# Science

## Environmental Science

## 2020 - Present

Aligned with Ohio's Learning Standards for Science (2018)

Department of Academic Services
Office of Teaching and Learning
Curriculum Division

COLUMBUS CITY SCHOOLS

# Curriculum Map

## Year-at-a-Glance

The Year-at-a-Glance provides a high-level overview of the course by grading period, including:

- Units;
- Standards/Learning Targets; and
- Timeframes.

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## Scope and Sequence

The Scope and Sequence provides an overview of each grading period, including:

- Units;
- Standards/Learning Targets;
- Timeframes;
- Big Ideas and Essential Questions; and
- Model Curriculum Possibilities.

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## Curriculum and Instruction Guide

The Curriculum and Instruction Guide provides direction for standards-based instruction, including:

- Standards;
- Content Elaborations;
- Sample Assessments;
- Instructional Strategies; and
- Instructional Resources.

## Year-at-a-Glance

### Semester X

**Grading Period 1**

| Unit 1. Sustainability and the Human Endeavor ENV: ES.1, ER.2, ER.3, GP.4 | 9 weeks |
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| ES.1 Biosphere<br>ER.2 Air and Air Pollution<br>ER.3 Water and Water Pollution<br>GP.4 Sustainability | |

**Grading Period 2**

| Unit 2. The Biosphere ENV: ES.1-5, ER.5, GP.5, 8 | 5 weeks | Unit 3. Population ENV: ER.1, GP.1 | 4 weeks |
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| ES.1 Biosphere<br>ES.2 Atmosphere<br>ES.3 Lithosphere<br>ES.4 Hydrosphere<br>ES.5 Movement of Matter and Energy<br>ER.5 Wildlife and Wilderness<br>GP.5 Species Depletion and Extinction<br>GP.8 Deforestation and Loss of Biodiversity | | 3.1 Energy Resources - Learning Target 15-18<br>3.2 Human Population - Learning Target 35 | |

### Semester Y

**Grading Period 3**

| Unit 4. Climate, Hydrosphere, Atmosphere ENV: ES.2, 4, 5, ER.2, GP.3, 6 | 5 weeks | Unit 5. Water Resources and Water Pollution ENV: ES.4-5, ER.3, GP.2 | 4 weeks |
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| 4.1 Atmosphere - Learning Target 5<br>4.2 Hydrosphere - Learning Targets 7-9<br>4.3 Movement of Matter and Energy - Learning Targets 10-14<br>4.4 Air and Air Pollution - Learning Targets 19-21<br>4.5 Climate Change - Learning Target 37<br>4.6 Air Quality - Learning Target 40 | | 5.1 Hydrosphere - Learning Targets 7-9<br>5.2 Movement of Matter and Energy - Learning Targets 10-14<br>5.3 Water and Water Pollution - Learning Targets 22-25<br>5.4 Potable Water Quality, Use and Availability - Learning Target 36 | |

| Grading Period 4 | Unit 6. Food, Soil and Pest Management<br>ENV: ER 4, GP.4, 7, 8 — 3 weeks | Unit 7. Geology, Mineral and Energy<br>ENV: ES.3, 5, ER.1, 4 — 4 weeks | Unit 8. Waste Management<br>ENV: ER.4, GP.9 — 2 weeks |
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| | 6.1 Energy Resources - Learning Targets 15-18<br>6.2 Soil and Land - Learning Targets 26-30<br>6.3 Sustainability - Learning Target 38<br>6.4 Food Production & Availability - Learning Target 41<br>6.5 Deforestation & Loss of Diversity - Learning Target 42 | 7.1 Lithosphere - Learning Target 6<br>7.2 Movement of Matter & Energy - Learning Targets 10-14<br>7.3 Energy Resources - Learning Targets 15-18<br>7.4 Soil and Land - Learning Targets 26-30 | 8.1 Soil and Land - Learning Targets 26-30<br>8.2 Waste Management (solid and hazardous) - Learning Target 43 |

## Scope and Sequence

| Grading Period 1 | Unit 1. Sustainability and the Human Endeavor ENV: ES.1, ER.2, ER.3, GP.4 — 9 weeks | | | |
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| | **Unit** | **Standards** | **Big Ideas / Essential Questions** | **Model Curriculum Possibilities** |
| | 1. Sustainability and the Human Endeavor | ES.1: Biosphere<br>• Ecosystems (equilibrium, species interactions, stability)<br>• Population dynamics<br>ER.2: Air and air pollution<br>• Primary and secondary contaminants<br>• Greenhouse gases<br>• Clean Air Act<br>ER.3 Water and water pollution<br>• Clean Water Act<br>• Point source and nonpoint source contamination<br>GP.4: Sustainability | **Concept**<br>• The decisions and actions of all people in the world affect the environment.<br>• Unequal distribution of wealth and resources around the world influence environmental problems.<br>• Humans' false belief that Earth's resources are inexhaustible have led to a worldwide deterioration of natural resources.<br>• Humans frequently look to short-term benefits without a view of the long-term consequences.<br><br>**Evidence**<br>• How can ecological footprint be predicted and managed? | • Labs, activities, videos and websites: https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf<br>• Use the Tragedy of the Commons simulation activity to identify and explain potential strategies to prevent the destruction of a common resource.<br>• Evaluate current protection and management laws pertaining to endangered species and their habitats.<br>• Identify an instance of biomagnification or bioaccumulation within a specific ecosystem and propose possible solutions. |

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| | | | • What are ways to be more sustainable in resource use?<br>• What are examples of social, political, and economic aspects of environmental science?<br>• What are the impacts of the major ecological laws?<br>• How do energy availability and energy use compare? | • Taking economics, government regulations and current technology into consideration, design a new method to reclaim a former brownfield in the Great Lakes Region.<br>• Looking at air quality data (e.g., from the US EPA) outline a plan for Ohio or the Great Lake States to improve air in the next seven years.<br>• Conduct tests for air quality in and around your school, investigate the sources of any pollutants and design a plan to remove or reduce the pollutants.<br>• Perform a water assessment on your home or school. Outline a water conservation plan based on the assessment. Explain where water can be conserved. Model how small changes can have large effects.<br>• Using the Clean Air Act as an example, propose an updated policy for the next 20 years, being sure to consider technology and demographics.<br>• Create a pie chart displaying the breakdown of components of an individual's ecological footprint (e.g., shelter, food, energy, transportation), and construct a plan to reduce his/her carbon footprint.<br>• Redesign a city/village/town to be more sustainable. Examine concepts such as waste treatment, water resources, pollution, transportation, |

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| | | | | energy resources and maintaining biodiversity. Share recommendations and incorporate feedback to make a final proposal for the city/village/town.<br>• Research and design a sustainable lifestyle in regard to energy efficient living space and mindfully using resources, alternative transportation, dietary sources and outdoor space. |

| Grading Period 2 | **Unit 2. The Biosphere ENV: ES.1-5, ER.5, GP.5, 8** **5 weeks**<br>**Unit 3. Population ENV: ER.1, GP.1** **4 weeks** | | | |
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| | **Unit** | **Standards** | **Big Ideas / Essential Questions** | **Model Curriculum Possibilities** |
| | 2. The Biosphere | ES.1 Biosphere<br>• Evolution and adaptation in populations<br>• Biodiversity<br>• Ecosystems<br>• Population dynamics<br>ES.2 Atmosphere<br>• Atmospheric properties and currents<br>ES.3 Lithosphere<br>• Geologic events and processes<br>ES.4 Hydrosphere<br>• Oceanic currents and patterns as they relate to climate<br>• Cryosphere<br>ES.5 Movement of Matter and Energy | **Concept**<br>• The biosphere is the portion of Earth where life occurs -- the lithosphere, hydrosphere and atmosphere.<br>• Ecosystems are composed of living populations interacting in and with the nonliving environment.<br>• Evolution can be biological or geological.<br>• Evolution relies on the process of natural selection which is the process through which populations of living organisms adapt and change.<br>**Evidence**<br>• How can the biosphere be defined?<br>• How do biotic and abiotic factors affect an ecosystem?<br>• How can it be determined if an ecosystem is in equilibrium?<br>• What factors can cause adaptations | • Labs, activities, videos and websites<br>• Conduct a pond study, calculate biodiversity index and construct a sustainable food web. Research how biomagnification or bioaccumulation impacts specific Ohio ecosystems. Research should include the possible impact to humans. Present research and findings on biomagnification and bioaccumulation impacts on specific Ohio ecosystems<br>• Graph survivorship curves to make judgements about environmental and health conditions in various habitats/ecosystems.<br>• Plan and implement a population study of a specific area over a period of time or critique/analyze an existing population study. Document changes |

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| | | • Energy transformation on global, regional and local scales<br>• Biogeochemical cycles<br>• Ecosystems<br>• Weather<br>• Climate<br>ER.5 Wildlife and Wilderness<br>• Wildlife and wilderness management<br>• Endangered species<br>• Invasive species<br>• Introduced species<br>GP.5 Species Depletion and Extinction<br>GP.8 Deforestation and Loss of Biodiversity | which lead to evolution?<br>• How does a system maintain conservation of mass?<br>• What factors impact biodiversity? | in weather, food availability and any change to the population. Prepare a scientific analysis and conclusion for the study.<br>• Identify an instance of biomagnification or bioaccumulation within a specific ecosystem and propose possible solutions.<br>• Research an endangered species and develop a conservation plan for the species taking into account the interests of all stakeholders. List the advantages and disadvantages of conservation.<br>• Research a water resource disaster and describe various ways the disaster has altered the ecosystem of the region. Explain the stability of that ecosystem, as well as how it has changed over time.<br>• Choose a specific living species. Using scientific data, trace the history of that species. Show existing, established evolutionary relationships, environmental (both biotic and abiotic) requirements, global locations, ecosystem characteristics and sustainability predictions. Use quantifiable data to support findings.<br>• Compare the biodiversity of two natural areas, including richness and distribution. Draw conclusions, including about how the biodiversity is relevant toward mitigating the impact of invasive species. |

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| | | | | • Design a plan to preserve/conserve a wilderness or waterway in Ohio. Be specific and defend your rationale with data. Include biological and ecological relationships within the system.<br>• Analyze a conservation case study (e.g., osprey, bald eagle, black bears in Ohio) and write an analysis and a recommendation for solutions.<br>• Using phenological protocols, collect information on the local plants and wildlife as the seasons progress and contribute data to a local or global study. Track for comparison from year to year and location to location. Identify trends in phenological changes and design solutions to local climate impacts.<br>• Write a proposal for the state setting limits/regulations for housing/commercial development through the lens of biodiversity. Consider federal laws.<br>• Use satellite mapping resources (NASA Forest Changes in Rondonia, Brazil) to investigate the connection between urbanization, population growth and deforestation. Summarize your findings.<br>• Design a community of the future that demonstrates responsible practices for preservation of biodiversity and forested areas.<br>• Research, design, create and maintain a tabletop sustainable biosphere (e.g., |

