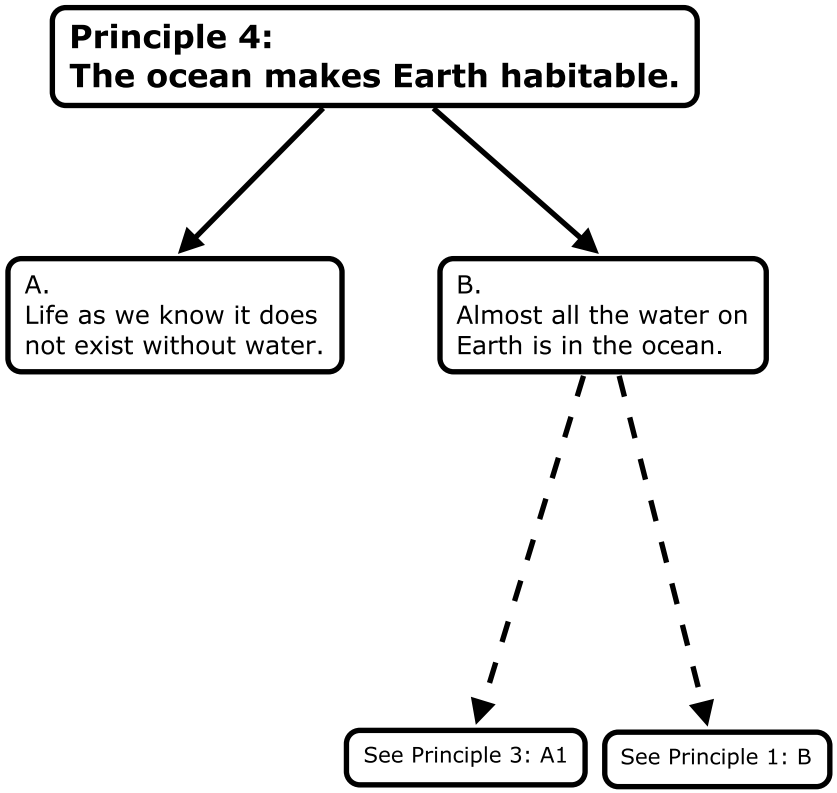
A.4.
Most of the water from land and in the atmosphere eventually returns to the ocean as runoff from rivers or precipitation.

See Principle 1: C1
See Principle 6: A6

See Principle 6: A3

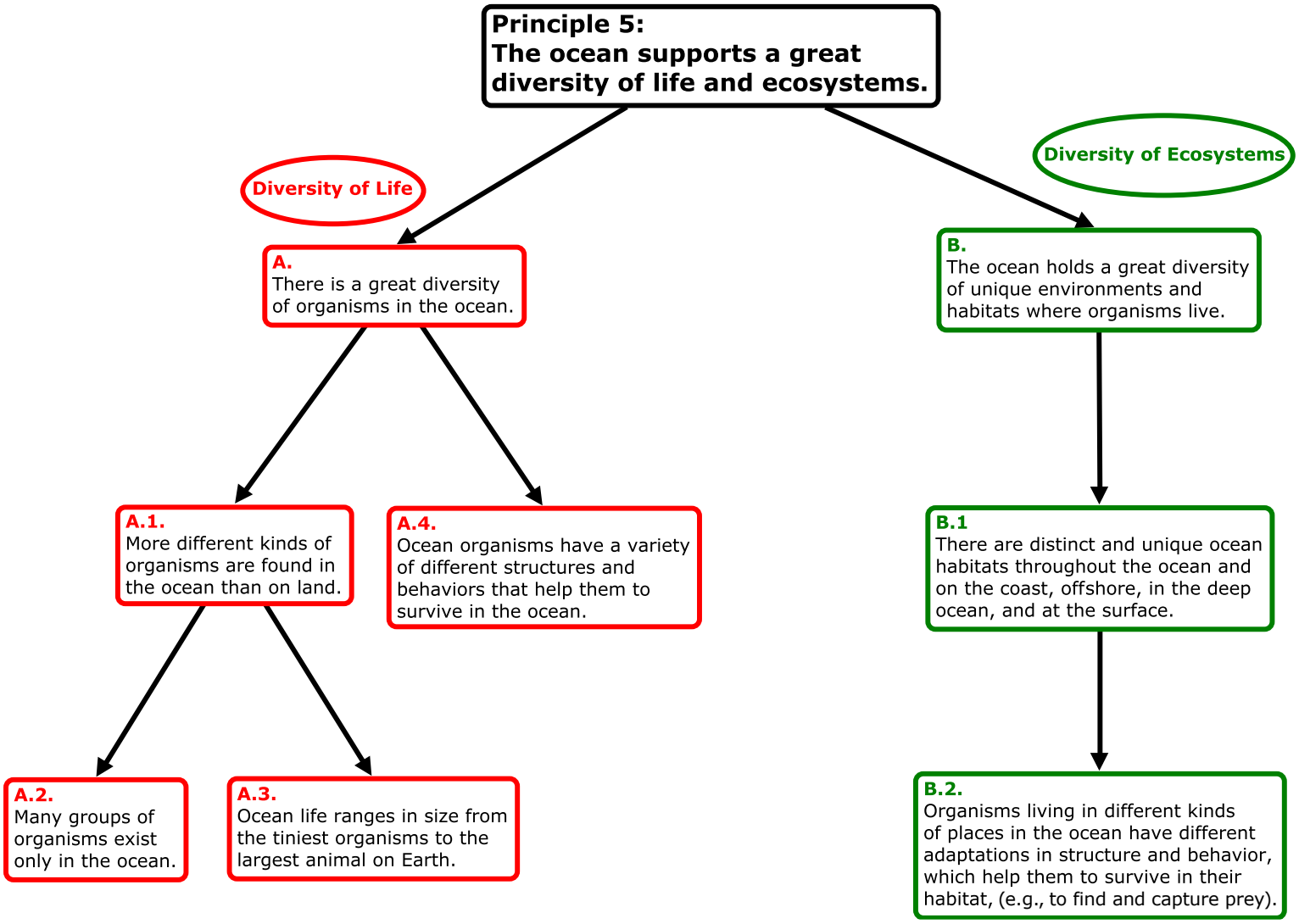
Principle 3: The ocean is a major influence on weather and climate.

Weather and Water Cycle — A		
Local weather, including precipitation, fog, and wind, can be caused by the ocean — no matter where you live.		
A1		
Most precipitation on Earth comes from water that evaporated from the ocean.		
A2	**A3**	**A4**
When water evaporates and condenses, clouds form, which can lead to precipitation.	Most of the water in lakes, ponds, rivers, and the ground comes from water that evaporated from the ocean and fell to the land as precipitation.	Most of the water from land and in the atmosphere eventually returns to the ocean as run-off from rivers or precipitation.


