Introduction: The Hydrosphere—The Waters of Earth

Begin your study of Earth's **hydrosphere**, or its waters, from a point somewhere above Earth. At first glance you notice how blue the surface of Earth looks. The blue you see is Earth's **ocean**, which covers more than 70 percent, or nearly three-fourths, of our planet. As your eyes sharpen their focus, you'll begin to see dark patches that look like islands within the vast expanse of blue. Those *islands* are the continents, or large land masses, upon which we live.

photograph of Earth

globe of Earth showing the oceans and continents

If you look closely enough, you'll notice that the ocean is not divided. In other words, Earth is covered by a single continuous ocean. However, using the continents as boundaries, we've sectioned this one great ocean into five smaller oceans: the Pacific, Atlantic, Indian, Arctic, and Antarctic oceans. The Antarctic Ocean or Southern Ocean is a smaller ocean that some scientists and geographers dispute as actually being an ocean. There are always difficulties when humans try to determine boundaries on something that has no boundaries. Smaller bodies of saltwater known as **seas** make up another part of this liquid surface of the Earth. Seas are often partially, or even totally, enclosed by land. For example, the Mediterranean, Caribbean, Baltic, Arabian, Red, and Black seas are separated from major oceans by projecting strips of land.

These oceans and seas that surround us have always interested us. We know that as far back as 3,500 years ago, sailors and navigators were exploring and charting the ocean. Today, many scientists continue to study and expand our understanding of the ocean and the organisms that live there.

In addition to our curiosity, other reasons and needs have prompted us to investigate the ocean. We've used the ocean's resources—from fish to water power—to support our existence. We've used the ocean to travel from one landlocked region to another. And we've used the ocean for the pleasure we get from sailing across its waves and swimming amongst its miraculous variety of marine life.

Oceans	
Pacific Ocean	**Description:** The world's largest and deepest ocean, covering one third of the Earth's surface. **Area:** 64,000,000 square miles or 166, 00,000 square kilometers **Average depth:** 14,050 feet or 4,280 meters **Volume:** 173,625,000 cubic mile or 723,700,000 cubic kilometers **Maximum depth:** Marianas Trench - 35,798 feet or 10,911 meters
Atlantic Ocean	**Description:** The second largest ocean and the most heavily traveled. The Atlantic Ocean is about one half the area of the Pacific Ocean. **Area:** 3,166,000 square miles or 82,000,000 square kilometers **Average depth:** 10,930 feet or 3,330 meters **Volume:** 77,235,000 cubic miles or 321,930,000 cubic kilometers **Maximum depth:** South Sandwich Trench - 30,000 feet or 9,144 meters
Indian Ocean	**Description:** The Indian Ocean covers about 20 percent of the total world ocean area and is the world's third largest ocean. **Area:** 28,4000,000 square miles or 73,600,000 square kilometers **Average depth:** 12,760 feet or 3,890 meters **Volume:** 70,086,000 cubic miles or 292,131,000 square kilometers **Maximum depth:** Java Trench - 24,442 feet or 7,450 meters
Arctic Ocean	**Description:** The smallest of the worlds's oceans. The Arctic Ocean is slightly more than one sixth the area of the Indian Ocean and it has a basin that is basically landlocked. **Area:** 4,700,000 square miles or 12,173,000 square kilometers **Average depth:** 3,250 feet or 990 meters **Maximum depth:** Pole Abyssal Plain - 15,091 feet or 4,600 meters
Antarctic Ocean	**Description:** Sometimes referred to as the Southern Ocean. Scientists and geographers dispute the area where three main oceans meet (the Pacific, Atlantic, and the Indian) at Antarctica (the continent) as an actual ocean. The Antarctic Ocean can be taken to include all oceanic areas lying south of the Antarctic Convergence, typically around latitude 55 degrees south. **Area:** 13,513,000 square miles or 35,000,000 square kilometers **Area that is sea ice:** 8,100,000 square miles or 35,000,000 square kilometers **Area that is permanently frozen:** 1,540,000 square miles or 4,000,000 square kilometers

However, understanding the ocean poses many difficulties. Because we're land animals, we've needed to develop special equipment to explore and measure the ocean. Today's scientists use technological equipment such as **drilling platforms** and **underwater research vehicles**. Drilling platforms are ships or stationary structures designed to obtain sediment, rock samples, oil, or gas from the deep-ocean floor. The *Resolution* is a well known drilling ship. The *Alvin* and *Argo* are two examples of underwater research vehicles. The *Alvin* is a tiny submarine designed to withstand pressure changes at more than 4,000 meters. The *Alvin* is equipped with robotic arms to take bottom samples and to collect marine specimens. Television and photography equipment are also on board the *Alvin*. The *Argo* is a sled-like submersible geared with camera, lights, and radar.

Nearly all of the sciences used to study the land are needed to study the oceans. Scientists have drawn on different sciences, from biology to zoology, from chemistry to physics, to probe the mysteries beneath the ocean's surface. **Oceanography** is the study of the Earth's oceans and involves all the other sciences.

The Science of Oceanography

The study of the ocean truly became a science in 1855 when Matthew Fontaine Maury published his research on the physical features of the ocean. In 1872 the British navy launched the *H.M.S. Challenger*, a warship remodeled to house a laboratory, to study the ocean in greater detail. Pioneering scientists on board performed experiments to begin to learn more about the ocean. They collected and recorded information on the ocean's depth, water temperature, water and sediment samples, currents, and plant and animal species.

