Smithsonian
National Museum of Natural History

2017-2018 School Year

Q?rius Field Trip Guide

School Program: BIRD STRIKE *WHODUNIT?*

- Welcome to Q?rius
- Field Trip Logistics
- Getting the Most from Q?rius
- Class Overview
- Teaching Resources
- Associated Standards

Q?rius
The Coralyn W. Whitney Science Education Center

SCIENCE EDUCATION AT THE SMITHSONIAN'S NATIONAL MUSEUM OF NATURAL HISTORY

Bringing the Museum's collections, scientists, and research out from behind the scenes and within your reach

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Welcome to Q?rius,
The Coralyn W. Whitney Science Education Center

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.

Q?rius is an interactive and experimental learning space that brings the unique assets of the Smithsonian's National Museum of Natural History – the science, researchers, and collections – out from behind the scenes. 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, including:

- 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:

- 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 collections 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 8 for information on introducing your students to field trip content.)*

GETTING READY	• Carefully review your confirmation letter. To make any changes to your reservation, e-mail us at NMNHSchoolPrograms@si.edu or call us at (202) 633-4039. Or, visit http://www.mnh.si.edu/calEvents/programs-for-school-groups.htm, click on the "Wait List" button for the event you registered for, and select "**Overwrite Previous Response** if you have already registered for this event" on the registration form. • Review all information in this packet so that you know what you can expect from your visit. Contact us at NMNHSchoolPrograms@si.edu if you have questions or concerns. • Prior to arriving at the Museum, **please divide students into no more than 6 teams of 4-6 individuals who will pursue the class investigation together.** • Arrange for the proper number of chaperones (see below) and distribute the Chaperone Guide to them.
ARRIVAL AND DEPARTURE	**ADDRESS:** 10th Street NW and Constitution Avenue NW Washington, D.C. 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. **CLOSEST METRO STATIONS:** Federal Triangle or Smithsonian on the Blue, Orange or Silver Lines. Archives-Navy on the Green or Yellow Lines. **DROP-OFF BUS LANE:** From 9:30 a.m. to 12:00 p.m., Monday-Friday, the curb lane of Constitution Avenue adjacent to the Museum is reserved for school bus drop-off. **PICK-UP BUS LANE:** 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:** As of February 26, 2018, the Museum's Atrium Cafe is closed for renovation. A light menu will be available at Café Natural on the Ground Floor. Seating is extremely limited. Outside food is prohibited in the Museum. There will be no seating area for school or tour groups. 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 for your students, we require one chaperone for every 10 students in grades 6-8 and one 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.
CANCELLATION POLICY	If you need to cancel your school program(s), please notify us via email **at least** 72 hours in advance of your program. If you cancel within 24 hours of your visit, or are a no show for your school program, you will not be allowed to book a school program for the remainder of the school year.

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, **no more than 6 teams total per program**, 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, review the scientific terms and preparation questions on page 7 with your students to prepare them for the content that will be covered during the program.
- 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 will also 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.
- To protect the specimens, students are not allowed to have any gum or candy in Q?rius.

CLASS OVERVIEW: BIRD STRIKE *WHODUNIT?*

School Program: Bird Strike

CLASS DESCRIPTION	During takeoff from Reagan National Airport, a plane collided with a flock of birds and was forced to make an emergency landing. During this staff-led program, students will follow in the footsteps of Smithsonian scientists to determine the species of bird that brought down the airplane by examining bird fragments and feathers collected from the affected aircraft, and simulating processing DNA. Students will learn how bird strike data is used by airport managers to alter airfield habitats, and debate proposed methods of discouraging bird congregation around airports.
SUMMARY OF STUDENT EXPERIENCE	Students will explore "snarge" collected from an aircraft involved in a bird-plane collision and, in the process, will develop skills used by forensic ornithologists. Teams will work together to collect data from evidence taken from the struck plane, using Museum collections, microscopes, microslides, reference guides, and DNA databases. As students analyze and interpret multiple sources of evidence, they will formulate and rethink hypotheses about which species of bird was involved in the collision. After completing their investigation, students will compare their conclusions to those arrived at by other classmates, and to the one presented in the Smithsonian researcher's case report. Students will participate in a classroom discussion about how evidence from a scientific investigation can be applied to the development of an airport wildlife management plan. They will draw upon their knowledge and the evidence uncovered during their investigation to generate ideas about how to prevent future bird strikes. Bringing natural history and environmental concerns into the conversation, a Museum Educator will help students analyze their proposed solutions involving engineering, human behavior modification, or bird behavior modification.
GRADE RANGE	Grades 6-12
DURATION OF PROGRAM	60 minutes

