Welcome to Q?rius
• Field Trip Logistics
  • Getting the Most from Q?rius
  • Class Overview
  • Connections to Curriculum Standards

Field Trip Guide
School Program: Reefs Unleashed

Part lab, part collections vault, part DIY garage, part hangout, and all fun.
Q?rius – Unlock your world.
qrius.si.edu
Welcome to Q?rius

Welcome to a New Kind of Field Trip

Thank you for choosing Q?rius at the Smithsonian’s National Museum of Natural History as your field trip destination! We think of Q?rius as both a place and an experience. We are excited to offer your students the chance to explore science, nature, and culture in a whole new way while supporting your curriculum needs.

We share your passion for learning! We have designed this Q?rius field trip to stimulate your students’ curiosity and to inspire them to better understand the world and their place in it.

The Q?rius Learning Lab

Q?rius is a first-of-its-kind interactive and experimental environment - part lab, part collections vault, part DIY garage, part hangout, and all fun and inspiring. We call it Q?rius because it is designed to inspire curiosity in a whole new way in the next generation of scientists and science-minded citizens. It is an exhibit-sized interactive space filled with resources that are available only to your students at the world’s largest natural history museum. The lab includes:

• A collection of 6,000 objects – fossils, bones, insects, cultural artifacts, pressed plants, and more – all accessible for investigations, carefully selected to support learning goals connected to curriculum for your specific class experience
• A suite of digital tools, including videos, virtual objects, and references to maximize learning from objects and link objects to core science ideas and the people who study them
• Scientific tools integrated with all school experiences
• Student materials based on scientists’ field books to guide the Q?rius experience

The Q?rius Approach

All classes and self-guided experiences:
• Feature the work and amazing discoveries of Smithsonian scientists
• Link real-world research of Smithsonian scientists to curriculum standards for a unique approach to inspiring your students
• Use inquiry-based, team-oriented approaches to key questions similar to those addressed by Smithsonian scientists
• Reflect the input of teens and teachers with whom we partnered so that we could guarantee program appeal for students and relevance for teachers
• Integrate objects, data, scientific equipment, and digital assets to investigate core ideas

Questions? Please feel free to contact us at (202) 633-4039 or NMNHSchoolPrograms@si.edu.
FIELD TRIP LOGISTICS

We look forward to your visit to Q?rius. The logistical information provided below will help you prepare for your visit and ensure a smooth arrival. Please see page 9 for information on introducing your students to field trip content.

| GETTING READY | ADDRESS: 10th Street NW and Constitution Avenue NW, Washington, DC 20013
|               | HOURS: School groups can enter the Museum anytime after 10:00 a.m.
|               | ENTRANCES: The best entrance for school groups is at 10th Street and Constitution Ave., NW, which is also the accessible entrance. You also may choose to enter through the main doors on the National Mall.
|               | CLOSEST METRO STATIONS: Federal Triangle or Smithsonian on the Blue or Orange Lines. Archives-Navy on the Green or Yellow Lines.
|               | BUS DROP-OFF LANE: Beginning at 9:30 a.m., Monday-Friday, the curb lane of Constitution Avenue adjacent to the Museum is reserved for school bus drop-off.
|               | STUDENT PICK-UP LANE FOR BUSES: Please board buses on Madison Drive NW (the Museum exit on the Mall side).
|               | SECURITY: For the safety of your students, all bags will be inspected upon entry to the Museum. We encourage students to leave their backpacks/bags on the bus or at school to speed up the entry process.

| RESTROOMS AND LUNCH | RESTROOMS: Restrooms are located near Q?rius on the Ground floor in the Constitution Avenue Lobby and also on the First floor, just off the Sant Ocean Hall.
|                     | LUNCH: The Atrium Café is open to groups and individuals who purchase their lunch at the Museum. If your students bring their own lunches, they are welcome to eat outside the Museum on the National Mall.

| CHAPERONES | To guarantee the best learning experience, we require 1 chaperone for every 10 students in grades 6-8 and 1 chaperone for every 15 students in grades 9-12.
|            | Please share the Chaperone Guide and lesson plans with your chaperones in advance so that they will be fully prepared to accompany and guide students in their learning.
An Invitation to Experience Science

This School Program will engage your students in an immersive 60-minute program led by an experienced Museum Educator. Students will use objects, data, scientific equipment, and digital assets to investigate core ideas of natural history science and to gain skills in the practices of science. Students will complete a series of activities, document their results, and discuss their conclusions with each other and with the class.