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| | | | | eco column) using aquarium gravel, live aquatic plants and aquatic organisms (e.g., fish, ghost shrimp, Sea Monkeys ®). Use it to study nutrient cycling, limiting factors, decomposition, water quality and eutrophication. |
| | 3. Population | ER.1 Energy resources<br>GP.1 Human population | **Concept**<br>● The global population has grown from 1 billion in 1800 to 7.8 billion in 2020.<br>● The growing human population has an effect on environmental events and cycles.<br>● The growing human population has an effect on resources.<br>**Evidence**<br>● How has the human population changed over time?<br>● How is the human population and its effects different for developing and developed countries?<br>● How can the human population be sustained? | ● Labs, activities, videos and websites: https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf<br>● Research a widely used energy source and create a detailed poster discussing the implications of human population and the resource.<br>● Interpret population demographic curves, graphs or pyramids (e.g., from US Census Bureau, the UN Census, World Fact Book) and discuss differences in population growth rates among several different countries (developing vs. developed).<br>● Compare local fertility rates to national and international rates. Consider environmental and societal factors contributing to differences.<br>● Relative to resource availability and rates of consumption, assess the scope of human population growth and potential limits to its growth.<br>● Plan and implement a population study of a specific area over a period of time or critique/analyze an existing population study. Document changes |

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| | | | | in weather, food availability and any change to the population. Prepare a scientific analysis and conclusion (in writing) for the study.<br>● Use data on birth rates, death rates, life expectancy, average income and literacy rates of various countries to develop a plan that could contribute to a change in the fertility and death rates. unicef data<br>● Work in design teams to create a plan to develop a parcel of undeveloped rural land or to revitalize an urban neighborhood that has been blighted. Solutions must address housing, transportation, business and industrial, green space and recreational land uses as well as food, water, waste and energy systems. An extension could limit funds available. |

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| | **Unit 4. Climate, Hydrosphere, Atmosphere ENV: ES.2, 4, 5, ER.2, GP.3, 6** | **5 weeks** |
| | **Unit 5. Water Resources and Water Pollution ENV: ES.4-5, ER.3, GP.2** | **4 weeks** |

| | Unit | Standards | Big Ideas / Essential Questions | Model Curriculum Possibilities |
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| Grading Period 3 | 4. Climate, Hydrosphere, Atmosphere | ES.2 Atmosphere<br>• Atmospheric properties and currents<br>ES.4 Hydrosphere<br>• Oceanic currents and patterns as they relate to climate<br>ES.5 Movement of matter and energy through the hydrosphere, lithosphere, atmosphere and biosphere<br>ER.2 Air and air pollution<br>• Primary and secondary contaminants<br>• Greenhouse gases<br>• Clean Air Act<br>GP:3 Climate change<br>GP:6 Air quality | **Concept**<br>• The atmosphere and hydrosphere have major characteristics.<br>• Energy moves within and among the atmosphere and hydrosphere.<br>• Land and sea breezes are caused by heat differentials.<br>• Mass and weather changes result in various weather patterns.<br>• Climate affects the biosphere, hydrosphere and lithosphere.<br>• There are various causes and effects of water and air pollution.<br>**Evidence**<br>• Trace the characteristics of the atmosphere and hydrosphere.<br>• Trace the movement of energy within and among the atmosphere and hydrosphere.<br>• How are land and sea breezes connected and how do they result in currents?<br>• How can external influences affect weather?<br>• What are the causes and effects of climate change to the biosphere, hydrosphere and lithosphere?<br>• How can climate change be slowed?<br>• How do rising $CO_2$ levels affect the ocean?<br>• How can primary and secondary air and water pollution sources be addressed?<br>• How could pollution be regulated to promote environmental justice? | • Labs, activities, videos and websites: https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf<br>• Explain the effects and causes of El Niño/La Niña weather patterns on Earth's spheres, biogeochemical cycles and biodiversity. Include regional comparisons of the effects of these events.<br>• Research and analyze an event (e.g., naturally caused [an Icelandic volcano] or anthropogenically caused [oil spills]) and make a model to demonstrate how the different spheres (e.g., atmosphere, biosphere, lithosphere, hydrosphere) are impacted.<br>• Plan a demonstration to illustrate the factors that lead to changing oceanic currents (both deep and shallow).<br>• Write an article explaining the difference between climate and weather and the importance of distinguishing between the two.<br>• Research an actual environmental or geologic event (e.g., release of a toxin/contaminant, hurricane, earthquake, volcano, flood, fire, landslide) and determine how each of Earth's spheres was impacted. Include long-term and short-term impacts. Trace the movement of contamination or energy through each sphere. |

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| | | | | Provide scientific evidence and data to support conclusions.<br>• Describe the relationship between ocean surface temperature and hurricane intensity, using the NOAA database. Create a map of the most vulnerable areas and use it to identify highly populated areas that could be affected.<br>• Explore, analyze and interpret past and current climate patterns for 10 different cities around the world. Analyze differences between climate patterns. Make predictions of future patterns.<br>• Use quantifiable data and evidence to investigate the relationship between deforestation and changing weather or, in some cases, climate, at a specific location (e.g., the Amazon region of South America). Analyze the data and draw a conclusion based upon the analysis.<br>• Create a presentation on the major types and sources of air pollution. Compare the main types and illustrate ways to prevent air pollution.<br>• Design and create a poster/graphic organizer/infographic illustrating the difference between primary and secondary contaminants.<br>• Construct a model of your home or school explaining the internal air pollutants. Determine the relationships between the pollutants |

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| | | | | and human activities in or near your home/school.<br>• Looking at air quality data (e.g., from the US EPA) outline a plan for Ohio or the Great Lake States to improve air in the next seven years.<br>• Using ice core models and/or datasets, make a graph showing how elements in the atmosphere can change over time. Interpret and extrapolate into the future.<br>• Conduct tests for air quality in and around your school, investigate the sources of any pollutants and design a plan to remove or reduce the pollutants.<br>• Design a "city makeover" for a city near you. Your new city must promote clean air practices. Consider mass transit, industry, infrastructure, homes, education and technology.<br>• Research monthly average precipitation data in different areas to strengthen conclusions about periods of drought or abnormal rainfall as they relate to climate change.<br>• Compare the effects of El Niño and La Niña at two different longitudinal locations, but at the same latitude, using sea surface temperature and precipitation from real satellite data.<br>• Create a timeline of climate science and policy initiatives over the past two centuries in developing and non developing countries. Include global |

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| | | | | data and compare different nations.<br>• Investigate the history of local habitats experiencing change (e.g., the Great Lakes).<br>• Develop position papers for and against increasing federal spending on climate change research.<br>• Choose a specific location in the United States. Research and analyze the patterns of climate change throughout the geologic record, human historical data and present day data for the location. Be able to explain the interpretation and analysis of the data.<br>• Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.<br>• Use a case study for a city that has historically experienced air pollution (e.g., Beijing, Detroit). Analyze the situation and identify issues/actions described in the case which may be problematic.<br>• Using real-time data, research air pollution issues (and the root causes for the problems) that face the local community, Ohio, the United States or the world. Present evidence (quantitative data) and conclusions orally, through a poster session or in written form (scientific research |

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| | | | | paper).<br>• Investigate the effects of acid rain (with a range of pH) on seed sprouting.<br>• Conduct an investigation comparing the concentration of tropospheric ozone in various locations in the community and analyze the results to determine the cause(s) for any differences in concentrations.<br>• Design and construct a scrubber for cleaning the sulfur emissions from burning coal. Assess how well the scrubber works by collecting calcium sulfate or sulfite to compare against a control.<br>• Identify a problem or issue with air quality in your school/community. Use real data from the EPA and develop a solution. |
| | 5. Water Resources and Water Pollution | ES.4 Hydrosphere<br>• Surface and groundwater flow patterns and movement<br>• Cryosphere<br>ES.5 Movement of matter and energy through the hydrosphere, lithosphere, atmosphere and biosphere<br>ER.3 Water and water pollution<br>• Potable water and water quality<br>• Hypoxia, eutrophication<br>• Clean Water Act<br>• point source and nonpoint | **Concept**<br>• Matter and energy transfer during the water cycle.<br>• Potable water is becoming more scarce in the world.<br>• Contaminants move through the lithosphere and water cycle.<br>• Eutrophication from human-induced factors can lead to hypoxia.<br>• Potable water testing is often an integral aspect of guaranteeing the quality of water supplies.<br>• The concentration of a water pollutant is commonly given in very small units such as parts per million (ppm) or even parts | • Labs, activities, videos and websites: https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf<br>• Create a map of the local watershed including boundaries of adjoining watersheds. Have the map depict movement and direction of water within the watershed.<br>• Use Ohio EPA well water data to compare water composition of a contaminated site with groundwater from your own community.<br>• Construct a functioning shower using |

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| | | source contamination<br>GP.2 Potable water quality, use and availability | per billion (ppb).<br>• There are both natural and man-made processes to purify poor quality water.<br>**Evidence**<br>• How can matter and energy transfers be illustrated in the water cycle?<br>• How is increasing use of freshwater resources worldwide, and a seemingly endless list of contaminants affecting the availability of potable water?<br>• How do human factors lead to eutrophication and hypoxia?<br>• How can water quality be tested?<br>• How can water pollutants be represented in ppm or ppb?<br>• How can natural and man-made processes be used to purify water? | only four gallons of water and household materials, which would allow someone to wash the body and hair effectively and capture the gray water produced. The shower construction should be tested to assure it meets design criteria and that it will adequately allow for a person to wash.<br>• Investigate various methods to clean up an oil spill using a model to evaluate their effectiveness. At the completion of the clean-up process, each team will assess the effectiveness, including environmental impact of the cleanup process, and make suggestions for improvement.<br>• Design methods to transport potable water to arid areas. Consider availability of materials, cost and efficiency.<br>• Examine and report on your town's or city's water delivery system. Include where your drinking water comes from and where your waste water goes.<br>• Read excerpts or summaries of Rachel Carson's Silent Spring and create scenarios which model the effects of toxins introduced into a water system. Examine the actions that resulted from the publication of this book.<br>• Conduct a water quality field test of various local bodies of water, and determine how the results (e.g., |