Scientist Focus

Bird Strke: Whodunit? gives students first-hand experience with the skills and practices used by Smithsonian scientist, Carla J. Dove, Program Manager, Division of Birds and manager of the Feather Identification Lab. After a bird strike, pilots around the country are encouraged to send Dr. Dove's team any remains of the bird, known as "snarge," that they can find at the scene. Snarge may contain whole feathers, feather parts, or any other body parts. Dr. Dove and her team of forensic ornithologists apply forensic methodologies to determine species of birds from fragmented evidence using microscopy, whole feather comparisons with Museum specimens, and DNA 'barcoding.' These investigations reveal which species of birds are striking planes. Dr. Dove hopes that her work will inform practices at airfields and by pilots that could reduce the occurrence of bird strikes in the United States.

Goals & Outcomes

GOAL

Students will apply forensic methods, including microscopy and the scientific practices of asking questions, gathering evidence, and constructing explanations, to solve a real-world wildlife forensics case. Students will develop explanations that explicitly link data from their investigations to make and defend recommendations for mitigation of human/bird conflicts, specifically bird strikes.

LEARNING OBJECTIVES

In this investigation students will:

- Determine what evidence can be obtained by examining bird remains or "snarge"
- Integrate multiple sources of data to create and revise hypotheses
- Use an identification key to identify a bird species from a single feather
- Use a microscope to examine feather barbules, compare gathered data to a field guide, and create hypotheses about species-level morphology
- Use different types of information to solve forensic cases involving birds and other animals

STUDENT OUTCOMES

After participating in *Bird Strike*, students will be better able to:

- Demonstrate how scientists form and revise hypotheses based on multiple sources of data
- Understand how Museum scientists use collections and morphology to perform research
- Increase their understanding of the tools used to perform microscopy in a laboratory environment
- Understand the ways in which humans, birds, and other organisms interact in ecosystems
- Increase their ability to critically examine, support, or refute solutions to real-world problems

Central Questions and Concepts

- What evidence can be collected from a bird or wildlife/airplane collision?
- How can we use microscopy to hypothesize about which species of bird was involved in the collision?
- How can we use DNA evidence to determine which species of bird was involved in the collision?
- How can we use museum collections to hypothesize about which species of bird was involved in the collision?
- How can we integrate conflicting data to arrive at a final conclusion?
- How can we apply conclusions from a scientific investigation to real-world problems?

Case Background

During takeoff from Reagan National Airport, a plane collided with a flock of birds and was forced to make an emergency landing. When a bird strike occurs, pilots around the country are encouraged to send any recoverable remains of the bird – known as "snarge" – to Dr. Dove and her team for identification. In this case, a small sample of blood wiped on a piece of cheesecloth, and a few damaged feathers were sent to the Feather Identification Lab at NMNH for study. The DNA from the snarge sample was tested, but unfortunately implicated a highly unlikely culprit. It is up to students to work through stations, using the evidence and data collected, to solve the case and present conclusions during a classroom discussion.

Program Format

ARRIVAL

A Museum Educator will meet your group outside of the Q?rius Entrance and escort you to your assigned classroom. Please do not enter Q?rius on your own. The educator then will introduce students to the forensic case, explain what is expected of them as scientists, teach them the techniques for handling evidence, and show them the available tools. Every team will receive a case file that will include an FAA bird strike report, a feather from the collision, simulated DNA samples, and data collection sheets that students can use to record their observations, and any other data gathered or observed.

INTRODUCTION (10 MINUTES)

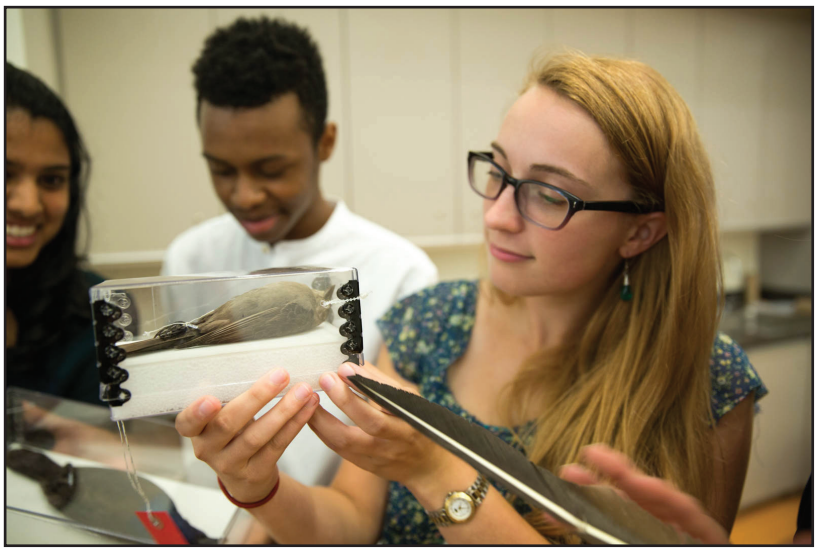
Through a classroom discussion led by a Museum Educator, students explore forensic practices and concepts and come to appreciate why investigators want to know which kinds of birds cause collisions. As a team, students will review the overall case file.