In School: Starting the Experience

• Research shows that students who are oriented to the logistics of a field trip typically learn more from their experience than those who are not. Be sure to discuss schedule, lunch plans, restroom availability, and most importantly – your expectations for students before arrival.
• Collaboration and communication are central components of science. You can prepare your students for collaboration by assigning them to teams of 4-6 individuals in advance and asking them to brainstorm ways in which they will work as a team, learn as a team, and achieve consensus.
• Before your visit, go to Q?rius online at qrius.si.edu and check out fun and intriguing virtual self-guided activities and science stories.
• Invite your students to practice their scientific inquiry skills by completing some of our online activities. These activities will introduce them to the types of investigations they will do on their field trip and get them exploring even before they arrive at the Museum!
• Remind students in advance that they will be working with valuable scientific equipment and collections, just like Museum scientists behind the scenes. These are important resources for learning more about the world and our place in it, and we ask that students treat equipment and collections with care and respect, just as our scientists do.

In Q?rius: Behind-the-Scenes Access

• Experienced Museum Educators and volunteers will lead your class. Students also will benefit significantly if their teachers and chaperones actively engage in the program, so please join in, remind them of the directions/instructions provided at each station, and support their learning.
• Just like scientists, students will work together in teams to complete an investigation, using real Museum specimens and sophisticated equipment.
• Equipment and objects are more accessible in Q?rius than anywhere else in the Museum. Students may need gentle reminders to treat objects and equipment carefully while investigating!
• To keep clutter to a minimum, personal items such as backpacks, lunches, and outerwear should be stored away from work tables.
**CLASS OVERVIEW: REEFS UNLEASHED**

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## School Program: Reefs Unleashed

| **CLASS DESCRIPTION** | Imagine being a Smithsonian marine biologist assessing biodiversity in coral reefs and measuring that which can't be seen with the naked eye. This is the challenge that your students will take on. They will be asked to identify species collected with an Autonomous Reef Monitoring Structure (ARMS), calculate the percentage of a species present in the habitat, and simulate DNA processing to contribute to the coral reef census. Students will discuss the need for quantifying biodiversity using non-destructive methods that are standardized, replicable, and applicable for the sake of comparison to other geographic areas. |
| **SUMMARY OF STUDENT EXPERIENCE** | We know that coral reefs are among the most diverse ecosystems on the planet but we don’t know how many species live in these reefs. Because they have so many nooks and crannies, it’s difficult to identify all of the small organisms that live there. In response to this challenge, scientists have developed Autonomous Reef Monitoring Structures (ARMS), a tool for collecting cryptic organisms in a standardized and replicable way. In this program, students will model scientific practices of marine biologists as they study plates from two ARMS units, collected from reefs in two different geographic locations: Bali, Indonesia and Moorea, French Polynesia. In a video presentation, Dr. Nancy Knowlton will set the stage for the students’ research challenge by sharing her thoughts on the relevance of biodiversity studies. Looking at high-resolution images of ARMS plates, students will identify organisms based on morphological features. They then will calculate the percentage covered on each plate by one group of organisms in order to compare differences between the two geographic areas sampled. Students also will simulate DNA processing of tissues taken from the ARMS plates and add their findings to a DNA database. To wrap up, students will participate in a classroom discussion about their experience modeling a real-world marine biology research scenario. They should be able to talk about why it is important to understand the biodiversity of coral reefs, how humans impact the health of oceans, and how new research methods are helping to quantify biodiversity faster than we ever could have imagined. |
| **GRADE RANGE** | Grades 6-12 |
| **DURATION OF PROGRAM** | 60 minutes |

