Convection, Currents and Circulation

ACTIVITY ONE

Until now, we've only touched the surface...

Part A. **Temperature and Density**

The Blue Planet: Seas of Life reveals that life in the oceans is regulated by the path of nutrient-carrying currents. Density affects the generation and maintenance of the currents, and in turn, temperature influences density. Cold, polar waters have a different density than warm, tropical waters.

In this activity, you'll investigate the behaviors of different temperatures and densities of water. Follow your teacher's directions.

- What happened to the water when you removed the divider?

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- If you know that materials denser than water sink and less dense materials float, what can you infer about the densities of water at each temperature?

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- Heating makes water expand. With expansion, the same mass of water takes up a slightly larger space (or volume). Density is mass divided by volume. How will the density of water be affected when it expands? (Remember, you will be dividing the same mass of water by a slightly **larger** volume.)

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- What does cooling do to the water?

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- How does this affect the density?

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- What would have happened if the water in both compartments had been the SAME temperature?

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- Where on Earth would there be cool water throughout the year?

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- Where would there be warm, heated water?

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Part B. **Convection Currents**

Differences in density due to temperature not only trigger lateral movements of water but vertical movements, or convection, as well.

In this activity, you will see a model of convection currents. Fill the container three-quarters full with very cold water. Fill the small bottle with very warm water and add food coloring. Hold your finger over the mouth of the small bottle and gently lower it to the bottom of the large container of cold water. Remove your finger from the small bottle.

- Describe what happens to the hot water from the small bottle.

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- Now reverse the above procedure and place a small bottle of very cold water inside a large container of very warm water. Describe what happens to the cold water from the small bottle.

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- What could cause the warm water to behave this way? Hint: Think of **Part A**.

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- What could cause the cold water to behave this way?

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- What do you think happens to the temperature of surface water after it has been exposed to continued winter cooling?

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- What would happen to the deeper water if it became slightly warmer than the surface water?

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- If density currents flow like rivers in the deep ocean, what do you think would happen to their waters if they collide with a large body of land such as an island or underwater island?

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- How could this benefit marine animals?

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The Pressure is On!

Until now, we've only touched the surface...

ACTIVITY TWO

Launching one of the submarines used to film *The Blue Planet: Seas of Life.*

The BBC crew discovered this octopus and nicknamed it Dumbo!

Part A. Although the majority of Earth is covered by water, researchers from *The Blue Planet: Seas of Life* estimate that less than one percent of the deep ocean has been explored. The only way to go there is by submersible, such as ALVIN, the one we see in *The Blue Planet: Seas of Life.*

In this activity, you will observe how a dropper (acting like a submarine) in a bottle filled with water can model the way actual submarines ascend and descend. Place the bottle on a flat surface and squeeze it in the middle and then hold the squeeze. Release the squeeze slowly. Observe what happens to the dropper (submarine). Repeat this procedure several times.

- What happens to the submarine when you squeeze the bottle and hold the squeeze?

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- How do you get the submarine to hover in one spot?

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- Since the volume of the submarine cannot change, what property varies as you squeeze and release the bottle?

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- When you release the squeeze, what happens to the submarine?

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- What determines if the submarine floats or sinks?

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- When it is floating, how dense must the submarine be in comparison to water?

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- When it sinks?

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Part B. In *The Blue Planet: Seas of Life*, we learn that 60 percent of the ocean is a mile or more deep. At that depth, there is no sunlight, and the pressure is 160 times greater than on the surface of the earth. On the deepest ocean floor, pressure is equal to a person supporting the weight of 50 jumbo jets. It's no wonder humans need the protection of submersibles!

The record dive using an untethered, pressurized diving suit is 1,968 feet, and the record for a scuba air dive is 475 feet. In comparison, ALVIN is rated safe for 20,000 feet with a normal operating depth of 13,124 feet. While filming *The Blue Planet: Seas of Life*, ALVIN made dives of 4,500 meters or 13,765 feet. Its dive record is 14,763 feet.