INVESTIGATIONS (30 MINUTES)

Working in small teams of 4–6 individuals, students will rotate among three investigation stations: Whole Feather Identification, DNA, and Microscopic Evidence. Teams will have 8 minutes at each station to examine the evidence, make observations, collect data, and analyze it. At each station, students will use reference collections, microscopes, books, charts, and iPads to aid them in their investigation. During a discussion facilitated by a Museum Educator, students will discuss their conclusions and then watch a video of Dr. Dove explaining the conclusion that her team uncovered during their actual investigation.

ANALYSIS AND MITIGATION PLANNING (10 MINUTES)

After completing their investigation, students will work together to brainstorm possible mitigation solutions. They will base these solutions on case-specific information and on other relevant data, such as species-specific food and habitat preferences, migration patterns, weight range, and flight mechanics.



DISCUSSION AND CONCLUSION (10 MINUTES)

Student groups will make recommendations and justify them to their classmates with evidence from their investigative work. The Museum Educator will record the agreed about recommendations into a master Wildlife Hazard Management Plan.

Before Your Visit

GRADES 6-8

SCIENTIFIC TERMS

The *Bird Strike* class will use the following terms in the context of natural history scientific investigations. Please review these terms with students before arrival.

DNA	Scavenger	Forensics
Base Pairs	Carrion	Ornithology
Evidence	Habitat	Migration

PREPARATION QUESTIONS

1. What information do you need know about an animal in order to predict its location and behavior?
2. What are the components of an ecosystem, and which components can you expect to find in the vicinity of an airport?
3. What is DNA and how can it be used to identify an animal?

GRADES 9-12

SCIENTIFIC TERMS

The *Bird Strike* class will use these terms in the context of natural history scientific investigations. Please review these terms with students before arrival, as well as the terms for grades 6- 8 as needed.

Mitigation	Asymmetry	Incident
Morphology	Monochrome	DNA Sequencing
Symmetry	Microstructure	

PREPARATION QUESTIONS

1. What human activities impact wildlife and their habitats?
2. What types of evidence could result from a collision between wildlife and an airplane?
3. How are the processes and practices of a scientist conducting original research different from those of an investigator investigating a case?
4. What benefits would DNA identification have over visual feather identification and vice versa?

SMITHSONIAN SCIENCE HOW: FORENSIC ORNITHOLOGY - BIRD DETECTIVE

FEATURING ORNITHOLOGIST CARLA DOVE

Prepare students to participate in *Bird Strike* by watching featured scientist Carla Dove's archived *Smithsonian Science How* webcast.

http://qrius.si.edu/explore-science/webcast/forensic-ornithology-bird-strikes

Dr. Carla Dove is an Ornithologist at the National Museum of Natural History. Join her in analyzing the remains of birds from airplane strikes and other events. See how she and her team use various types of evidence to identify the birds. Marvel at how modern techniques such as DNA barcoding can complement old-fashioned comparisons of feathers. Consider what bird remains tell you about populations of birds over time. Learn how Carla and her team are making your flights safer while also improving management of natural populations of birds.

Permanent Exhibits at the National Museum of Natural History

Brandishing their fine plumage, the birds in the **Birds of D.C.** exhibit have helped generations of visitors identify local species. Year-round and seasonal residents, migrants, and vagrants – hundreds of species in all – are displayed here.

Other bird species representing a variety of ecosystems can be found throughout the Museum.

> *SUGGESTED ACTIVITY:* In the exhibition, students can explore the biodiversity of birds and make note of the variety seen. Students should be encouraged to read exhibit labels carefully in order to gather data and document the biodiversity of birds and range of habitats represented.