### Scientist Focus

*Reefs Unleashed* gives students first-hand experiences with the skills and practices used by Smithsonian scientists as they try to answer the question, “How many species live in the sea?” The Smithsonian has pioneered investigative research into ocean biodiversity with Autonomous Reef Monitoring Structures, or ARMS. Smithsonian scientists, in collaboration with other institutions, are providing the resources, knowledge, and skills needed to standardize a methodology for sampling the 1.3 billion cubic kilometers of ocean habitat and measure ocean biodiversity.
Your students will be modeling research done by truly world-class scientists! Dr. Nancy Knowlton, the Sant Chair for Marine Science at NMNH, is a lead scientist for the Census of Marine Life, a ten-year global initiative to measure and understand ocean biodiversity. Chris Meyer, Director of the Moorea Biocode Project, studies marine life in spectacular places like the French Polynesian island of Moorea, located in the Pacific Ocean. His work is helping to document marine biodiversity, determine how ecosystems function, and predict how ecosystems respond to change. Allen Collins, curator of Invertebrate Zoology at the Museum and a biologist with the National Oceanographic and Atmospheric Administration, focuses on the amazing biodiversity of relatively simple animals. He studies the evolutionary histories of simple animals like cnidarians (jellyfishes, corals, etc.), placozoans (aka *Trichoplax*), and sponges. He generates and uses evolutionary trees (otherwise known as phylogenetic hypotheses) to better understand how such amazing biodiversity, evident in morphology, life history, and genetics, came to be.

**Goals & Outcomes**

**GOAL**
Students will apply science practices for sampling and cataloging biodiversity in a coral reef system, using tools and techniques that protect the fragile reef ecosystem. Skills and activities include microscopy, identifying species, and adding to a DNA database. By asking questions and analyzing data, students will investigate real-world issues of quantifying biodiversity for future generations.

**STUDENT OBJECTIVES**
In this Investigation students will:
- Identify functional groups of organisms living on an ARMS plate
- Calculate the percentage of plate coverage by one group of organisms
- Compare data collected from reef systems in two geographic locations
- Simulate the analysis of organisms molecularly through DNA barcoding
- Identify and evaluate the evidence needed to understand changes in environmental conditions that may contribute to changes in an ecosystem’s species
- Discuss the importance of biodiversity studies

**STUDENT OUTCOMES**
Students who demonstrate understanding can:
- Use scientific tools to observe
- Recognize patterns and identify/classify coral reef animals
- Analyze information about DNA of organisms
Central Questions and Concepts

- Why is it important to understand the inventory or the biodiversity of a site?
- What roles do DNA and molecular analysis play in biodiversity studies?
- What challenges do scientists face when trying to quantify all living things on land and in the ocean?
- What can Museums do to create awareness and appreciation for biodiversity and generate interest and ideas for sustaining our planet’s biodiversity?

Program Format

ARRIVAL
You can find the entrance to Q?rius from the Constitution Avenue lobby on the Ground Floor of the Museum. If your class begins at 10:15 a.m., please enter the Museum at Constitution Avenue and 10th Street beginning at 10:00 a.m. If you will be exploring the Museum before your Q?rius class, please bring your students to the Constitution Avenue lobby 15 minutes prior to the start of your class. A Museum Educator will meet your group and escort you to a Q?rius classroom.

INTRODUCTION (5 MINUTES)
A Museum Educator will lead your students in a discussion that will introduce the topic of biodiversity and highlight the challenges of designing research projects to inventory our planet’s biodiversity. The educator will focus especially on challenges specific to coral reef systems. Students find out about Autonomous Reef Monitoring Structures (ARMS) as a method for studying reef biodiversity and for revealing especially those tiny organisms that hide in nooks and crannies! In a video presentation, students also will hear from Dr. Nancy Knowlton, who will tell them about the work that ocean scientists do and share her thoughts on the importance of understanding biodiversity. Finally, the Museum Educator will introduce students to their challenge! They will be asked to analyze a plate from two ARMS units collected from reefs in two different geographic areas: Bali, Indonesia and Moorea, French Polynesia.