Principle 4:
The ocean makes Earth habitable.
A.
Life as we know it does not exist without water.
B.
Almost all the water on Earth is in the ocean.
See Principle 3: A1
See Principle 1: B

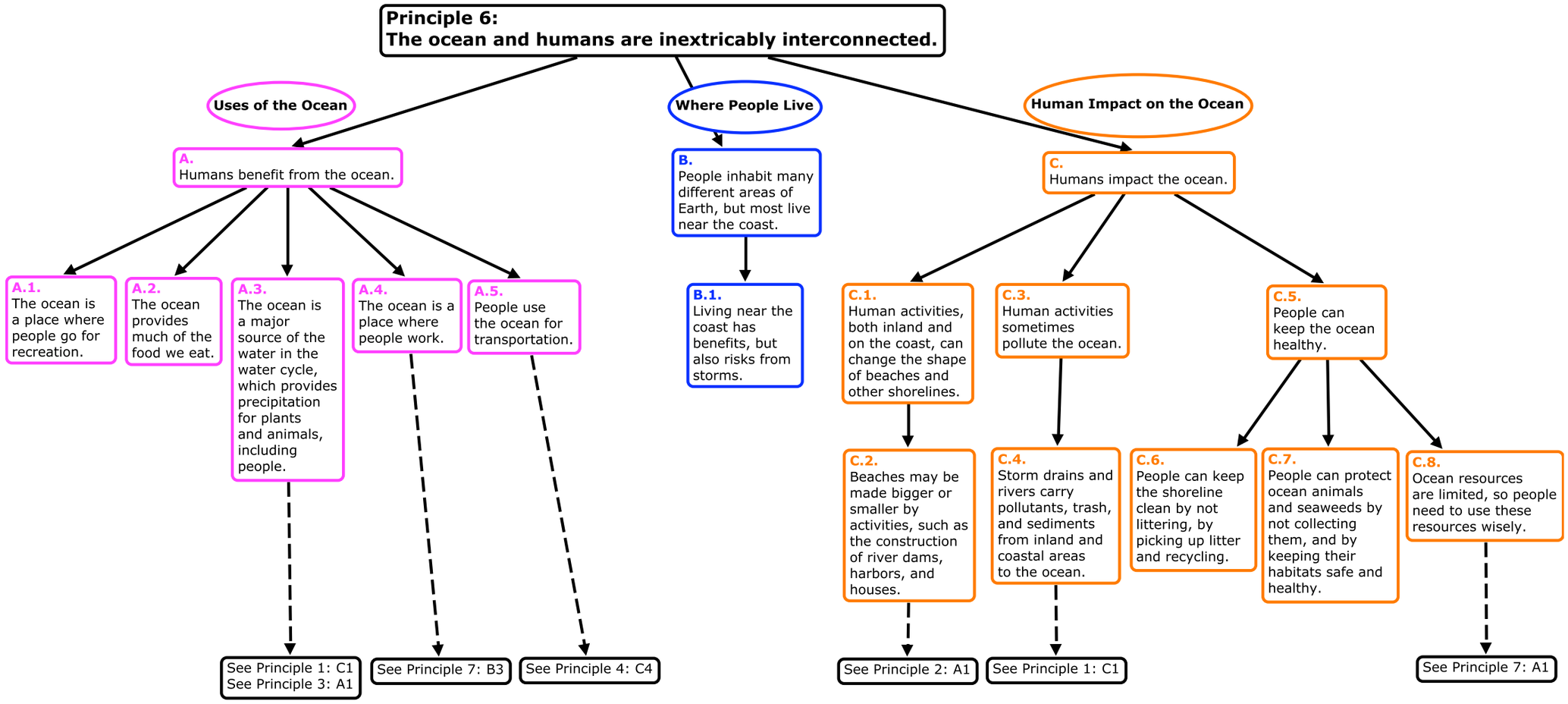
Principle 4: The ocean makes Earth habitable.

A	B
Life as we know it does not exist without water.	Almost all the water on Earth is in the ocean.


Principle 5:
The ocean supports a great diversity of life and ecosystems.
Diversity of Life
Diversity of Ecosystems
A.
There is a great diversity of organisms in the ocean.
B.
The ocean holds a great diversity of unique environments and habitats where organisms live.
A.1.
More different kinds of organisms are found in the ocean than on land.
A.4.
Ocean organisms have a variety of different structures and behaviors that help them to survive in the ocean.
B.1
There are distinct and unique ocean habitats throughout the ocean and on the coast, offshore, in the deep ocean, and at the surface.
A.2.
Many groups of organisms exist only in the ocean.
A.3.
Ocean life ranges in size from the tiniest organisms to the largest animal on Earth.
B.2.
Organisms living in different kinds of places in the ocean have different adaptations in structure and behavior, which help them to survive in their habitat, (e.g., to find and capture prey).

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

<table>
<tr><th colspan="3">Diversity of Life — A</th><th>Diversity of Ecosystems — B</th></tr>
<tr><td colspan="3">There is a great diversity of organisms in the ocean.</td><td>The ocean holds a great diversity of unique environments and habitats where organisms live.</td></tr>
<tr><th colspan="2">A1</th><th>A4</th><th>B1</th></tr>
<tr><td colspan="2">More different kinds of organisms are found in the ocean than on land.</td><td>Ocean organisms have a variety of different structures and behaviors that help them to survive in the ocean.</td><td>There are distinct and unique ocean habitats throughout the ocean and on the coast, offshore, in the deep ocean, and at the surface.</td></tr>
<tr><th>A2</th><th>A3</th><td rowspan="2"></td><th>B2</th></tr>
<tr><td>Many groups of organisms exist only in the ocean.</td><td>Ocean life ranges in size from the tiniest organisms to the largest animal on Earth.</td><td>Organisms living in different kinds of places in the ocean have different adaptations in structure and behavior, which help them to survive in their habitat, (e.g., to find and capture prey).</td></tr>
</table>


Principle 6:
The ocean and humans are inextricably interconnected.
Uses of the Ocean
Where People Live
Human Impact on the Ocean
A.
Humans benefit from the ocean.
B.
People inhabit many different areas of Earth, but most live near the coast.
C.
Humans impact the ocean.
A.1.
The ocean is a place where people go for recreation.
A.2.
The ocean provides much of the food we eat.
A.3.
The ocean is a major source of the water in the water cycle, which provides precipitation for plants and animals, including people.
A.4.
The ocean is a place where people work.
A.5.
People use the ocean for transportation.
B.1.
Living near the coast has benefits, but also risks from storms.
C.1.
Human activities, both inland and on the coast, can change the shape of beaches and other shorelines.
C.3.
Human activities sometimes pollute the ocean.
C.5.
People can keep the ocean healthy.
C.2.
Beaches may be made bigger or smaller by activities, such as the construction of river dams, harbors, and houses.
C.4.
Storm drains and rivers carry pollutants, trash, and sediments from inland and coastal areas to the ocean.
C.6.
People can keep the shoreline clean by not littering, by picking up litter and recycling.
C.7.
People can protect ocean animals and seaweeds by not collecting them, and by keeping their habitats safe and healthy.
C.8.
Ocean resources are limited, so people need to use these resources wisely.
See Principle 1: C1
See Principle 3: A1
See Principle 7: B3
See Principle 4: C4
See Principle 2: A1
See Principle 1: C1
See Principle 7: A1

Principle 6: The ocean and humans are inextricably interconnected.

Uses of the Ocean — A					Where People Live — B	Human Impact on the Ocean — C				
Humans benefit from the ocean.					People inhabit many different areas of Earth, but most live near the coast.	Humans impact the ocean.				
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**C1**	**C3**	**C5**		
The ocean is a place where people go for recreation.	The ocean provides much of the food we eat.	The ocean is a major source of the water in the water cycle, which provides precipitation for plants and animals, including people.	The ocean is a place where people work.	People use the ocean for transportation.	Living near the coast has benefits, but also risks from storms.	Human activities, both inland and on the coast, can change the shape of beaches and other shorelines.	Human activities sometimes pollute the ocean.	People can keep the ocean healthy.		
						C2	**C4**	**C6**	**C7**	**C8**
						Beaches may be made bigger or smaller by activities, such as the construction of river dams, harbors, and houses.	Storm drains and rivers carry pollutants, trash, and sediments from inland and coastal areas to the ocean.	People can keep the shoreline clean by not littering, by picking up litter and recycling.	People can protect ocean animals and seaweeds by not collecting them, and by keeping their habitats safe and healthy.	Ocean resources are limited, so people need to use these resources wisely.

