Unit 1:
Ecology

Khaled bin Sultan Living Oceans Foundation

Coral Reef Ecology Curriculum

Khaled bin Sultan
Living Oceans
Foundation

This unit is part of the *Coral Reef Ecology Curriculum* that was developed by the Education Department of the Khaled bin Sultan Living Oceans Foundation. It has been designed for secondary school students, but can be adapted for other uses. The entire curriculum can be found online at *lof.org/CoralReefCurriculum.*

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STANDARDS

- **CCSS**: RST.9-10.1, 3, 4, 5, 7, 8, 10; RST.11-12.1, 3, 4, 10; SL.9-10.1, 2, 3, 4, 6; SL.11-12.1, 2, 3, 4, 6; HSN.Q.A.1; HSS.IC.A.1
- **NGSS**: HS-LS1-2, HS-LS2-6
- **OLP**: 1.B, 5.B.1, 5.B.5

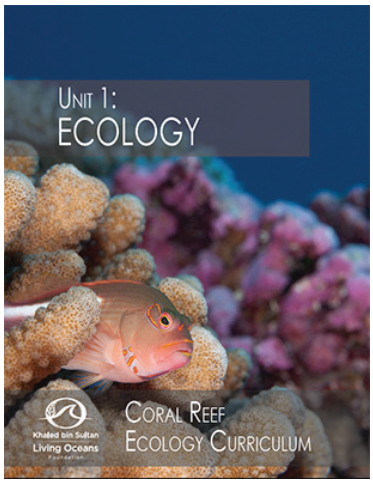
ONLINE CONTENTS

- Ecology Quiz
- *What Is Ecology?* Video
  Ecology explores living things, plus the way they interact with one another, and their physical surroundings. A coral reef is a very special type of home, it provides nourishment and shelter to an amazing range of living creatures. They interact with non-living things like rocks and sand, ocean currents, temperature, and much more. A vast web of living and non-living things makes up the ecology of coral reefs.

ECOLOGY

This lesson is a part of the *Ecology* unit, which explains what ecologists study and how it applies to coral reefs. Below is a summary of what is included in the entire unit.

UNIT CONTENTS



A. Background Information
   - Ecology
   - Biological Hierarchy of Life
   - Ecological Levels of Organization

B. Lessons

Watch it! What is Ecology?
- A worksheet to accompany the *What is Ecology?* video

Factors of the Reef
- A lesson to differentiate between inference and observation

Backyard Ecosystem
- An activity to perform a biological survey of an outdoor area

Read It! Lionfish: Scourge of the Caribbean
- A worksheet to accompany the *Lionfish: Scourge of the Caribbean* field blog

BACKGROUND INFORMATION

Welcome to coral reef ecology! In this unit, we will learn about what ecologists study and how it applies to coral reefs.

Before we begin talking about coral reefs, we first have to understand the meaning of the word ecology. In Greek, this word translates to:

eco	***logy***
οίκος (oikos)	λογία (logos)
house	the study of

So the word ecology translates to *the study of the home*. What's in your house? Can you categorize all of the items you listed as either living or non-living? The answer is yes. Pets, plants, and family members are all living things. TVs, couches, beds, water, air conditioning, radios, cooking utensils, and books are all non-living things (figure 1-1). Who cares if there are living and non-living things in your house? You should! If your house didn't have electricity or running water, how could you cook your meals or take a shower? This interaction of you (living) and the non-living things in your house is all part of the definition of ecology. **Ecology** is the scientific study of the distribution and abundance of life and the interactions between organisms (living) and their natural environment or *home* (non-living).