INVESTIGATION (45 MINUTES)
Working in small teams of 4 - 6 individuals, students will conduct three different surveys of their ARMS plate. They will 1) identify 8 different functional groups of organisms morphologically using microscopes, hand lenses, and a reference guide; 2) calculate the percentage of the plate covered by one of the functional groups in order to compare richness of the Bali and Moorea samples; and 3) simulate DNA processing of tissues taken from the ARMS plates and add their findings to a DNA database. After each survey, the Museum Educator will lead a short discussion about the research method just used, with teams collaborating and sharing their data.

DISCUSSION AND CONCLUSION (10 MINUTES)
Student groups will gather to share insights on their research experience. Engaging students in conversation, the Museum Educator will underscore that the use of ARMS is still a relatively new method for quantifying biodiversity in reef systems and that because of new research methods such as this one, scientists are now inventorying and studying fragile reef systems in ways never before imagined.
Before Your Visit

GRADES 6-8

SCIENTIFIC TERMS
The *Reefs Unleashed* class will use these terms in the context of natural history scientific investigations. Please review the terms with students before arrival.

- Biodiversity
- Classification
- DNA Barcoding
- Coral reef ecosystem

PREPARATION QUESTIONS
1. What are the different ways that scientists can identify biodiversity? What are the limits and benefits of each one?
2. Why is it important to understand biodiversity in different areas of the world, within ecosystems, or by species?

GRADES 9-12

SCIENTIFIC TERMS
The *Reefs Unleashed* class will use these terms in the context of natural history scientific investigations. Please review the terms with students before arrival.

- Biodiversity
- DNA Barcoding
- Taxonomy
- Binomial nomenclature

PREPARATION QUESTIONS
1. What role do Museums play in unlocking the mysteries of the universe and creating understanding?
2. What does it mean to “sustain a biodiverse planet”?
3. What are the different ways that scientists can identify biodiversity? What are the limits and benefits of each one?
4. Why is it important to understand biodiversity in different areas of the world, within ecosystems, or by species?

Related Resources

PERMANENT EXHIBITS AT THE NATIONAL MUSEUM OF NATURAL HISTORY
The *Sant Ocean Hall* is a one-of-a-kind interpretive exhibit that uses marine specimens and models, high definition video experiences, one-of-a-kind exhibits, and the newest technology to reveal the ocean as a global system essential to all life on Earth. Extraordinary in scale, the exhibit presents the global ocean from a cross-disciplinary perspective, highlighting the biological, geological, and anthropological expertise and unparalleled scientific collections of the Museum, as well as ongoing research in marine science.

**SUGGESTED ACTIVITY:** Make use of our Teacher’s Guide, available online, to help your students (grades 4 - 12) formulate their own questions and then search for evidence to answer them when visiting the Sant Ocean Hall. [http://www.mnh.si.edu/education/exhibitions/OH_Educators_Guide.pdf](http://www.mnh.si.edu/education/exhibitions/OH_Educators_Guide.pdf)
**Back in School: Curiosity Continues**

The Q?rius website at qrius.si.edu offers a variety of different follow-up opportunities for your students. Students can conduct an investigation with an online activity, jump into science stories, create a digital field book, complete a natural history badge challenge, or explore science in action.