Principle 7:
The ocean is largely unexplored.

Life on Earth Depends on the Ocean

A.
All living things depend on resources from the ocean, such as oxygen, food, water, energy, etc.

A.1.
Ocean resources are limited. People need to learn about these resources through exploration and scientific investigation.

See Principle 6: C8

People Explore the Ocean

B.
People have always been interested in the ocean. People explore the ocean to answer questions they have about it.

B.1.
People are still discovering new things about the ocean all the time.

B.2.
Ocean exploration helps us understand the health of the ocean and find new medicines, food for humans, and new sources of energy (e.g., oil, gas and wind).

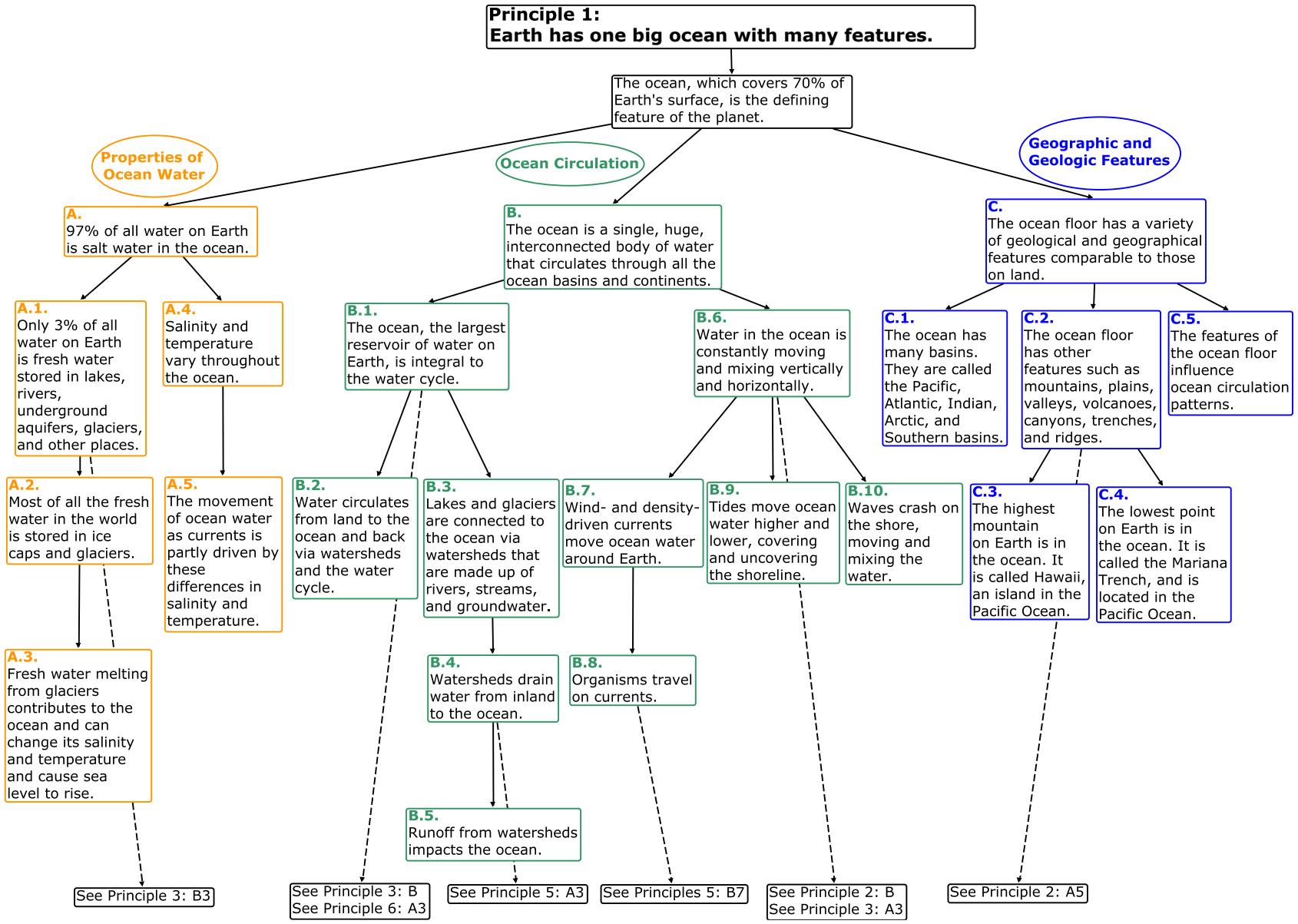
B.3.
People explore the ocean through many different hobbies and careers: scientists, fishers, engineers, surfers, swimmers, photographers, filmmakers, artists, and explorers all spend time exploring the ocean.

See Principle 6: A4

B.4.
People use creativity, curiosity, tools, and technology to make better observations of the ocean.

Principle 7: The ocean is largely unexplored.

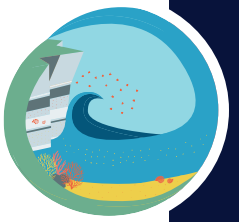
Life on Earth Depends on the Ocean — A	People Explore the Ocean — B		
All living things depend on resources from the ocean, such as oxygen, food, water, energy, etc.	People have always been interested in the ocean. People explore the ocean to answer questions they have about it.		
A1	**B1**	**B3**	**B4**
Ocean resources are limited. People need to learn about these resources through exploration and scientific investigation.	People are still discovering new things about the ocean all the time.	People explore the ocean through many different hobbies and careers: scientists, fishers, engineers, surfers, swimmers, photographers, filmmakers, artists, and explorers all spend time exploring the ocean.	People use creativity, curiosity, tools, and technology to make better observations of the ocean.
	B2		
	Ocean exploration helps us understand the health of the ocean and find new medicines, food for humans, and new sources of energy (e.g., oil, gas, and wind).		


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.
Properties of Ocean Water
Ocean Circulation
Geographic and Geologic Features
A. 97% of all water on Earth is salt water in the ocean.
B. The ocean is a single, huge, interconnected body of water that circulates through all the ocean basins and continents.
C. The ocean floor has a variety of geological and geographical features comparable to those on land.
A.1. Only 3% of all water on Earth is fresh water stored in lakes, rivers, underground aquifers, glaciers, and other places.
A.4. Salinity and temperature vary throughout the ocean.
B.1. The ocean, the largest reservoir of water on Earth, is integral to the water cycle.
B.6. Water in the ocean is constantly moving and mixing vertically and horizontally.
C.1. The ocean has many basins. They are called the Pacific, Atlantic, Indian, Arctic, and Southern basins.
C.2. The ocean floor has other features such as mountains, plains, valleys, volcanoes, canyons, trenches, and ridges.
C.5. The features of the ocean floor influence ocean circulation patterns.
A.2. Most of all the fresh water in the world is stored in ice caps and glaciers.
A.5. The movement of ocean water as currents is partly driven by these differences in salinity and temperature.
B.2. Water circulates from land to the ocean and back via watersheds and the water cycle.
B.3. Lakes and glaciers are connected to the ocean via watersheds that are made up of rivers, streams, and groundwater.
B.7. Wind- and density-driven currents move ocean water around Earth.
B.9. Tides move ocean water higher and lower, covering and uncovering the shoreline.
B.10. Waves crash on the shore, moving and mixing the water.
C.3. The highest mountain on Earth is in the ocean. It is called Hawaii, an island in the Pacific Ocean.
C.4. The lowest point on Earth is in the ocean. It is called the Mariana Trench, and is located in the Pacific Ocean.
A.3. Fresh water melting from glaciers contributes to the ocean and can change its salinity and temperature and cause sea level to rise.
B.4. Watersheds drain water from inland to the ocean.
B.8. Organisms travel on currents.
B.5. Runoff from watersheds impacts the ocean.
See Principle 3: B3
See Principle 3: B
See Principle 6: A3
See Principle 5: A3
See Principles 5: B7
See Principle 2: B
See Principle 3: A3
See Principle 2: A5

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.