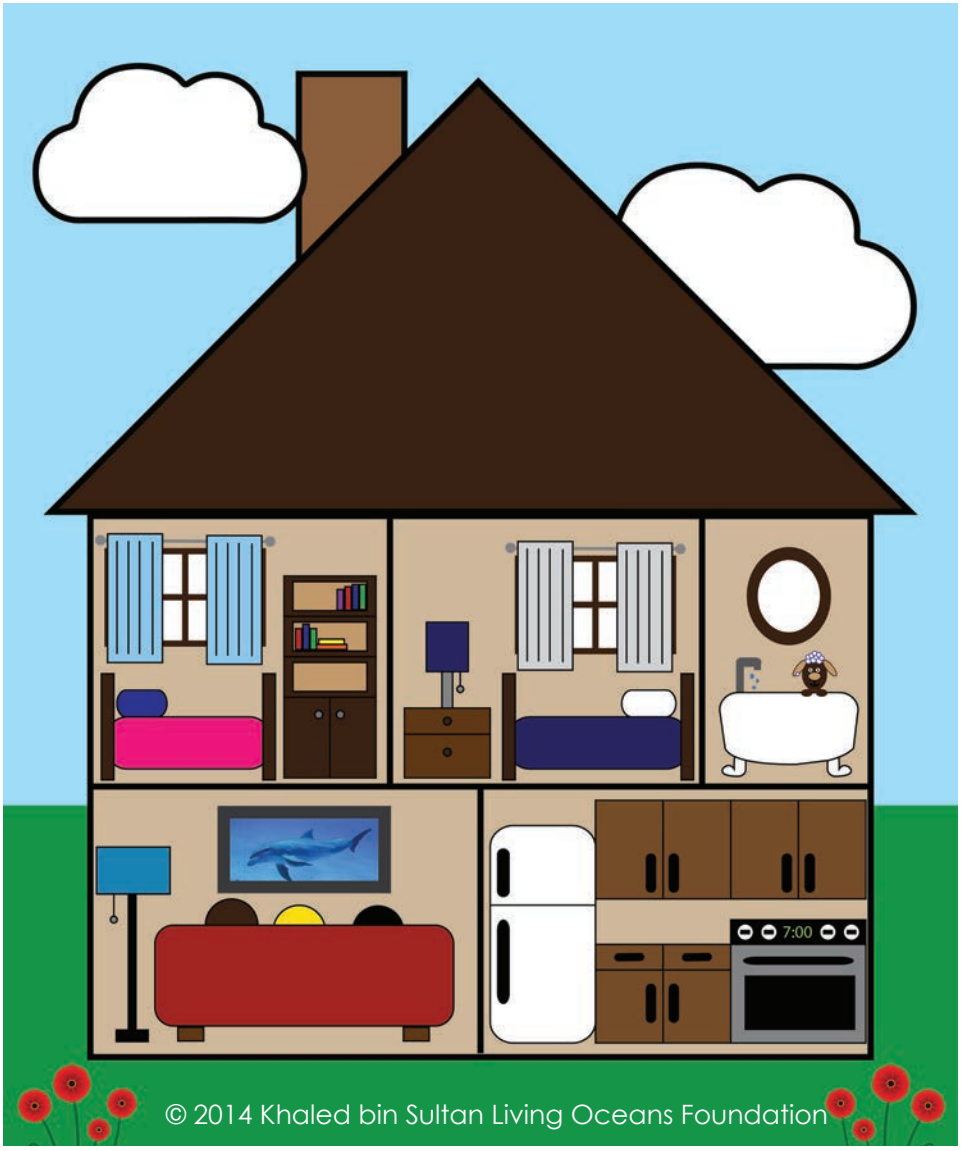


FIGURE 1-1. Cross section of a house

Non-living components are referred to as **abiotic factors**. Let's break down the word abiotic:

a	***biotic***
without	life

Therefore, abiotic means *without life*. Abiotic factors are non-living components of an organism's environment. What do you think biotic means? It means *life*. **Biotic factors** are living or once living components of a community.

The study of ecology encompasses more than all of the living plants, animals, bacteria, and the non-living things like rocks, soil, sunlight, weather, temperature, and water. It also describes how the living and non-living factors interact. Ecology also includes processes such as photosynthesis, cellular respiration, and relationships like mutualism and commensalism (*Unit 4: Coral Feeding*); reproduction (*Unit 5: Coral Reproduction*); life cycles (*Unit 6: Life Cycle*); distribution (*Unit 7: Distribution*); adaptations and evolution (*Unit 13: Evolutionary History*); diversity, abundance, and populations (*Unit 14: Biodiversity*); interactions such as predation, energy movement in a system, and food web dynamics (*Unit 17: Food Web Dynamics*); and natural and man-made influences (*Unit 19:Threats*). Ecology also includes knowledge about the past, present, and future.

Ecology is a branch of **biology**, a natural science concerned with the study of life and living organisms. As we have learned, there are a lot of different topics in this branch of science. Often, ecology is referred to as a multidisciplinary science, which means that other branches of math and science are used to aid in studying and understanding ecology. These include architecture, biology, biophysics, chemistry, climatology, engineering, geology, mathematics, mechanics, and physics. For example, ecologists must use chemistry to help understand chemical cycles such as photosynthesis or the formation of sulfuric acid in volcanic vents. Mathematics is central to ecology and helps us measure things like population size, biodiversity, energy transfer, and distribution of species.

