SEEd Swap Workshop

2017

7th Grade
Welcome to the 2017 SEEd Swap Teacher Workshop

It’s an exciting time for the world of science instruction; advances in cognitive and pedagogical research are reshaping the way we think about engaging students in science and engineering. The state of Utah has reflected these improvements in the new 6-8th grade SEEd (Science and Engineering Education) Standards, which will be implemented across the state during the 2017-2018 school year. While this change is exciting, it also poses significant challenges. The SEEd standards are built on Disciplinary Core Ideas, as were the previous standards. The new components include the explicit integration of Science and Engineering Practices into every single standard, and the framing of ideas within Crosscutting Concepts to allow instructors to help students organize their thoughts. These three components, called ‘dimensions,’ when anchored to instruction that allows students to explore phenomena they encounter in the world, allows students to act as sense-makers and science/engineering practitioners.

In order to provide 6-8th grade teachers with professional learning support to successfully implement the new standards, the Center for Science and Mathematics Education (CSME) is offering a week-long workshop focusing on the content that has ‘swapped,’ or is new to each grade – the “SEEd Swap.”

**USBE Credit:**
80% documented attendance, taken 2x daily by your instructor, as well as an accurate CACTUS ID number on record, are required to earn 3 USBE credits.

**Supply Stipend**
A $150 check will be issued to each attendee who
Completed the pre-assessment by the July 29th deadline
Attend 100% of the workshop
Complete the post-assessment between noon on Aug. 4 and midnight Aug. 8th.

**Curricular Resources**
The majority of the resources found in this book will be available online at the Center for Science and Mathematics Education website: https://csme.utah.edu/resources/k12curriculum/
Megan Black

Megan Black is an elementary science curriculum specialist in Granite School District. She taught science for twelve years working with students in grades 4 - 9, but most often 6th grade. Megan was on the 6th grade SEEd standards writing committee and has been involved with developing the 6th Grade SEEd OER textbook. She is interested in developing curriculum and instructional strategies that engage students as scientists as they explore and figure out the natural world around them.

Sarah Braden

Sarah K. Braden started her career in education as a high school biology, physics, and English as a Second Language (ESL) teacher. Dr. Braden is currently an Assistant Professor of English Language Learner education in The School of Teacher Education and Leadership at Utah State University. Her research centers on understanding language socialization phenomena and promoting equity the sciences.

Brad Carroll, Professor Emeritus - Physics, Weber State University

Brad Carroll began his career as a high school math and physics teacher in Bakersfield, California. After receiving his Ph.D. in astrophysics from the University of Colorado, Brad spent time as a postdoc at the University of Rochester before joining the Physics Dept. at Weber State University in 1985. At WSU, Brad collaborated with faculty in the Dept. of Chemistry to develop a unique physical science course for elementary education majors. He also co-authored An Introduction to Modern Astrophysics, the standard undergraduate astrophysics text. Brad retired in 2015 after 30 years at WSU, 10 of them as chair of the Physics Department. In retirement, he continues to teach with the Physics Department and Honors Program, and is working on the third edition of his astrophysics text.
Jordan Gerton, Director of CSME and Associate Professor of Physics

I received my Bachelor’s degree in Engineering Physics from the University of Arizona and my Master’s and Doctorate degrees in Physics from Rice University. I have had a number of formative experiences over the years that have stoked my passion for math and science education and have driven me to leadership roles in these areas. Math and Science are among the most important and impactful human pursuits, and I am committed to helping students of all ages and backgrounds develop a passion for and proficiency in these enabling disciplines.

Holly Godsey

Dr. Holly Godsey is the Director of Student Success and Teacher Development at the CSME and an Associate Professor (Lecturer) in the Department of Geology and Geophysics. She has a BS and PhD in Geology from the University of Utah and an MS in Oceanography (Marine Geology and Geochemistry) from the University of Michigan. Since 2004, she has been involved with several science education projects that connect faculty, graduate and undergraduate students to K-12 teachers and students to inspire, empower and educate learners from across generations and disciplines.

Maura Hanenberger

Maura Hahnenberger is an Assistant Professor in the Geosciences Department at Salt Lake Community College. At SLCC she teaches and advises in the Atmospheric Sciences and Geography programs in both face to face and online settings. Maura is the founder of the WaterGirls outreach program which provides middle school girls with field experiences conducting water science. She also serves on the boards of the SLCC Chapter of the Utah Women in Higher Education Network, Utah Chapter of the American Meteorological Society, and the Earth Science Women’s Network.

Emily Harward, 7th & 8th Grade Science & Biology Teacher at Granite Schools

Emily was lucky to grow up in the Salt Lake Valley, with opportunities to spend time exploring nature. She graduated from the University of Utah in 2004, and has been teaching science at Evergreen Junior High in Granite District ever since. For Emily, the most rewarding part of teaching is developing lessons and activities that provide a pathway for students to develop their own understanding and make sense of the world they live in.
Patrice Kurnarth

Patrice received her B.S. in Biology from Ithaca College and worked in academia for a few years at Yale University and UC Berkeley. She earned her Ph.D. in Biology from the University of Utah in 2016. During her doctoral thesis, Patrice worked with middle school science teachers in the Salt Lake valley for two years as part of a GK-12 graduate school fellowship funded by the National Science Foundation. This experience was truly transformative because she learned about pedagogical theory and experienced first-hand the set-backs and successes of teaching.

Candace Penrod, District Science Supervisor at SLC School District

Candace’s teaching career began in California in elementary education. Upon moving to Utah, she transitioned to secondary science teaching, followed by several years as instructional coach. She is currently the District Science Supervisor for Salt Lake City School District. Candace obtained a Master in Education from the University of Utah in 2009 and a Master of Science in Earth Science Teaching from the University of Utah. Candace is passionate about K-12 science education and continually seeks for opportunities to improve science teaching and student learning at all levels.

Scott Roskelley, Science Assessment Specialist at Utah State Board of Education

Scott was born and raised in Chicago, Illinois and from a young age loved science. He holds degrees in wildlife biology, marine biology, teaching and learning, and educational administration. Never expecting to work in education, Scott fell into teaching in 2001 as he entered the alternative route to licensure in Utah. Scott worked for 15 years in the Jordan School District, mostly teaching middle school. Now as the state science assessment specialist, he is responsible for working with Utah teachers to develop the new end-of-year assessment for the new SEEd standards.

James Ruff

I am an evolutionary biologist studying basic evolutionary topics including sexual selection, and the forces maintaining genetic diversity in populations; furthermore, I apply evolutionary principles and techniques to questions concerning nutrition, toxicology, and pharmaceutical safety assessment. I am passionate about science education and prefer to focus on the process of science relative to the ‘fruits’ of the process. In this vein, I incorporate study designs, data analysis and writing into each of my courses. I have been a teaching fellow at both elementary and middle schools in SLCSD.
Heather Waite

I received my degree and teaching certificate from Weber State University in 2006 in Biology. I’ve been recently teaching 7th and 8th grade science at South Ogden Jr. High for 10 years. This summer I have taken the opportunity to write assessment pieces for the state. I have also worked on a District Level to develop assessments for test review and teacher evaluation. I am currently serving as department chair at SOJH. I also served on the School Transformation Team (Assessment to Achievement) for 2 years.

Tamara Young, Academic Advisor in the Department of Physics & Astronomy

Tamara’s interest in physics began in high school. As an undergraduate at Utah State University, Tamara’s studies focused on nuclear and particle physics. Tamara taught science and math for several years in the public education system. For the last couple years, Tamara has taught astronomy at SLCC, participated in course curriculum development with CSME, and taught a computational astronomy course for Master’s students in Physics Teaching. Tamara is the academic advisor in the Department of Physics & Astronomy at the University of Utah. She also engages in public outreach and education, and loves to talk about physics.
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SCIENCE WITH ENGINEERING EDUCATION (SEEd) STANDARDS

FOR UTAH

Adopted December 2015
by the
Utah State Board of Education
INTRODUCTION | GRADE 7

Science Literacy for All Students
Science is a way of knowing, a process for gaining knowledge and understanding of the natural world. Engineering combines the fields of science, technology, and mathematics to provide solutions to real-world problems. The nature and process of developing scientific knowledge and understanding includes constant questioning, testing, and refinement, which must be supported by evidence and has little to do with popular consensus. Since progress in the modern world is tied so closely to this way of knowing, scientific literacy is essential for a society to be competitively engaged in a global economy. Students should be active learners who demonstrate their scientific understanding by using it. It is not enough for students to read about science; they must participate in the three dimensions of science. They should observe, inquire, question, formulate and test hypotheses, analyze data, report, and evaluate findings. The students, as scientists, should have hands-on, active experiences throughout the instruction of the science curriculum. These standards help students find value in developing novel solutions as they engage with complex problems.

Three Dimensions of Science¹
Science education includes three dimensions of science understanding: science and engineering practices, crosscutting concepts, and disciplinary core ideas. Every standard includes each of the three dimensions; Science and Engineering Practices are bolded, Crosscutting Concepts are underlined, and Disciplinary Core Ideas are in normal font. Standards with specific engineering expectations are italicized.

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<th>Scientific and Engineering Practices</th>
<th>Crosscutting Concepts</th>
<th>Disciplinary Core Ideas</th>
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<td>Obtaining, evaluating, and communicating information</td>
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</tbody>
</table>

¹ NRC Framework K–12 Science Education: http://www.nap.edu/catalog.php?record_id=13165
Organization of Standards
The Utah SEEd standards† are organized into strands, which represent significant areas of learning within content areas. Within each strand are standards. A standard is an articulation of the demonstrated proficiency to be obtained. A standard represents an essential element of the learning that is expected. While some standards within a strand may be more comprehensive than others, all standards are essential for mastery.

Grade Seven |
Utah Science With Engineering Education (SEEd) Standards
The seventh grade SEEd standards look for relationships of cause and effect which enable students to pinpoint mechanisms of nature and allow them to make predictions. Students will explore how forces can cause changes in motion and are responsible for the transfer of energy and the cycling of matter. This takes place within and between a wide variety of systems, from simple, short-term forces on individual objects to the deep, long-term forces that shape our planet. In turn, Earth’s environments provide the conditions for life as we know it. Organisms survive and reproduce only to the extent that their own mechanisms and adaptations allow. Evidence for the evolutionary histories of life on Earth is provided through the fossil record, similarities in the various structures among species, organism development, and genetic similarities across all organisms. Additionally, mechanisms shaping Earth are understood as forces affecting the cycling of Earth’s materials. Questions about cause and effect and the ongoing search for evidence in science, or science’s ongoing search for evidence, drive this storyline.

† Most SEEd Standards are based on the Next Generation Science Standards: http://www.nextgenscience.org
Strand 7.1: FORCES ARE INTERACTIONS BETWEEN MATTER

Forces are push or pull interactions between two objects. Changes in motion, balance and stability, and transfers of energy are all facilitated by forces on matter. Forces, including electric, magnetic, and gravitational forces, can act on objects that are not in contact with each other. Scientists use data from many sources to examine the cause and effect relationships determined by different forces.

- **Standard 7.1.1** Carry out an investigation which provides evidence that a change in an object’s motion is dependent on the mass of the object and the sum of the forces acting on it. Various experimental designs should be evaluated to determine how well the investigation measures an object’s motion. Emphasize conceptual understanding of Newton’s First and Second Laws. Calculations will only focus on one-dimensional movement; the use of vectors will be introduced in high school.

- **Standard 7.1.2** Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects in a system. Examples could include collisions between two moving objects or between a moving object and a stationary object.

- **Standard 7.1.3** Construct a model using observational evidence to describe the nature of fields existing between objects that exert forces on each other even though the objects are not in contact. Emphasize the cause and effect relationship between properties of objects (such as magnets or electrically-charged objects) and the forces they exert.

- **Standard 7.1.4** Collect and analyze data to determine the factors that affect the strength of electric and magnetic forces. Examples could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or of increasing the number or strength of magnets on the speed of an electric motor.

- **Standard 7.1.5** Engage in argument from evidence to support the claim that gravitational interactions within a system are attractive and dependent upon the masses of interacting objects. Examples of evidence for arguments could include mathematical data generated from various simulations.
Strand 7.2: CHANGES TO EARTH OVER TIME

Earth’s processes are dynamic and interactive, and are the result of energy flowing and matter cycling within and among Earth’s systems. Energy from the sun and Earth’s internal heat are the main sources driving these processes. Plate tectonics is a unifying theory that explains crustal movements of Earth’s surface, how and where different rocks form, the occurrence of earthquakes and volcanoes, and the distribution of fossil plants and animals.

■ **Standard 7.2.1** Develop a model of the rock cycle to describe the relationship between energy flow and matter cycling that create igneous, sedimentary, and metamorphic rocks. Emphasize the processes of melting, crystallization, weathering, deposition, sedimentation, and deformation, which act together to form minerals and rocks.

