

## AP ENVIRONMENTAL SCIENCE

# UNIT 1

# The Living World: Ecosystems



**6–8%**  
AP EXAM WEIGHTING



**~14–15**  
CLASS PERIODS

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The icon consists of a white circle containing a blue square with the letters 'AP' in white. Below the square are two horizontal lines representing a computer monitor.

Remember to go to [AP Classroom](#) to assign students the online **Personal Progress Check** for this unit.

Whether assigned as homework or completed in class, the **Personal Progress Check** provides each student with immediate feedback related to this unit's topics and skills.

### **Personal Progress Check 1**

**Multiple-choice: ~30 questions**

**Free-response: 1 question (partial)**

- Analyze an environmental problem and propose a solution

# The Living World: Ecosystems



## Developing Understanding

### BIG IDEA 1

#### Energy Transfer **ENG**

- How does energy change forms?

### BIG IDEA 2

#### Interactions Between Earth Systems **ERT**

- How old is the water you drink?

The first unit sets the foundation for the course by examining the Earth as a system with interdependent components, processes, and relationships. Students will examine the distribution of resources in ecosystems and its influences on species interactions. There is a global distribution of terrestrial and aquatic biomes—regional ecosystems—that each have specific environmental features based on their shared climate. This distribution is dynamic, and it has changed due to global climate change. Each ecosystem relies on biogeochemical cycles for survival. These cycles facilitate the acquisition and transfer of energy into usable forms, and they can be altered by human activities. In subsequent units, students will apply their understanding of ecosystems to the living world and examine the importance of biodiversity.

## Building the Science Practices

**1.A 1.B 2.A 2.B 6.C**

The ability to describe environmental processes and relationships within an environment is central to this unit. Students can practice this skill with visual representations and models, particularly those of biogeochemical cycles, food chains, food webs, and trophic diagrams. By the end of this unit, students should be able to use visual representations to describe the individual steps of the hydrologic, carbon, nitrogen, and phosphorus cycles and then explain how each chemical is either stored or transferred throughout its cycle. Students should also be able to predict the effects of a change in one or more parts of a given cycle, including impacts to humans and the ecosystem at large.

In this unit, students should also develop a foundational understanding of biomes and describe how relationships between organisms are affected by environmental conditions. They should develop the quantitative skills to calculate the decrease of energy as it passes through ecosystems and then explain the transfer of energy through ecosystems.

## Preparing for the AP Exam

On the AP Exam, students must be able to apply environmental concepts and processes in real-world situations. This starts with the ability to identify and describe the biogeochemical cycles and then predict the effects of a change within a cycle. For example, while students can identify the biogeochemical cycle, they often struggle to describe each of the steps. Students also struggle to identify the reservoir portion of the cycle, which is the step that takes the longest to complete. To combat these challenges, providing visual representations of biogeochemical cycles can help students organize information. Students can also write step-by-step descriptions of the cycles, including characteristics and attributes.

## UNIT AT A GLANCE

Enduring Understanding	Topic	Suggested Skill	Class Periods
			~14–15 CLASS PERIODS
ERT-1	1.1 Introduction to Ecosystems	1.A Describe environmental concepts and processes.	
	1.2 Terrestrial Biomes	1.B Explain environmental concepts and processes.	
	1.3 Aquatic Biomes	1.B Explain environmental concepts and processes.	
	1.4 The Carbon Cycle	2.B Explain relationships between different characteristics of environmental concepts, processes, or models represented visually: <ul style="list-style-type: none"> <li>In theoretical contexts</li> <li>In applied contexts</li> </ul>	
	1.5 The Nitrogen Cycle	2.B Explain relationships between different characteristics of environmental concepts, processes, or models represented visually: <ul style="list-style-type: none"> <li>In theoretical contexts</li> <li>In applied contexts</li> </ul>	
	1.6 The Phosphorus Cycle	2.B Explain relationships between different characteristics of environmental concepts, processes, or models represented visually: <ul style="list-style-type: none"> <li>In theoretical contexts</li> <li>In applied contexts</li> </ul>	
	1.7 The Hydrologic (Water) Cycle	2.B Explain relationships between different characteristics of environmental concepts, processes, or models represented visually: <ul style="list-style-type: none"> <li>In theoretical contexts</li> <li>In applied contexts</li> </ul>	
ENG-1	1.8 Primary Productivity	1.A Describe environmental concepts and processes.	
	1.9 Trophic Levels	1.B Explain environmental concepts and processes.	
	1.10 Energy Flow and the 10% Rule	6.C Calculate an accurate numeric answer with appropriate units.	
	1.11 Food Chains and Food Webs	2.A Describe characteristics of an environmental concept, process, or model represented visually.	
	Go to <a href="#">AP Classroom</a> to assign the <b>Personal Progress Check</b> for Unit 1. Review the results in class to identify and address any student misunderstandings.		