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| | | | | dissolved oxygen content, phosphates, nitrates/nitrites, pH, fecal coliform) could impact aquatic ecosystems.<br>• Identify two waterways in your area, one in a developed area and another in a natural area. Use biotic indicators and chemical tests to determine if any differences exist. Explain your findings, including ways contaminants may have moved from area to area.<br>• Design and build a water filter with commonly available materials for either wastewater or drinking water, taking into account cost and efficiency. Test the water filter, analyze the data collected and brainstorm ideas on how to improve the design.<br>• Investigate the source of various bottled water. Some brands come from municipal water supplies. Record each water source on a map.<br>• Examine the water quality report from a municipality to determine the health of the water. Investigate the effects of disinfection byproducts (DBPs) which result when chlorine and other disinfectants breakdown over time.<br>• Investigate sources of drinking water pollutants and design a plan to lower, restrict or prevent those pollutants.<br>• Conduct a water survey in your home/school. How much water do you use on a daily basis and how much does it cost? Identify areas where |

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| | | | water can be saved.<br>• Using data, research a severe water related environmental problem (and its root causes) that faces the local community, Ohio, the United States or the world. Propose ways to mitigate the problem.<br>• Test a local water source for contaminants and compare findings to the released water quality reports. If discrepancies exist, predict possible causes.<br>• Design a water treatment system or process that can be implemented at a low cost and without the need for electricity to be used in areas that do not have access to potable water.<br>• Design and build an irrigation system that will move water at a specific rate. |

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| **Unit 6: Food, Soil and Pest Management ENV: ER.1, 4, GP.4, 7, 8** | | | | **3 weeks** |
| **Unit 7: Geology, Mineral and Energy ENV: ES.3, 5, ER.1, 4** | | | | **4 weeks** |
| **Unit 8: Waste Management ENV: ER.4, GP.9** | | | | **2 weeks** |
| | **Unit** | **Standards** | **Big Ideas / Essential Questions** | **Model Curriculum Possibilities** |
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| Grading Period 4 | 6. Food, Soil and Pest Management | ER.1 Energy resources<br>ER.4 Soil and land<br>● Land use and land management (including food production, agriculture and zoning)<br>GP.4 Sustainability<br>GP.7 Food production and availability<br>GP.8 Deforestation and loss of biodiversity | **Concept**<br>● Over half of the land surface area on Earth is uninhabitable.<br>● Nearly half of the habitable Earth is used for agriculture.<br>● Desertification and erosion are causing loss of habitable lands.<br>● Agricultural production is the use of cultivated plants or animals to produce products for sustaining or enhancing human life.<br>● Fertilizers and pesticides have both positive and negative aspects.<br>● The continual ploughing of fields, combined with heavy use of fertilizers, has degraded soils across the world.<br>● Agricultural runoff is water from farm fields due to irrigation, rain, or melted snow that flows over the earth and can be absorbed into the ground, enter bodies of water or evaporate.<br>**Evidence**<br>● How could land be suitable for farming and human habitation?<br>● How are erosion and desertification impacting habitable lands?<br>● What are different types of agriculture and food production?<br>● Discuss the positive and negative impacts of fertilizers and pesticides.<br>● How does agricultural runoff impact lakes and rivers?<br>● How will future food production needs be met? | ● Labs, activities, videos and websites: https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf<br>● Model and describe how toxins enter and accumulate in a food chain. Find and paraphrase laws/regulations which attempt to regulate use of potential contaminants (e.g., DDT, BPA, pharmaceuticals, lead).<br>● Compare soils found in various parts of the community. Use information gathered to create a soil texture map of the community.<br>● Research current FDA laws pertaining to food safety for agriculture and write user-friendly versions of the laws for the public to access on the FDA website.<br>● Write a letter to a company which historically violated EPA laws outlining their violations and the impact on the environment.<br>● Find a large tract of property for sale in your community. Using knowledge of the lithosphere through data found on the United States Department of Agriculture's site, make recommendations on how this property could be used in the future.<br>● Deconstruct an area affected by a mass wasting, desertification or erosion event and write a detailed explanation with data. Write a “brief” for a law |

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| | | | | firm assigning responsibility for purposes of restitution and remediation.<br>• Conduct soil tests on various sites around the school or community. Determine an appropriate location for planting a community garden. Consider soil types, precipitation and yield.<br>• Create a plan to revitalize a brownfield site in one of the Great Lake States. Be sure to include an explanation of how it became a brownfield.<br>• Using the National Geographic Website, What the World Eats, explore and compare the pie graphs to determine which country consumes the most/least daily calories, the most/least grains, the most/least meat, etc.<br>• Design and conduct an investigation to determine if a fertilizer or pesticide is toxic to an organism (e.g., radish seeds).<br>• Research food production in developing and underdeveloped nations, comparing land use vs. crop yield. Present your findings.<br>• Identify the locations of food deserts in your community or surrounding areas. Write a proposal to the local government to provide that community with better food resources.<br>• Construct a plan for a sustainable garden that could provide food for |

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| | | | | your school/community. Share your plan with stakeholders.<br>• Develop a PSA on commercial products that contribute to deforestation (e.g., palm oil) and how deforestation contributes to the loss of biodiversity.<br>• Use satellite mapping resources (NASA Forest Changes in Rondonia, Brazil) to investigate the connection between urbanization, population growth and deforestation. Summarize your findings.<br>• Design a community of the future that demonstrates responsible practices for preservation of biodiversity and forested areas. |
| | 7. Geology, Mineral and Energy | ES.3 Lithosphere<br>• Geologic events and processes<br>ES.5 Movement of matter and energy through the hydrosphere, lithosphere, atmosphere and biosphere<br>ER.1 Energy Resources<br>• Renewable and nonrenewable energy sources and efficiency<br>• Alternate energy sources and efficiency<br>• Resource availability<br>• Mining and resource extraction<br>ER.4 Soil and land<br>• Mass movement and erosion | **Concept**<br>• Tectonic activity is responsible for some of Earth's geologic events.<br>• Geochemical cycles are the movement of material between the deep Earth and the surface reservoirs. This occurs through two different processes: volcanism and subduction of tectonic plates.<br>• Most non-renewable energy sources are fossil fuels: coal, petroleum, and natural gas.<br>• Biofuels are a renewable energy source, made from organic matter or wastes, that can play a valuable role in reducing carbon dioxide emissions.<br>• Energy is transformed during the generation of electricity. | • Labs, activities, videos and websites: https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf<br>• Research and analyze an event (e.g., naturally caused [an Icelandic volcano] or anthropogenically caused [oil spills]) and make a model to demonstrate how the different spheres (e.g., atmosphere, biosphere, lithosphere, hydrosphere) are impacted.<br>• Examine human impacts on the lithosphere (e.g., hydraulic fracturing, surface mining, urbanization) and hypothesize possible consequences.<br>• Research an actual environmental or geologic event (e.g., release of a |

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| | | • Sediment contamination | **Evidence**<br>• How is energy harnessed from fossil fuels?<br>• What are the economic impacts of fossil fuels?<br>• How are fossil fuels formed?<br>• How can nonrenewable resources affect the environment?<br>• How do biofuels compare to fossil fuels?<br>• How is energy transformed generating electricity from different types of fuels? | toxin/contaminant, hurricane, earthquake, volcano, flood, fire, landslide) and determine how each of Earth's spheres was impacted. Include long-term and short-term impacts. Trace the movement of contamination or energy through each sphere. Provide scientific evidence and data to support conclusions.<br>• Research an actual environmental or geologic event (e.g., release of a toxin/contaminant, hurricane, earthquake, volcano, flood, fire, landslide) and determine how each of Earth's spheres was impacted. Include long-term and short-term impacts. Trace the movement of contamination or energy through each sphere. Provide scientific evidence and data to support conclusions.<br>• Compose a letter to a local politician or school board outlining the need for renewable/alternative energy exploration and incorporation into your city. Include information about taxes, resources and infrastructure.<br>• Compare energy usage of the United States to energy usage of a developing nation. Parse it down to a "typical" family in America and a "typical" family in the developing country.<br>• Create a public service announcement explaining the importance of energy conservation in your community, home and school. Include methods for |

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| | | | | conservation.<br>• Contact your local energy provider and conduct an energy audit of your school. Identify areas where energy can be conserved. Generate a plan to decrease energy footprint.<br>• Record energy usage in your home for a 24 to 48-hour period. With parental permission, review an electric bill for your home and identify adoptable strategies to reduce your home's energy usage.<br>• Design an energy efficient, clean, renewable community based upon real data and models of other cities or communities. Include explanations of the benefits and consequences of various aspects of the city design.<br>• Using existing energy technologies (e.g., tidal power plants, solar panels, scrubbers) as an example, generate an alternative way to collect energy or improve an existing energy technology. Test your design. |

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| | 8. Waste Management | ER.4 Soil and land<br>● Sediment contamination<br>● Land use and land management<br>● Solid and hazardous waste<br>GP.9 Waste management (solid and hazardous) | **Concept**<br>● Humans produce many types of solid waste.<br>● Manufacturers produce solid waste.<br>**Evidence**<br>● How can different methods of trash disposal be sustained?<br>● What are ways solid waste from manufacturers and consumers can be reduced? | ● Labs, activities, videos and websites: https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf<br>● Collect research information on various waste management types. Compare and contrast the practices of waste management of developed and developing nations. Compare methods of at least two different nations and identify the best practices.<br>● Research the waste management issues and the root causes for the problems that face the local community, Ohio, the United States or the world.<br>● Plan and implement an investigation to explore human health issues related to the disposal of hazardous waste materials (e.g., biomagnification or bioaccumulation within a specific Ohio ecosystem). Existing public case studies can be used, such as a local Brownfields case.<br>● Conduct a landfill decomposition study over an extended period to determine the rate at which typical materials found in landfills decompose.<br>● Develop a risk assessment for humans or the environment due to a toxin or hazardous chemical used by a company. The assessment should include: nature of the toxin/chemical, on-site use and handling (including |

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| | | | | existing safety practices), by-products (e.g., vapors, dilution processes), storage, transportation and emergency plans. Consider the topography and geology of the area and how these contribute to the flow of spills or leaks. Use a computer modeling program (many are available through freeware sites) to model and predict the movement and possible pathways of the toxin/chemical. Make recommendations for containment methods.<br>• Research composting techniques. Analyze the wastes produced by the school and design an appropriate composting system to process the biodegradable waste produced.<br>• Construct and maintain a composting site on school grounds. |