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<thead>
<tr>
<th>PARTICIPATE IN LIVE WEBCASTS</th>
<th><strong>Smithsonian Science How</strong> delivers real-world science into classrooms through free, interactive, live webcasts and supporting classroom resources. The 25-minute programs feature the research and personalities of the Smithsonian's National Museum of Natural History, providing your students with positive STEM role models, information about science careers and pathways, and connections to current research. Every webcast includes a package of standards-aligned lessons, activities, and other resources that highlight science content and practice.</th>
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<tbody>
<tr>
<td>DO AN ACTIVITY</td>
<td>Are your students predisposed to the super science skill of pattern recognition? In the “Decoding Mars” activity, students can look for geologic features that indicate evidence of water on Mars. Other online activities invite students to measure coral reef diversity in Bali or examine human bones.</td>
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<tr>
<td>JUMP INTO SCIENCE STORIES</td>
<td>Delve into the same topics being explored by Smithsonian scientists, such as volcanoes, genomics, extinction, and human evolution. Read about the cutting-edge work and adventures of Smithsonian scientists, watch videos of them in action, hear them talk about what inspires their curiosity, and manipulate digital objects similar to the ones they use.</td>
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<td>CREATE A DIGITAL FIELDBOOK</td>
<td>Just like a scientist records their observations, students ages 13 and over may record the results from their experiences with Q?rius activities and collections online. Create an account to save objects, stories, images, and notes to a Digital Field Book.</td>
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<td>EARN A NATURAL HISTORY BADGE</td>
<td>Field Book accounts also enable students over age 13 to earn points for their activities online that they can share through their own social media networks. Complete multiple activities online or while exploring Q?rius on subsequent visits, get enough points, and earn a digital badge that you can share through social media.</td>
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<td>EXPLORE SCIENCE IN ACTION</td>
<td>Watch videos of real-life scientists explaining their work, how they got started in their careers, and how they balance and integrate their work, passions, and everyday lives.</td>
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<td>KEEP EXPLORING SCIENCE</td>
<td>Even more Web-based science learning activities can be accessed through the Museum’s main webpages, including a forensic mystery webcomic and interactive maps. Activities cover topics such as the Earth and solar system, human culture and diversity, and life’s diversity.</td>
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RECOMMENDED RESOURCES FROM SMITHSONIAN SCIENTISTS

THE ENCYCLOPEDIA OF LIFE
http://eol.org/
This free, online resource provides information about all life on Earth in text, images, video, sounds, maps, classifications, and more. It is a database with unlimited applications for investigating the living world.

PRESERVING GENOMIC DIVERSITY
http://www.mnh.si.edu/ggi/
http://ggbn.org/
Read about the National Museum of Natural History’s effort to preserve the genomic diversity of life on earth. The data represent the breadth of NMNH collections, including birds, insects, spiders, plants, mammals, worms, amphibians, reptiles, and fish. As existing data are migrated to the museum’s catalog and inventory systems and as new data are digitized, this resource will become even more comprehensive. This effort ties into the Museum’s overall effort, through the Global Genome Initiative http://www.mnh.si.edu/ggi/, to make the genomic collections of Global Genome Biodiversity Network (GGBN) http://ggbn.org/members discoverable for research through the Global Genome Biodiversity Network’s Data Portal.

MEASURING BIODIVERSITY ACROSS NORTH AMERICA
http://www.mnh.si.edu/mna/TeacherResources.cfm
Utilizing web-based resources, this series on measuring biodiversity encourages students to conduct investigations based on their own questioning, develop methodology, collect and analyze data, test hypotheses, and communicate results. Each example given is a model for analysis with step-by-step procedures for investigating categories of questions on biodiversity and the inherent value of the different landscapes of North America.

LESSON PLANS
CORAL REEF INTERACTIVE
http://www.mnh.si.edu/exhibits/ocean_hall/reef_interactive/reef_interactive.html
With this web-based tool, students take on the persona of a local resident, a hotel manager, or a tourist. From these three different vantage points, they weigh the interdependence of the economic and social impact of human activity and the biological needs of a coral reef and its conservation.

OCEAN PORTAL EDUCATORS’ CORNER
HTTP://OCEAN.SI.EDU/FOR-EDUCATORS
The National Museum of Natural History’s Ocean Portal Educators’ Corner provides activities, lesson plans for grades 3 – 12, and educational resources to bring the ocean to life for students. The Portal links to resources from collaborators in order to provide teacher-tested ocean science materials for your classroom.
### CROSSCUTTING CONCEPTS

**Patterns**
- Recognize that macroscopic patterns are related to the nature of microscopic structure
- Use patterns to identify cause and effect relationships

**Scale, Proportion and Quality**
- Observe time, space and energy phenomena in various scales using models

**Structure and Function**
- Analyze complex natural and designed structures to determine how they function

### SCIENCE AND ENGINEERING PRACTICES

**Asking Questions and Defining Problems**
- Specifying relationships between variables, and clarifying arguments and models