## SAMPLE INSTRUCTIONAL ACTIVITIES

The sample activities on this page are optional and are offered to provide possible ways to incorporate various instructional approaches into the classroom. They were developed in partnership with teachers from the AP community to share ways that they approach teaching some of the topics in this unit. Please refer to the Instructional Approaches section beginning on p. 201 for more examples of activities and strategies.

Activity	Topic	Sample Activity
1	1.4	<p><b>Idea Spinner</b></p> <p>Use a spinner to represent different carbon reservoirs (land plants, atmosphere, surface ocean, deep ocean, marine organisms, fossil fuels, terrestrial animals). Have students predict the movement of carbon to different reservoirs to demonstrate understanding of the processes in the carbon cycle.</p> <p>Example: Draw an arrow leaving fossil fuels. Where does the carbon go? What is the process that moves it from one sink to another? What is the new form of carbon?</p>
2	1.5	<p><b>Debate</b></p> <p>Ask students to develop a strategy to reduce human impact on the nitrogen cycle. Have them develop an argument to support their strategy as a viable solution that shows their understanding of the processes involved in the nitrogen cycle. Students can then debate the merits of the strategy they developed.</p>
3	1.8	<p><b>Graph and Switch</b></p> <p>Have students generate graphs showing net primary production of the world's common ecosystems. Have some students graph productivity measures as kilocalories (kcal) per unit area and others graph total kcal. Then have them discuss and explain why the rankings are different. They should focus on the open ocean to develop their explanation.</p>



### Unit Planning Notes

Use the space below to plan your approach to the unit.

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## SUGGESTED SKILL

 *Concept Explanation*

## 1.A

Describe environmental concepts and processes.



## AVAILABLE RESOURCES

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- The Exam > Chief Reader Report (2018, Q2, 2017, Q1)
- The Exam > Samples and Commentary (2018, Q2, 2017, Q1)

## TOPIC 1.1

# Introduction to Ecosystems

### Required Course Content

#### ENDURING UNDERSTANDING

**ERT-1**

Ecosystems are the result of biotic and abiotic interactions.

#### LEARNING OBJECTIVE

**ERT-1.A**

Explain how the availability of resources influences species interactions.

#### ESSENTIAL KNOWLEDGE

**ERT-1.A.1**

In a predator-prey relationship, the predator is an organism that eats another organism (the prey).

**ERT-1.A.2**

Symbiosis is a close and long-term interaction between two species in an ecosystem. Types of symbiosis include mutualism, commensalism, and parasitism.

**ERT-1.A.3**

Competition can occur within or between species in an ecosystem where there are limited resources. Resource partitioning—using the resources in different ways, places, or at different times—can reduce the negative impact of competition on survival.

## TOPIC 1.2

# Terrestrial Biomes

### SUGGESTED SKILL

 *Concept Explanation*

#### 1.B

Explain environmental concepts and processes.



### AVAILABLE RESOURCES

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- The Exam > [Student Performance Q&A 2016, Q1](#)
- The Exam > [Samples and Commentary 2016, Q1](#)

## Required Course Content

### ENDURING UNDERSTANDING

#### ERT-1

Ecosystems are the result of biotic and abiotic interactions.

### LEARNING OBJECTIVE

#### ERT-1.B

Describe the global distribution and principal environmental aspects of terrestrial biomes.

### ESSENTIAL KNOWLEDGE

#### ERT-1.B.1

A biome contains characteristic communities of plants and animals that result from, and are adapted to, its climate.