## Curriculum and Instruction Guide

### Unit 1: Sustainability and the Human Endeavor

**Content Elaboration**

| Standards | Essential Understanding | Academic Vocabulary |
|---|---|---|
| ES.1: Biosphere<br>● Ecosystems (equilibrium, species interactions, stability)<br>● Population dynamics<br>ER.2: Air and air pollution<br>● Primary and secondary contaminants<br>● Greenhouse gases<br>● Clean Air Act<br>ER.3 Water and water pollution<br>● Clean Water Act<br>● Point source and nonpoint source contamination<br>GP.4: Sustainability | – Endangered Species Act, Clean Water Act, Clean Air Act<br>– Sustainability is the avoidance of the depletion of natural resources in order to maintain an ecological balance. Sustainability focuses on meeting the needs of the present without compromising the ability of future generations to meet their needs. The concept of sustainability is composed of three pillars: economic, environmental, and social.<br>– Environmental racism refers to the way in which minority group neighborhoods are burdened with a disproportionate number of hazards, including toxic waste facilities, garbage dumps, and other sources of environmental pollution and foul odors that lower the quality of life. https://courses.lumenlearning.com/alamo-sociology/chapter/reading-environmental-racism/<br>– The study of relevant, local problems can be a way to connect the classroom to the real world. Within Ohio, there are numerous environmental topics that can be investigated.<br>– Feasibility, availability, remediation and environmental cost are included in the extraction, storage, use and disposal of both abiotic and biotic resources. Environmental impact is evaluated as it pertains to both environmental and human risks. Examples include chemical hazards, radiation, biological hazards, toxicology and risk analysis studies.<br>– Learning about conservation and protection of the environment also requires an understanding of the existence and rationale for laws and regulations to conserve resources and reduce and/or remediate contamination, but the emphasis should be on the science behind the laws and regulations.<br>– The connections and interactions of energy and matter between Earth's spheres are researched and investigated using actual data. The emphasis is on the interconnectedness of Earth's spheres and the understanding of the complex relationships between them, including both abiotic and biotic factors. One event, such as a petroleum release or a flood, can impact each sphere. Some impacts are long-term, others are short-term and most are a combination of both long- and short-term. It is important to use real, quantifiable data to study the interactions, patterns and cycles among Earth's spheres. | https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf |

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| | – Technology can be used for comparative studies to share local data internationally so that specific quantifiable data can be compared and used in understanding the impact of some of the environmental problems that exist on a global scale. Researching and investigating environmental factors on a global level contributes to the depth of understanding by applying the environmental science concepts to problem solving and design.<br>– Researching contemporary discoveries, new technology and new discoveries can lead to improvement in environmental management.<br><br>**Extended Understanding**<br>– Relating Earth's resources to a global scale and using technology to collect global resource data for comparative classroom study is recommended. In addition, it is important to connect the industry and the scientific community to the classroom to increase the depth of understanding. Critical thinking and problem-solving skills are important in evaluating resource use, management and conservation. New discoveries and research are important parts of this topic. | |
| **Ultimate Learning Target Type: Knowledge** | **Broad Learning Target:**<br>– The student can understand the social, political and economic aspects of environmental science as it relates to sustainability.<br>**Underpinning Knowledge Learning Targets:**<br>– The student can define sustainability.<br>– The student can discuss the issue of ecological "footprint" and how humans can attain and maintain sustainability.<br>– The student can provide examples that illustrate the social, political and economic aspects of environmental science.<br>– The student can explain conflicting ethical concerns regarding activities that affect the environment.<br>– The student can define environmental racism and its effect on environmental efforts and laws.<br>– The student can correlate air and water quality around the globe to socioeconomic status of the local population.<br>– The student can describe how costs and values are assigned to natural resources and environmental concerns.<br>– The student can describe the events leading up to, the main points and the impacts of major ecological laws: | |

- Endangered Species Act
- Clean Water Act
- Clean Air Act

- The student can provide examples of actions that can be taken to protect the environment.
- The student can define scientific models.
- The student can list benefits and shortcomings of using models to describe natural processes.
- The student can distinguish between matter and energy.
- The student can demonstrate energy conservation within a system by describing conversions of energy from each form to another.
- The student can describe chemical measurements that are important to environmental science.
- The student can compare and contrast energy efficiency, conserving energy and conservation of energy.
- The student can list the major sources of energy available to the biosphere.
- The student can list the major categories of energy uses by humans.

**Underpinning Skills/Product Learning Targets:**

- The student can utilize scientific models to address environmental issues.

**Underpinning Reasoning Learning Targets:**

- The student can evaluate the competing interests for scarce water resources by industry or geographic/ethnic groups and the role of this competition in global conflicts.

**Middle School (Prior Knowledge)**

geologic processes, biogeochemical cycles, climate, the composition and properties of the atmosphere, lithosphere and hydrosphere (including the hydrologic cycle)

**Physical Science and Biology (Prior Knowledge)**

energy transfer and transformation, conservation of energy and matter, evolution, adaptation, biodiversity, population studies and ecosystem composition and dynamics

**(Future Knowledge)**

**Content Elaborations**

http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US
Ohio Department of Education Learning Standards for Science
Scroll to page:

ES.I: 290
ER.2-3: 295-296
GP.4: 300

## Instructional Strategies

http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US
Ohio Department of Education Learning Standards for Science
Scroll to page 289 to find The Nature of Science strategies.
Scroll to find the Model Curriculum examples on pages:
ES.1: 291
ER.2: 297
ER.3: 298
GP.4: 303

## Sample Assessments and Performance Tasks

https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources

Sample Lessons:

- A Study in Sustainability Tutorial: https://www.cpalms.org/Public/PreviewResourceStudentTutorial/Preview/163500
- Building a Home for the Future:https://www.cpalms.org/Public/PreviewResourceLesson/Preview/129125 Students will learn about green homes and how they allow for a more sustainable future. Students will learn how an individual family's carbon footprint can be reduced by designing their own green home. Students also complete a cost analysis of the expenses in constructing a green home and savings over time.
- Sustainability Unit: http://nkhs.nkschools.org/UserFiles/Servers/Server_419825/File/Staff%20Sites/Foley,%20Holey%20Ann/Physical%20Science/Sustainablitiy.pdf
- Everybody Lives Downstream: http://techalive.mtu.edu/meec/module01/Downstream.htm
- The People Paradox Video: https://www.youtube.com/watch?reload=9&v=D3yJZm06Hrk
- The Habitable Planet: Demographics: https://www.learner.org/series/the-habitable-planet-a-systems-approach-to-environmental-science/demographics-lab/

Sample Assessments:

- Determine the carrying capacity of an ecosystem using historical or current data (e.g., Moose on Isle Royale, Kaibab Deer in Arizona).
- Read the Clean Air Act and Clean Water Acts and create a timeline demonstrating major events that led up to them and major events which occurred after them. Include results of those events.

- Describe the role of water scarcity in global conflicts.
- How does environmental racism affect environmental laws?
- How does socioeconomic status affect local air and water quality?
- Use an online ecological footprint calculator (e.g., Earth Day Network) to compare how many Earths it would take to sustain the world population for various lifestyles.

| Instructional Resources |
|---|
| https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources (labs, activities, intervententions, extensions, supplements, case studies, videos, websites, text chapters) |
| https://drive.google.com/drive/folders/1EZC4MKEJP5SEoeHBeywxzB9K_Mdv9P7v?usp=sharing - Environmental Science Resources |

## Unit 2: The Biosphere

| Content Elaboration | | |
|---|---|---|
| **Standards**<br>ES.1 Biosphere<br>• Evolution and adaptation in populations<br>• Biodiversity<br>• Ecosystems<br>• Population dynamics<br>ES.2 Atmosphere<br>• Atmospheric properties and currents<br>ES.3 Lithosphere<br>• Geologic events and processes<br>ES.4 Hydrosphere<br>• Oceanic currents and patterns as they relate to climate<br>• Cryosphere<br>ES.5 Movement of Matter and Energy | **Essential Understanding**<br>– The focus is on the connections and interactions between Earth's spheres (the hydrosphere, atmosphere, biosphere and lithosphere).<br>– Both natural and anthropogenic interactions are studied. This includes an understanding of causes and effects of climate, global climate (including El Niño/La Niña patterns and trends) and changes in climate through Earth's history, geologic events (e.g., volcanic activity or mass wasting) that impact Earth's spheres, biogeochemical cycles and patterns, the effect of abiotic and biotic factors within an ecosystem, and the understanding that each of Earth's spheres is part of the dynamic Earth system.<br>– Groundwater and surface water velocities and patterns are included as the movement of water (either at the surface, in the atmosphere or beneath the surface) can be a mode of transmission of contamination. This builds upon previous hydrologic cycle studies in earlier grades. | **Academic Vocabulary**<br>https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf |

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| • Energy transformation on global, regional and local scales<br>• Biogeochemical cycles<br>• Ecosystems<br>• Weather<br>• Climate<br>ER.5 Wildlife and Wilderness<br>• Wildlife and wilderness management<br>• Endangered species<br>• Invasive species<br>• Introduced species<br>GP.5 Species Depletion and Extinction<br>GP.8 Deforestation and Loss of Biodiversity | – Geomorphology and topography are helpful in determining flow patterns and pathways for contamination.<br>– The connections and interactions of energy and matter between Earth's spheres are researched and investigated using actual data. The emphasis is on the interconnectedness of Earth's spheres and the understanding of the complex relationships between them, including both abiotic and biotic factors.<br>– One event, such as a petroleum release or a flood, can impact each sphere. Some impacts are long-term, others are short-term and most are a combination of both long- and short-term. It is important to use real, quantifiable data to study the interactions, patterns and cycles among Earth's spheres.<br>– Evolutionary change is based on changes in the genetic makeup of populations over time. Populations, not individual organisms, evolve. Changes in an individual over the course of its lifetime may be development (e.g., a male bird growing more colorful plumage as it reaches sexual maturity) or may be caused by how the environment affects an organism (e.g., a bird losing feathers because it is infected with many parasites). New gene variants (i.e., alleles) are produced by random mutation.<br>– Humans often cause major changes in the environment and we are frequently the instigators of evolution in other organisms. Here are just a few examples of human-caused evolution:<br>o Several species have evolved in response to climate change.<br>o Fish populations have evolved in response to our fishing practices.<br>o Insects like bed bugs and crop pests have evolved resistance to our pesticides.<br>o Bacteria, HIV, malaria, and cancer have evolved resistance to our drugs.<br>– Case studies, developing and using models, collecting and analyzing water and/or air quality data, conducting or researching population studies and methods of connecting to the real world is emphasized for this topic. Technology can be used for comparative studies to share local data internationally so that specific quantifiable data can be compared and used in understanding the impact of some of the environmental | |