■ **Standard 7.2.2** Construct an explanation based on evidence for how processes have changed Earth’s surface at varying time and spatial scales. Examples of processes that occur at varying time scales could include slow plate motions or rapid landslides. Examples of processes that occur at varying spatial scales could include uplift of a mountain range or deposition of fine sediments.

■ **Standard 7.2.3** Ask questions to identify constraints of specific geologic hazards and evaluate competing design solutions for maintaining the stability of human-engineered structures, such as homes, roads, and bridges. Examples of geologic hazards could include earthquakes, landslides, or floods.

■ **Standard 7.2.4** Develop and use a scale model of the matter in the Earth’s interior to demonstrate how differences in density and chemical composition (silicon, oxygen, iron, and magnesium) cause the formation of the crust, mantle, and core.

■ **Standard 7.2.5** Ask questions and analyze and interpret data about the patterns between plate tectonics and:

1. The occurrence of earthquakes and volcanoes.
2. Continental and ocean floor features.
3. The distribution of rocks and fossils.

Examples could include identifying patterns on maps of earthquakes and volcanoes relative to plate boundaries, the shapes of the continents, the locations of ocean structures (including mountains, volcanoes, faults, and trenches), and similarities of rock and fossil types on different continents.

■ **Standard 7.2.6** Make an argument from evidence for how the geologic time scale shows the age and history of Earth. Emphasize scientific evidence from rock strata, the fossil record, and the principles of relative dating, such as superposition, uniformitarianism and recognizing unconformities.
Strand 7.3: STRUCTURE AND FUNCTION OF LIFE

Living things are made of smaller structures, which function to meet the needs of survival. The basic structural unit of all living things is the cell. Parts of a cell work together to function as a system. Cells work together and form tissues, organs, and organ systems. Organ systems interact to meet the needs of the organism.

- **Standard 7.3.1** Plan and carry out an investigation that provides evidence that the basic structures of living things are cells. Emphasize that cells can form single-celled or multicellular organisms, and that multicellular organisms are made of different types of cells.

- **Standard 7.3.2** Develop and use a model to describe the function of a cell in living systems and the way parts of cells contribute to cell function. Emphasize the cell as a system, including the interrelating roles of the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.

- **Standard 7.3.3** Construct an explanation using evidence to explain how body systems have various levels of organization. Emphasize understanding that cells form tissues, tissues form organs, and organs form systems specialized for particular body functions. Examples could include relationships between the circulatory, excretory, digestive, respiratory, muscular, skeletal, and nervous systems. Specific organ functions will be taught at the high school level.
Strand 7.4: REPRODUCTION AND INHERITANCE

The great diversity of species on Earth is a result of genetic variation. Genetic traits are passed from parent to offspring. These traits affect the structure and behavior of organisms, which affect the organism’s ability to survive and reproduce. Mutations can cause changes in traits that may affect an organism. As technology has developed, humans have been able to change the inherited traits in organisms, which may have an impact on society.

- **Standard 7.4.1** Develop and use a model to explain the effects that different types of reproduction have on genetic variation, including asexual and sexual reproduction.

- **Standard 7.4.2** Obtain, evaluate, and communicate information about specific animal and plant adaptations and structures that affect the probability of successful reproduction. Examples of adaptations could include nest building to protect young from the cold, herding of animals to protect young from predators, vocalization of animals and colorful plumage to attract mates for breeding, bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.

- **Standard 7.4.3** Develop and use a model to describe why genetic mutations may result in harmful, beneficial, or neutral effects to the structure and function of the organism. Emphasize the conceptual idea that changes to traits can happen because of genetic mutations. Specific changes of genes at the molecular level, mechanisms for protein synthesis, and specific types of mutations will be introduced at the high school level.

- **Standard 7.4.4** Obtain, evaluate, and communicate information about the technologies that have changed the way humans affect the inheritance of desired traits in organisms. Analyze data from tests or simulations to determine the best solution to achieve success in cultivating selected desired traits in organisms. Examples could include artificial selection, genetic modification, animal husbandry, and gene therapy.
Strand 7.5: CHANGES IN SPECIES OVER TIME

Genetic variation and the proportion of traits within a population can change over time. These changes can result in evolution through natural selection. Additional evidence of change over time can be found in the fossil record, anatomical similarities and differences between modern and ancient organisms, and embryological development.

■ **Standard 7.5.1** Construct an explanation that describes how the genetic variation of traits in a population can affect some individuals’ probability of surviving and reproducing in a specific environment. Over time, specific traits may increase or decrease in populations. Emphasize the use of proportional reasoning to support explanations of trends in changes to populations over time. Examples could include camouflage, variation of body shape, speed and agility, or drought tolerance.

■ **Standard 7.5.2** Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth, under the assumption that natural laws operate today as in the past.

■ **Standard 7.5.3** Construct explanations that describe the patterns of body structure similarities and differences between modern organisms, and between ancient and modern organisms, to infer possible evolutionary relationships.

■ **Standard 7.5.4** Analyze data to compare patterns in the embryological development across multiple species to identify similarities and differences not evident in the fully formed anatomy.
<table>
<thead>
<tr>
<th>Element of Classroom Practice</th>
<th>Content-driven Teacher-centered</th>
<th>Closer...</th>
<th>Closer still...</th>
<th>3-Dimensional Student-centered</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct Instruction</strong> (teacher TELLING, vs. eliciting student lang.)</td>
<td>75-100%</td>
<td>50-75%</td>
<td>25-50%</td>
<td>&lt;25%</td>
</tr>
<tr>
<td><strong>Use of Phenomena</strong></td>
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<td>Cookbook labs conducted before direct instruction</td>
<td>Student-built experiments before direct instruction</td>
<td>Exploring a phenomena motivates creation of experiment/model to explore content</td>
</tr>
<tr>
<td>Teacher uses <strong>questioning</strong> to motivate student thought/discussion</td>
<td>&lt;25%</td>
<td>25-50%</td>
<td>50-75%</td>
<td>75-100%</td>
</tr>
<tr>
<td>% that students are generating language (vs. copying notes/reading script)</td>
<td>&lt;25%</td>
<td>25-50%</td>
<td>50-75%</td>
<td>75-100%</td>
</tr>
<tr>
<td><strong>Classroom community’s relationship to knowledge</strong></td>
<td>Teacher has it, students work to get it from teacher</td>
<td>Teacher has it, creates experiences to show students (instead of tell)</td>
<td>Teacher has it, facilitates students to ‘discover’ it, as well</td>
<td>The world is full of it, and students can discover it with the support of teacher</td>
</tr>
<tr>
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<td>Teacher creates discrepant event to challenge misconceptions</td>
<td>Students experience facilitated discrepant event that challenges their misconceptions</td>
<td>Student experiments allow meaning making, and misconceptions are acknowledged and corrected</td>
</tr>
<tr>
<td><strong>3-Dimensional Instruction</strong></td>
<td>CCCs not present “Scientific Method” taught as a numbered list of steps</td>
<td>Students name SEPs and use CCCs to organize ideas</td>
<td>Students engage with phenomenon and plan investigations</td>
<td>Students use SEPs to engage with phenomena, and use CCCs to organize ideas.</td>
</tr>
</tbody>
</table>
# Implementing 3D Instruction - A 4-Year Timeline

## Year 1

### Classroom Culture
- Encourage a culture of questioning: offer equal positive feedback for student questions and answers.
- Explicitly support students to argue about ideas rather than with each other, and using evidence to support their arguments/ideas/opinions.

### Three Dimensions
- Resist teaching the “Scientific Method” in one unit at the start of the year. This creates a misconception that science proceeds in a linear list of steps, rather than a responsive, iterative deployment of practices based on the learning/communication that a situation requires.
- Explicitly name the science/engineering practice each lesson utilizes in front of students.
  - Note how students engage with the science/engineering practice; as you reflect on lessons, think about what scaffolding techniques may be useful to help future students develop these skills.
- Introduce scientific modeling as formative assessment: pick a lesson or two where you can have students create explanatory models to show how they understand the concepts. Reflect on what went well and what scaffolding and questioning techniques may be useful in the future.

### Lesson Planning and Implementation
- Flip the order of instruction for lessons that include an investigation: let the students start with the investigation, allow them to make sense of their observations, and then introduce vocabulary and/or follow with direct instruction.
- For a few lessons, start with a relevant phenomenon that students can investigate.
- During some lessons, let students come up with questions about the topic being studied. Record student questions for future planning on that topic.

### Assessment
- Use the questions, models, and hypothesis that students generate as formative assessments throughout lessons to gauge student understanding.

### Professional Planning
- Keep a written reflection of what is working and what isn’t as you begin to implement pieces of the 3D model; record student questions, ideas for phenomena, scaffolding techniques, etc.
- Collect and learn about phenomena that you may be able to use in future lessons.
- Consider tasks/activities that you currently use; which could be further used/adapted to work within the 3D model, and which are not in line with the vision of NGSS?
- Engage in professional development opportunities, including building a community of teachers with whom you can plan/work to implement 3D instruction.

Emily Harward
# Year 2

## Classroom Culture
- Incorporate partner, small group and whole group discussions; use scaffolding techniques and talk moves to make discussions meaningful and promote equity and student responsibility.
- Continue to cultivate a classroom culture where questioning and the process of learning is valued over products and right answers. Support students to publicly voice and change ideas when presented with new information.

## Three Dimensions
- Use scaffolded approaches to help students equitably engage in the science practices; emphasize to students the science practice that they are engaged in.
- Start incorporating CCCs into lessons; when using a CCC, identify the CCC to students. Consider asking students to explain their understanding in terms of the CCC in writing prompts.
- Continue to use scientific modeling, deliberately asking students to model when modeling helps to build conceptual understanding. Providing scaffolds to help students create explanatory initial models from their background knowledge and assumptions when a new phenomenon is introduced.

## Lesson Planning and Implementation
- Lessons begin with, and are based on, a phenomenon that students can investigate.
- Teacher anticipates and plans questions and strategies to guide students through exploration of phenomena.
- Student questions are incorporated into lessons; during lessons, students are investigating questions that they have generated.

## Assessment
- Continue to use formative assessments daily.
- Use explanatory models, arguments supported by evidence, student questions and investigations as formative assessments.

## Professional Planning
- Continue to participate in professional development and PLCs
- Write down how lessons and phenomena connect with each other; use these reflections to start building complete 3D lessons and storylines that you can use next year

## Unit Planning and Storylines
- Start using an anchor phenomenon for a few units; throughout the unit, students gather and reason through information that will help them explain the anchor phenomenon
### Year 3

#### Classroom Culture
- Resist immediately correcting student misconceptions/answering all student questions. Instead, provide opportunities for students to gather and reason through authentic information to come to evidence-based explanations that address their own questions/misconceptions.
- Continue to cultivate a classroom culture where questioning and the process of learning is valued over products and right answers.
- Foster a climate where students reason through information both individually and in groups, and in which students know that making mistakes and coming up with “wrong” answers is a normal part of scientific exploration.

#### Three Dimensions
- Each lesson contains a clearly articulated SEP, CCC and DCI.

#### Lesson Planning and Implementation
- Questions generated during one lesson are used to plan the following lesson; anticipate student questions and use them to guide the planning process.
- Each lesson provides an opportunity for students to gather information, reason through the information they have collected, and communicate their ideas.

#### Assessment
- Continue to use formative assessments, including explanatory models, arguments supported by evidence, student questions and investigations.
- Use summative assessments which include all three dimensions; students show that they know the DCI through the lens of a given CCC, and also show proficiency in the SEP.

#### Professional Planning
- Continue to participate in professional development and PLCs, and explicitly commit time to plan and evaluate 3-Dimensional instruction.
- Continue to reflect on what is working and what is not; use reflections to inform future lesson and storyline planning.

#### Unit Planning and Storylines
- Start building and using storylines for some topics; each storyline should include an anchor phenomenon and several learning episodes with supporting phenomena that build students' knowledge/skills to explain the anchor phenomenon.
Year 4

Classroom Culture

- Implement strategies that help promote equity in the classroom, including strategies that allow all students to participate in small group and whole group discussions, small group investigations and sense-making activities.
- Continue to cultivate a classroom culture where questioning and the process of learning is valued over products and right answers.
- Continue to foster a climate where students reason through information both individually and in groups, and in which students know that making mistakes and coming up with “wrong” answers is a normal part of scientific exploration.

Three Dimensions

- Each lesson contains an SEP, CCC and DCI.
- Plan and review storyline and lesson plans to ensure that students engage with several different SEPs and CCCs throughout the course.