#### ERT-1.B.2

Major terrestrial biomes include taiga, temperate rainforests, temperate seasonal forests, tropical rainforests, shrubland, temperate grassland, savanna, desert, and tundra.

#### ERT-1.B.3

The global distribution of nonmineral terrestrial natural resources, such as water and trees for lumber, varies because of some combination of climate, geography, latitude and altitude, nutrient availability, and soil.

#### ERT-1.B.4

The worldwide distribution of biomes is dynamic; the distribution has changed in the past and may again shift as a result of global climate changes.

## SUGGESTED SKILL

 *Concept Explanation*

## 1.B

Explain environmental concepts and processes.



## AVAILABLE RESOURCES

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- The Exam > [Chief Reader Report 2017, Q1](#)
- The Exam > [Student Performance Q&A 2015, Q1](#)
- The Exam > [Samples and Commentary \(2017 Q1, 2015, Q1\)](#)

## TOPIC 1.3

# Aquatic Biomes

### Required Course Content

#### ENDURING UNDERSTANDING

**ERT-1**

Ecosystems are the result of biotic and abiotic interactions.

#### LEARNING OBJECTIVE

**ERT-1.C**

Describe the global distribution and principal environmental aspects of aquatic biomes.

#### ESSENTIAL KNOWLEDGE

**ERT-1.C.1**

Freshwater biomes include streams, rivers, ponds, and lakes. These freshwater biomes are a vital resource for drinking water.

**ERT-1.C.2**

Marine biomes include oceans, coral reefs, marshland, and estuaries. Algae in marine biomes supply a large portion of the Earth's oxygen, and also take in carbon dioxide from the atmosphere.

**ERT-1.C.3**

The global distribution of nonmineral marine natural resources, such as different types of fish, varies because of some combination of salinity, depth, turbidity, nutrient availability, and temperature.



## TOPIC 1.4

# The Carbon Cycle

### Required Course Content

#### ENDURING UNDERSTANDING

##### ERT-1

Ecosystems are the result of biotic and abiotic interactions.

#### LEARNING OBJECTIVE

##### ERT-1.D

Explain the steps and reservoir interactions in the carbon cycle.

#### ESSENTIAL KNOWLEDGE

##### ERT-1.D.1

The carbon cycle is the movement of atoms and molecules containing the element carbon between sources and sinks.

##### ERT-1.D.2

Some of the reservoirs in which carbon compounds occur in the carbon cycle hold those compounds for long periods of time, while some hold them for relatively short periods of time.

##### ERT-1.D.3

Carbon cycles between photosynthesis and cellular respiration in living things.

##### ERT-1.D.4

Plant and animal decomposition have led to the storage of carbon over millions of years. The burning of fossil fuels quickly moves that stored carbon into atmospheric carbon, in the form of carbon dioxide.

#### SUGGESTED SKILL

 *Visual Representations*

##### 2.B

Explain relationships between different characteristics of environmental concepts, processes, or models represented visually:


- In theoretical contexts
- In applied contexts



#### AVAILABLE RESOURCES

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- Classroom Resource > [Outdoor Education Experiences and AP Environmental Science](#)
- The Exam > [Chief Reader Report 2018, Q1](#)
- The Exam > [Student Performance Q&A 2014, Q4](#)
- The Exam > [Samples and Commentary \(2018, Q1, 2014, Q4\)](#)

## SUGGESTED SKILL

 Visual Representations

## 2.B

Explain relationships between different characteristics of environmental concepts, processes, or models represented visually:

- In theoretical contexts
- In applied contexts



## AVAILABLE RESOURCES

- Classroom Resource > [Agriculture and the Nitrogen Cycle](#)
- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- Classroom Resource > [Ecology](#)
- Classroom Resource > [Nitrogen Cycling in Ecosystems](#)
- The Exam > Chief Reader Report (2018, Q1, 2017, Q1)
- The Exam > Samples and Commentary (2018, Q1, 2017 Q1)

## TOPIC 1.5

# The Nitrogen Cycle

### Required Course Content

#### ENDURING UNDERSTANDING

**ERT-1**

Ecosystems are the result of biotic and abiotic interactions.