Properties of Ocean Water — A		Ocean Circulation — B					Geographic and Geologic Features — C		
97% of all water on Earth is salt water in the ocean.		The ocean is a single, huge, interconnected body of water that circulates through all the ocean basins and continents.					The ocean floor has a variety of geological and geographical features comparable to those on land.		
A1	**A4**	**B1**		**B6**			**C1**	**C2**	**C5**
Only 3% of all water on Earth is fresh water stored in lakes, rivers, underground aquifers, glaciers, and other places.	Salinity and temperature vary throughout the ocean.	The ocean, the largest reservoir of water on Earth, is integral to the water cycle.		Water in the ocean is constantly moving and mixing vertically and horizontally.			The ocean has many basins. They are called the Pacific, Atlantic, Indian, Arctic, and Southern basins.	The ocean floor has other features such as mountains, plains, valleys, volcanoes, canyons, trenches, and ridges.	The features of the ocean floor influence ocean circulation patterns.
A2	**A5**	**B2**	**B3**	**B7**	**B9**	**B10**		**C3**	**C4**
Most of all the fresh water in the world is stored in ice caps and glaciers	The movement of ocean water as currents is partly driven by these differences in salinity and temperature.	Water circulates from land to the ocean and back via watersheds and the water cycle.	Lakes and glaciers are connected to the ocean via watersheds that are made up of rivers, streams, and groundwater.	Wind- and density-driven currents move ocean water around Earth.	Tides move ocean water higher and lower, covering and uncovering the shoreline.	Waves crash on the shore moving and mixing the water.		The highest mountain on Earth is in the ocean. It is called Hawaii, an island in the Pacific Ocean.	The lowest point on Earth is in the ocean. It is called the Mariana Trench, and is located in the Pacific Ocean.
A3			**B4**	**B8**					
Fresh water melting from glaciers contributes to the ocean and can change its salinity and temperature and cause sea level to rise.			Watersheds drain water from inland to the ocean.	Organisms travel on currents.					
			B5						
			Runoff from watersheds impacts the ocean.						



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

Rock Cycle

A. Many rocks found on land were formed in the ocean.

A.1. Some rocks found on land were formed from compacted ocean sediments.

A.5. Some rocks found on land were formed in the ocean by underwater volcanic activity.

A.2. Sediment is made up of materials that sink to the bottom of the ocean, which may include the shells of dead ocean organisms.

A.3. Dead organisms that fall into ocean sediments may become fossils.

A.4. Marine fossils can be found on land in places that used to be covered by the ocean, (e.g., the Rocky Mountains).

See Principle 4: A1

See Principle 1: C2

Erosion

B. The movement of water erodes and deposits materials that shape the coastline.

B.1. The movement of water can break down cliffs, rocks, and other beach materials, which constantly changes the appearance and location of the shoreline.

B.7. Rivers carry sediments downstream to the ocean.

B.9. Waves and currents move sediment along the coastline.

B.2. Beaches are made of different materials, such as sand, rocks, silt, and organic material.

B.8. Sediments are deposited at the mouths of rivers, contributing to formation of coastlines.

B.10. Large amounts of sediment from one area can be deposited in other locations along the coast.

B.3. Rocks and minerals from the shoreline and from inland are broken down into pebbles, sand, silt, and smaller materials.

B.4. Shells and other hard materials from once-living organisms are broken down into sand, silt, and smaller materials.

B.5. Most sand on most ocean beaches comes from rivers.

B.6. Sand grains come in many shapes, sizes, and colors that provide clues to their origin.

See Principle 1: B6

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

Rock Cycle — A			Erosion — B				
Many rocks found on land were formed in the ocean.			The movement of water erodes and deposits materials that shape the coastline.				
A1		**A5**	**B1**			**B7**	**B9**
Some rocks found on land were formed from compacted ocean sediments.		Some rocks found on land were formed in the ocean by underwater volcanic activity.	The movement of water can break down cliffs, rocks, and other beach materials, which constantly changes the appearance and location of the shoreline.			Rivers carry sediments downstream to the ocean.	Waves and currents move sediment along the coastline.
A2	**A3**		**B2**			**B8**	**B10**
Sediment is made up of materials that sink to the bottom of the ocean, which may include the shells of dead ocean organisms.	Dead organisms that fall into the ocean sediments may become fossils.		Beaches are made from different materials, such as sand, rocks, silt, and organic material.			Sediments are deposited at the mouths of rivers, contributing to formation of coastlines.	Large amounts of sediment from one area can be deposited in other locations along the coast.
	A4		**B3**	**B4**	**B5**	**B5**	
	Marine fossils can be found on land in places that used to be covered by the ocean, (e.g., the Rocky Mountains).		Rocks and minerals from the shoreline and from inland are broken down into pebbles, sand, silt, and smaller materials.	Shells and other hard materials from once-living organisms are broken down into sand, silt, and smaller materials.	Most sand on most ocean beaches comes from rivers.	Most sand on most ocean beaches comes from rivers.	
			B6	**B6**	**B6**	**B6**	
			Sand grains come in many shapes, sizes, and colors that provide clues to their origin.	Sand grains come in many shapes, sizes and colors that provide clues to their origin.	Sand grains come in many shapes, sizes and colors that provide clues to their origin.	Sand grains come in many shapes, sizes and colors that provide clues to their origin.	

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

Nearly all the water on Earth is stored in the ocean. The ocean, which covers over 70% of Earth's surface, controls the weather by dominating Earth's energy and water systems.

Weather

A.
The ocean absorbs and holds much of the solar energy that reaches Earth.

A.1.
The ocean absorbs and holds more heat than the land.

A.2.
The ocean moderates coastal weather because the temperature of air masses over the ocean fluctuates less than the temperature of air masses over the land.

See Principle 6: B3

A.3.
The uneven heating of Earth causes convection currents, the movement of air and ocean water, from one place to another.

A.4.
Ocean currents move heat throughout ocean basins, which in turn, affects Earth's weather.

A.5.
Warm ocean water warms the air. The warm air rises, creating a low pressure area. Winds are set in motion as air moves from high-pressure to low-pressure areas.

See Principle 1: B6

A.6.
The ocean provides the energy for wind, which can produce severe weather, such as hurricanes and cyclones.

See Principle 6: B4

Water Cycle

B.
The ocean is an integral part of the water cycle. Solar energy absorbed by the ocean drives the water cycle.

B.1.
Solar energy warms water in the ocean and causes it to evaporate. Most water in the air comes from the ocean.