Lesson Planning and Implementation

- Use questions deliberately; pre-plan (in writing) the open-ended questions you will use to promote student engagement and understanding throughout the lesson; know why/when/how you will question students.
- Build lessons which provide an opportunity for students to gather information, reason through the information they have collected, and communicate their ideas in ways that are scientifically authentic.

Assessment

- Continue to use formative assessments, including explanatory models, arguments supported by evidence, student questions, and investigations.
- Summative assessments include all three dimensions; students show that they know the DCI through the lens of a given CCC, and also show proficiency in the SEP.

Professional Planning

- Continue to participate in PD and PLCs, focusing on staying current on content.
- Use reflections in lesson and storyline planning.

Unit Planning and Storylines

- The year is built as an overarching storyline made of smaller, interconnected ones. Each storyline includes an anchor phenomenon and learning episodes that build students’ knowledge/skills to explain the anchor phenomenon.
- Reflect on storylines as you teach and after you complete each; determine what changes could lead to improved student understanding in the future.
Strand 7.1: FORCES ARE INTERACTIONS BETWEEN MATTER

Forces are push or pull interactions between two objects. Changes in motion, balance and stability, and transfers of energy are all facilitated by forces on matter. Forces, including electric, magnetic, and gravitational forces, can act on objects that are not in contact with each other. Scientists use data from many sources to examine the cause and effect relationships determined by different forces.

Strand 7.1.1: MOTION AND STABILITY: FORCES AND INTERACTIONS

Students who demonstrate understanding can:

**Carry out an investigation** which provides evidence that a change in an object’s motion is dependent on the mass of the object and the sum of the forces acting on it. Various experimental designs should be evaluated to determine how well the investigation measures an object’s motion. Emphasize conceptual understanding of Newton’s First and Second Laws. Calculations will only focus on one-dimensional movement; the use of vectors will be introduced in high school.

Science and Engineering Practices

**Planning and Carrying out Investigations**

Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.

- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

**Connections to Nature of Science**

Scientific Knowledge is Based on Empirical Evidence

- Science knowledge is based upon logical and conceptual connections between evidence and explanations.

Disciplinary Core Ideas

**Forces and Motion**

- The motion of an object is determined by the sum of the forces acting on it; the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.

- All positions of objects and the direction of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people. These choices must also be shared.

Crosscutting Concepts

**Stability and Change**

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales.

1. **Identifying the phenomenon to be investigated**
   - A. Students identify the phenomenon under investigation, which includes the change in motion of an object.
   - B. Students identify the purpose of the investigation, which includes providing evidence that the change in an object’s motion is due to the following factors:
     - i. Balanced or unbalanced forces acting on the object.
     - ii. The mass of the object.

2. **Identifying the evidence to address the purpose of the investigation**
   - A. Students develop a plan for the investigation individually or collaboratively. In the plan, students describe:
     - i. That the following data will be collected:
       1. Data on the motion of the object.
       2. Data on the total forces acting on the object.
       3. Data on the mass of the object.
     - ii. Which data are needed to provide evidence for each of the following:
       1. An object subjected to balanced forces does not change its motion (sum of F=0).
       2. An object subjected to unbalanced forces changes its motion over time (sum of F≠0).
       3. The change in the motion of an object subjected to unbalanced forces depends on the mass of the object.
Strand 7.1: FORCES ARE INTERACTIONS BETWEEN MATTER
Forces are push or pull interactions between two objects. Changes in motion, balance and stability, and transfers of energy are all facilitated by forces on matter. Forces, including electric, magnetic, and gravitational forces, can act on objects that are not in contact with each other. Scientists use data from many sources to examine the cause and effect relationships determined by different forces.

Strand 7.1.1: MOTION AND STABILITY: FORCES AND INTERACTIONS
Students who demonstrate understanding can:

**Carry out an investigation** which provides evidence that a change in an object’s motion is dependent on the mass of the object and the sum of the forces acting on it. Various experimental designs should be evaluated to determine how well the investigation measures an object’s motion. Emphasize conceptual understanding of Newton’s First and Second Laws. Calculations will only focus on one-dimensional movement; the use of vectors will be introduced in high school.

3. **Planning the investigation**
   A. In the investigation plan, students describe:
      i. How the following factors will be determined and measured:
         1. The motion of the object, including a specified reference frame and appropriate units for distance and time.
         2. The mass of the object, including appropriate units.
         3. The forces acting on the object, including balanced and unbalanced forces.
      ii. Which factors will serve as independent and dependent variables in the investigation (e.g., mass is an independent variable, forces and motion can be independent or dependent).
      iii. The controls for each experimental condition.
      iv. The number of trials for each experimental condition.
Strand 7.1: FORCES ARE INTERACTIONS BETWEEN MATTER

Forces are push or pull interactions between two objects. Changes in motion, balance and stability, and transfers of energy are all facilitated by forces on matter. Forces, including electric, magnetic, and gravitational forces, can act on objects that are not in contact with each other. Scientists use data from many sources to examine the cause and effect relationships determined by different forces.

Strand 7.1.2: MOTION AND STABILITY: FORCES AND INTERACTIONS

Students who demonstrate understanding can:
Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects in a system. Examples could include collisions between two moving objects or between a moving object and a stationary object.

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<td>Constructing Explanations and Designing Solutions</td>
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<tr>
<td>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.</td>
<td>• For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton’s third law).</td>
<td>• Models can be used to represent systems and their interactions – such as inputs, processes and outputs – and energy and matter flows within systems.</td>
</tr>
<tr>
<td>• Apply scientific ideas or principles to design an object, tool, process or system.</td>
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<td></td>
</tr>
<tr>
<td>1. Using scientific knowledge to generate solutions</td>
<td>2. Describing criteria and constraints, including quantification when appropriate</td>
<td>3. Evaluating potential solutions</td>
</tr>
<tr>
<td>A. Given a problem to solve involving a collision of two objects, students design a solution (e.g., an object, tool, process, or system). In their designs, students identify and describe:</td>
<td>A. Students describe the given criteria and constraints, including how they will be taken into account when designing the solution.</td>
<td>A. Students use their knowledge of Newton’s third law to systematically determine how well the design solution meets the criteria and constraints.</td>
</tr>
<tr>
<td>i. The components within the system that are involved in the collision.</td>
<td>i. Students describe how the criteria are appropriate to solve the given problem.</td>
<td>B. Students identify the value of the device for society.</td>
</tr>
<tr>
<td>ii. The force that will be exerted by the first object on the second object.</td>
<td>ii. Students describe the constraints, which may include:</td>
<td>C. Students determine how the choice of technologies that are used in the design is affected by the constraints of the problem and the limits of technological advances.</td>
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<tr>
<td>iii. How Newton’s third law will be applied to design the solution to the problem.</td>
<td>1. Cost.</td>
<td></td>
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<td>iv. The technologies (i.e., any human-made material or device) that will be used in the solution.</td>
<td>2. Mass and speed of objects.</td>
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<tr>
<td>2. Describing criteria and constraints, including quantification when appropriate</td>
<td>3. Time.</td>
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<tr>
<td>A. Students describe the given criteria and constraints, including how they will be taken into account when designing the solution.</td>
<td>4. Materials.</td>
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<td>i. Students describe how the criteria are appropriate to solve the given problem.</td>
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Forces are push or pull interactions between two objects. Changes in motion, balance and stability, and transfers of energy are all facilitated by forces on matter. Forces, including electric, magnetic, and gravitational forces, can act on objects that are not in contact with each other. Scientists use data from many sources to examine the cause and effect relationships determined by different forces.

**Strand 7.1.3: MOTION AND STABILITY: FORCES AND INTERACTIONS**

Students who demonstrate understanding can: Construct a model using observational evidence to describe the nature of fields existing between objects that exert forces on each other even though the objects are not in contact. Emphasize the cause and effect relationship between properties of objects (such as magnets or electrically-charged objects) and the forces they exert.

### Science and Engineering Practices

#### Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions to test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.

- Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation.

### Disciplinary Core Ideas

#### Types of Interactions

- Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively).

### Crosscutting Concepts

#### Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

### 1. Identifying the phenomenon to be investigated

A. From the given investigation plan, students identify the phenomenon under investigation, which includes the idea that objects can interact at a distance.

B. Students identify the purpose of the investigation, which includes providing evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

### 2. Identifying evidence to address the purpose of the investigation

A. From the given plan, students identify and describe the data that will be collected to provide evidence for each of the following:

   i. Evidence that two interacting objects can exert forces on each other even though the two interacting objects are not in contact with each other.

   ii. Evidence that distinguishes between electric and magnetic forces

   iii. Evidence that the cause of a force on one object is the interaction with the second object (e.g., evidence for the presence of force disappears when the second object is removed from the vicinity of the first).

### 3. Planning the investigation

A. Students describe the rationale for why the given investigation plan includes:

   i. Changing the distance between objects.

   ii. Changing the charge or magnetic orientation of objects.

   iii. Changing the magnitude of the charge on an object or the strength of the magnetic field.

   iv. A means to indicate or measure the presence of electric or magnetic forces.

### 4. Collecting the data

A. Students make and record observations according to the given plan. The data recorded may include observations of:

   i. Motion of objects

   ii. Suspension of objects.

   iii. Simulations of objects that produce either electric or magnetic fields through space and the effects of moving those objects closer to or farther away from each other.

   iv. A push or pull exerted on the hand of an observer holding an object.
Strand 7.1: FORCES ARE INTERACTIONS BETWEEN MATTER

Forces are push or pull interactions between two objects. Changes in motion, balance and stability, and transfers of energy are all facilitated by forces on matter. Forces, including electric, magnetic, and gravitational forces, can act on objects that are not in contact with each other. Scientists use data from many sources to examine the cause and effect relationships determined by different forces.

Strand 7.1.3: MOTION AND STABILITY: FORCES AND INTERACTIONS

Students who demonstrate understanding can:
Construct a model using observational evidence to describe the nature of fields existing between objects that exert forces on each other even though the objects are not in contact. Emphasize the cause and effect relationship between properties of objects (such as magnets or electrically-charged objects) and the forces they exert.

5. Evaluation of the design
   A. Students evaluate the experimental design by assessing whether or not the data produced by the investigation can provide evidence that fields exist between objects that act on each other even though the objects are not in contact.
Strand 7.1: FORCES ARE INTERACTIONS BETWEEN MATTER

Forces are push or pull interactions between two objects. Changes in motion, balance and stability, and transfers of energy are all facilitated by forces on matter. Forces, including electric, magnetic, and gravitational forces, can act on objects that are not in contact with each other. Scientists use data from many sources to examine the cause and effect relationships determined by different forces.

Strand 7.1.4: MOTION AND STABILITY: FORCES AND INTERACTIONS

Students who demonstrate understanding can:

Collect and analyze data to determine the factors that affect the strength of electric and magnetic forces. Examples could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or of increasing the number or strength of magnets on the speed of an electric motor.

Science and Engineering Practices

Asking Questions and Defining Problems

Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

• Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate frame a hypothesis based on observations and scientific principles.

Disciplinary Core Ideas

Types of Interactions

• Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.

Crosscutting Concepts

Cause and Effect

• Cause and effect relationships may be used to predict phenomena in natural or designed systems.

1. Addressing phenomena of the natural world or scientific theories

A. Students formulate questions that arise from examining given data of objects (which can include particles) interacting through electric and magnetic forces, the answers to which would clarify:

i. The cause-and-effect relationships that affect magnetic forces due to:

1. The magnitude of any electric current present in the interaction, or other factors related to the effect of the electric current (e.g., number of turns of wire in a coil).

2. The distance between the interacting objects.

3. The relative orientation of the interacting objects

4. The magnitude of the magnetic strength of the interacting objects.

ii. The cause-and-effect relationship that affect electric forces due to:

1. The magnitude and signs of the electric charges on the interacting objects

2. The distances between the interacting objects.

3. Magnetic forces.

B. Based on scientific principles and given data, students frame hypotheses that:

i. Can be used to predict the strength of electric and magnetic forces due to cause-and-effect relationships.

ii. Can be used to distinguish between possible outcomes, based on an understanding of the cause-and-effect relationships driving the system.

2. Identifying the scientific nature of the question

A. Students’ questions can be investigated scientifically within the scope of a classroom, outdoor environment, museum, or other public facility.
Strand 7.1: FORCES ARE INTERACTIONS BETWEEN MATTER

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Strand 7.1.5: MOTION AND STABILITY: FORCES AND INTERACTIONS

Students who demonstrate understanding can:
Engage in argument from evidence to support the claim that gravitational interactions within a system are attractive and dependent upon the masses of interacting objects. Examples of evidence for arguments could include mathematical data generated from various simulations.