Recommended Resources from Smithsonian Scientists

Watch the Ask the Smithsonian video or Meet Our Scientist about identifying birds and forensics ornithology as a pre-visit tool.
http://www.smithsonianmag.com/video/How-to-Identify-a-Bird-From-a-Single-Feather.html
http://vertebrates.si.edu/birds/MeetCarlaDove.html

Read more about Dr. Carla Dove, including an interview by Alisa Opar featured in the article "Feather Forensics," published in Audubon Magazine. This is great for students interested in exploring career opportunities but it is a case "spoiler," so please provide as a post-program resource!
http://vertebrates.si.edu/birds/birds_staff_pages/CarlaDove_staffpage.cfm

In School: Curiosity Continues

The Q?rius website at www.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, or explore science in action.

LIVE SMITHSONIAN SCIENCE HOW WEBCASTS	*Smithsonian Science How* delivers real-world science into classrooms through free, interactive, live webcasts and supporting classroom resources. The 30-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 teaching resources that includes lessons, activities, and other resources that highlight science content and practice.
SMITHSONIAN SCIENCE HOW VIDEO LIBRARY	Visit our video library to watch the collection of dozens of *Smithsonian Science How* videos, featuring experts and topics in the subject areas of earth science, life science, paleontology, and social studies. Each video has a complementary package of standards aligned teaching resources that include lessons, activities, and other resources that highlight science content and practice.
SMITHSONIAN SCIENCE HOW LIVE CHATS	Participate in live, text-based chats with scientists that have previously been featured on a *Smithsonian Science How* live webcast. Students have the opportunity to have a direct conversation with scientists about their career pathways and work at the Museum. Supplement the live chat by watching the Smithsonian Science How video archive of the featured scientist and using the available teaching resources before and after the live chat.
TEACHING RESOURCES	Resources include webcasts and podcasts, lessons, online activities, posters, science literacy resources, websites, videos, and Smithsonian science career profiles. Use the resources to create a lesson plan, develop a research project, generate an interactive class experience, or otherwise engage pre-teen and teen learners in a science topic. Relevant national science standards are provided.
JUMP INTO SCIENCE STORIES	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.
CREATE A DIGITAL FIELDBOOK	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.
WATCH SCIENCE UNFOLD	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.

Associated Standards

Participating in *Bird Strike* supports students in being better able to meet the following standards. The degree to which standards are addressed will depend on student participation, preparation, and connections made in the classroom.

Next Generation Science Standards

MIDDLE SCHOOL	HIGH SCHOOL
MS-ESS3 EARTH AND HUMAN ACTIVITY **MS-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. *MS-LS2 ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS* **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-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-LS2-5** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. *MS-ETS-1 ENGINEERING DESIGN* **MS-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	*HS-LS2 ECOSYSTEMS: INTERACTIONS, ENERGY, AND DYNAMICS* **HS-LS2-6** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. **HS-LS2-7** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. **HS-LS2-8** Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. *HS-ETS1 ENGINEERING DESIGN* **HS-ETS1-1** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. **HS-ETS1-3** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Science Standards of Learning for Virginia Public Schools

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

e. a method is devised to test the validity of predictions and inferences

i. models and simulations are designed and used to illustrate and explain phenomena and systems

j. current applications are used to reinforce science concepts

EARTH RESOURCES

6.9

c. the mitigation of land-use and environmental hazards through preventive measures; and

d. cost/benefit tradeoffs in conservation policies

MIDDLE & HIGH SCHOOL

LIFE SCIENCE

LS.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which

e. sources of experimental error are identified

i. patterns are identified in data and are interpreted and evaluated

j. current applications are used to reinforce life science concepts

LS.7 The student will investigate and understand that interactions exist among members of a population. Key concepts include

b. influence of behavior on a population.

LS.8 The student will investigate and understand interactions among populations in a biological community. Key concepts include

a. the relationships among producers, consumers, and decomposers in food webs

b. the relationship between predators and prey

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

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

LS.12 The student will investigate and understand that organisms reproduce and transmit genetic information to new generations. Key concepts include

a. the structure and role of DNA

(continued on the next page)

Science Standards of Learning for Virginia Public Schools (continued)

	MIDDLE & HIGH SCHOOL
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 b. hypotheses are formulated based on direct observations and information from scientific literature; e. conclusions are formed based on recorded quantitative and qualitative data g. validity of data is determined l. alternative scientific explanations and models are recognized and analyzed **BIO.5** The student will investigate and understand common mechanisms of inheritance and protein synthesis. Key concepts include f. genetic variation j. exploration of the impact of DNA technologies

Need additional standards alignment? Please contact us for the full list of associated standards.