### DISCIPLINARY CORE IDEAS

**LS2.A: Interdependent Relationships in Ecosystems.** Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support.

Students who demonstrate understanding can:

**MS-LS2-1.** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

**MS-LS2-2.** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

**MS-ESS3-3.** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
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<th>STANDARDS</th>
<th>GRADES 6-8</th>
<th>GRADES 9-12</th>
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<td><strong>NEXT GENERATION SCIENCE STANDARDS (CONTINUED)</strong></td>
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<tr>
<td><strong>ESS3.C: Human Impacts on Earth Systems</strong></td>
<td>Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things.</td>
<td>Students who demonstrate understanding can:</td>
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<tr>
<td><strong>ETS1.B: Developing Possible Solutions</strong></td>
<td>When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.</td>
<td><strong>HS-LS2-1.</strong> Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.</td>
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<tr>
<td><strong>ESS3.C: Human Impacts on Earth Systems</strong></td>
<td>Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things.</td>
<td><strong>HS-LS2-2.</strong> Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.</td>
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<td>Students who demonstrate understanding can:</td>
<td><strong>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</strong> Moreover, anthropogenic changes (induced by human activity) in the environment can disrupt an ecosystem and threaten the survival of some species.</td>
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<td><strong>MS-ESS3-3.</strong> Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment</td>
<td><strong>LS4.C: Adaptation</strong> Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species.</td>
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<td>Students who demonstrate understanding can:</td>
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<td><strong>HS-LS4-5.</strong> Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.</td>
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<td><strong>NEXT GENERATION SCIENCE STANDARDS (CONTINUED)</strong></td>
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<td><strong>HS-LS4-6.</strong> Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.</td>
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<tr>
<td><strong>LS4.D: Biodiversity and Humans</strong></td>
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<td>Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).</td>
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<td><strong>ETS1.B: Developing Possible Solutions</strong></td>
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<td>When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts</td>
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<tr>
<th>DISTRICT OF COLUMBIA PUBLIC SCHOOLS</th>
<th><strong>SCIENTIFIC INVESTIGATION AND INQUIRY</strong></th>
<th><strong>HIGH SCHOOL BIOLOGY STANDARDS</strong></th>
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<tr>
<td><strong>6.1</strong> Asking questions</td>
<td><strong>9 Biodiversity</strong></td>
<td>Students should understand Biodiversity as the result of genetic changes.</td>
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<tr>
<td><strong>6.7</strong> Draw conclusions</td>
<td><strong>11 Environmental Impact on Evolution</strong></td>
<td>Students should appreciate Evolution as the result of genetic changes that occur in constantly changing environments.</td>
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<tr>
<td><strong>STANDARDS AND LEARNING ACTIVITIES</strong></td>
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<td><strong>B.11.1.</strong> Explain how a large diversity of species increases the chance that at least some living things will survive in the face of large or even catastrophic changes in the environment.</td>
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<tr>
<td><strong>6.1.</strong> Broad Concept: Scientific progress is made by asking relevant questions and conducting careful investigations.</td>
<td><strong>16 Classification of Systems</strong></td>
<td>Students should understand classification in systems.</td>
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<tr>
<td><strong>7.</strong> Draw conclusions based on scientific evidence</td>
<td><strong>18 Stability of Dynamic Systems</strong></td>
<td>Students should understand Stability in ecosystems as a specific example of stability in Systems of dynamic equilibrium.</td>
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<tr>
<td><strong>RESOURCES</strong></td>
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<td><strong>6.6.</strong> Sources of materials differ in amounts, distribution, usefulness, and the time required for their formation.</td>
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<td><strong>3.</strong> Recognize that the Earth’s resources for humans, such as fresh water, air, arable soil, and trees, are finite</td>
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</table>
**STANDARDS** | **GRADES 6-8** | **GRADES 9-12**
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**DISTRICT OF COLUMBIA PUBLIC SCHOOLS (CONTINUED)** | **GRADE 7 STANDARDS AND LEARNING ACTIVITIES**  
*Biological Classification*  
7.3. Similarities are used to classify organisms because they may be used to infer the degree of relatedness among organisms.  
2. Recognize and describe that biological classifications are based on how organisms are related: Organisms are classified into a hierarchy of groups and subgroups, with species as the most fundamental unit.  
*Ecology*  
7.8. Organisms in ecosystems exchange energy and nutrients among themselves and with the physical environment.  
7. Describe how, as any population of organisms grows, it is held in check by one or more environmental constraints  