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<tr>
<td>Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.</td>
<td>• Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun.</td>
<td>• Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems.</td>
</tr>
<tr>
<td>• Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.</td>
<td>Crosscutting Concepts</td>
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<tr>
<td>Connections to Nature of Science</td>
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<tr>
<td>Scientific Knowledge is Based on Empirical Evidence</td>
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<td></td>
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<tr>
<td>• Science knowledge is based upon logical and conceptual connections between evidence and explanations.</td>
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1. Supported Claims
   A. Students make a claim to be supported about a given phenomenon. In their claim, students include the following idea: Gravitational interactions are attractive and depend on the masses of interacting objects.

2. Identifying scientific Evidence
   A. Students identify and describe the given evidence that supports the claim, including:
      i. The masses of objects in the relevant system(s).
      ii. The relative magnitude and direction of the forces between objects in the relevant system(s).

3. Evaluating and Critiquing the evidence
   A. Students evaluate the evidence and identify its strengths and weaknesses, including:
      i. Types of sources.
      ii. Sufficiency, including validity and reliability, of the evidence to make and defend the claim.
      iii. Any alternative interpretations of the evidence, and why the evidence supports the given claim as opposed to any other claims.

4. Reasoning and synthesis
   A. Students use reasoning to connect the appropriate evidence about the forces on objects and construct the argument that gravitational forces are attractive and mass dependent. Students describe the following chain of reasoning:
      i. Systems of objects can be modeled as a set of masses interacting via gravitational forces.
      ii. In systems of objects, larger masses experience and exert proportionally larger gravitational forces.
      iii. In every case for which evidence exists, gravitational force is attractive.
   B. To support the claim, students present their oral or written argument concerning the direction of gravitational forces and the role of the mass of the interacting objects.
Strand 7.2: Changes to Earth Overtime

Earth’s processes are dynamic and interactive, and are the result of energy flowing and matter cycling within and among Earth’s systems. Energy from the sun and Earth’s internal heat are the main sources driving these processes. Plate tectonics is a unifying theory that explains crustal movements of Earth’s surface, how and where different rocks form, the occurrence of earthquakes and volcanoes, and the distribution of fossil plants and animals.

Strand 7.2.1: Earth’s Systems

Students who demonstrate understanding can: Develop a model of the rock cycle to describe the relationship between energy flow and matter cycling that create igneous, sedimentary, and metamorphic rocks. Emphasize the processes of melting, crystallization, weathering, deposition, sedimentation, and deformation, which act together to form minerals and rocks.

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<td><strong>Developing and Using Models</strong></td>
<td><strong>Earth’s Materials and Systems</strong></td>
<td><strong>Stability and Change</strong></td>
</tr>
<tr>
<td>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</td>
<td>• All Earth processes are the result of energy flowing and matter cycling within and among the planet’s systems. This energy is derived from the sun and Earth’s hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth’s materials and living organisms.</td>
<td>• Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.</td>
</tr>
</tbody>
</table>

1. **Components of the model**
   A. To make sense of a given phenomenon, students develop a model in which they identify the relevant components, including:
      i. General types of Earth materials that can be found in different locations, including:
         1. Those located at the surface (exterior) and/or in the interior
         2. Those that exist(ed) before and/or after chemical and/or physical changes that occur during Earth processes (e.g., melting, sedimentation, weathering).
      ii. Energy from the sun.
      iii. Energy from the Earth’s hot interior
      iv. Relevant earth processes
      v. The temporal and spatial scales for the system.

2. **Relationships**
   A. In the model, students describe relationships between components, including:
      i. Different Earth processes (e.g., melting, sedimentation, crystallization) drive matter cycling (i.e., from one type of Earth material to another) through observable chemical and physical changes.
      ii. The movement of energy that originates from the Earth’s hot interior and causes the cycling of matter through the Earth processes of melting, crystallization, and deformation.
      iii. Energy flows from the sun cause matter cycling via processes that produce weathering, erosion, and sedimentation (e.g., wind, rain).
      iv. The temporal and spatial scales over which the relevant Earth processes operate.
Strand 7.2: Changes to Earth Overtime

Earth’s processes are dynamic and interactive, and are the result of energy flowing and matter cycling within and among Earth’s systems. Energy from the sun and Earth’s internal heat are the main sources driving these processes. Plate tectonics is a unifying theory that explains crustal movements of Earth’s surface, how and where different rocks form, the occurrence of earthquakes and volcanoes, and the distribution of fossil plants and animals.

Strand 7.2.1: Earth’s Systems

Students who demonstrate understanding can:

**Develop a model of** the rock cycle to describe the relationship between energy flow and matter cycling that create igneous, sedimentary, and metamorphic rocks. Emphasize the processes of melting, crystallization, weathering, deposition, sedimentation, and deformation, which act together to form minerals and rocks.

### 3. Connections

A. Students use the model to describe (based on evidence for changes over time and processes at different scales) that energy from the Earth’s interior and the sun drive Earth processes that together cause matter cycling through different forms of Earth materials.

B. Students use the model to account for interactions between different Earth processes, including:
   i. The Earth’s internal heat energy drives processes such as melting, crystallization, and deformation that change the atomic arrangement of elements in rocks and that move and push rock material to the Earth’s surface where it is subject to surface processes like weathering and erosion.
   ii. Energy from the sun drives the movement of wind and water that causes the erosion, movement, and sedimentation of weathered Earth materials.
   iii. Given the right setting, any rock on Earth can be changed into a new type of rock by processes driven by the Earth’s internal energy or by energy from the sun.

C. Students describe that these changes are consistently occurring but that landforms appear stable to humans because they are changing on time scales much longer than human lifetimes.
**Strand 7.2: Changes to Earth Overtime**

Earth’s processes are dynamic and interactive, and are the result of energy flowing and matter cycling within and among Earth’s systems. Energy from the sun and Earth’s internal heat are the main sources driving these processes. Plate tectonics is a unifying theory that explains crustal movements of Earth’s surface, how and where different rocks form, the occurrence of earthquakes and volcanoes, and the distribution of fossil plants and animals.

**Strand 7.2.2: Earth’s Systems**

Students who demonstrate understanding can:

**Construct an explanation** based on evidence for how processes have changed Earth’s surface at varying time and spatial scales. Examples of processes that occur at varying time scales could include slow plate motions or rapid landslides. Examples of processes that occur at varying spatial scales could include uplift of a mountain range or deposition of fine sediments.

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<td>Scale Proportion and Quantity</td>
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<tr>
<td>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.</td>
<td>• The planet’s systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth’s history and will determine its future.</td>
<td>• Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.</td>
</tr>
<tr>
<td>• Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe nature operate today as they did in the past and will continue to do so in the future.</td>
<td><strong>The Roles of Water in Earth’s Surface Processes</strong></td>
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<td></td>
<td>• Water’s movements—both on the land and underground—cause weathering and erosion, which change the land’s surface features and create underground formations.</td>
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1. **Articulating the explanation of phenomena**
   A. Students articulate a statement that relates a given phenomenon to a scientific idea, including that geoscience processes have changed the Earth’s surface at varying time and spatial scales.
   B. Students use evidence and reasoning to construct an explanation for the given phenomenon, which involves changes at Earth’s surface.

2. **Evidence**
   A. Students identify and describe the evidence necessary for constructing an explanation, including:
      i. The slow and large-scale motion of the Earth’s plates and the results of that motion
      ii. Surface weathering, erosion, movement, and the deposition of sediment ranging from large to microscopic scales (e.g., sediment consisting of boulders and microscopic grains of sand, raindrops dissolving microscopic amounts of minerals).
      iii. Rapid catastrophic events (e.g., earthquakes, volcanoes, meteor impacts).
   B. Students identify the corresponding timescales for each identified geoscience process.
   C. Students use multiple valid and reliable sources, which may include students’ own investigations, evidence from data, and observations from conceptual models used to represent changes that occur on very large or small spatial and/or temporal scales (e.g., stream tables to illustrate erosion and deposition, maps and models to show the motion of tectonic plates).
**Strand 7.2: Changes to Earth Overtime**

Earth’s processes are dynamic and interactive, and are the result of energy flowing and matter cycling within and among Earth’s systems. Energy from the sun and Earth’s internal heat are the main sources driving these processes. Plate tectonics is a unifying theory that explains crustal movements of Earth’s surface, how and where different rocks form, the occurrence of earthquakes and volcanoes, are the distribution of fossil plants and animals.

**Strand 7.2.2: Earth’s Systems**

Students who demonstrate understanding can:

**Construct an explanation** based on evidence for how processes have changed Earth’s surface at varying time and spatial scales. Examples of processes that occur at varying time scales could include slow plate motions or rapid landslides. Examples of processes that occur at varying spatial scales could include uplift of a mountain range or deposition of fine sediments.

3. **Reasoning**

   A. Students use reasoning, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to connect the evidence and support an explanation for how geoscience processes have changed the Earth’s surface at a variety of temporal and spatial scales. Students describe the following chain of reasoning for their explanation:

   i. The motion of the Earth’s plates produces changes on a planetary scale over a range of time periods from millions to billions of years. Evidence for the motion of plates can explain large-scale features of the Earth’s surface (e.g., mountains, distribution of continents) and how they change.

   ii. Surface processes such as erosion, movement, weathering, and the deposition of sediment can modify surface features, such as mountains, or create new features, such as canyons. These processes can occur at spatial scales ranging from large to microscopic over time periods ranging from years to hundreds of millions of years.

   iii. Catastrophic changes can modify or create surface features over a very short period of time compared to other geoscience processes, and the results of those catastrophic changes are subject to further changes over time by processes that act on longer time scales (e.g., erosion of a meteor crater).

   iv. A given surface feature is the result of a broad range of geoscience processes occurring at different temporal and spatial scales.

   v. Surface features will continue to change in the future as geoscience processes continue to occur.
**Strand 7.2: Changes to Earth Overtime**

Earth’s processes are dynamic and interactive, and are the result of energy flowing and matter cycling within and among Earth’s systems. Energy from the sun and Earth’s internal heat are the main sources driving these processes. Plate tectonics is a unifying theory that explains crustal movements of Earth’s surface, how and where different rocks form, the occurrence of earthquakes and volcanoes, and the distribution of fossil plants and animals.

**Strand 7.2.3: Engineering Design**

Students who demonstrate understanding can:

**Ask questions** to identify constraints of specific geologic hazards and evaluate competing design solutions for maintaining the stability of human-engineered structures, such as homes, roads, and bridges. Examples of geologic hazards could include earthquakes, landslides, or floods.

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<td><strong>Asking Questions and Defining Problems</strong></td>
<td><strong>Defining and Delimiting Engineering Problems</strong></td>
<td><strong>Influence of Science, Engineering, and Technology on Society and the Natural World</strong></td>
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<tr>
<td>Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.</td>
<td>• The more precisely a design task’s criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.</td>
<td>• All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.</td>
</tr>
<tr>
<td>• Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge.</td>
<td></td>
<td>• The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.</td>
</tr>
</tbody>
</table>

1. **Identifying the problem to be solved**
   A. Students describe a problem that can be solved through the development of an object, tool, process, or system.

2. **Defining the process or system boundaries and the components of the process or system**
   A. Students identify the system in which the problem is embedded, including the major components and relationships in the system and its boundaries, to clarify what is and is not part of the problem. In their definition of the system, students include:
   i. Which individuals or groups need this problem to be solved.
   ii. The needs that must be met by solving the problem.
   iii. Scientific issues that are relevant to the problem.
   iv. Potential societal and environmental impacts of solutions
   v. The relative importance of the various issues and components of the process or system.
**Strand 7.2: Changes to Earth Overtime**

Earth’s processes are dynamic and interactive, and are the result of energy flowing and matter cycling within and among Earth’s systems. Energy from the sun and Earth’s internal heat are the main sources driving these processes. Plate tectonics is a unifying theory that explains crustal movements of Earth’s surface, how and where different rocks form, the occurrence of earthquakes and volcanoes, are the distribution of fossil plants and animals.

**Strand 7.2.3: Engineering Design**

Students who demonstrate understanding can:

**Ask questions** to identify constraints of specific geologic hazards and evaluate competing design solutions for maintaining the stability of human-engineered structures, such as homes, roads, and bridges. Examples of geologic hazards could include earthquakes, landslides, or floods.

3. **Defining criteria and constraints**
   
   A. Students define criteria that must be taken into account in the solution that:
      
      i. Meet the needs of the individuals or groups who may be affected by the problem (including defining who will be the target of the solution).
      
      ii. Enable comparisons among different solutions, including quantitative considerations when appropriate.
   
   B. Students define constraints that must be taken into account in the solution, including:
      
      i. Time, materials, and costs.
      
      ii. Scientific or other issues that are relevant to the problem.
      
      iii. Needs and desires of the individuals or groups involved that may limit acceptable solutions.
      
      iv. Safety considerations.
      
      v. Potential effect(s) on other individuals or groups
      
      vi. Potential negative environmental effects of possible solutions or failure to solve the problem.
# 7.2: Changes to Earth Overtime

All Earth processes are the result of energy flowing and matter cycling within and among the planet’s systems. Heat energy from the Sun, transmitted by radiation, is the primary source of energy that affects Earth’s weather and drives the water cycle. Uneven heating across Earth’s surface causes changes in density, which result in convection currents in water and air, creating patterns of atmospheric and oceanic circulation that determine regional and global climates.