B.2.
Water in the air eventually cools, condenses into clouds, and returns to the ocean or the land as precipitation.

B.3.
Most of the fresh water on Earth comes from water that evaporated from the tropical ocean.

See Principle 1: A1

B.4.
Most of the water on land returns to the ocean through river runoff.

See Principle 1: B1
See Principle 6: A3

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

Nearly all the water on Earth is stored in the ocean. The ocean, which covers over 70% of Earth's surface, controls the weather by dominating Earth's energy and water systems.

<table>
<tr><th colspan="4">Weather — A</th><th colspan="3">Water Cycle — B</th></tr>
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</table>

Principle 4:
The ocean makes Earth habitable.

Origins of Life

A.
There is evidence that life started in the ocean.

A.1.
There is fossil evidence that the first organisms on Earth were bacteria that lived in the ocean.

See Principle 2: A2

Oxygen Production

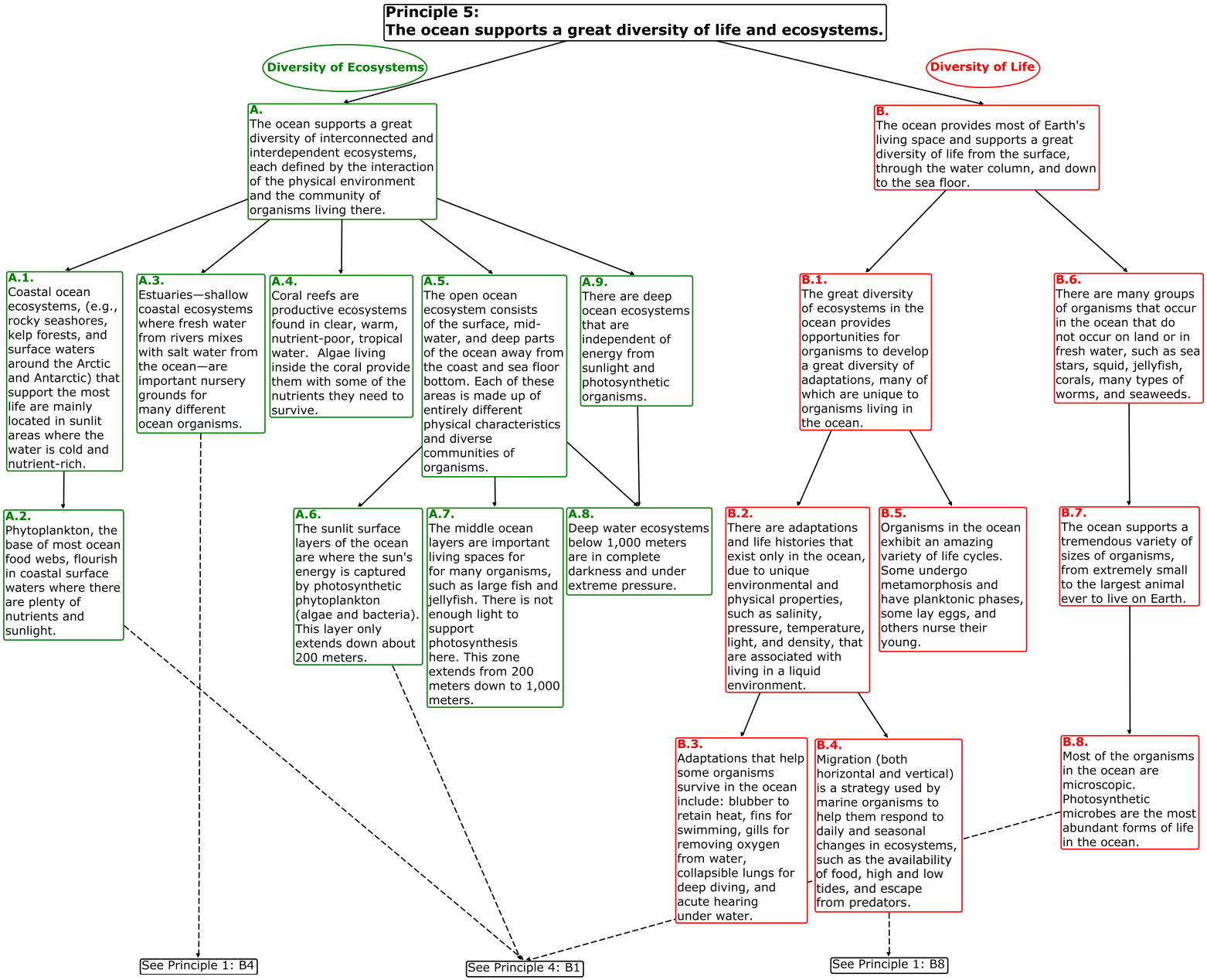
B.
Most of the oxygen in the atmosphere originally came from the activities of photosynthetic organisms in the ocean.

B.1.
Some organisms on land and in the ocean use carbon dioxide, water, and sunlight to make their own food. This process is called photosynthesis, and it releases oxygen.

See Principle 5: A6 and B3
See Principle 6: A5

Principle 4: The ocean makes Earth habitable.

Origins of Life — A	Oxygen Production — B
There is evidence that life started in the ocean.	Most of the oxygen in the atmosphere originally came from the activities of photosynthetic organisms in the ocean.
A1	**B1**
There is fossil evidence that the first organisms on Earth were bacteria that lived in the ocean.	Some organisms on land and in the ocean use carbon dioxide, water, and sunlight to make their own food. This process is called photosynthesis, and it releases oxygen.


Principle 5:
The ocean supports a great diversity of life and ecosystems.
Diversity of Ecosystems
Diversity of Life
A.
The ocean supports a great diversity of interconnected and interdependent ecosystems, each defined by the interaction of the physical environment and the community of organisms living there.
B.
The ocean provides most of Earth's living space and supports a great diversity of life from the surface, through the water column, and down to the sea floor.
A.1.
Coastal ocean ecosystems, (e.g., rocky seashores, kelp forests, and surface waters around the Arctic and Antarctic) that support the most life are mainly located in sunlit areas where the water is cold and nutrient-rich.
A.3.
Estuaries—shallow coastal ecosystems where fresh water from rivers mixes with salt water from the ocean—are important nursery grounds for many different ocean organisms.
A.4.
Coral reefs are productive ecosystems found in clear, warm, nutrient-poor, tropical water. Algae living inside the coral provide them with some of the nutrients they need to survive.
A.5.
The open ocean ecosystem consists of the surface, mid-water, and deep parts of the ocean away from the coast and sea floor bottom. Each of these areas is made up of entirely different physical characteristics and diverse communities of organisms.
A.9.
There are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms.
B.1.
The great diversity of ecosystems in the ocean provides opportunities for organisms to develop a great diversity of adaptations, many of which are unique to organisms living in the ocean.
B.6.
There are many groups of organisms that occur in the ocean that do not occur on land or in fresh water, such as sea stars, squid, jellyfish, corals, many types of worms, and seaweeds.
A.2.
Phytoplankton, the base of most ocean food webs, flourish in coastal surface waters where there are plenty of nutrients and sunlight.
A.6.
The sunlit surface layers of the ocean are where the sun's energy is captured by photosynthetic phytoplankton (algae and bacteria). This layer only extends down about 200 meters.
A.7.
The middle ocean layers are important living spaces for for many organisms, such as large fish and jellyfish. There is not enough light to support photosynthesis here. This zone extends from 200 meters down to 1,000 meters.
A.8.
Deep water ecosystems below 1,000 meters are in complete darkness and under extreme pressure.
B.2.
There are adaptations and life histories that exist only in the ocean, due to unique environmental and physical properties, such as salinity, pressure, temperature, light, and density, that are associated with living in a liquid environment.
B.5.
Organisms in the ocean exhibit an amazing variety of life cycles. Some undergo metamorphosis and have planktonic phases, some lay eggs, and others nurse their young.
B.7.
The ocean supports a tremendous variety of sizes of organisms, from extremely small to the largest animal ever to live on Earth.
B.3.
Adaptations that help some organisms survive in the ocean include: blubber to retain heat, fins for swimming, gills for removing oxygen from water, collapsible lungs for deep diving, and acute hearing under water.
B.4.
Migration (both horizontal and vertical) is a strategy used by marine organisms to help them respond to daily and seasonal changes in ecosystems, such as the availability of food, high and low tides, and escape from predators.
B.8.
Most of the organisms in the ocean are microscopic. Photosynthetic microbes are the most abundant forms of life in the ocean.
See Principle 1: B4
See Principle 4: B1
See Principle 1: B8