**B.18. 2.** Explain that ecosystems tend to have cyclic fluctuations around a state of rough equilibrium, and change results from shifts in climate, natural causes, human activity, or when a new species or non-native species appears.  

**19 Pollution**  
Students should understand the effects of Pollution and other environmental challenges and their longer term consequences.  

**ENVIRONMENTAL SCIENCE STANDARDS AND LEARNING ACTIVITIES: SCIENTIFIC INVESTIGATION AND INQUIRY**  
E.1. Scientific progress is made by asking relevant questions and conducting careful investigations.  
12. Analyze situations and solve problems that require combining concepts from more than one topic area of science and applying these concepts.  
14. Observe natural phenomena and analyze their location, sequence, or time intervals  

**ENVIRONMENTAL SYSTEMS**  
E.2. The environment is a system of interdependent components affected by natural phenomena and human activity.  
1. Understand and explain that human beings are part of Earth’s ecosystems, and that human activities can, deliberately or inadvertently, alter ecosystems.  

**ECOSYSTEMS**  
E.3. Stability in an ecosystem is a balance between competing effects.
### STANDARDS

#### DISTRICT OF COLUMBIA PUBLIC SCHOOLS (CONTINUED)

1. Explain that biodiversity is the sum total of different kinds of organisms in a given ecological community or system, and is affected by alterations of habitats.

#### POPULATIONS

E.4. The amount of life any environment can support is limited by the available energy, water, oxygen, and minerals, and by the ability of ecosystems to recycle organic materials from the remains of dead organisms.

1. Explain the concept of carrying capacity

### MARYLAND COMMON CORE STATE CURRICULUM

#### 1.0 SKILLS AND PROCESSES

**C. Communicating Scientific Information**

1. Develop explanations that explicitly link data from investigations conducted, selected readings and when appropriate, contributions from historical discoveries.

e) Explain how different models can be used to represent the same thing.

**D. Technology**

1. Analyze the value and the limitations of different types of models in explaining real things and processes.

#### 3.0 LIFE SCIENCE

**A. Diversity of Life**

**Grade 7.1.** Compile evidence to verify the claim of biologists that the features of organisms connect or differentiate them.

b) Identify general distinctions among organisms that support classifying

#### GOAL 1: SKILLS AND PROCESSES

**1.1** The student will explain why curiosity, honesty, openness, and skepticism are highly regarded in science.

**1.3** The student will carry out scientific investigations effectively and employ the instruments, systems of measurement, and materials of science appropriately.

**1.4** The student will demonstrate that data analysis is a vital aspect of the process of scientific inquiry and communication.

**1.4.6** The student will describe trends revealed by data.

**1.5** The student will use appropriate methods for communicating in writing and orally the processes and results of scientific investigation.