## Strand 7.2.4:

Students who demonstrate understanding can:

**Develop and use a scale model** of the matter in the Earth’s interior to demonstrate how differences in density and chemical composition (silicon, oxygen, iron, and magnesium) cause the formation of the crust, mantle, and core.

No evidence statements available as of July 2017
Strand 7.2: Changes to Earth Overtime

Earth’s processes are dynamic and interactive, and are the result of energy flowing and matter cycling within and among Earth’s systems. Energy from the sun and Earth’s internal heat are the main sources driving these processes. Plate tectonics is a unifying theory that explains crustal movements of Earth’s surface, how and where different rocks form, the occurrence of earthquakes and volcanoes, are the distribution of fossil plants and animals.

Strand 7.2.5: Earth’s Systems

Students who demonstrate understanding can:

Ask questions and analyze and interpret data about the patterns between plate tectonics and:

1) The occurrence of earthquakes and volcanoes.
2) Continental and Ocean floor features.
3) The distribution of rocks and fossils.

Examples could include identifying patterns on maps of earthquakes and volcanoes relative to plate boundaries, the shapes of the continents, the locations of ocean structures (including mountains, volcanoes, faults, and trenches), and similarities of rock and fossil types on different continents.

Science and Engineering Practices

Analyzing and Interpreting Data
Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

• Analyze and interpret data to provide evidence for phenomena.

Connections to Nature of Science

Scientific Knowledge is Open to Revision in Light of New Evidence

• Science findings are frequently revised and/or reinterpreted based on new evidence.

Disciplinary Core Ideas

The History of Planet Earth
• Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches.

Plate Tectonics and Large-Scale System Interactions
• Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth’s plates have moved great distances

Crosscutting Concepts

Patterns
• Patterns in rates of change and other numerical relationships can provide information about natural systems.

Patterns

1. Organizing data
A. Students organize given data that represent the distribution and ages of fossils and rocks, continental shapes, seafloor structures, and/or age of oceanic crust.
B. Students describe what each dataset represents.
C. Students organize the given data in a way that facilitates analysis and interpretation.

2. Identifying relationships
A. Students analyze the data to identify relationships (including relationships that can be used to infer numerical rates of change, such as patterns of age of seafloor) in the datasets about Earth features.

3. Interpreting data
A. Students use the analyzed data to provide evidence for past plate motion. Students describe:
   i. Regions of different continents that share similar fossils and similar rocks suggest that, in the geologic past, those sections of continent were once attached and have since separated.
   ii. The shapes of continents, which roughly fit together (like pieces in a jigsaw puzzle) suggest that those land masses were once joined and have since separated.
   iii. The separation of continents by the sequential formation of new seafloor at the center of the ocean is inferred by age patterns in oceanic crust that increase in age from the center of the ocean to the edges of the ocean.
   iv. The distribution of seafloor structures (e.g., volcanic ridges at the centers of oceans, trenches at the edges of continents) combined with the patterns of ages of rocks of the seafloor (youngest ages at the ridge, oldest ages at the trenches) supports the interpretation that new crust forms at the ridges and then moves away from the ridges as new crust continues to form and that the oldest crust is being destroyed at seafloor trenches.
Strand 7.2: Changes to Earth Overtime

Earth’s processes are dynamic and interactive, and are the result of energy flowing and matter cycling within and among Earth’s systems. Energy from the sun and Earth’s internal heat are the main sources driving these processes. Plate tectonics is a unifying theory that explains crustal movements of Earth’s surface, how and where different rocks form, the occurrence of earthquakes and volcanoes, and the distribution of fossil plants and animals.

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**Strand 7.2.6: Earth’s Place in the Universe**

Students who demonstrate understanding can:

Make an argument from evidence for how the geologic time scale shows the age and history of Earth. Emphasize scientific evidence from rock strata, the fossil record, and the principles of relative dating, such as superposition, uniformitarianism and recognizing unconformities.

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<td><strong>Constructing Explanations and Designing Solutions</strong></td>
<td><strong>The History of Planet Earth</strong></td>
<td><strong>Scale, Proportion, and Quantity</strong></td>
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<tr>
<td>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.</td>
<td>- The geologic time scale interpreted from rock strata provides a way to organize Earth’s history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale.</td>
<td>- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.</td>
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<tr>
<td><strong>• Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.</strong></td>
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</table>

1. **Articulating the explanation of phenomena**
   A. Students articulate a statement that relates the given phenomenon to a scientific idea, including how events in the Earth’s 4.6 billion-year-old history are organized relative to one another using the geologic time scale.
   B. Students use evidence and reasoning to construct an explanation. In their explanation, students describe how the relative order of events is determined on the geologic time scale using:
      i. Rock strata and relative ages of rock units (e.g., patterns of layering).
      ii. Major events in the Earth’s history and/or specific changes in fossils over time (e.g., formation of mountain chains, formation of ocean basins, volcanic eruptions, glaciations, asteroid impacts, extinctions of groups of organism).

2. **Evidence**
   A. Students identify and describe the evidence necessary for constructing the explanation, including:
      i. Types and order of rock strata.
      ii. The fossil record.
      iii. Identification of and evidence for major event(s) in the Earth’s history (e.g., volcanic eruptions, asteroid impacts, etc.).
   B. Students use multiple valid and reliable sources of evidence, which may include students’ own experiments.
**Strand 7.2: Changes to Earth Overtime**

Earth’s processes are dynamic and interactive, and are the result of energy flowing and matter cycling within and among Earth’s systems. Energy from the sun and Earth’s internal heat are the main sources driving these processes. Plate tectonics is a unifying theory that explains crustal movements of Earth’s surface, how and where different rocks form, the occurrence of earthquakes and volcanoes, and the distribution of fossil plants and animals.

**Strand 7.2.6: Earth’s Place in the Universe**

Students who demonstrate understanding can:

**Make an argument from evidence** for how the geologic time scale shows the age and history of Earth. Emphasize scientific evidence from rock strata, the fossil record, and the principles of relative dating, such as superposition, uniformitarianism and recognizing unconformities.

3. **Reasoning**

   A. Students use reasoning, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to connect the evidence and support an explanation for how the geologic time scale is used to construct a timeline of the Earth’s history. Students describe the following chain of reasoning for their explanation:

   i. Unless they have been disturbed by subsequent activity, newer rock layers sit on top of older rock layers, allowing for a relative ordering in time of the formation of the layers (i.e., older sedimentary rocks lie beneath younger sedimentary rocks).

   ii. Any rocks or features that cut existing rock strata are younger than the rock strata that they cut (e.g., a younger fault cutting across older, existing rock strata).

   iii. The fossil record can provide relative dates based on the appearance or disappearance of organisms (e.g., fossil layers that contain only extinct animal groups are usually older than fossil layers that contain animal groups that are still alive today, and layers with only microbial fossils are typical of the earliest evidence of life).

   iv. Specific major events (e.g., extensive lava flows, volcanic eruptions, asteroid impacts) can be used to indicate periods of time that occurred before a given event from periods that occurred after it.

   v. Using a combination of the order of rock layers, the fossil record, and evidence of major geologic events, the relative time ordering of events can be constructed as a model for Earth’s history, even though the timescales involved are immensely vaster than the lifetimes of humans or the entire history of humanity.
**Strand 7.3: STRUCTURE AND FUNCTION OF LIFE**

Living things are made of smaller structures, which function to meet the needs of survival. The basic structural unit of all living things is the cell. Parts of a cell work together to function as a system. Cells work together and form tissues, organs, and organ systems. Organ systems interact to meet the needs of the organism.

**Strand 7.3.1: FROM MOLECULES TO ORGANISMS: STRUCTURE AND PROCESSES**

Students who demonstrate understanding can:

**Plan and carry out an investigation** that provides evidence that the basic structures of living things are cells. Emphasize that cells can form single-celled or multicellular organisms, and that multicellular organisms are made of different types of cells.

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<td><strong>Investigations</strong></td>
<td>● All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).</td>
<td>● Phenomena that can be observed at one scale may not be observable at another scale.</td>
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<td></td>
<td><em>Connections to Engineering, Technology and Applications of Science</em></td>
</tr>
<tr>
<td><em>Interdependence of Science, Engineering, and Technology</em></td>
<td>● Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.</td>
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</table>

1. **Identifying the phenomenon under investigation**
   A. From the given investigation plan, students identify and describe the phenomenon under investigation, which includes the idea that living things are made up of cells.
   B. Students identify and describe the purpose of the investigation, which includes providing evidence for the following ideas: that all living things are made of cells (either one cell or many different numbers and types of cells) and that the cell is the smallest unit that can be said to be alive.

2. **Identifying the evidence to address the purpose of the investigation**
   A. From the given investigation plan, students describe the data that will be collected and the evidence to be derived from the data, including:
   i. The presence or absence of cells in living and nonliving things.
   ii. The presence or absence of any part of a living thing that is not made up of cells.
   iii. The presence or absence of cells in a variety of organisms, including unicellular and multicellular organisms.
   iv. Different types of cells within one multicellular organism.
   B. Students describe how the evidence collected will be relevant to the purpose of the investigation.

3. **Planning the investigation**
   A. From the given investigation plan, students describe how the tools and methods included in the experimental design will provide the evidence necessary to address the purpose of the investigation, including that due to their small-scale size, cells are unable to be seen with the unaided eye and require engineered magnification devices to be seen.
   B. Students describe how the tools used in the investigation are an example of how science depends on engineering advances.
Living things are made of smaller structures, which function to meet the needs of survival. The basic structural unit of all living things is the cell. Parts of a cell work together to function as a system. Cells work together and form tissues, organs, and organ systems. Organ systems interact to meet the needs of the organism.

**Strand 7.3.1: FROM MOLECULES TO ORGANISMS: STRUCTURE AND PROCESSES**

Students who demonstrate understanding can:

**Plan and carry out an investigation** that provides evidence that the basic structures of living things are cells. Emphasize that cells can form single-celled or multicellular organisms, and that multicellular organisms are made of different types of cells.

4. **Collecting the data**
   
   A. According to the given investigation plan, students collect and record data on the cellular composition of living organisms
   
   B. Students identify the tools used for observation at different magnifications and describe that different tools are required to observe phenomena related to cells at different scales.
   
   C. Students evaluate the data they collect to determine whether the resulting evidence meets the goals of the investigation, including cellular composition as a distinguishing feature of living things.
Living things are made of smaller structures, which function to meet the needs of survival. The basic structural unit of all living things is the cell. Parts of a cell work together to function as a system. Cells work together and form tissues, organs, and organ systems. Organ systems interact to meet the needs of the organism.

Students who demonstrate understanding can:

**Develop and use a model** to describe the function of a cell in living systems and the way parts of cells contribute to cell function. Emphasize the cell as a system, including the interrelating roles of the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.

### Components of the model

A. To make sense of a phenomenon, students develop a model in which they identify the parts (i.e., components; e.g., nucleus, chloroplasts, cell wall, mitochondria, cell membrane, the function of a cell as a whole) of cells relevant for the given phenomenon.

### Relationships

A. In the model, students describe the relationships between components, including:
   
   i. The particular functions of parts of cells in terms of their contributions to overall cellular functions (e.g., chloroplasts’ involvement in photosynthesis and energy production, mitochondria’s involvement in cellular respiration).
   
   ii. The structure of the cell membrane or cell wall and its relationship to the function of the organelles and the whole cell.

### Connections

A. Students use the model to describe a causal account for the phenomenon, including how different parts of a cell contribute to how the cell functions as a whole, both separately and together with other structures. Students include how components, separately and together, contribute to:
   
   i. Maintaining a cell’s internal processes, for which it needs energy.
   
   ii. Maintaining the structure of the cell and controlling what enters and leaves the cell.
   
   iii. Functioning together as parts of a system that determines cellular function.

B. Students use the model to identify key differences between plant and animal cells based on structure and function, including:
   
   i. Plant cells have a cell wall in addition to a cell membrane, whereas animal cells have only a cell membrane. Plants use cell walls to provide structure to the plant.
   
   ii. Plant cells contain organelles called chloroplasts, while animal cells do not. Chloroplasts allow plants to make the food they need to live using photosynthesis.
**Strand 7.3: STRUCTURE AND FUNCTION OF LIFE**

Living things are made of smaller structures, which function to meet the needs of survival. The basic structural unit of all living things is the cell. Parts of a cell work together to function as a system. Cells work together and form tissues, organs, and organ systems. Organ systems interact to meet the needs of the organism.