A) BIOLOGICAL HIERARCHY OF LIFE

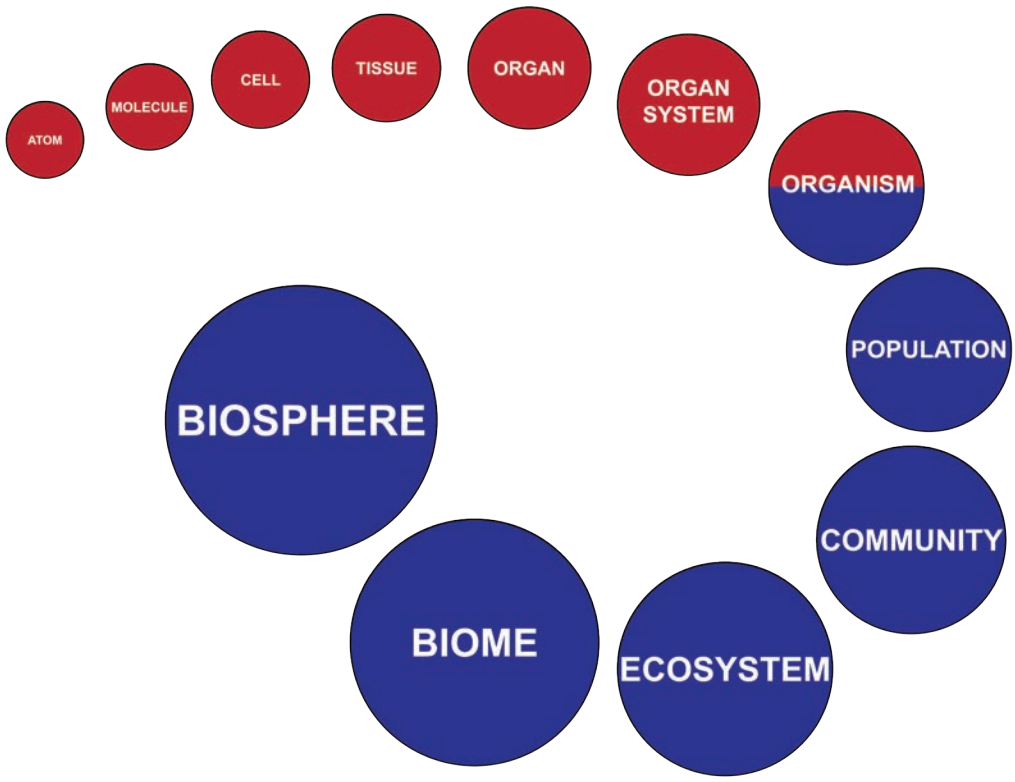


FIGURE 1-2. The red circles represent levels of biology and blue circles represent levels of ecology. Notice that the levels are arranged from smallest (atoms) to largest (biosphere).

Biology is organized into a hierarchical system - from small to large (figure 1-2; red circles). These levels are made up of several parts, each a part of the previous level. For example, tissue is composed of many cells. Each level of organization has **emergent properties**. With each level, there is a property that shows up that isn't in the previous level. Therefore, each level becomes more complex than the previous one. Here are two examples:

- Hydrogen (H) and oxygen (O) atoms exist as individual *atoms* (figure 1-3). When two hydrogen atoms combine with one oxygen atom, they form a water *molecule* (H_2O). The water molecule is more complex and stable than the individual atoms. A *molecule* emerges from *atoms*.

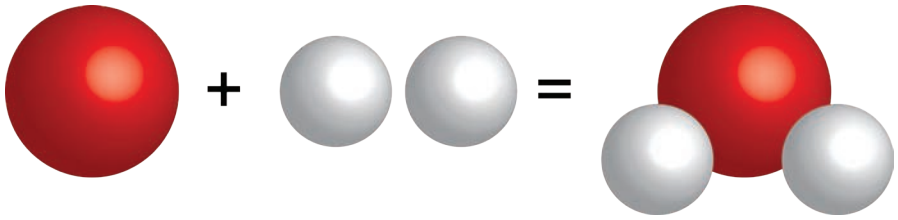


FIGURE 1-3. A red oxygen atom (1) and white hydrogen atoms (2) bond, forming a water molecule

- Multiple butterflyfish that live in a defined area are part of a *population*. When other species of organisms, like coral, live in the same defined area, they are part of a *community* with butterflyfish. Some butterflyfish feed on coral. In this example, the emergent property is predation.