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

Diversity of Ecosystems — A

The ocean supports a great diversity of interconnected and interdependent ecosystems, each defined by the interaction of the physical environment and the community of organisms living there.

A1

Coastal ocean ecosystems, (e.g., rocky seashores, kelp forests, and surface waters around the Arctic and Antarctic) that support the most life are mainly located in sunlit areas where the water is cold and nutrient-rich.

A3

Estuaries — shallow coastal ecosystems where fresh water from rivers mixes with salt water from the ocean — are important nursery grounds for many different ocean organisms.

A4

Coral reefs are productive ecosystems found in clear, warm, nutrient-poor, tropical water. Algae living inside the coral provide them with some of the nutrients that they need to survive.

A5

The open ocean ecosystem consists of the surface, mid-water, and deep parts of the ocean away from the coast and sea floor bottom. Each of these areas is made up of entirely different physical characteristics and diverse communities of organisms.

A9

There are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms.

A2

Phytoplankton, the base of most ocean food webs, flourish in coastal surface waters where there are plenty of nutrients and sunlight.

A6

The sunlit surface layers of the ocean are where the sun's energy is captured by photosynthetic phytoplankton (algae and bacteria). This layer only extends down about 200 meters.

A7

The middle ocean layers are important living spaces for many organisms, such as large fish and jellyfish. There is not enough light to support photosynthesis here. This zone extends from 200 meters down to 1,000 meters.

A8

Deep water ecosystems below 1,000 meters are in complete darkness and under extreme pressure.

A8

Deep water ecosystems below 1,000 meters are in complete darkness and under extreme pressure.

Diversity of Life — B

The ocean provides most of Earth's living space and supports a great diversity of life from the surface, through the water column, and down to the sea floor.

B1

The great diversity of ecosystems in the ocean provides opportunities for organisms to develop a great diversity of adaptations, many of which are unique to organisms living in the ocean.

B6

There are many groups of organisms that occur in the ocean that do not occur on land or in fresh water, such as sea stars, squid, jellyfish, corals, many types of worms, and seaweeds.

B2

There are adaptations and life histories that exist only in the ocean, due to unique environmental and physical properties, such as salinity, pressure, temperature, light, and density, that are associated with living in a liquid environment.

B5

Organisms in the ocean exhibit an amazing variety of life cycles. Some undergo metamorphosis and have planktonic phases, some lay eggs, and others nurse their young.

B7

The ocean supports a tremendous variety of sizes of organisms, from extremely small to the largest animal ever to live on Earth.

B3

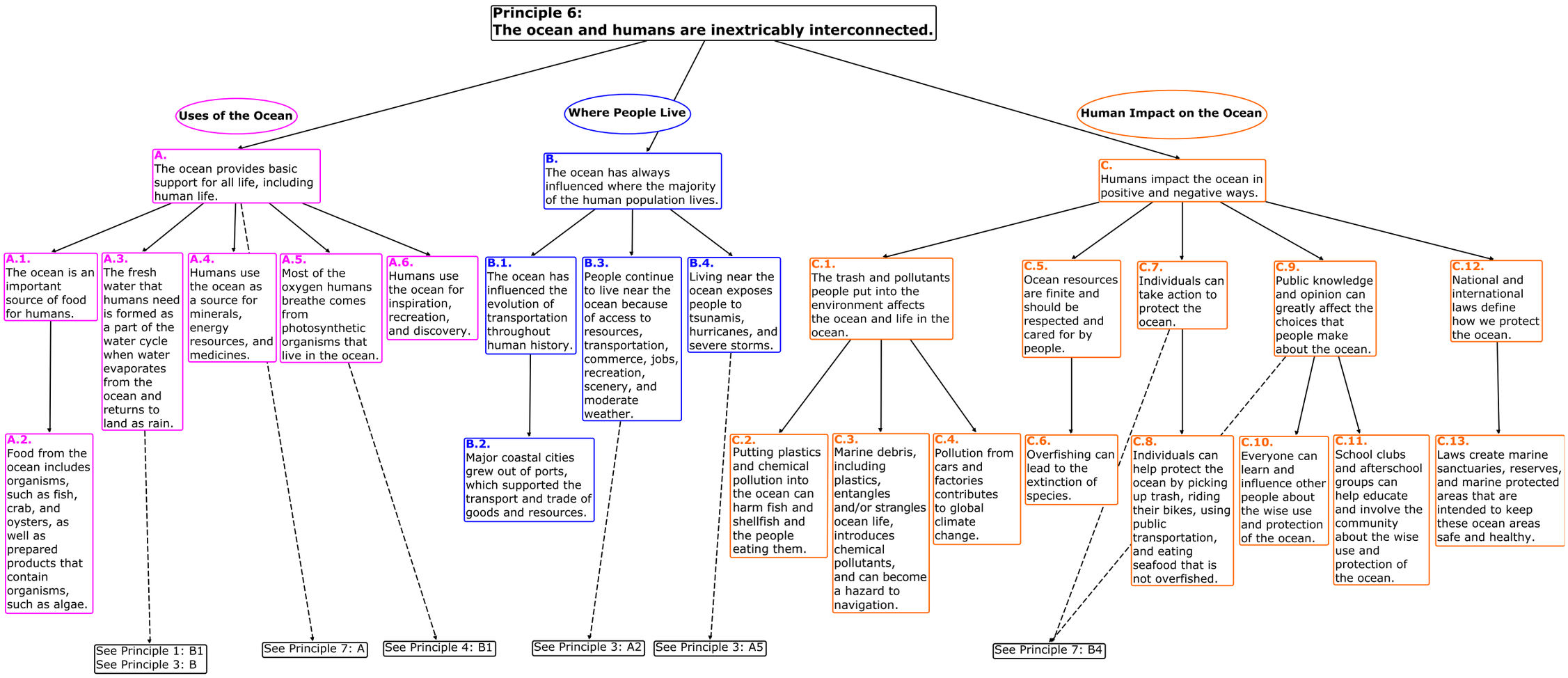
Adaptations that help some organisms survive in the ocean include: blubber to retain heat, fins for swimming, gills for removing oxygen from water, collapsible lungs for deep diving, and acute hearing under water.