**Strand 7.3.3: FROM MOLECULES TO ORGANISMS: STRUCTURE AND PROCESSES**

Students who demonstrate understanding can:

**Construct an explanation** using evidence to explain how body systems have various levels of organization. Emphasize understanding that cells form tissues, tissues form organs, and organs form systems specialized for particular body functions. Examples could include relationships between the circulatory, excretory, digestive, respiratory, muscular, skeletal, and nervous systems. Specific organ functions will be taught at the high school level.

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<td><strong>Engaging in Argument from Evidence</strong></td>
<td><strong>Structure and Function</strong></td>
<td><strong>Systems and System Models</strong></td>
</tr>
<tr>
<td>Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).</td>
<td>• In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.</td>
<td>• Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.</td>
</tr>
<tr>
<td>• Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon.</td>
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<td><strong>Connections to Nature of Science</strong></td>
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</table>

1. **Supported claims**

   A. Students make a claim to be supported, related to a given explanation or model of a phenomenon. In the claim, students include the idea that the body is a system of interacting subsystems composed of groups of cells.

2. **Identifying scientific evidence**

   A. Students identify and describe the given evidence that supports the claim (e.g., evidence from data and scientific literature), including evidence that:

   i. Specialized groups of cells work together to form tissues (e.g., evidence from data about the kinds of cells found in different tissues, such as nervous, muscular, and epithelial, and their functions).
   
   ii. Specialized tissues comprise each organ, enabling the specific organ functions to be carried out (e.g., the heart contains muscle, connective, and epithelial tissues that allow the heart to receive and pump blood).
   
   iii. Different organs can work together as subsystems to form organ systems that carry out complex functions (e.g., the heart and blood vessels work together as the circulatory system to transport blood and materials throughout the body).
   
   iv. The body contains organs and organ systems that interact with each other to carry out all necessary functions for survival and growth of the organism (e.g., the digestive, respiratory, and circulatory systems are involved in the breakdown and transport of food and the transport of oxygen throughout the body to cells, where the molecules can be used for energy, growth, and repair).

3. **Evaluating and critiquing the evidence**

   A. Students evaluate the evidence and identify the strengths and weaknesses of the evidence, including:

   i. Types of sources.
   
   ii. Sufficiency, including validity and reliability, of the evidence to make and defend the claim.
   
   iii. Any alternative interpretations of the evidence and why the evidence supports the student’s claim, as opposed to any other claims.
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4. **Reasoning and synthesis**
   
   A. Students use reasoning to connect the appropriate evidence to the claim. Students describe the following chain of reasoning in their argumentation:
      
      i. Every scale (e.g., cells, tissues, organs, organ systems) of body function is composed of systems of interacting components.
      
      ii. Organs are composed of interacting tissues. Each tissue is made up of specialized cells. These interactions at the cellular and tissue levels enable the organs to carry out specific functions.
      
      iii. A body is a system of specialized organs that interact with each other and their subsystems to carry out the functions necessary for life.
      
   B. Students use oral or written arguments to support or refute an explanation or model of a phenomenon.
Strand 7.4: REPRODUCTION AND INHERITANCE

The great diversity of species on Earth is a result of genetic variation. Genetic traits are passed from parent to offspring. These traits affect the structure and behavior of organisms, which affect the organism’s ability to survive and reproduce. Mutations can cause changes in traits that may affect an organism. As technology has developed, humans have been able to change the inherited traits in organisms, which may have an impact on society.

Strand 7.4.1: HEREDITY: INHERITANCE AND VARIATION OF TRAITS

Students who demonstrate understanding can: Develop and use a model to explain the effects that different types of reproduction have on genetic variation, including asexual and sexual reproduction.

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<td><strong>Developing and Using Models</strong></td>
<td><strong>Growth and Development of Organisms</strong></td>
<td><strong>Cause and Effect</strong></td>
</tr>
<tr>
<td>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</td>
<td>● Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring.</td>
<td>● Cause and effect relationships may be used to predict phenomena in natural systems.</td>
</tr>
<tr>
<td>○ Develop and use a model to describe phenomena.</td>
<td><strong>Inheritance of Traits</strong></td>
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<td>● Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.</td>
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<tr>
<td></td>
<td><strong>Variation of Traits</strong></td>
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<td>● In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring.</td>
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<td></td>
<td>Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.</td>
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</table>

1. Components of the model
   A. Students develop a model (e.g., Punnett squares, diagrams, simulations) for a given phenomenon involving the differences in genetic variation that arise from sexual and asexual reproduction. In the model, students identify and describe the relevant components, including:
   i. Chromosome pairs, including genetic variants, in asexual reproduction:
      1. Parents.
      2. Offspring.
   ii. Chromosome pairs, including genetic variants, in sexual reproduction:
      1. Parents.
      2. Offspring.

2. Relationships
   A. In their model, students describe the relationships between components, including:
      i. During reproduction (both sexual and asexual), parents transfer genetic information in the form of genes to their offspring.
      ii. Under normal conditions, offspring have the same number of chromosomes, and therefore genes, as their parents.
      iii. During asexual reproduction, a single parent’s chromosomes (one set) are the source of genetic material in the offspring.
      iv. During sexual reproduction, two parents (two sets of chromosomes) contribute genetic material to the offspring.
Strand 7.4: REPRODUCTION AND INHERITANCE

The great diversity of species on Earth is a result of genetic variation. Genetic traits are passed from parent to offspring. These traits affect the structure and behavior of organisms, which affect the organism’s ability to survive and reproduce. Mutations can cause changes in traits that may affect an organism. As technology has developed, humans have been able to change the inherited traits in organisms, which may have an impact on society.

Strand 7.4.1: HEREDITY: INHERITANCE AND VARIATION OF TRAITS

Students who demonstrate understanding can:

**Develop and use a model** to explain the effects that different types of reproduction have on genetic variation, including asexual and sexual reproduction.

3. **Connections**
   
   A. Students use the model to describe a causal account for why sexual and asexual reproduction result in different amounts of genetic variation in offspring relative to their parents, including that:
      
      i. In asexual reproduction:
         1. Offspring have a single source of genetic information, and their chromosomes are complete copies of each single parent pair of chromosomes.
         2. Offspring chromosomes are identical to parent chromosomes.
       
      ii. In sexual reproduction:
         1. Offspring have two sources of genetic information (i.e., two sets of chromosomes) that contribute to each final pair of chromosomes in the offspring.
         2. Because both parents are likely to contribute different genetic information, offspring chromosomes reflect a combination of genetic material from two sources and therefore contain new combinations of genes (genetic variation) that make offspring chromosomes distinct from those of either parent.
   
   B. Students use cause-and-effect relationships found in the model between the type of reproduction and the resulting genetic variation to predict that more genetic variation occurs in organisms that reproduce sexually compared to organisms that reproduce asexually.
Strand 7.4: REPRODUCTION AND INHERITANCE
The great diversity of species on Earth is a result of genetic variation. Genetic traits are passed from parent to offspring. These traits affect the structure and behavior of organisms, which affect the organism’s ability to survive and reproduce. Mutations can cause changes in traits that may affect an organism. As technology has developed, humans have been able to change the inherited traits in organisms, which may have an impact on society.

Strand 7.4.2: FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES
Students who demonstrate understanding can:
Obtain, evaluate, and communicate information about specific animal and plant adaptations and structures that affect the probability of successful reproduction. Examples of adaptations could include nest building to protect young from the cold, herding of animals to protect young from predators, vocalization of animals and colorful plumage to attract mates for breeding, bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.

Science and Engineering Practices
Engaging in Argument from Evidence
Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).
• Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.

Disciplinary Core Ideas
Growth and Development of Organisms
• Animals engage in characteristic behaviors that increase the odds of reproduction.
• Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.

Crosscutting Concepts
Cause and Effect
• Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

1. Supported claims
   A. Students make a claim to support a given explanation of a phenomenon. In their claim, students include the idea that characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

2. Identifying scientific evidence
   A. Students identify the given evidence that supports the claim (e.g., evidence from data and scientific literature), including:
      i. Characteristic animal behaviors that increase the probability of reproduction.
      ii. Specialized plant and animal structures that increase the probability of reproduction.
      iii. Cause-and-effect relationships between:
          1. Specialized plant structures and the probability of successful reproduction of plants that have those structures.
          2. Animal behaviors and the probability of successful reproduction of animals that exhibit those behaviors.
          3. Plant reproduction and the animal behaviors related to plant reproduction.

3. Evaluating and critiquing the evidence
   A. Students evaluate the evidence and identify the strengths and weaknesses of the evidence used to support the claim, including:
      i. Validity and reliability of sources.
      ii. Sufficiency — including relevance, validity, and reliability — of the evidence to make and defend the claim.
      iii. Alternative interpretations of the evidence and why the evidence supports the student’s claim, as opposed to any other claims.
The great diversity of species on Earth is a result of genetic variation. Genetic traits are passed from parent to offspring. These traits affect the structure and behavior of organisms, which affect the organism’s ability to survive and reproduce. Mutations can cause changes in traits that may affect an organism. As technology has developed, humans have been able to change the inherited traits in organisms, which may have an impact on society.

Students who demonstrate understanding can:

**Obtain, evaluate, and communicate** information about specific animal and plant adaptations and structures that affect the probability of successful reproduction. Examples of adaptations could include nest building to protect young from the cold, herding of animals to protect young from predators, vocalization of animals and colorful plumage to attract mates for breeding, bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.

4. **Reasoning and synthesis**
   A. Students use reasoning to connect the appropriate evidence to the claim, using oral or written arguments. Students describe the following chain of reasoning in their argumentation:
   i. Many characteristic animal behaviors affect the likelihood of successful reproduction.
   ii. Many specialized plant structures affect the likelihood of successful reproduction.
   iii. Sometimes, animal behavior plays a role in the likelihood of successful reproduction in plants.
   iv. Because successful reproduction has several causes and contributing factors, the cause and-effect relationships between any of these characteristics, separately or together, and reproductive likelihood can be accurately reflected only in terms of probability.
The great diversity of species on Earth is a result of genetic variation. Genetic traits are passed from parent to offspring. These traits affect the structure and behavior of organisms, which affect the organism’s ability to survive and reproduce. Mutations can cause changes in traits that may affect an organism. As technology has developed, humans have been able to change the inherited traits in organisms, which may have an impact on society.

**Strand 7.4: REPRODUCTION AND INHERITANCE**

The great diversity of species on Earth is a result of genetic variation. Genetic traits are passed from parent to offspring. These traits affect the structure and behavior of organisms, which affect the organism’s ability to survive and reproduce. Mutations can cause changes in traits that may affect an organism. As technology has developed, humans have been able to change the inherited traits in organisms, which may have an impact on society.

**Strand 7.4.3: HEREDITY: INHERITANCE AND VARIATION OF TRAITS**

Students who demonstrate understanding can:

Develop and use a model to describe why genetic mutations may result in harmful, beneficial, or neutral effects to the structure and function of the organism. Emphasize the conceptual idea that changes to traits can happen because of genetic mutations. Specific changes of genes at the molecular level, mechanisms for protein synthesis, and specific types of mutations will be introduced at the high school level.

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing and Using Models</td>
<td>Inheritance of Traits</td>
<td>Structure and Function</td>
</tr>
<tr>
<td>Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</td>
<td>• Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.</td>
<td>• Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function.</td>
</tr>
<tr>
<td>• Develop and use a model to describe phenomena.</td>
<td>Variation of Traits</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism.</td>
<td></td>
</tr>
</tbody>
</table>

1. **Components of the model**

   A. Students develop a model in which they identify the relevant components for making sense of a given phenomenon involving the relationship between mutations and the effects on the organism, including:

   i. Genes, located on chromosomes.
   ii. Proteins.
   iii. Traits of organisms.

2. **Relationships**

   A. In their model, students describe the relationships between components, including:

   i. Every gene has a certain structure, which determines the structure of a specific set of proteins.
   ii. Protein structure influences protein function (e.g., the structure of some blood proteins allows them to attach to oxygen, the structure of a normal digestive protein allows it break down particular food molecules).
   iii. Observable organism traits (e.g., structural, functional, behavioral) result from the activity of proteins.

3. **Connections**

   A. Students use the model to describe that structural changes to genes (i.e., mutations) may result in observable effects at the level of the organism, including why structural changes to genes:

   i. May affect protein structure and function.
   ii. May affect how proteins contribute to observable structures and functions in organisms.
   iii. May result in trait changes that are beneficial, harmful, or neutral for the organism.