#### LEARNING OBJECTIVE

**ERT-1.E**

Explain the steps and reservoir interactions in the nitrogen cycle.

#### ESSENTIAL KNOWLEDGE

**ERT-1.E.1**

The nitrogen cycle is the movement of atoms and molecules containing the element nitrogen between sources and sinks.

**ERT-1.E.2**

Most of the reservoirs in which nitrogen compounds occur in the nitrogen cycle hold those compounds for relatively short periods of time.

**ERT-1.E.3**

Nitrogen fixation is the process in which atmospheric nitrogen is converted into a form of nitrogen (primarily ammonia) that is available for uptake by plants and that can be synthesized into plant tissue.

**ERT-1.E.4**

The atmosphere is the major reservoir of nitrogen.

## TOPIC 1.6

# The Phosphorus Cycle

### Required Course Content

#### ENDURING UNDERSTANDING

##### ERT-1

Ecosystems are the result of biotic and abiotic interactions.

#### LEARNING OBJECTIVE

##### ERT-1.F

Explain the steps and reservoir interactions in the phosphorus cycle.

#### ESSENTIAL KNOWLEDGE

##### ERT-1.F.1

The phosphorus cycle is the movement of atoms and molecules containing the element phosphorus between sources and sinks.


##### ERT-1.F.2

The major reservoirs of phosphorus in the phosphorus cycle are rock and sediments that contain phosphorus-bearing minerals.

##### ERT-1.F.3

There is no atmospheric component in the phosphorus cycle, and the limitations this imposes on the return of phosphorus from the ocean to land make phosphorus naturally scarce in aquatic and many terrestrial ecosystems. In undisturbed ecosystems, phosphorus is the limiting factor in biological systems.

#### SUGGESTED SKILL

 *Visual Representations*

##### 2.B

Explain relationships between different characteristics of environmental concepts, processes, or models represented visually:

- In theoretical contexts
- In applied contexts



#### AVAILABLE RESOURCES

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- Classroom Resource > [Outdoor Education Experiences and AP Environmental Science](#)
- The Exam > Student Performance Q&A ([2014 Q4](#), [2015, Q1](#))
- The Exam > Samples and Commentary ([2014 Q4](#), [2015, Q1](#))

**SUGGESTED SKILL** *Visual Representations***2.B**

Explain relationships between different characteristics of environmental concepts, processes, or models represented visually:

- In theoretical contexts
- In applied contexts

**AVAILABLE RESOURCES**

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- Classroom Resource > [Outdoor Education Experiences and AP Environmental Science](#)
- Collaborations with AP > [Access to Clean Water](#)

## TOPIC 1.7

# The Hydrologic (Water) Cycle

### Required Course Content

#### ENDURING UNDERSTANDING

**ERT-1**

Ecosystems are the result of biotic and abiotic interactions.

#### LEARNING OBJECTIVE

**ERT-1.G**

Explain the steps and reservoir interactions in the hydrologic cycle.

#### ESSENTIAL KNOWLEDGE

**ERT-1.G.1**

The hydrologic cycle, which is powered by the sun, is the movement of water in its various solid, liquid, and gaseous phases between sources and sinks.

**ERT-1.G.2**

The oceans are the primary reservoir of water at the Earth's surface, with ice caps and groundwater acting as much smaller reservoirs.

## TOPIC 1.8

# Primary Productivity

**SUGGESTED SKILL**
 *Concept Explanation*
**1.A**

Describe environmental concepts and processes.

**AVAILABLE RESOURCES**

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- Classroom Resource > [Quantitative Skills in the AP Sciences \(2018\)](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- Classroom Resource > [Outdoor Education Experiences and AP Environmental Science](#)
- The Exam > [Chief Reader Report 2018, Q2](#)
- The Exam > [Samples and Commentary 2018, Q2](#)

## Required Course Content

### ENDURING UNDERSTANDING

**ENG-1**

Energy can be converted from one form to another.

### LEARNING OBJECTIVE

**ENG-1.A**

Explain how solar energy is acquired and transferred by living organisms.

### ESSENTIAL KNOWLEDGE

**ENG-1.A.1**

Primary productivity is the rate at which solar energy (sunlight) is converted into organic compounds via photosynthesis over a unit of time.