To determine the relationship between water pressure and depth, place tape over the holes in the bottle your teacher gives you. Fill the container with water and stand it up with the holes facing into a sink. Remove the tape from each hole. Measure the lengths the water squirts from each of the holes.

- How did the streams differ from each other?

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- What does this demonstration tell you about the relationship between pressure and depth?

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Part C. Submersibles such as ALVIN must be constructed of materials strong enough to withstand intense pressures. ALVIN is a 2-meter (6.5 ft) titanium sphere. This size and shape help prevent implosion. While there are only five submersibles capable of reaching the abyssal plain, some animals make incredibly deep dives. In Episode Two of *The Blue Planet: Seas of Life*, a sperm whale dives more than 1,000 meters (over 3,000 feet) in search of food. Pressure squeezes the animal's lungs to just one percent of their volume.

Calculate the pressure conditions in atmospheres (atm) and pounds per square inch (psi) for each of the items in the list below. To convert the feet of depth readings to atmospheres, divide by 33 because for each 33 feet of depth, the pressure changes one atmosphere. You must add 1 atm to the answers to account for the surface air pressure at sea level. To get psi, multiply the number of atmospheres by 14.7—the pressure of one atmosphere.

Dive record	feet	atm	psi
ALVIN (3-person submersible)	14,763	399	5,865
Titanic final resting place	12,500		
Jason (robotic submarine)	19,685		
Sperm whale dive record	3,773		
North elephant seal dive record	4,921		
Mariana Trench dive record	35,802		

Energy for Life

Until now, we've only touched the surface...

ACTIVITY THREE

The hairy angler fish was not known to science until the BBC crew discovered it.

Part A. Every organism has its unique place in the food chain—the route by which energy flows from *producers* (organisms that manufacture their own food) to *consumers* (organisms that get energy by feeding on other organisms). Consumers that feed directly on producers are called *primary consumers*. Organisms that eat the decaying remains of others are called *scavengers*.

In *The Blue Planet: Seas of Life*, we see that food chains often rely on tides, seasons, weather, storms, and migrations. Humans often harm the balance. After your teacher assigns a marine ecosystem to your group, do some research to make a poster displaying the information listed below:

1. Where this ecosystem can be found
2. A flow chart of one possible food chain within this ecosystem—identifying producers, primary consumers, intermediate/secondary consumers, top consumers, scavengers/decomposers
3. Forces, factors, phenomena this food chain depends upon
4. Factors, actions that can damage this food chain
5. Problems within the ecosystem that affect the food chain
6. What you think will happen to this ecosystem in the future

Part B. *In The Blue Planet: Seas of Life*, we see adaptations within marine predator-prey relationships. *The Blue Planet: Seas of Life* refers to this as "an evolutionary arms race" in which "one device for escape is countered by another for attack."

Look at this list of animals and adaptations. Explain how the adaptation is beneficial.

Part C. Plants convert the sun's energy to food energy through *photosynthesis*. In *The Blue Planet: Seas of Life*, we see that plankton is responsible for photosynthesis in the seas. We also see striking examples of organisms thriving in environments completely devoid of sunlight. These strange creatures rely on host bacteria to convert the chemical energy in hydrogen sulfide and methane found in deep thermal vents. This process of conversion of chemical energy to food energy is called *chemosynthesis*.

Research photosynthesis and chemosynthesis. On the back of this sheet, construct a Venn diagram to compare and contrast these processes. List the names of some organisms that carry on each process.

Animal	Adaptation	Benefit of Adaptation
Puffin, ring seal, polar bear	Hide young in caves, burrows	Young hard to find by predators
Harp seal, hooded seal	Short nursing period	
Polar bear, gray whale	Long period of maternal care	
Deep-sea jellyfish	Protective coloration	
Octopus	Sense organs detect movement	
Emperor penguin	Male protects single egg for 115 days	
Herring	Excessive numbers of eggs	
Ridley turtle	Synchronized egg lay	
Angler fish	Bioluminescence	
Hatchet fish	Flat body, mirrored underbody	
Sail fish	Changes color	