   B. Students use the model to describe that beneficial, neutral, or harmful changes to protein function can cause beneficial, neutral, or harmful changes in the structure and function of organisms.
Strand 7.4: REPRODUCTION AND INHERITANCE

The great diversity of species on Earth is a result of genetic variation. Genetic traits are passed from parent to offspring. These traits affect the structure and behavior of organisms, which affect the organism’s ability to survive and reproduce. Mutations can cause changes in traits that may affect an organism. As technology has developed, humans have been able to change the inherited traits in organisms, which may have an impact on society.

Strand 7.4.4: BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Students who demonstrate understanding can:

**Obtain, evaluate, and communicate** information about the technologies that have changed the way humans affect the inheritance of desired traits in organisms. Analyze data from tests or simulations to determine the best solution to achieve success in cultivating selected desired traits in organisms. Examples could include artificial selection, genetic modification, animal husbandry, and gene therapy.

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Obtaining, Evaluating, and Communicating Information</strong></td>
<td><strong>Natural Selection</strong></td>
<td><strong>Cause and Effect</strong></td>
</tr>
<tr>
<td>Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.</td>
<td>- In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring.</td>
<td>- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.</td>
</tr>
<tr>
<td>• Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.</td>
<td></td>
<td><strong>Connections to Engineering, Technology, and Applications of Science</strong></td>
</tr>
<tr>
<td>1. <strong>Obtaining information</strong></td>
<td>2. <strong>Evaluating information</strong></td>
<td><strong>Interdependence of Science, Engineering, and Technology</strong></td>
</tr>
<tr>
<td>A. Students gather information about at least two technologies that have changed the way humans influence the inheritance of desired traits in plants and animals through artificial selection by choosing desired parental traits determined by genes, which are then often passed on to offspring. Examples could include gene therapy, genetic modification, and selective breeding of plants and animals.</td>
<td>A. Students assess the credibility, accuracy, and possible bias of each publication and method used in the information they gather</td>
<td></td>
</tr>
<tr>
<td>B. Students use at least two appropriate and reliable sources of information for investigating each technology.</td>
<td>B. Students use their knowledge of artificial selection and additional sources to describe how the information they gather is or is not supported by evidence.</td>
<td></td>
</tr>
<tr>
<td>2. <strong>Evaluating information</strong></td>
<td>C. Students synthesize the information from multiple sources to provide examples of how technologies have changed the ways that humans are able to influence the inheritance of desired traits in organisms.</td>
<td>D. Students use the information to identify and describe how a better understanding of cause-and effect relationships in how traits occur in organisms has led to advances in technology that provide a higher probability of being able to influence the inheritance of desired traits in organisms.</td>
</tr>
</tbody>
</table>
**Strand 7.4: REPRODUCTION AND INHERITANCE**

The great diversity of species on Earth is a result of genetic variation. Genetic traits are passed from parent to offspring. These traits affect the structure and behavior of organisms, which affect the organism’s ability to survive and reproduce. Mutations can cause changes in traits that may affect an organism. As technology has developed, humans have been able to change the inherited traits in organisms, which may have an impact on society.

**Strand 7.4.4: BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY**

Students who demonstrate understanding can:

- **Obtain, evaluate, and communicate** information about the technologies that have changed the way humans affect the inheritance of desired traits in organisms. Analyze data from tests or simulations to determine the best solution to achieve success in cultivating selected desired traits in organisms. Examples could include artificial selection, genetic modification, animal husbandry, and gene therapy.
Strand 7.5: CHANGES IN SPECIES OVER TIME

Genetic variation and the proportion of traits within a population can change over time. These changes can result in evolution through natural selection. Additional evidence of change over time can be found in the fossil record, anatomical similarities and differences between modern and ancient organisms, and embryological development.

Strand 7.5.2: BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Students who demonstrate understanding can:

**Analyze and interpret data** for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth, under the assumption that natural laws operate today as in the past.

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Analyzing and Interpreting Data</strong></td>
<td><strong>Evidence of Common Ancestry and Diversity</strong></td>
<td><strong>Patterns</strong></td>
</tr>
<tr>
<td>Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.</td>
<td>• The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth.</td>
<td>• Graphs, charts, and images can be used to identify patterns in data.</td>
</tr>
<tr>
<td>• Analyze and interpret data to determine similarities and differences in findings.</td>
<td><strong>Connections to Nature of Science Scientific</strong></td>
<td><strong>Connections to Nature of Science Scientific</strong></td>
</tr>
<tr>
<td><strong>Knowledge is Based on Empirical Evidence</strong></td>
<td><strong>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</strong></td>
<td><strong>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</strong></td>
</tr>
<tr>
<td>• Science knowledge is based upon logical and conceptual connections between evidence and explanations.</td>
<td>• Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.</td>
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</tbody>
</table>

1. **Obtaining information**
   A. Students organize the given data (e.g., using tables, graphs, charts, images), including the appearance of specific types of fossilized organisms in the fossil record as a function of time, as determined by their locations in the sedimentary layers or the ages of rocks.
   B. Students organize the data in a way that allows for the identification, analysis, and interpretation of similarities and differences in the data.

2. **Identifying relationships**
   A. Students identify:
      i. Patterns between any given set of sedimentary layers and the relative ages of those layers.
      ii. The time period(s) during which a given fossil organism is present in the fossil record.
      iii. Periods of time for which changes in the presence or absence of large numbers of organisms or specific types of organisms can be observed in the fossil record (e.g., a fossil layer with very few organisms immediately next to a fossil layer with many types of organisms).
      iv. Patterns of changes in the level of complexity of anatomical structures in organisms in the fossil record, as a function of time.

3. **Interpreting data**
   A. Students analyze and interpret the data to determine evidence for the existence, diversity, extinction, and change in life forms throughout the history of Earth, using the assumption that natural laws operate today as they would have in the past. Students use similarities and differences in the observed patterns to provide evidence for:
      i. When mass extinctions occurred.
      ii. When organisms or types of organisms emerged, went extinct, or evolved.
      iii. The long-term increase in the diversity and complexity of organisms on Earth.
Strand 7.5: CHANGES IN SPECIES OVER TIME

Genetic variation and the proportion of traits within a population can change over time. These changes can result in evolution through natural selection. Additional evidence of change over time can be found in the fossil record, anatomical similarities and differences between modern and ancient organisms, and embryological development.

Strand 7.5.3: BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Students who demonstrate understanding can: Construct explanations that describe the patterns of body structure similarities and differences between modern organisms, and between ancient and modern organisms, to infer possible evolutionary relationships.

<table>
<thead>
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<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
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</thead>
<tbody>
<tr>
<td><strong>Constructing Explanations and Designing Solutions</strong></td>
<td><strong>Evidence of Common Ancestry and Diversity</strong></td>
<td><strong>Patterns</strong></td>
</tr>
</tbody>
</table>
| Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.  
  • Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. | • Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. | • Patterns can be used to identify cause and effect relationships. |
|  |  | **Connections to Nature of Science Scientific Knowledge Assumes an Order and Consistency in Natural Systems** |
|  |  | • Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. |

1. **Articulating the explanation of phenomena**
   A. Students articulate a statement that relates a given phenomenon to scientific ideas, including the following ideas about similarities and differences in organisms and their evolutionary relationships:
      i. Anatomical similarities and differences among organisms can be used to infer evolutionary relationships, including:
         1. Among modern organisms.
         2. Between modern and fossil organisms.
   B. Students use evidence and reasoning to construct an explanation for the given phenomenon.

2. **Evidence**
   A. Students identify and describe evidence (e.g., from students’ own investigations, observations, reading material, archived data, simulations) necessary for constructing the explanation, including similarities and differences in anatomical patterns in and between:
      i. Modern, living organisms (e.g., skulls of modern crocodiles, skeletons of birds; features of modern whales and elephants).
      ii. Fossilized organisms (e.g., skulls of fossilized crocodiles, fossilized dinosaurs).

3. **Reasoning**
   A. Students use reasoning to connect the evidence to support an explanation. Students describe the following chain of reasoning for the explanation:
      i. Organisms that share a pattern of anatomical features are likely to be more closely related than are organisms that do not share a pattern of anatomical features, due to the cause-and-effect relationship between genetic makeup and anatomy (e.g., although birds and insects both have wings, the organisms are structurally very different and not very closely related; the wings of birds and bats are structurally similar, and the organisms are more closely related; the limbs of horses and zebras are structurally very similar, and they are more closely related than are birds and bats or birds and insects).
      ii. Changes over time in the anatomical features observable in the fossil record can be used to infer lines of evolutionary descent by linking extinct organisms to living organisms through a series of fossilized organisms that share a basic set of anatomical features.
<table>
<thead>
<tr>
<th><strong>Strand 7.5: CHANGES IN SPECIES OVER TIME</strong></th>
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<tbody>
<tr>
<td>Genetic variation and the proportion of traits within a population can change over time. These changes can result in evolution through natural selection. Additional evidence of change over time can be found in the fossil record, anatomical similarities and differences between modern and ancient organisms, and embryological development.</td>
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<th><strong>Strand 7.5.3: BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY</strong></th>
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</thead>
<tbody>
<tr>
<td>Students who demonstrate understanding can: <strong>Construct explanations</strong> that describe the patterns of body structure similarities and differences between modern organisms, and between ancient and modern organisms, to infer possible evolutionary relationships.</td>
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</table>
Genetic variation and the proportion of traits within a population can change over time. These changes can result in evolution through natural selection. Additional evidence of change over time can be found in the fossil record, anatomical similarities and differences between modern and ancient organisms, and embryological development.

### Strand 7.5: CHANGES IN SPECIES OVER TIME

Students who demonstrate understanding can:

- **Analyze data** to compare patterns in the embryological development across multiple species to identify similarities and differences not evident in the full formed anatomy.

### Strand 7.5.3: BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

Students who demonstrate understanding can:

- **Analyze data** to compare patterns in the embryological development across multiple species to identify similarities and differences not evident in the full formed anatomy.

### Science and Engineering Practices

**Analyzing and Interpreting Data**

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze displays of data to identify linear and nonlinear relationships.

### Disciplinary Core Ideas

**Evidence of Common Ancestry and Diversity**

- Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully formed anatomy.

### Crosscutting Concepts

**Patterns**

- Graphs, charts, and images can be used to identify patterns in data.

#### 1. Organizing data

- **A. Students** organize the given displays of pictorial data of embryos by developmental stage and by organism (e.g., early, middle, just prior to birth) to allow for the identification, analysis, and interpretation of relationships in the data.

#### 2. Identifying relationships

- **A. Students** analyze their organized pictorial displays to identify linear and nonlinear relationships, including:
  - **i. Patterns of similarities in embryos across species** (e.g., early mammal embryos and early fish embryos both contain gill slits, whale embryos and the embryos of land animals — even some snakes — have hind limbs).
  - **ii. Patterns of changes as embryos develop** (e.g., mammal embryos lose their gill slits, but the gill slits develop into gills in fish).

#### 3. Interpreting data

- **A. Students** use patterns of similarities and changes in embryo development to describe* evidence for relatedness among apparently diverse species, including similarities that are not evident in the fully formed anatomy (e.g., mammals and fish are more closely related than they appear to be based on their adult features, whales are related to land animals).
Integrating Science Practices Into Assessment Tasks

The Next Generation Science Standards call for the development of “three-dimensional science proficiency,” that is, students’ integrated understanding of disciplinary core ideas, science and engineering practices, and crosscutting concepts. To assess three-dimensional science proficiency requires multicomponent tasks (National Research Council, 2014). These are sets of tasks linked by a common scenario, phenomenon, or engineering design challenge.

Developing three-dimensional science assessments is challenging. Most current assessments focus on testing students’ knowledge of science facts. Few focus on having students apply their understanding of disciplinary core ideas in the context of engaging in a science or engineering practice. Fewer still make connections to crosscutting concepts.

These “task format” tables included in this document are tools to help teachers and district leaders design three-dimensional assessment tasks. They are based on the language of A Framework for K-12 Science Education and the NGSS Evidence Statements, focusing on all eight science practices and two engineering practices. These task formats represent different ways that assessment tasks can be written to engage students in science practice. They do not specify precisely which disciplinary core ideas are to be integrated into tasks, a process that would be determined by an analysis of the disciplinary core ideas.

The different formats get at different aspects of the focal science and engineering practice. In addition, some formats are likely to be more demanding cognitively for students. The idea of presenting multiple formats is to give task developers a sense of the range of tasks that can be written. A good “test” (comprised of multiple tasks) of a student’s grasp of a particular practice, in the context of a disciplinary core idea and crosscutting concept, would draw on multiple formats.

These task formats provide some specific suggestions for the intellectual work associated with the science and engineering practices. However, there are many possible ways of engaging in relevant forms of the intellectual work for the practices. It is important in instruction and assessment that the practices not become fixed, narrow routines or procedures.

An example multi-component assessment task is included on page 16 of this document.