B4

Migration (both horizontal and vertical) is a strategy used by marine organisms to help them respond to daily and seasonal changes in ecosystems, such as the availability of food, high and low tides, and escape from predators.

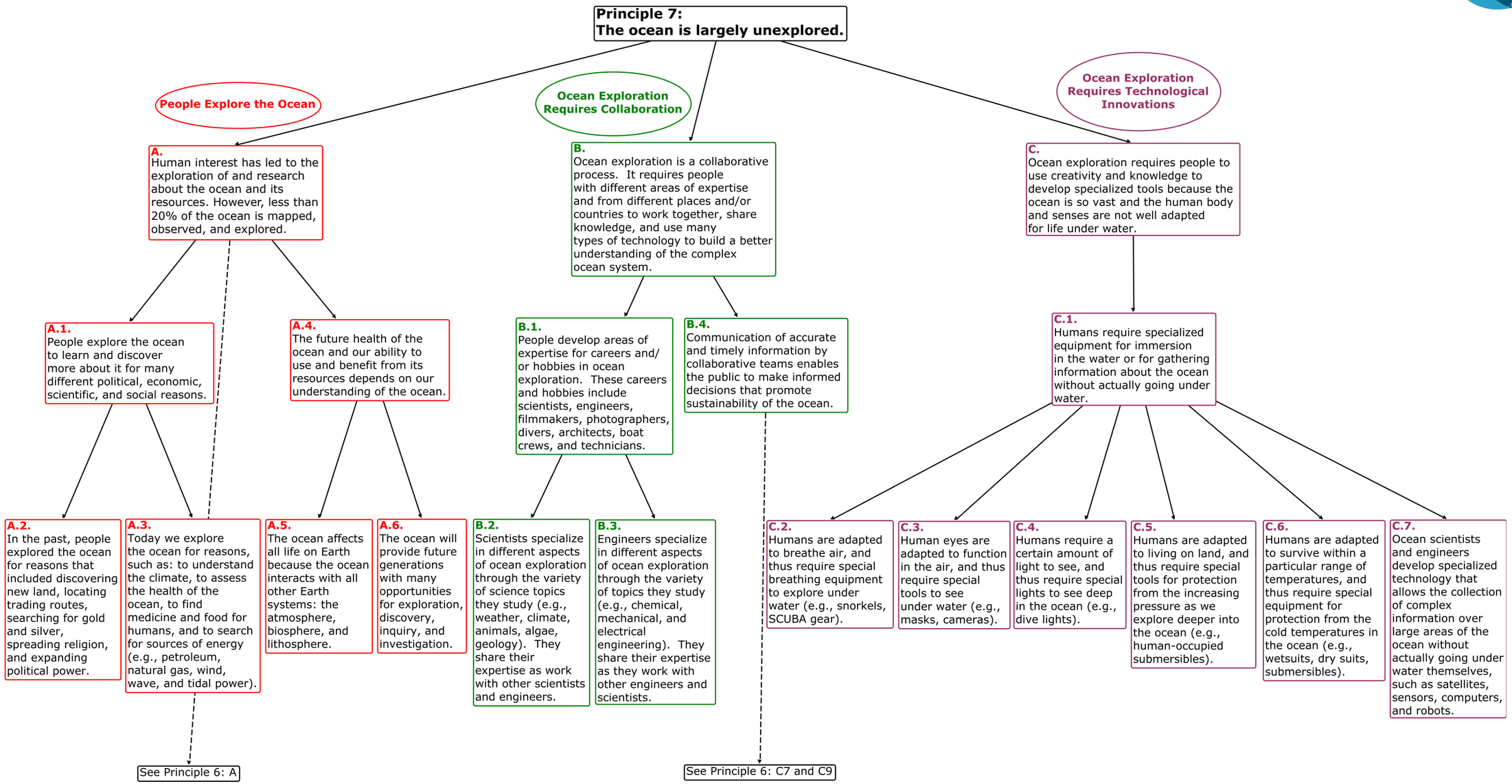
B8

Most of the organisms in the ocean are microscopic. Photosynthetic microbes are the most abundant forms of life in the ocean.


Principle 6:
The ocean and humans are inextricably interconnected.
Uses of the Ocean
Where People Live
Human Impact on the Ocean
A. The ocean provides basic support for all life, including human life.
B. The ocean has always influenced where the majority of the human population lives.
C. Humans impact the ocean in positive and negative ways.
A.1. The ocean is an important source of food for humans.
A.2. Food from the ocean includes organisms, such as fish, crab, and oysters, as well as prepared products that contain organisms, such as algae.
A.3. The fresh water that humans need is formed as a part of the water cycle when water evaporates from the ocean and returns to land as rain.
A.4. Humans use the ocean as a source for minerals, energy resources, and medicines.
A.5. Most of the oxygen humans breathe comes from photosynthetic organisms that live in the ocean.
A.6. Humans use the ocean for inspiration, recreation, and discovery.
B.1. The ocean has influenced the evolution of transportation throughout human history.
B.2. Major coastal cities grew out of ports, which supported the transport and trade of goods and resources.
B.3. People continue to live near the ocean because of access to resources, transportation, commerce, jobs, recreation, scenery, and moderate weather.
B.4. Living near the ocean exposes people to tsunamis, hurricanes, and severe storms.
C.1. The trash and pollutants people put into the environment affects the ocean and life in the ocean.
C.2. Putting plastics and chemical pollution into the ocean can harm fish and shellfish and the people eating them.
C.3. Marine debris, including plastics, entangles and/or strangles ocean life, introduces chemical pollutants, and can become a hazard to navigation.
C.4. Pollution from cars and factories contributes to global climate change.
C.5. Ocean resources are finite and should be respected and cared for by people.
C.6. Overfishing can lead to the extinction of species.
C.7. Individuals can take action to protect the ocean.
C.8. Individuals can help protect the ocean by picking up trash, riding their bikes, using public transportation, and eating seafood that is not overfished.
C.9. Public knowledge and opinion can greatly affect the choices that people make about the ocean.
C.10. Everyone can learn and influence other people about the wise use and protection of the ocean.
C.11. School clubs and afterschool groups can help educate and involve the community about the wise use and protection of the ocean.
C.12. National and international laws define how we protect the ocean.
C.13. Laws create marine sanctuaries, reserves, and marine protected areas that are intended to keep these ocean areas safe and healthy.
See Principle 1: B1
See Principle 3: B
See Principle 7: A
See Principle 4: B1
See Principle 3: A2
See Principle 3: A5
See Principle 7: B4

Principle 6: The ocean and humans are inextricably connected.