B) ECOLOGICAL LEVELS OF ORGANIZATION

Due to the complexity of ecology, when we study it, it's easiest to organize it into different levels. There are six levels of organization in ecology (figure 1-2; blue circles). Notice that we begin with organism, which is very specific, and continue to biosphere, the broadest description.

Ecologists study each ecological level from the individual organism to the entire biosphere and how each of these levels is interconnected (figure 1-4). The first level of ecology is **organism**, which is most specific and deals only with a single individual. The second level builds onto the first and consists of multiple organisms of the same species that are living in a defined area. This is called a **population**. The third level of ecology is called a **community**. In this level, there are several different populations composed of different species living in a defined area. In the fourth level, ecologists are now taking into account the biotic and abiotic factors of that environment; together they all form an **ecosystem**. The fifth level is called a **biome**, which consists of several different ecosystems that are geographically and climatically defined. On Earth we have 5 main types of biomes: aquatic, desert, forest, grasslands, and tundra. The final level of ecological organization is **biosphere**, which contains all the biomes on Earth.

Using a coral reef ecosystem as an example, let's look at the ecological levels of organization (figure 1-4). In the first box, we have a single *organism* - the butterflyfish. Next, a group of butterflyfish makes up a *population*. A *community* could consist of butterflyfish, hermit crabs, corals, starfish, and even sea slugs. Finally, this *ecosystem* would consist of the living organisms just mentioned, but it would also include abiotic factors such as water temperature, pH, sunlight, salinity (amount of salt in the water), and even water currents (not all pictured). A coral reef ecosystem would be a part of the aquatic *biome*. This biome is just one of many that make up the Earth's *biosphere*.

Coral reefs are classified as *ecosystems*. In the following units, we will be discussing the living organisms and the non-living environment, processes, mechanisms, and relationships that make-up the coral reef ecosystem.

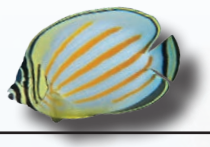
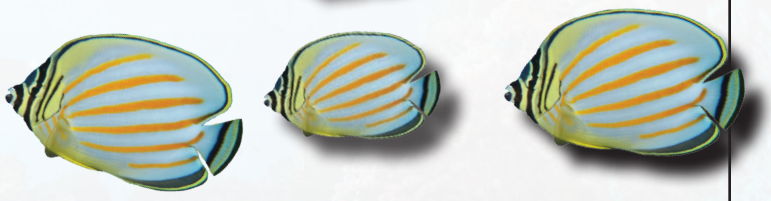
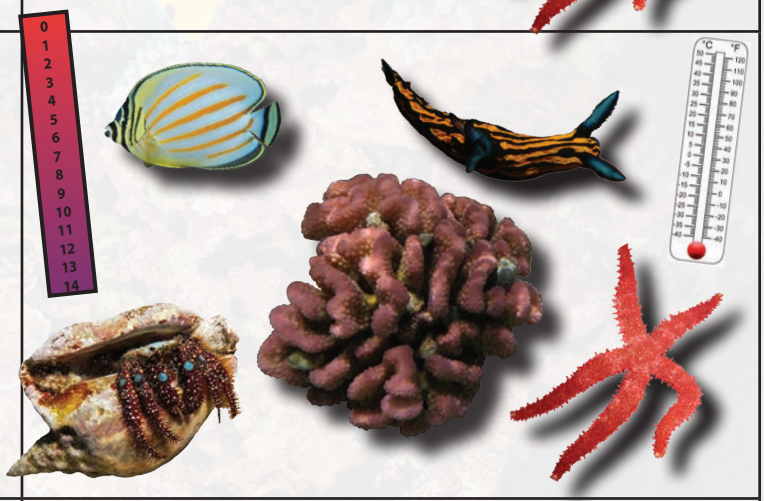
LEVEL	MEANING	EXAMPLE
Organism	A single species.	
Population	Multiple organisms of the same species living in a defined area.	
Community	Different populations composed of different species that live in a defined area.	
Ecosystem	Include all of the biotic (living) factors and the abiotic (nonliving) factors. Some abiotic factors include water temperature, sunlight, pH, salinity, sand, rocks, etc. (not all pictured).	
Biome	They are major ecosystems that are geographically and climatically defined. A biome (aquatic) can be made up of multiple ecosystems (coral reefs and mangroves.	 
Biosphere	Contains all the biomes on Earth. Again, dependent on biome classification system.	