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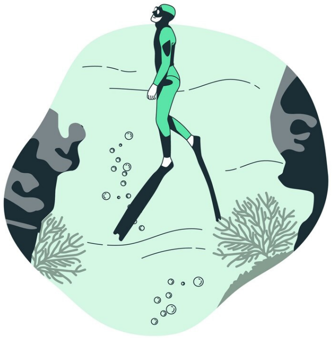
In the years following, scientists who studied the ocean became known as **oceanographers**. There were so many different features of the ocean to study that oceanographers began grouping themselves according to their interests. Consequently, four different kinds of oceanographers developed.

Geological oceanographers study the ocean's sediments and the **topography** of the ocean floor. These scientists analyze the topography and rock movements under the ocean's surface in order to answer the following questions: How were the oceans formed? What is their geological history, and what does movement on and below the ocean's floor suggest about future changes in the ocean?

Chemical oceanographers measure the chemical composition of seawater and the chemical reactions that occur in seawater. Because the ocean covers such a large portion of the Earth's surface, chemical interactions between ocean water and the atmosphere have a big effect on the Earth's climate. For example, carbon dioxide is dissolved in the water. But how much carbon dioxide dissolves in the water is directly related to the chemical make-up of the water. Thus, the chemical make-up of water determines the amount of carbon dioxide in the air, and the amount of carbon dioxide in the air affects how many clouds form in the atmosphere, how much rain falls, and, consequently, temperature and weather patterns.



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Biological oceanographers chart marine life in the ocean. These scientists spend many hours observing, collecting, tagging, and identifying specimens of plant and animal marine life. They work to understand the role of marine life in the ocean and people's impact on marine life.

Physical oceanographers focus on the currents and motions of the ocean. These oceanographers attempt to find answers to the following questions: Where do currents originate? How do liquids that vary in density, temperature, or momentum interact?

Some oceanographers search the seas for potential medicines to cure diseases, while others study ways to predict and even slow the development of hurricanes and other adverse weather conditions. Some oceanographers are working to harness the power of the ocean for use as energy, while others study how to limit our pollution of the seas and create a healthy relationship between human life and marine life.

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What a particular oceanographer wants to understand will determine his or her work site. Oceanographers may work on a research ship, in a laboratory, or on an offshore oil rig, to name just a few of their settings.

An oceanographer may be employed by a university, the government, or in one of the various industries. As people in science, commerce, and industry have begun to understand what an essential role the ocean plays in our lives and how rich it is in resources, more and more career opportunities have opened up in the field of oceanography.

Why Study the Ocean?

When we study the ocean, we're really increasing our knowledge of how Earth supports life.

Much of our life on land is dependent on the ocean. If the ocean suddenly dried up or its features and composition were radically changed, life on Earth as we know it would not survive. So when we study the ocean, we're really increasing our knowledge of how Earth supports life.

Climate and Weather

When you feel rain, you probably look to the clouds overhead as its source. But the ocean plays an important part in precipitation and other kinds of weather and climate. The rain you feel on your face may have evaporated from the surface of the ocean as it was heated by the sun. The evaporated water rises until it condenses and falls to the Earth as rain, snow, hail, or sleet.

Our weather on land is also affected by the temperature of the nearby ocean. Winds carry warm or cool air from the ocean's surface onto land. This air in turn alters the temperature on land. Sometimes the solar energy radiating over tropical waters is so powerful that it *destabilizes*, or changes the design and condition of, large masses of air, creating huge rotating weather systems of wind and rain known as *hurricanes*. Hurricanes can occur in the North Atlantic Ocean, eastern North Pacific Ocean, Caribbean Sea, and Gulf of Mexico. Such storms in the western Pacific Ocean are called *typhoons*. By studying the Earth's oceans, we will be better equipped to predict water movement, heating, cooling, and evaporative processes that impact weather systems. A better understanding of the oceans will enable oceanographers and meteorologists to forecast dangerous storms such as tornadoes and hurricanes.

The Ocean as a Resource

Many of us in Florida are fortunate enough to enjoy a variety of fresh seafood. Looking across the ocean or the gulf as far as the horizon, we may think that these waters are a limitless frontier and that sea creatures are easy to find and eternally plentiful. But such is not the case. *Aquaculturists* help us find seafood, predict its availability, and help insure the continued survival of the delicacies we enjoy from the ocean.

Did you know that the ocean is also a source for many medicines and health products? Fish and marine plants are already used to produce certain drugs, and oceanographers believe many more medicines can be harvested from the ocean. The ocean already supplies us with many chemical resources such as sodium chloride ($NaCl$), or common table salt, magnesium, and bromine. In the future, scientists may even discover a practical way to extract gold and uranium from the ocean.

As we increase our need for energy—forms of power to do work—scientists have looked more and more to the ocean as a source. For example, oceanographers now collect **thermal energy**, or heat, from the ocean's absorption of sunlight. This thermal energy, as well as the force of ocean currents, waves, and tides, can be used to push turbine blades that in turn produce electricity. Tides flowing in and out of channels and bays produce energy collected in power stations. This type of energy is called **tidal power**. Thermal energy, wave energy, current energy, and tidal power are the most abundant forms of energy available from the ocean. Unlike fossil fuel, there is an endless supply of ocean currents, waves, and tides for us to tap in the future.

The oceans are very important to people and all life forms on Earth. Much of our food, water, and other resources are taken directly or indirectly from the oceans. By understanding the chemical and physical aspects of the ocean as well as the organisms that live there, we can learn to properly manage marine resources.

As you continue reading the units in the book, consider the following: Regardless of where you live, whether you can see the ocean or not, the ocean plays an essential role in your survival.

Summary

Nearly three-fourths of our planet is covered by oceans: the Pacific, Atlantic, Indian, Arctic, and Antarctic. Different features of the ocean are studied by four types of oceanographers: geological, chemical, biological, and physical. The ocean is a source for food, water, medicines, energy, recreation, and transportation. Our life on Earth is dependent on the ocean and its well being.