Uses of the Ocean — A					Where People Live- B			Human Impact on the Ocean — C								
The ocean provides basic support for all life, including human life.					The ocean has always influenced where the majority of the human population lives.			Humans impact the ocean in positive and negative ways.								
A1	**A3**	**A4**	**A5**	**A6**	**B1**	**B3**	**B4**	**C1**			**C5**	**C7**	**C9**		**C12**	
The ocean is an important source of food for humans.	The freshwater that humans need is formed as a part of the water cycle when water evaporates from the ocean and returns to land as rain.	Humans use the ocean as a source for minerals, energy resources, and medicines.	Most of the oxygen humans breathe comes from photosynthetic organisms that live in the ocean.	Humans use the ocean for inspiration, recreation, and discovery.	The ocean has influenced the evolution of transportation throughout human history.	People continue to live near the ocean because of access to resources, transportation, commerce, jobs, recreation, scenery, and moderate weather.	Living near the ocean exposes people to tsunamis, hurricanes, and severe storms.	The trash and pollutants people put into the environment affects the ocean and life in the ocean.			Ocean resources are finite and should be respected and cared for by people.	Individuals can take action to protect the ocean.	Public knowledge and opinion can greatly affect the choices that people make about the ocean.		National and international laws define how we protect the ocean.	
A2					**B2**			**C2**	**C3**	**C4**	**C6**	**C8**	**C10**	**C11**	**C13**	
Food from the ocean includes organisms, such as fish, crab, and oysters, as well as prepared products that contain organisms, such as algae.					Major coastal cities grow out of ports, which supported the transport and trade of goods and resources.			Putting plastics and chemical pollution into the ocean can harm fish and shellfish and the people eating them.	Marine debris, including plastics, entangles and/or strangles ocean life, introduces chemical pollutants, and can become a hazard to navigation.	Pollution from cars and factories contributes to global climate change.	Overfishing can lead to the extinction of species.	Individuals can help protect the ocean by picking up trash, riding their bikes,using public transportation, and eating seafood that is not overfished.	Everyone can learn and influence other people about the wise use and protection of the ocean.	School clubs and afterschool groups can help educate and involve the community about the wise use and protection of the ocean.	Laws create marine sanctuaries, reserves, and marine protected areas that are intended to keep these ocean areas safe and healthy.	


Principle 7:
The ocean is largely unexplored.
People Explore the Ocean
Ocean Exploration Requires Collaboration
Ocean Exploration Requires Technological Innovations
A.
Human interest has led to the exploration of and research about the ocean and its resources. However, less than 20% of the ocean is mapped, observed, and explored.
B.
Ocean exploration is a collaborative process. It requires people with different areas of expertise and from different places and/or countries to work together, share knowledge, and use many types of technology to build a better understanding of the complex ocean system.
C.
Ocean exploration requires people to use creativity and knowledge to develop specialized tools because the ocean is so vast and the human body and senses are not well adapted for life under water.
A.1.
People explore the ocean to learn and discover more about it for many different political, economic, scientific, and social reasons.
A.4.
The future health of the ocean and our ability to use and benefit from its resources depends on our understanding of the ocean.
B.1.
People develop areas of expertise for careers and/or hobbies in ocean exploration. These careers and hobbies include scientists, engineers, filmmakers, photographers, divers, architects, boat crews, and technicians.
B.4.
Communication of accurate and timely information by collaborative teams enables the public to make informed decisions that promote sustainability of the ocean.
C.1.
Humans require specialized equipment for immersion in the water or for gathering information about the ocean without actually going under water.
A.2.
In the past, people explored the ocean for reasons that included discovering new land, locating trading routes, searching for gold and silver, spreading religion, and expanding political power.
A.3.
Today we explore the ocean for reasons, such as: to understand the climate, to assess the health of the ocean, to find medicine and food for humans, and to search for sources of energy (e.g., petroleum, natural gas, wind, wave, and tidal power).
A.5.
The ocean affects all life on Earth because the ocean interacts with all other Earth systems: the atmosphere, biosphere, and lithosphere.
A.6.
The ocean will provide future generations with many opportunities for exploration, discovery, inquiry, and investigation.
B.2.
Scientists specialize in different aspects of ocean exploration through the variety of science topics they study (e.g., weather, climate, animals, algae, geology). They share their expertise as work with other scientists and engineers.
B.3.
Engineers specialize in different aspects of ocean exploration through the variety of topics they study (e.g., chemical, mechanical, and electrical engineering). They share their expertise as they work with other engineers and scientists.
C.2.
Humans are adapted to breathe air, and thus require special breathing equipment to explore under water (e.g., snorkels, SCUBA gear).
C.3.
Human eyes are adapted to function in the air, and thus require special tools to see under water (e.g., masks, cameras).
C.4.
Humans require a certain amount of light to see, and thus require special lights to see deep in the ocean (e.g., dive lights).
C.5.
Humans are adapted to living on land, and thus require special tools for protection from the increasing pressure as we explore deeper into the ocean (e.g., human-occupied submersibles).
C.6.
Humans are adapted to survive within a particular range of temperatures, and thus require special equipment for protection from the cold temperatures in the ocean (e.g., wetsuits, dry suits, submersibles).
C.7.
Ocean scientists and engineers develop specialized technology that allows the collection of complex information over large areas of the ocean without actually going under water themselves, such as satellites, sensors, computers, and robots.
See Principle 6: A
See Principle 6: C7 and C9

Principle 7: The ocean is largely unexplored.

People Explore the Ocean — A				Ocean Exploration Requires Collaboration — B			Ocean Exploration Requires Technological Innovations — C					
Human interest has led to the exploration of and research about the ocean and its resources. However, less than 20% of the ocean has been mapped, observed, and explored.				Ocean exploration is a collaborative process. It requires people with different areas of expertise and from different places and/or countries to work together, share knowledge, and use many types of technology to build a better understanding of the complex ocean system.			Ocean exploration requires people to use creativity and knowledge to develop specialized tools because the ocean is so vast and the human body and senses are not well adapted for life under water.					
A1		**A4**		**B1**		**B4**	**C1**					
People explore the ocean to learn and discover more about it for many different political, economic, scientific, and social reasons.		The future health of the ocean and our ability to use it and benefit from its resources depends on our understanding of the ocean.		People develop areas of expertise for careers and/or hobbies in ocean exploration. These careers and hobbies include scientists, engineers, filmmakers, photographers, divers, architects, boat crews, and technicians.		Communication of accurate and timely information by collaborative teams enables the public to make informed decisions that promote sustainability of the ocean.	Humans require specialized equipment for immersion in the water or for gathering information about the ocean without actually going under water.					
A2	**A3**	**A5**	**A6**	**B2**	**B3**		**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
In the past, people explored the ocean for reasons that included discovering new land, locating trading routes, searching for gold and silver, spreading religion, and expanding political power.	Today we explore the ocean for reasons, such as: to understand the climate, to assess the health of the ocean, to find medicine and food for humans, and to search for sources of energy (e.g., petroleum, natural gas, wind, wave and tidal power).	The ocean affects all life on Earth because the ocean interacts with all other Earth systems: the atmosphere, biosphere and lithosphere.	The ocean will provide future generations with many opportunities for exploration, discovery, inquiry, and investigation.	Scientists specialize in different aspects of ocean exploration through the variety of science topics they study (e.g., weather, climate, animals, algae, geology). They share their expertise as they work with other scientists and engineers.	Engineers specialize in different aspects of ocean exploration through the variety of topics they study (e.g., chemical, mechanical, and electrical engineering). They share their expertise as they work with other engineers and scientists.		Humans are adapted to breathe air, and thus require special breathing equipment to explore under water (e.g., snorkels, SCUBA gear).	Human eyes are adapted to function in the air, and thus require special tools to see under water (e.g., masks, cameras).	Humans require a certain amount of light to see, and thus require special lights to see deep in the ocean (e.g., dive lights).	Humans are adapted to living on land, and thus require special tools for protection from increasing pressure as we explore deeper into the ocean (e.g., human-occupied submersibles).	Humans are adapted to survive within a particular range of temperatures, and thus require special equipment for protection from the cold temperatures in the ocean (e.g., wetsuits, dry suits, submersibles).	Ocean scientists and engineers develop specialized technology that allows the collection of complex information over large areas of the ocean without actually going under water themselves, such as satellites, sensors, computers, and robots.