FIGURE 1-4. Ecological levels of organization

ATTRIBUTIONS

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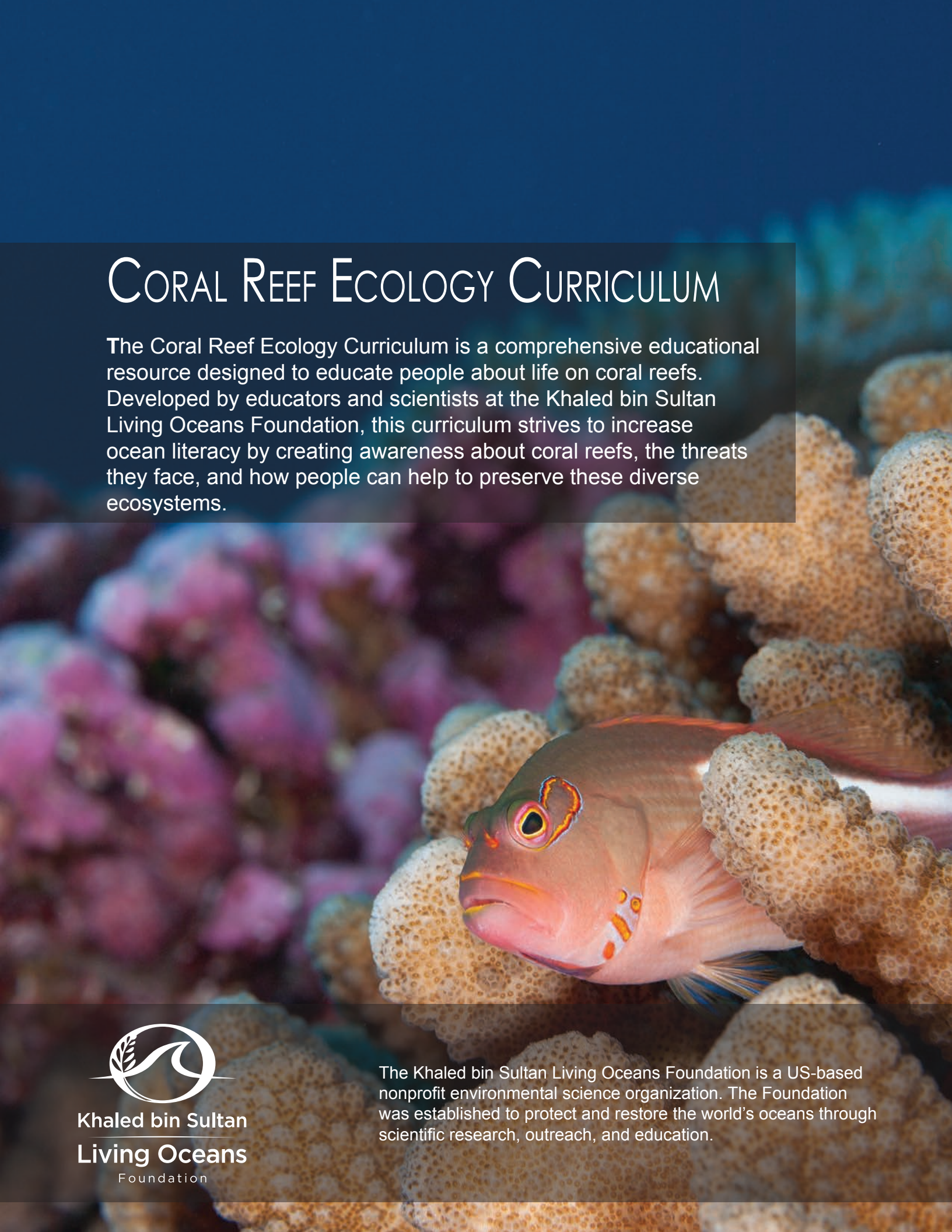
Coral Reef Ecology Curriculum

The Coral Reef Ecology Curriculum is a comprehensive educational resource designed to educate people about life on coral reefs. Developed by educators and scientists at the Khaled bin Sultan Living Oceans Foundation, this curriculum strives to increase ocean literacy by creating awareness about coral reefs, the threats they face, and how people can help to preserve these diverse ecosystems.



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The Khaled bin Sultan Living Oceans Foundation is a US-based nonprofit environmental science organization. The Foundation was established to protect and restore the world's oceans through scientific research, outreach, and education.