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| | problems that exist on a global scale. Researching and investigating environmental factors on a global level contributes to the depth of understanding by applying the environmental science concepts to problem solving and design. Examples of global topics that can be explored include monitoring endangered, introduced or invasive species and studying the environmental effects of an increasing human population. Researching contemporary discoveries, new technology and new discoveries can lead to improvement in environmental management.<br><br>**Extended Understanding**<br>– Relating Earth's resources to a global scale and using technology to collect global resource data for comparative classroom study is recommended. In addition, it is important to connect the industry and the scientific community to the classroom to increase the depth of understanding. Critical thinking and problem-solving skills are important in evaluating resource use, management and conservation. New discoveries and research are important parts of this topic. | |
| **Ultimate Learning Target Type: Knowledge** | **Broad Learning Target:**<br>– The student can understand the major characteristics of the Biosphere's ecosystems and biomes, and how they maintain equilibrium.<br>**Underpinning Knowledge Learning Targets:**<br>– The student can define major characteristics of the Biosphere (ecosystems/biomes).<br>– The student can distinguish between abiotic and biotic factors and their effects on an ecosystem.<br>– The student can list the variables that determine if an ecosystem demonstrates equilibrium.<br>– The student can describe evolutionary processes and discuss factors that cause adaptations.<br>– The student can describe how evidence and inference are used to support biological and geological evolution.<br>– The student can demonstrate conservation of mass within a system by describing the conversion of matter from each substance to another<br>– The student can explain the importance of biodiversity and the factors that impact it.<br>**Underpinning Skills Learning Targets:**<br>– The student can use real-world examples to identify ecosystem diversity and equilibrium.<br>**Underpinning Reasoning Learning Targets:**<br>– The student can reason whether or not an ecosystem is in equilibrium and justify their decision. | |

| Middle School (Prior Knowledge) | (Future Knowledge) |
|---|---|
| geologic processes, biogeochemical cycles, climate, the composition and properties of the atmosphere, lithosphere and hydrosphere (including the hydrologic cycle)<br><br>**Physical Science and Biology (Prior Knowledge)**<br><br>energy transfer and transformation, conservation of energy and matter, evolution, adaptation, biodiversity, population studies and ecosystem composition and dynamics | |

| Content Elaborations |
|---|
| http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US<br>Ohio Department of Education Learning Standards for Science<br>Scroll to page:<br>ES.I-5: 290<br>ER.5: 295-296<br>GP.5, 8: 300 |
| **Instructional Strategies** |
| http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US<br>Ohio Department of Education Learning Standards for Science<br>Scroll to page 289 to find The Nature of Science strategies.<br>Scroll to find the Model Curriculum examples on pages:<br>ES.1: 291<br>ES.2-3: 292<br>ES.4: 293<br>ES.5: 294<br>ER.5: 299<br>GP.5: 304<br>GP.8: 306 |
| **Sample Assessments and Performance Tasks** |

https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources

Sample Lessons:

- Law of Conservation of Mass Lab: https://www.troup.org/userfiles/929/My%20Files/Science/MS%20Science/8th%20Science/Matter/conservation_matter/conservation_mass_lab2.pdf?id=8053
- Biomagnification Lab: https://blogs.cornell.edu/cibt/files/2015/05/Biomagnification-Lab-Todd-Shuskey-12qtxb5.pdf
- Biodiversity and Non-native Species Tutorial: https://www.cpalms.org/Public/PreviewResourceStudentTutorial/Preview/166281
- Measuring Biodiversity: https://www.cpalms.org/Public/PreviewResourceLesson/Preview/121418 Students will complete an investigation which will allow them to use the Simpson's diversity index formula to evaluate and compare biodiversity around their school campus. Students will draw conclusions based on their data set.
- CK12 6.24-6.27: https://flexbooks.ck12.org/cbook/ck-12-biology-flexbook-2.0/section/6.24/primary/lesson/biodiversity-bio biodiversity, importance of biodiversity, mass extinction, resources
- The Biology of Interactions: https://earthref.org/SCC/lessons/2010/ecology/ This is a 2-week unit on Ecology, in which students will be introduced to the interaction and interdependence between organisms and the environment. In exploring ecosystems they will learn about Earth's basic biomes, the abiotic and biotic factors that make up different ecosystems, and how these factors interact with living organisms in the classroom. This unit will introduce biodiversity and population dynamics within ecosystems and how they are important in structuring an ecosystem through food webs and trophic interactions. Students will investigate the biodiversity of invertebrates and microorganisms from a nearby offshore ocean ecosystem. Finally, students will build ecosystems in jars that they must balance to keep alive.
- Biodiversity and Conservation Lesson Plan: https://earthref.org/SCC/lessons/2010/biodiversity/ This 5-day unit covers topics in biodiversity, biogeography, and conservation biology. Students will gain knowledge by using computer skill-exercises, collaborative learning, hands-on laboratory activities, current research, and group debates. Students will learn about specific topics such as why biodiversity is important and why conserving biodiversity and biogeography is so essential to preserving the environment. To strengthen the students' understanding of the material additional topics in biodiversity, Earth's major biomes and their importance, the effects of historical and modern fishing techniques, and the importance of conservation and difficulties of managing natural resources. As a final objective students will work in groups. Students will then use the information learned in a group activity and debate to determine the "value" of organisms and have a debate about which are the most important to us and why.

Sample Assessments:

- Explain advantages and disadvantages of a conservation plan for an endangered species.
- Explain how evolution relies on natural selection.
- Describe some human impacts on the lithosphere and explain some possible consequences.
- Explain the effects weather patterns can have on biodiversity.
- Explain how factors such as schools, neighborhoods, shopping centers, industry, farming may infringe upon the health of the water sources.
- Explain the climate of different biomes.

- Discuss the process of biomagnification and the ramifications if a primary consumer or a producer is removed or too many consumers or producers are introduced.
- Identify invasive species in the community and describe their impacts on the local food web.
- List the requirements for listing a species as a species of concern, threatened or endangered on the state or federal level.
- Explain the effect climate change has had on a specific living or extinct species.
- Identify areas where urban sprawl has impacted plant, wildlife and human communities. Describe the effects on biodiversity.

| Instructional Resources |
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| https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources (labs, activities, intervententions, extensions, supplements, case studies, videos, websites, text chapters)<br>https://drive.google.com/drive/folders/1EZC4MKEJP5SEoeHBeywxzB9K_Mdv9P7v?usp=sharing - Environmental Science Resources |

## Unit 3: Population

| Standards / Clear Learning Targets | | |
|---|---|---|
| **Standards**<br>ER.1 Energy resources<br>GP.1 Human population | **Essential Understanding**<br>– The world population is growing by approximately 74 million people per year. Population growth is not evenly distributed across the globe. Scientists are yet to conclusively determine the human 'carrying capacity' of Earth. Population is only one of many factors influencing the environment. We have consumed more resources in the last 50 years than the whole of humanity before us. The 20th century saw the biggest increase in the world's population in human history. https://www.science.org.au/curious/earth-environment/population-environment<br>– Case studies, developing and using models, analyzing data, conducting or researching population studies and methods of connecting to the real world is emphasized for this topic.<br>– Technology can be used for comparative studies to share local data internationally so that specific quantifiable data can be compared and | **Academic Vocabulary**<br>https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf |

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| | used in understanding the impact of some of the environmental problems that exist on a global scale.<br>– Examples of global topics that can be explored include studying the environmental effects of an increasing human population.<br>– Researching contemporary discoveries, new technology and new discoveries can lead to improvement in environmental management.<br><br>**Extended Understanding**<br>– Researching and investigating environmental factors on a global level contributes to the depth of understanding by applying the environmental science concepts to problem solving and design. | |
| **Ultimate Learning Target Type: Knowledge** | **Broad Learning Target:**<br>– The student can understand the trends and changes in the human population and the impact that has on the environment.<br>**Underpinning Knowledge Learning Targets:**<br>– The student can discuss the trends and changes in the human population during the 20th and 21st centuries.<br>– The student can describe interaction of climate, biotic influences to discuss patterns of human habitation.<br>– The student can classify and define developed and developing countries.<br>– The student can evaluate effects of population growth trends on resources (food, energy) and the environment.<br>– The student can describe methods for helping population growth maintain sustainability.<br>**Underpinning Skills/Products Learning Targets:**<br>– The student can evaluate demographics and trends using growth curves, projections, and age structures.<br>**Underpinning Reasoning Learning Targets:**<br>– The student can reason how global human population patterns and changes relate to environmental events or cycles. | |
| **(Prior Knowledge)** | | **(Future Knowledge)** |

| Content Elaborations |
|---|
| http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US<br>Ohio Department of Education Learning Standards for Science |

Scroll to page:
ER.1: 295-296
GP.1: 300

## Instructional Strategies

http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US
Ohio Department of Education Learning Standards for Science
Scroll to page 289 to find The Nature of Science strategies.
Scroll to find the Model Curriculum examples on pages:
ER.1: 297
GP.1: 301

## Sample Assessments and Performance Tasks

https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources

Sample Lessons:

- Duckweed Lab: https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8592&dataid=9748&FileName=ducky%20lab.pdf
- Population and Population Density: https://www.cpalms.org/Public/PreviewResourceLesson/Preview/133402 This an introductory population density and distribution lesson for one class period. https://www.youtube.com/watch?v=s9dFy6xBOBM (video)
- Population Dynamics: https://www.cpalms.org/Public/PreviewResourceUpload/Preview/28486 This 7E lesson plan is broken down into 3 lessons used to teach high school students in grades 9-12 about the characteristics used to describe populations. There are inquiry based and project based inquiry activities incorporated within the lesson. Students will also learn the difference between exponential and logistic growth by doing hands -on activities. A PowerPoint is used to guide the activities, and learning.
- The Game of Population Changes: https://www.cpalms.org/Public/PreviewResourceLesson/Preview/152046 This lesson plan uses multicolor paper dots to model how events change a bird population over time.
- The Human Population Growth Rate Lesson: https://www.cpalms.org/ExportTemplates/Export.aspx?url=/Public/PreviewResource/PrintResource/?id=48758&IsAuthenticated=False&display=block&Private=true&ProtectedUser=true&type=Resource&providerUserKey=00000000-0000-0000-0000-000000000000 The students will understand that some factors are more responsible than others for the population growth rate in different countries. They will also interpret that the graph gives information to be used to make mathematical calculations. Students will develop an understanding of how population growth can positively or negatively impact the economy of a country.
- CK12 Population Lessons: 6.17-6.23 https://flexbooks.ck12.org/cbook/ck-12-biology-flexbook-2.0/section/6.17/primary/lesson/population-size-density-and-distribution-bio

Sample Assessments:

- Compare developing and developed countries, identifying the factors that separate the two types of countries.
- Describe how climate and biotic influences can affect human habitation.
- Evaluate demographics and trends given growth curves, projections, and age structures.
- Discuss how population growth affects food and energy resources. How does it affect the environment?
- Describe different methods to sustain human population growth.