**1.6** The student will use mathematical processes.
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<th>STANDARDS</th>
<th>GRADES 6-8</th>
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| **D. Evolution**  
*Grade 6* 1. Explain that any particular environment, the growth and survival of organisms and species depend on the physical conditions. e) Describe ways in which changes in environmental conditions can affect the survival of individual organisms and entire species.  
*Grade 8* 1. Recognize and describe  
a) Recognize and describe that gradual and sudden changes in environmental conditions affect the survival of organisms and populations.  
e) Identify and describe the processes that form metamorphic rocks. |
| **6.0 ENVIRONMENTAL SCIENCE**  
**B. Environmental Issues**  
*Grade 6* 1. Recognize and explain that human-caused changes have consequences for Maryland’s environment as well as for other places and future times.  
*Grade 7* 1. Recognize and describe that environmental changes can have local, regional, and global consequences.  
*Grade 8* 1. Recognize and explain how human activities can accelerate or magnify many naturally occurring changes. |
| **GOAL 3: CONCEPTS OF BIOLOGY**  
**EXPECTATION**  
**Expectation 3.5** The student will investigate the interdependence of diverse living organisms and their interactions with the components of the biosphere.  
3.5.2 The student will analyze the interrelationships and interdependencies among different organisms and explain how these relationships contribute to the stability of the ecosystem.  
• Diversity  
• Niche  
3.5.3 The student will investigate how natural and man-made changes in environmental conditions will affect individual organisms and the dynamics of populations.  
3.5.4 The student will illustrate how all organisms are part of and depend on two major global food webs that are positively or negatively influenced by human activity and technology. |
| **SOCIAL STUDIES**  
**3.0 GEOGRAPHY**  
**D. Modifying and Adapting to the Environment**  
*Grade 6* 1. Analyze why and how people modify their natural environment and the impact of those modifications  
*Grade 7* 1. Analyze why and how people in contemporary world regions modify their natural environment and the impact of those modifications |
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<td>MARYLAND COMMON CORE STATE CURRICULUM (CONTINUED)</td>
<td>c. Identify and explain land use issues that illustrate the conflict between economic growth, deforestation, mining, and burning fossil fuels <strong>Grade 8</strong> 1. Analyze why and how people in the United States modify their natural environment and the impact of those modifications <strong>b.</strong> Explain the consequences of modifying the natural environment, such as soil erosion, loss of soil fertility and over-fishing</td>
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| VIRGINIA STANDARDS OF LEARNING | **GRADE 6**  
*Scientific Investigation, Reasoning, and Logic*  
*6.1* The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which a) observations are made involving fine discrimination between similar objects and organisms; and j) current applications are used to reinforce science concepts.  
*Earth Resources*  
*6.9* The student will investigate and understand public policy decisions relating to the environment. a) management of renewable resources; b) management of nonrenewable resources; c) the mitigation of land-use and environmental hazards through preventive measures; and d) cost/benefit tradeoffs in conservation policies. | **BIOLOGY**  
*BIO.1* The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which a) observations of living organisms are recorded in the lab and in the field;  
*BIO.6* The student will investigate and understand bases for modern classification systems. Key concepts include: a) structural similarities among organisms  
*BIO.7* The student will investigate and understand how populations change through time. Key concepts include: c) how natural selection leads to adaptations |
**BIO.8** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include: a) interactions within and among populations including carrying capacities and limiting factors.

**LIFE SCIENCE**

**LS.4** The student will investigate and understand how organisms can be classified. Key concepts include: b) the distinguishing characteristics of kingdoms of organisms; and c) the distinguishing characteristics of major animal phyla and plant divisions; and

**LS.11** The student will investigate and understand the relationships between ecosystem dynamics and human activity. Key concepts include: b) change in habitat size, quality, or structure; and c) change in species competition;

**LS.10** The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic, change over time, and respond to daily, seasonal, and long-term changes in their environment. Key concepts include: b) factors that increase or decrease population size; and c) climate changes and catastrophic disturbances.

**LS.13** The student will investigate and understand that populations of organisms change over time. Key concepts include: c) how environmental influences, as well as genetic variation, can lead to diversity of organisms.
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<td>VIRGINIA STANDARDS OF LEARNING (CONTINUED)</td>
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<td>EARTH SCIENCE ES.10 The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include: b) importance of environmental and geologic implications; c) systems interactions; d) features of the sea floor as reflections of tectonic processes; and e) economic and public policy issues concerning the oceans and the coastal zone</td>
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<td>21ST CENTURY SKILLS GLOBAL</td>
<td>• Learning and Innovation Skills - Work creatively with others • Critical Thinking and Problem Solving - Use systems thinking, Solve problems • Communication and Collaboration - Communicate clearly • Collaborate with others • Information Literacy • Access and Evaluate Information • Initiative and Self-Direction - Manage goals and time and Be self-directed learners</td>
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