**ENG-1.A.2**

Gross primary productivity is the total rate of photosynthesis in a given area.

**ENG-1.A.3**

Net primary productivity is the rate of energy storage by photosynthesizers in a given area, after subtracting the energy lost to respiration.

**ENG-1.A.4**Productivity is measured in units of energy per unit area per unit time (e.g., kcal/m<sup>2</sup>/yr).**ENG-1.A.5**

Most red light is absorbed in the upper 1m of water, and blue light only penetrates deeper than 100m in the clearest water. This affects photosynthesis in aquatic ecosystems, whose photosynthesizers have adapted mechanisms to address the lack of visible light.

**SUGGESTED SKILL** *Concept Explanation***1.B**

Explain environmental concepts and processes.

**AVAILABLE RESOURCES**

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- Classroom Resource > [An Energy Primer for the AP Environmental Science](#)
- Classroom Resource > [Outdoor Education Experiences and AP Environmental Science](#)
- The Exam > Chief Reader Report (2018, Q3, 2017, Q1)
- The Exam > Samples and Commentary (2018, Q3, 2017, Q1)

**TOPIC 1.9**  
**Trophic Levels****Required Course Content****ENDURING UNDERSTANDING****ENG-1**

Energy can be converted from one form to another.

**LEARNING OBJECTIVE****ENG-1.B**

Explain how energy flows and matter cycles through trophic levels.

**ESSENTIAL KNOWLEDGE****ENG-1.B.1**

All ecosystems depend on a continuous inflow of high-quality energy in order to maintain their structure and function of transferring matter between the environment and organisms via biogeochemical cycles.

**ENG-1.B.2**

Biogeochemical cycles are essential for life and each cycle demonstrates the conservation of matter.

**ENG-1.B.3**

In terrestrial and near-surface marine communities, energy flows from the sun to producers in the lowest trophic levels and then upward to higher trophic levels.

## TOPIC 1.10

# Energy Flow and the 10% Rule

### Required Course Content

#### ENDURING UNDERSTANDING

##### ENG-1

Energy can be converted from one form to another.

#### LEARNING OBJECTIVE

##### ENG-1.C

Determine how the energy decreases as it flows through ecosystems.

#### ESSENTIAL KNOWLEDGE

##### ENG-1.C.1

The 10% rule approximates that in the transfer of energy from one trophic level to the next, only about 10% of the energy is passed on.

##### ENG-1.C.2

The loss of energy that occurs when energy moves from lower to higher trophic levels can be explained through the laws of thermodynamics.

#### SUGGESTED SKILL

 *Mathematical Routines*

##### 6.C

Calculate an accurate numeric answer with appropriate units.



#### AVAILABLE RESOURCES

- Classroom Resource > [An Energy Primer for the AP Environmental Science](#)
- Classroom Resource > [Quantitative Skills in the AP Sciences \(2018\)](#)
- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- Classroom Resource > [Outdoor Education Experiences and AP Environmental Science](#)
- The Exam > [Chief Reader Report 2018, Q2](#)
- The Exam > [Samples and Commentary 2018, Q2](#)

**SUGGESTED SKILL** *Visual Representations***2.A**

Describe characteristics of an environmental concept, process, or model represented visually.

**AVAILABLE RESOURCES**

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- Classroom Resource > [Outdoor Education Experiences and AP Environmental Science](#)
- The Exam > Chief Reader Report ([2018 Q3](#), [2017, Q1](#))
- The Exam > Samples and Commentary ([2018 Q3](#), [2017 Q1](#))

## TOPIC 1.11

# Food Chains and Food Webs

### Required Course Content

#### ENDURING UNDERSTANDING

**ENG-1**

Energy can be converted from one form to another.

#### LEARNING OBJECTIVE

**ENG-1.D**

Describe food chains and food webs, and their constituent members by trophic level.

#### ESSENTIAL KNOWLEDGE

**ENG-1.D.1**

A food web is a model of an interlocking pattern of food chains that depicts the flow of energy and nutrients in two or more food chains.

**ENG-1.D.2**

Positive and negative feedback loops can each play a role in food webs. When one species is removed from or added to a specific food web, the rest of the food web can be affected.