**Instructional Resources**

https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources (labs, activities, intervententions, extensions, supplements, case studies, videos, websites, text chapters)

https://drive.google.com/drive/folders/1EZC4MKEJP5SEoeHBeywxzB9K_Mdv9P7v?usp=sharing - Environmental Science Resources

## Unit 4: Climate, Hydrosphere, Atmosphere

**Standards / Clear Learning Targets**

**Standards**

ES.2 Atmosphere
- Atmospheric properties and currents

ES.4 Hydrosphere
- Oceanic currents and patterns as they relate to climate

ES.5 Movement of matter and energy through the hydrosphere, lithosphere, atmosphere and biosphere

ER.2 Air and air pollution
- Primary and secondary contaminants
- Greenhouse gases
- Clean Air Act

GP:3 Climate change

GP:6 Air quality

**Essential Understanding**

- In this course, the focus is on the connections and interactions between Earth's spheres (the hydrosphere, atmosphere, biosphere and lithosphere).
- Both natural and anthropogenic interactions are studied. This includes an understanding of causes and effects of climate, global climate (including El Niño/La Niña patterns and trends) and changes in climate through Earth's history, geologic events (e.g., volcanic activity or mass wasting) that impact Earth's spheres, biogeochemical cycles and patterns, the effect of abiotic and biotic factors within an ecosystem, and the understanding that each of Earth's spheres is part of the dynamic Earth system.
- Groundwater and surface water velocities and patterns are included as the movement of water (either at the surface, in the atmosphere or beneath the surface) can be a mode of transmission of contamination.
- The connections and interactions of energy and matter between Earth's spheres are researched and investigated using actual data.
- The emphasis is on the interconnectedness of Earth's spheres and the understanding of the complex relationships between them, including both abiotic and biotic factors. One event, such as a petroleum release or a flood, can impact each sphere. Some impacts are long-term, others are short-term and most are a combination of both long- and short-term.
- It is important to use real, quantifiable data to study the interactions, patterns and cycles among Earth's spheres.
- Researching and investigating environmental factors on a global level contributes to the depth of understanding by applying the environmental science concepts to problem solving and design. Examples of global topics that can be explored include investigating climate change data. Researching contemporary discoveries, new technology and new discoveries can lead to improvement in environmental management.

**Extended Understanding**

- To understand the effects that certain contaminants may have on the environment, scientific investigations and research should be conducted on a local, national and global level. Water, air, land and biotic field and

**Academic Vocabulary**

https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf

| | | |
|---|---|---|
| | lab sampling/testing equipment and methods are utilized with real-world application. Quantifiable field and/or lab data are used to analyze and draw conclusions regarding air, water or land quality.<br>– Relating Earth's resources to a global scale and using technology to collect global resource data for comparative classroom study is recommended. In addition, it is important to connect the industry and the scientific community to the classroom to increase the depth of understanding. Critical thinking and problem-solving skills are important in evaluating resource use, management and conservation. New discoveries and research are important parts of this topic. | |
| **Ultimate Learning Target Type: Knowledge** | **Broad Learning Target:**<br>– The student can understand the interconnectedness of Earth's spheres and the complex relationships between them.<br>**Underpinning Knowledge Learning Targets:**<br>– The student can describe major characteristics for the atmosphere (layers, composition, meteorological events) and hydrosphere (weather, cryosphere).<br>– The student can describe the mechanisms that cause land and sea breezes.<br>– The student can evaluate the differences and similarities between la nina and el nino.<br>– The student can describe how external influences (e.g. moon phases and seasonal solar radiation) can affect mass and energy changes occurring in various weather patterns.<br>– The student can describe how climate affects biosphere, hydrosphere and lithosphere.<br>– The student can describe causes and effects of climate changes.<br>– The student can detail and analyze sources of air and water contamination and pollution, both primary and secondary.<br>– The student can compare and contrast the effects of greenhouse gases and ozone depleting gases.<br>– The student can explain the impact of rising CO2 levels on the oceans (rising sea levels, acidification).<br>**Underpinning Skills/Products Learning Targets:**<br>– The student can trace the movement of energy within and among the hydrosphere and atmosphere.<br>– The student can analyze the costs and benefits of proposed solutions for slowing climate change.<br><br>**Underpinning Reasoning Learning Targets:**<br>– The student can reason how different biotic and abiotic factors impact climate and climatic trends. | |
| **Middle School (Prior Knowledge)** | | **(Future Knowledge)** |

| | |
|---|---|
| geologic processes, biogeochemical cycles, climate, the composition and properties of the atmosphere, lithosphere and hydrosphere (including the hydrologic cycle)<br><br>**Physical Science and Biology (Prior Knowledge)**<br><br>energy transfer and transformation, conservation of energy and matter, evolution, adaptation, biodiversity, population studies and ecosystem composition and dynamics | |

## Content Elaborations

http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US
Ohio Department of Education Learning Standards for Science
Scroll to page:
ES.2, 4, 5: 290
ER.2: 295-296
GP.3, 6: 300

## Instructional Strategies

http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US
Ohio Department of Education Learning Standards for Science
Scroll to page 289 to find The Nature of Science strategies.
Scroll to find the Model Curriculum examples on pages:
ES.2: 292
ES.4: 293
ES.5: 294
ER.2: 297
GP.3: 303
GP.6: 305

## Sample Assessments and Performance Tasks

https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources

Sample Lessons:

- Effects of Earth's Surface Features on Climate: https://www.cpalms.org/Public/PreviewResourceLesson/Preview/72246 In this lesson, students will investigate the ability of water to retain its temperature, and explain how the proximity of an area to an ocean or lake will contribute to the climate of an area. Students will measure the temperature of three beakers; one empty, one with water, and one with sand to determine how quickly their temperatures will change over specific time period.
- The Role of Oceans in Climate Change:https://www.cpalms.org/Public/PreviewResourceLesson/Preview/71508 Students will use multiple hands-on activities, videos, and text resources to evaluate the ocean's influence on global climate change.
- Climate Change Calamity: The Arctic Ecosystem: https://www.cpalms.org/Public/PreviewResourceLesson/Preview/128821 This resource includes a 5E lesson plan, a PowerPoint presentation on climate change, an interactive game, a student worksheet, and an engaging video link on the Arctic ecosystem.
- Sea Turtle Sex and Climate Change: https://www.cpalms.org/Public/PreviewResourceLesson/Preview/75527 In this lesson students will examine how changes in an ecosystem result from environmental factors specifically demonstrating the consequences of climate change on sea turtles. The lesson is in four parts: 1) a fact finding/research component; 2) a group discussion and student presentation; 3) a multimedia component; and 4) a laboratory activity.
- The Link between Temperature and Carbon Dioxide: https://archive.epa.gov/climatechange/kids/documents/temp-and-co2.pdf
- Carbon through the Seasons: https://archive.epa.gov/climatechange/kids/documents/carbon-through-the-seasons.pdf
- A Hole in the Ozone: https://www.cpalms.org/Public/PreviewResourceLesson/Preview/154901
- Model Greenhouse: https://www.teachengineering.org/activities/view/cub_housing_lesson03_activity2 Students learn about the advantages and disadvantages of the greenhouse effect. They construct their own miniature greenhouses and explore how their designs take advantage of heat transfer processes to create controlled environments. They record and graph measurements, comparing the greenhouse indoor and outdoor temperatures over time. Students are also introduced to global issues such as greenhouse gas emissions and their relationship to global warming.
- CK12: Carbon Cycle 6.6: https://flexbooks.ck12.org/cbook/ck-12-biology-flexbook-2.0/section/6.6/primary/lesson/carbon-cycle-bio
- CK12: Air Pollution and Global Warming 6.29-30: https://flexbooks.ck12.org/cbook/ck-12-biology-flexbook-2.0/section/6.29/primary/lesson/air-pollution-bio
- Chemistry Shorts video and lesson on Climate Change: https://www.youtube.com/watch?v=Tj32UYGrbas&feature=youtu.be (video) https://docs.google.com/presentation/d/1EnZqRCC1P8IjVuzdhLnmEbRkyqhmZn4EchH5GiyFDMw/edit#slide=id.g8b7d950b8e_0_73 (lesson plan)

Sample Assessments:

- What are the layers of the Earth's atmosphere, complete with description and chemical composition?
- What are the differences between climate and weather?
- How does energy move between the hydrosphere and atmosphere?
- Describe what influences weather patterns.
- Explain the causes and effects of climate change.

- Define the difference between primary and secondary sources of air and water pollution.
- Compare the effects of greenhouse gases and ozone-depleting gases.
- Explain how rising $CO_2$ levels are affecting the oceans.
- Explain the correlation between historical carbon dioxide concentration data and historical global temperature data.
- Identify indoor pollutants and their sources. Explain their impacts.
- Illustrate the process of how acid rain is created and describe its effects on each component of the environment.

| Instructional Resources |
|---|
| https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources (labs, activities, intervententions, extensions, supplements, case studies, videos, websites, text chapters) |
| https://drive.google.com/drive/folders/1EZC4MKEJP5SEoeHBeywxzB9K_Mdv9P7v?usp=sharing - Environmental Science Resources |

## Unit 5: Water Resources and Water Pollution

| Standards / Clear Learning Targets | | |
|---|---|---|
| **Standards**<br>ES.4 Hydrosphere<br>• Surface and groundwater flow patterns and movement<br>• Cryosphere<br>ES.5 Movement of matter and energy through the hydrosphere, lithosphere, atmosphere and biosphere<br>ER.3 Water and water pollution<br>• Potable water and water quality<br>• Hypoxia, eutrophication<br>• Clean Water Act<br>• point source and nonpoint source contamination<br>GP.2 Potable water quality, use and availability | **Essential Understanding**<br>– Groundwater and surface water velocities and patterns are included as the movement of water (either at the surface, in the atmosphere or beneath the surface) can be a mode of transmission of contamination. Geomorphology and topography are helpful in determining flow patterns and pathways for contamination.<br>– To understand the effects that certain contaminants may have on the environment, scientific investigations and research should be conducted on a local, national and global level. Water lab sampling/testing equipment and methods are utilized with real-world application. Quantifiable field and/or lab data are used to analyze and draw conclusions regarding water quality.<br>– Examples of types of water-quality testing include: hydraulic conductivity, suspended and dissolved solids, dissolved oxygen, biochemical oxygen demand, temperature, pH, fecal coliform and macro-invertebrate | **Academic Vocabulary**<br>https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf |

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| | studies.<br>– Wetland delineations and analysis are appropriate field study investigations. Comparative analysis of scientific field or lab data should be used to quantify the environmental quality or conditions. Local data can also be compared to national and international data.<br>– Case studies, developing and using models, collecting and analyzing water data, methods of connecting to the real world is emphasized for this topic.<br>– Technology can be used for comparative studies to share local data internationally so that specific quantifiable data can be compared and used in understanding the impact of some of the environmental problems that exist on a global scale.<br>– Researching and investigating environmental factors on a global level contributes to the depth of understanding by applying the environmental science concepts to problem solving and design. Examples of global topics that can be explored include building water filtration models,<br>– Researching contemporary discoveries, new technology and new discoveries can lead to improvement in environmental management.<br><br>**Extended Understanding**<br>– The study of relevant, local problems can be a way to connect the classroom to the real world. Within Ohio, there are numerous environmental topics that can be investigated. Examples include wetland loss or mitigation, surface or groundwater contamination (including sediment, chemical or thermal contamination), watershed management, acid rain, septic system or sewage overflows/failures, landfill seepage, and underground storage tank/pipe releases. | |
| **Ultimate Learning Target Types: Knowledge and Skills/Products** | **Broad Learning Target:**<br>– The student can understand the concepts and impact of the water cycle, potable water, eutrophication, hypoxia, and water pollution sources.<br>**Underpinning Knowledge Learning Targets:**<br>– The student can explain the matter and energy changes that occur during the water cycle.<br>– The student can describe the requirements of "potable" water and changes in its availability.<br>– The student can describe how the lithosphere affects the movement of water and the flow of contaminants. | |

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| | – The student can describe the amounts, locations and sources of fresh water for farming, drinking and washing.<br>– The student can differentiate methods for testing water quality against the requirements for potable water.<br>– The student can explain the processes used to purify water of poor quality, both natural and manmade.<br>**Underpinning Skills/Products Learning Targets:**<br>– The student can model how the lithosphere affects the movement of water and the flow of contaminants.<br>– The student can create a representation of pollutant concentrations on the ppm and ppb levels.<br>– The student can perform water quality testing.<br>**Underpinning Reasoning Learning Targets:**<br>– The student can reason how eutrophication from human-induced factors can lead to hypoxia. |
| **Middle School (Prior Knowledge)**<br>Hydrologic cycle studies | **(Future Knowledge)** |

| Content Elaborations |
|---|
| http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US<br>Ohio Department of Education Learning Standards for Science<br>Scroll to page:<br>ES.4-5: 290<br>ER.3: 295-296<br>GP.2: 300 |
| **Instructional Strategies** |
| http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US<br>Ohio Department of Education Learning Standards for Science<br>Scroll to page 289 to find The Nature of Science strategies.<br>Scroll to find the Model Curriculum examples on pages:<br>ES.4: 293<br>ES.5: 294<br>ER.3: 298 |

GP.2: 301

**Sample Assessments and Performance Tasks**

https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources

Sample Lessons:

- Got Water?: https://www.cpalms.org/Public/PreviewResourceLesson/Preview/128761 Students will be learning about natural resources and the human impact on them. Specifically, students will discover where local water sources are and how much water is available within the community using research skills. Students will also design experiments to collect data and discover how residents of the community are using the water and how much they are using. Lastly, they will take the information they discover and the data they collect to hypothesize what the local human impact will be on the water source.
- Water Related Education Materials from The Water Project: https://thewaterproject.org/community/student-resources/water-related-education-materials-for-high-school/
- Understanding Our Water Footprint Lessons: https://www.watercalculator.org/resource/high-school-lessons/ Three free, downloadable lessons encourage students to explore how their food choices and shopping habits have a larger impact on their daily water consumption than they may realize
- Water Pollution Lesson Plans: https://extension.usu.edu/waterquality/educator-resources/lessonplans/wp Water shed models; Pave it or plant it; Groundwater model; Watershed detectives
- Water Sustainability Lesson: https://cgs.la.psu.edu/teaching-resources/k-12-resources-1/cgs-k-12-curricular-materials/high-school-level-8-12/water-sustainability-lesson
- Watershed Balance: https://www.teachengineering.org/lessons/view/cub_watershed_lesson01 First, they learn about the concept of a watershed and why it is important in the context of engineering hydrology. Then they learn how we can use the theory of conservation of mass to estimate the amount of water that enters a watershed (precipitation, groundwater flowing in) and exits a watershed (evaporation, runoff, groundwater out). Finally, students learn about runoff and how we visualize runoff in the form of hydrographs.
- Benthic Bugs Lab: https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8594&dataid=9761&FileName=Copy%20of%20benthic%20bugs.pdf
- CK12 Soil and Water 6.28: https://flexbooks.ck12.org/cbook/ck-12-biology-flexbook-2.0/section/6.28/primary/lesson/soil-and-water-resources-bio/

Sample Assessments:

- Represent the water cycle. Explain how matter and energy are transferred in the water cycle.
- Identify a local water source and its proximity to a school, neighborhood, shopping center, industry, agriculture, etc. and indicate how those developments may infringe upon the health of the water source.
- Classify various sources of water (e.g., fresh, salt, ground, surface, glacier). Identify areas of concern for water as a resource for these sources.

- Define potable water.
- Identify the locations of large sources of freshwater in the world and use this to explain why certain populations have little access to clean water.
- Describe the processes used to purify water of poor quality.

| Instructional Resources |
|---|
| https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources (labs, activities, intervententions, extensions, supplements, case studies, videos, websites, text chapters)<br>https://drive.google.com/drive/folders/1EZC4MKEJP5SEoeHBeywxzB9K_Mdv9P7v?usp=sharing - Environmental Science Resources |

**Unit 6: Food, Soil and Pest Management**

| Standards / Clear Learning Targets | | |
|---|---|---|
| **Standards**<br>ER.1 Energy resources<br>ER.4 Soil and land<br>• Land use and land management (including food production, agriculture and zoning)<br>GP.4 Sustainability<br>GP.7 Food production and availability<br>GP.8 Deforestation and loss of biodiversity | **Essential Understanding**<br>– The study of relevant, local problems can be a way to connect the classroom to the real world. Within Ohio, there are numerous environmental topics that can be investigated. Examples include deforestation and soil loss/erosion.<br>– This topic is a culminating section that incorporates the previous topics and applies them to a global or international scale. Case studies, developing and using models, collecting and analyzing soil quality data, methods of connecting to the real world is emphasized for this topic.<br>– Agriculture is a major use of land. Half of the world's habitable land is used for agriculture. The extensive land use has a major impact on the earth's environment as it reduces wilderness and threatens biodiversity. Taken directly from: https://ourworldindata.org/land-use<br>– Reducing the consumption of resource-intensive products and increasing the productivity of land makes it possible to produce food with much smaller inputs and reducing the impact on the environment.<br>– The expansion of agriculture has been one of humanity's largest impacts on the environment. It has transformed habitats and is one of the greatest pressures for biodiversity: of the 28,000 species evaluated to be | **Academic Vocabulary**<br>https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf |

| | | |
|---|---|---|
| | threatened with extinction on the IUCN Red List, agriculture is listed as a threat for 24,000 of them.4 But we also know that we can reduce these impacts – both through dietary changes, by substituting some meat with plant-based alternatives and through technology advances. Crop yields have increased significantly in recent decades, meaning we have spared a lot of land from agricultural production: globally, to produce the same amount of crops as in 1961, we need only 30% of the farmland. Taken directly from: https://ourworldindata.org/land-use<br><br>**Extended Understanding**<br>– Researching and investigating environmental factors on a global level contributes to the depth of understanding by applying the environmental science concepts to problem solving and design. | |
| **Ultimate Learning Target Types: Knowledge, Skills/Products and Reasoning** | **Broad Learning Target:**<br>– The student can understand land usage for agriculture and human habitation and the impact on habitable lands.<br>**Underpinning Knowledge Learning Targets:**<br>– The student can discuss requirements for land to be suitable for farming and human habitation.<br>– The student can describe the processes leading to loss of habitable lands including erosion and desertification<br>– The student can describe significant improvements to agriculture and food processing throughout history.<br>**Underpinning Skills/Products Learning Targets:**<br>– The student can determine the fractions of earth's land masses that are used for farming and human habitation.<br>– The student can classify types of agriculture and food production.<br>**Underpinning Reasoning Learning Targets:**<br>– The student can evaluate the positive and negative impacts of fertilizers and pesticides.<br>– The student can assess the impact of agricultural runoff on lakes and rivers.<br>– The student can predict future food production needs and potential ways for meeting those needs. | |
| **Middle School (Prior Knowledge)** | | **(Future Knowledge)** |

## Content Elaborations

http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US
Ohio Department of Education Learning Standards for Science
Scroll to page:
ER.1, 4: 295-296
GP.4, 7, 8: 300

## Instructional Strategies

http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US
Ohio Department of Education Learning Standards for Science
Scroll to page 289 to find The Nature of Science strategies.
Scroll to find the Model Curriculum examples on pages:
ER.1: 297
ER.4: 299
GP.4: 303
GP.7: 305
GP.8: 306

## Sample Assessments and Performance Tasks

https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources

Sample Lessons:

- Agricultural Land Use: https://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=82 Students explore the impact of fertilizer on algae growth, soil erosion, and agricultural soil and water conservation practices.
- Fertilizers and the Environment: https://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=238 Students will recognize that fertile soil is a limited resource, describe the role fertilizer plays in increasing food productivity, distinguish between organic and commercial fertilizers, describe how excess nutrients are harmful to the environment, and identify different sources of nutrient pollution.
- Investigating the pH of Soils: https://www.cpalms.org/Public/PreviewResourceLesson/Preview/36341 In this activity students will conduct research then test the effects of adding products to soil. Students will learn about soil pH, what factors affect the pH of soil and how important it is to the growth of plants.
- How to Fight Desertification and Reverse Climate Change Ted Talk: https://www.agclassroom.org/me/matrix/resources.cfm?rid=488&search_term_cr=desertification
- CK12 Soil and Water 6.28: https://flexbooks.ck12.org/cbook/ck-12-biology-flexbook-2.0/section/6.28/primary/lesson/soil-and-water-resources-bio

- Human Impact: Desertification Tutorial: https://www.cpalms.org/Public/PreviewResourceStudentTutorial/Preview/174850

Sample Assessments:

- Identify at least two examples of modern desertification. Choose one in the United States and one in another country. Explain how this occurred.
- Discuss advantages and disadvantages of Genetically Modified Organisms.
- Construct an energy pyramid (with a human at the top) and use data to defend or oppose the position that eating lower on the food chain is better for the environment.
- Explain what food deserts are and recommend solutions.
- Identify areas where urban sprawl has impacted plant, wildlife and human communities. Describe the effects on biodiversity.
- Explain the rationale and methods to reduce the deer population in an Ohio community.
- Differentiate various tree harvesting practices (e.g., clear cutting, seed tree cutting, selective cutting, slash & burn). Include a description of economic and ecological advantages and disadvantages of each.

**Instructional Resources**

https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources (labs, activities, intervententions, extensions, supplements, case studies, videos, websites, text chapters)

https://drive.google.com/drive/folders/1EZC4MKEJP5SEoeHBeywxzB9K_Mdv9P7v?usp=sharing - Environmental Science Resources

**Unit 7: Geology, Mineral and Energy**

| Standards / Clear Learning Targets | | |
|---|---|---|
| **Standards**<br>ES.3 Lithosphere<br>● Geologic events and processes<br>ES.5 Movement of matter and energy through the hydrosphere, lithosphere, atmosphere and biosphere<br>ER.1 Energy Resources<br>● Renewable and nonrenewable energy sources and efficiency<br>● Alternate energy sources and efficiency<br>● Resource availability<br>● Mining and resource extraction<br>ER.4 Soil and land<br>● Mass movement and erosion<br>● Sediment contamination | **Essential Understanding**<br>– The connections and interactions of energy and matter between Earth's spheres are researched and investigated using actual data. It is important to use real, quantifiable data.<br>– Both natural and anthropogenic interactions are studied. This includes an understanding of causes and effects of geologic events (e.g., volcanic activity or mass wasting) that impact Earth's spheres, and biogeochemical cycles and patterns.<br>– Renewable and nonrenewable energy resources topics investigate the effectiveness, risk and efficiency for differing types of energy resources at a local, state, national and global level.<br>– Nuclear and geothermal energy are included in this topic.<br>– Feasibility, availability, remediation and environmental cost are included in the extraction, storage, use and disposal of both abiotic and biotic resources. Environmental impact is evaluated as it pertains to both environmental and human risks. Examples include chemical hazards, radiation, biological hazards, toxicology and risk analysis studies.<br><br>**Extended Understanding**<br>– Relating Earth's resources to a global scale and using technology to collect global resource data for comparative classroom study is recommended. In addition, it is important to connect the industry and the scientific community to the classroom to increase the depth of understanding. Critical thinking and problem-solving skills are important in evaluating resource use, management and conservation. New discoveries and research are important parts of this topic. | **Academic Vocabulary**<br>https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf |
| **Ultimate Learning Target Type: Knowledge** | **Broad Learning Targets:**<br>– The student can understand the structure of the lithosphere, its patterns and cycles, nonrenewable resources, alternatives to fossil fuels and energy transformation.<br>**Underpinning Knowledge Learning Targets:**<br>– The student can define major characteristics for each of the lithosphere (geologic structure, events and processes).<br>– The student can compare geological events and processes and how the tectonic plates are involved. | |

- The student can list geochemical cycles and the factors that affect them and analyze how these have an overall effect on the global environment.
- The student can explain how geologic events impact earth's systems (biogeochemical cycles).
- The student can define mass and energy cycles during the formation, extraction, refining and utilization of fossil fuels.
- The student can detail the environmental impact of extracting, storing, using and refining nonrenewable resources.
- The student can compare and contrast alternatives to fossil fuels, such as biofuels.
- The student can describe the energy transformation that occur during the generation of electricity from:
  - fossil fuels (coal, natural gas, petroleum),
  - nuclear
  - hydro-electric,
  - wind, and ocean waves
  - solar photovoltaic
  - fuel cells

**Underpinning Skills/Products Learning Targets:**

-

**Underpinning Reasoning Learning Targets:**

- The student can draw conclusions about how the usage and dependency on fossil fuels has impacted the earth's systems.

**Middle School (Prior Knowledge)**

Geologic processes, biogeochemical cycles, climate, the composition and properties of the atmosphere, lithosphere and hydrosphere (including the hydrologic cycle); energy and Earth's resources

**Physical Science and Biology (Prior Knowledge)**

Energy transfer and transformation, conservation of energy and matter, evolution, adaptation, biodiversity, population studies and ecosystem composition and dynamics; chemistry and energy

**(Future Knowledge)**

## Content Elaborations

http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US
Ohio Department of Education Learning Standards for Science
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ES.3, 5: 290
ER.1, 4: 295-296

## Instructional Strategies

http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US
Ohio Department of Education Learning Standards for Science
Scroll to page 289 to find The Nature of Science strategies.
Scroll to find the Model Curriculum examples on pages:
ES.3: 292
ES.5: 294
ER.1: 297
ER.4: 299

## Sample Assessments and Performance Tasks

https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources

Sample Lessons:

- Cookie Mining: https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8596&dataid=9771&FileName=CoalMiningReading.pdf and https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8596&dataid=9770&FileName=CookieMining.pdf
- Going Green: https://www.cpalms.org/Public/PreviewResourceLesson/Preview/75983 This lesson will build student awareness of renewable and non-renewable resources using a combination of discussion, a group simulation activity, and a group research project and presentation.
- Biomass Energy and Algae Biofuels: https://earthref.org/SCC/lessons/2010/biomass/
- Nuclear Energy through a Virtual Field Trip: https://www.teachengineering.org/lessons/view/ncs-2026-nuclear-energy-virtual-field-trip
- Electricity Options for Rolling Blackouts and Environmental Impact: https://www.teachengineering.org/activities/view/wpi_rolling_blackouts
- Biogeochemical Cycles: https://www.cpalms.org/ExportTemplates/Export.aspx?url=/Public/PreviewResource/PrintResource/?id=130004&IsAuthenticated=False&display=block&Private=true&ProtectedUser=true&type=Resource&providerUserKey=00000000-0000-0000-0000-000000000000
- CK12 Resources 6.27: https://flexbooks.ck12.org/cbook/ck-12-biology-flexbook-2.0/section/6.27/primary/lesson/renewable-and-nonrenewable-resources-bio

Sample Assessments:

- Build a model of the layers of the Earth in order to identify and describe the components and their role in geologic events.
- Identify the primary resources used in your community for energy. Explain and compare the sources.
- Discuss the pros and cons of a widely used energy source (e.g., nuclear, oil, gas, wind, solar).
- Describe how tectonic plates are involved in different geologic events and processes.
- Define mass and energy cycles during the formation, extraction, refining and utilization of fossil fuels.
- Describe different nonrenewable resources. Discuss the environmental impact of extracting, storing, using and refining those nonrenewable resources.
- Describe alternatives to fossil fuels and discuss their pros and cons.

| Instructional Resources |
|---|
| https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources (labs, activities, intervententions, extensions, supplements, case studies, videos, websites, text chapters) |
| https://drive.google.com/drive/folders/1EZC4MKEJP5SEoeHBeywxzB9K_Mdv9P7v?usp=sharing - Environmental Science Resources |

## Unit 8: Waste Management

| Standards / Clear Learning Targets | | |
|---|---|---|
| **Standards**<br>ER.4 Soil and land<br>• Sediment contamination<br>• Land use and land management<br>• Solid and hazardous waste<br>GP.9 Waste management (solid and hazardous) | **Essential Understanding**<br>– This topic explores the contamination problems, remediation techniques and the storage/disposal of the resources or by-products.<br>– To understand the effects that certain contaminants may have on the environment, scientific investigations and research should be conducted on a local, national and global level. Water, air, land and biotic field and lab sampling/testing equipment and methods are utilized with real-world application. Quantifiable field and/or lab data are used to analyze and draw conclusions regarding air, water or land quality.<br>– The study of relevant, local problems can be a way to connect the classroom to the real world. Within Ohio, there are numerous environmental topics that can be investigated. Examples include surface or groundwater contamination (including sediment, chemical or thermal | **Academic Vocabulary** |

| | | |
|---|---|---|
| | contamination), landfill seepage, underground storage tank/pipe releases, or acid mine drainage.<br>– Feasibility, availability, remediation and environmental cost are included.<br>– Environmental impact is evaluated as it pertains to both environmental and human risks. Examples include chemical hazards, radiation, biological hazards, toxicology and risk analysis studies.<br>– This topic is a section that incorporates the previous topics and applies them to a global or international scale. Case studies, developing and using models, collecting and analyzing water and/or air quality data, conducting or researching population studies and methods of connecting to the real world is emphasized for this topic.<br>– Technology can be used for comparative studies to share local data internationally so that specific quantifiable data can be compared and used in understanding the impact of some of the environmental problems that exist on a global scale.<br>– Researching and investigating environmental factors on a global level contributes to the depth of understanding by applying the environmental science concepts to problem solving and design.<br><br>**Extended Understanding**<br>– Comparative analysis of scientific field or lab data should be used to quantify the environmental quality or conditions. Local data can also be compared to national and international data. | |
| **Ultimate Learning Target Types: Knowledge and Skills/Products** | **Broad Learning Target:**<br>– The student can understand the management of waste on a global level.<br>**Underpinning Knowledge Learning Targets:**<br>– The student can list the kinds of solid waste humans produce.<br>– The student can assess the sustainability of various methods of trash disposal (landfills, trash-to-steam, recycling, etc.).<br>– The student can discuss efforts to reduce the amounts of solid wastes by manufacturers and consumers.<br>**Underpinning Skills/Products Learning Targets:**<br>–<br>**Underpinning Reasoning Learning Targets:**<br>– | |

| (Prior Knowledge) | (Future Knowledge) |
|---|---|

## Content Elaborations

http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US
Ohio Department of Education Learning Standards for Science
Scroll to page:
ER.4: 295-296
GP.9: 300

## Instructional Strategies

http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Science/Ohios-Learning-Standards-and-MC/SciFinalStandardsMC060719.pdf.aspx?lang=en-US
Ohio Department of Education Learning Standards for Science
Scroll to page 289 to find The Nature of Science strategies.
Scroll to find the Model Curriculum examples on pages:
ES.4: 293
GP.9: 307

## Sample Assessments and Performance Tasks

https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources

Sample Lessons:

- Build a Landfill Model: http://www.wakegov.com/recycling/recycle/ftb/Documents/Lesson%20Plans/STL_LFModel_Re.pdf elementary activity; modify for high school level; see landfill article for help: https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8597&dataid=9783&FileName=Copy%20of%20Landfill%20101.pdf
- Waste Management Activity: http://www.spacegrant.hawaii.edu/class_acts/Waste.html To design and build a model waste management system for a human settlement on the Moon.
- Buy, Use, Toss: https://peacelearner.files.wordpress.com/2012/10/buy-use-toss-complete-unit.pdf Use applicable activities and lessons

Sample Assessments:

- Given a list of waste materials, determine if they are recyclable or non recyclable. Justify your reasoning.
- Describe the benefits and challenges of recycling.
- Draw a diagram of a modern landfill and label the various components that are required or used in landfills today to prevent them from polluting the

air and water.
- Discuss methods to reduce solid waste from consumers and manufacturers.

| Instructional Resources |
| --- |
| https://www.ccsoh.us/site/handlers/filedownload.ashx?moduleinstanceid=8588&dataid=12607&FileName=Environmental%20Pacing%20Guide.pdf - Environmental Science Pacing Guide Resources (labs, activities, intervententions, extensions, supplements, case studies, videos, websites, text chapters) |
| https://drive.google.com/drive/folders/1EZC4MKEJP5SEoeHBeywxzB9K_Mdv9P7v?usp=sharing - Environmental Science Resources |