How to Read a Template Task

<table>
<thead>
<tr>
<th>Format</th>
<th>Task Requirements for Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Present students with a textual description of an investigation of an observable phenomenon, then Ask students to formulate a scientific question relevant to investigating that phenomenon.</td>
</tr>
</tbody>
</table>

Task(s) for students to complete
<table>
<thead>
<tr>
<th>Format</th>
<th>Task Requirements for Students</th>
</tr>
</thead>
</table>
| 1      | Present students with a scientific phenomenon and questions related to that phenomenon, *then*  
  Ask students to identify which questions are testable scientific questions. |
| 2a     | Present students with an observable scientific phenomenon to be explained, *then*  
  Ask students to formulate descriptive questions about the phenomenon they observed. |
| 2b     | Present students with a scientific phenomenon to be explained, *then*  
  Ask students to formulate a scientific question to investigate the phenomenon. |
| 2c     | Present students with a scientific phenomenon to be explained, *then*  
  Ask students to generate a scientific question relevant to investigating that phenomenon, *and*  
  Ask students to describe what evidence is needed to answer the question they generated. |
| 3a     | Present students with a scientific phenomenon to be explained and a scientific question, *then*  
  Ask students what questions we need to answer along the way to answer the scientific question, *and*  
  Ask students to describe what evidence is needed to answer those questions might and how they help build toward an explanation of the phenomenon. |
| 3b     | Present students with a scientific phenomenon to be explained and a scientific question, *then*  
  Ask students to evaluate whether or not the question is relevant to explaining the phenomenon.  
  If the question is relevant, ask students to describe what evidence is needed to answer that question. |
| 4      | Present students with a textual description of an investigation of an observable phenomenon, a scientific question, and a set of data and findings, *then*  
  Ask students to formulate a follow-up question to extend the investigation. |
| 5      | Present students with a scenario of a scientific argument in the context of an investigation, *then*  
  Ask students to generate questions they would ask to clarify the argument or to ask for elaboration of the ideas presented in the argument. |
|   | Present students with a scientific phenomenon to be explained and a scientific question, *then*  
<table>
<thead>
<tr>
<th></th>
<th>Ask students to revise the question to make it investigable with available resources in the classroom.</th>
</tr>
</thead>
</table>
| 7 | Present students with a scientific phenomenon to be explained and with a question or a set of questions, *then*  
  |   | Ask students to evaluate and explain whether or not the question(s) is empirically testable. |
## Potential Task Formats: Defining Problems (Engineering)

<table>
<thead>
<tr>
<th>Format</th>
<th>Task Requirements for Students</th>
</tr>
</thead>
</table>
| 1      | Present students with a textual description of a scenario of a need or desire of society and/or the natural world and a defined problem, *then*  
  Ask students to describe why the problem is a major global challenge. |
| 2      | Present students with a textual description of a scenario of a need or desire of society and/or the natural world that includes quantitative and qualitative data, *then*  
  Ask students to describe the problem, *and*  
  Ask students to interpret quantitative and qualitative data to describe the major consequences of the problem if it remains unsolved. |
| 3      | Present students with a textual description of a scenario of a need or desire of society and/or the natural world and with excerpts from related scientific research, *then*  
  Ask students to describe how each piece of scientific research is relevant background research for defining the problem. |
| 4      | Present students with a textual description of a scenario of a need or desire of society and/or the natural world and a defined problem, *then*  
  Ask students to define the components and relationships between the components of the system in which the problem is embedded, *and*  
  Ask students to define the boundaries of that system and what is and is not part of the system. |
| 5      | Present students with a textual description a defined problem and with experts of scientific research and popular texts, *then*  
  Ask students to analyze and describe the societal needs and wants relative to the problem. |
| 6a     | Present students with a textual description of a scenario of a need or desire of society and/or the natural world, *then*  
  Ask students to describe the problem, *and*  
  Ask students to define the criteria and constraints for acceptable solutions to the problem. |
| 6b     | Present students with a textual description of a scenario of a need or desire of society and/or the natural world, *then*  
  Ask students to describe the problem,  
  Ask students to define the criteria and constraints for acceptable solutions to the problem, *and*  
  Ask students what evidence is needed to know whether or not a solution fits within the defined criteria and constraints. |
<p>| 7 | Present students with a textual description of a scenario of a need or desire of society and/or the natural world along with design criteria and constraints, then Ask students to plan an investigation that would allow them to better understand the design space for the problem. |</p>
<table>
<thead>
<tr>
<th>Format</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Present two models to students, then Ask them to compare the models to identify both common and unique model components, relationships, and mechanisms.</td>
</tr>
<tr>
<td>2</td>
<td>Present students with an illustration or drawing of a scientific process or system, then Ask students to label the components, interactions, and mechanisms in the model, and Write a description of what is shown in the drawing.</td>
</tr>
<tr>
<td>3</td>
<td>Present students with a model of an observable scientific process or system and some evidence about how the system behaves that does not fit the model, then Ask students to revise the model to better fit available evidence.</td>
</tr>
<tr>
<td>4</td>
<td>Present students with a textual description of an observable scientific phenomenon, then Ask students to draw and label the model components, interactions among components, and mechanisms in the model, and Ask students to write an explanation for the phenomenon, using the model as supporting evidence.</td>
</tr>
<tr>
<td>5</td>
<td>Present students with a textual description of an observable scientific phenomenon, then Ask students to draw a model that helps explain how this phenomenon occurs by applying their understanding of a disciplinary core idea, and Write a prediction about something that might happen in the future that could be explained by the model.</td>
</tr>
<tr>
<td>6</td>
<td>Present students with two different models for the same observable phenomenon, then Ask students to compare the two models with respect to their accuracy, and Apply what they know about a disciplinary core idea to justify their answer.</td>
</tr>
<tr>
<td>7</td>
<td>Present students with two different models for the same observable phenomenon, then Ask students to develop a test to determine which model better fits available evidence.</td>
</tr>
<tr>
<td>8</td>
<td>Provide students with a digital modeling tool that is intended to represent a system or process in which the mechanisms are not visible to the naked eye, then Ask students to use the modeling tool to identify and describe model components, interactions, and mechanisms.</td>
</tr>
</tbody>
</table>
# Potential Task Formats: Planning and Carrying Out Investigations (Science)

## Relevant definitions
- An **investigation plan** encompasses a description of data sources and measures to be used, procedures for observing and recording data, and, where relevant, a plan for how observations will be sampled.
- A **data source** refers to a type of data only (“We would need data on the size of the white-colored moth population” or “We would need data comparing the color of tail feathers in birds in the mountains and in the city”)

<table>
<thead>
<tr>
<th>Format</th>
<th>Task Requirements for Students</th>
</tr>
</thead>
</table>
| 1      | Present students with a scientific phenomenon to be explained, *then*  
  Ask students to identify questions to ask, *and*  
  Ask students to evaluate different ways of observing and/or measuring to answer those questions, *and*  
  Ask students to conduct the investigation by observing and/or measuring and then making comparisons between data collected. |
| 2      | Present students with a scientific phenomenon to be explained, a scientific question, and an investigation plan, *then*  
  Ask students to perform the investigation plan and collect and record data. |
| 3      | Present students with a scientific phenomenon (or scientific model) to be explained and a scientific question, *then*  
  Ask students to create an investigation plan to investigate the scientific phenomenon (or model), *and*  
  Ask students to describe how the investigation will generate relevant patterns of evidence for answering the scientific question or for supporting the model. |
| 4      | Present students with a scientific phenomenon (or a scientific model) to be explained, *then*  
  Ask students to generate a scientific question to investigate the phenomenon (or model) with resources available in the classroom (or with a given list of resources), *and*  
  Ask students to identify the variables needed in the investigation to explain the phenomenon (or model), *and*  
  Ask students to characterize each variable as dependent or independent and to explain any variables to be controlled and why. |
| 5      | Present students with a scientific phenomenon to be explained, a scientific question, and an investigation plan, *then*  
  Ask students to describe how the data will be collected precisely, *and*  
  Ask students to how much data is needed to be reliable. |
<table>
<thead>
<tr>
<th></th>
<th>Present students with a scientific phenomenon to be explained, a scientific question, and a description of the type of investigation to be conducted, then Ask students to describe the possible confounding variables, and Ask students to write an investigation plan that addresses the confounding variables.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Present students with a scientific phenomenon to be explained, a scientific question, and investigation plan, and data collected from the investigation, then Ask students analyze how well the data collected generated relevant evidence to answer the scientific question, and Ask students to revise the investigation plan to be more relevant and to generate more accurate and precise data.</td>
</tr>
<tr>
<td>8</td>
<td>Present students with a scientific question, then Ask students to generate ideas about data sources they would need to answer the question, and Ask students to say how the data sources are relevant to answering the question</td>
</tr>
<tr>
<td>9</td>
<td>Present students with a scientific question and a list of data sources they could gather to answer the question, then Ask students to select which data sources are most relevant to answering the question, and Ask students to say how the data are relevant to answering the question</td>
</tr>
</tbody>
</table>
## Potential Task Formats: Analyzing and Interpreting Data

### Relevant definitions
- A *pattern of evidence* from data is what the data say (“The population of white-colored moths disappeared in cities,” or “The birds’ tail feathers are whiter in the mountains than in the city”)

<table>
<thead>
<tr>
<th>Format</th>
<th>Task Requirements for Students</th>
</tr>
</thead>
</table>
| 1      | Present students with recorded observations of the natural world, *then*  
      | Ask them to describe a pattern or relationship they can infer from the observations |
| 2      | Describe an investigation, the phenomenon under investigation, and one or more recorded observations from the investigation, *then*  
      | Ask students to organize, represent, and analyze the data in at least two different ways, *and*  
      | Ask students to compare how the representations and analyses help them to identify patterns in the data |
| 3      | Describe an investigation, the phenomenon under investigation, and one or more recorded observations from the investigation, *then*  
      | Ask students to use grade-level appropriate mathematics and/or statistics to analyze patterns the data, *and*  
      | Ask students to draw conclusions supported by their mathematical analysis |
| 4      | Describe an investigation, the phenomenon under investigation, and recorded observations from the investigation that are directly relevant to explaining the phenomenon, *then*  
      | Ask students to organize the data and describe how this organization helps them to analyze the data, *and*  
      | Ask students to identify and describe the patterns they see in the organized data, *and/or*  
      | Ask students to student to describe how the patterns of evidence in the data help to explain the phenomenon |
| 5      | Describe an investigation, the phenomenon under investigation, a hypothesis about the phenomenon that the investigation was intended to test, and multiple recorded observations from the investigation, *then*  
      | Ask students to organize the data and describe how this organization helps them to see whether the evidence supports the hypothesis, *and*  
      | Draw a conclusion about whether the data are consistent with the hypothesis |
| 6      | Describe an investigation, the phenomenon under investigation, and recorded observations from the investigation from multiple groups of investigators, *then*  
      | Ask students to organize (e.g., tabulate, graph, or statistically summarize) the data, and  
      | Ask students to identify outliers in the different data sets, *and*  
      | Develop hypotheses about what sources of error might have caused the outliers |
| 7 | Present a causal explanation of a phenomenon developed from either an experiment or from a simulation, empirical data from the experiment or simulation, *then*  
  Ask students to decide whether the data presented provide causal or correlational evidence, *and*  
  Ask students to assess whether the data are consistent with the causal explanation presented. |
|---|---|
| 8 | Describe an investigation, the phenomenon under investigation, one or more recorded observations from the investigation, the results of analyses, and an interpretation of the data, *then*  
  Ask students to assess whether the interpretation is consistent with the data and the analysis, *or*  
  Ask students to evaluate how the interpretation is affected by variation or uncertainty in the data. |
<table>
<thead>
<tr>
<th>Format</th>
<th>Task Requirements for Students</th>
</tr>
</thead>
</table>
| 1      | Present students with multiple objects, *then*  
|        | Ask students to construct quantitative attributes (e.g., measurements of heights) of the objects, *and*  
|        | Display the data using simple graphs. |
| 2      | Present students with a dataset from an investigation, the question the investigation is intended to answer, *then*  
|        | Ask students to identify features of the dataset (e.g., range, average) that should be analyzed in order to answer the question. |
| 3      | Present students with a textual description and measured quantities of an observable scientific phenomenon, *then*  
|        | Ask students to develop a grade-level appropriate equation or algorithm that corresponds to the textual description, *and*  
|        | Explain how the equation or algorithm represents the textual description. |
| 4      | Present students with a textual description, measured quantities of data, and a grade-level appropriate mathematical equation of an observable scientific phenomenon, *then*  
|        | Ask students to make a prediction about the state of the phenomenon in the future that the equation can be used to support, *and*  
|        | Ask students to write an explanation for the prediction, using the mathematical model as supporting evidence. |
| 5      | Engage students in using a simulation of an observable scientific phenomenon, *then*  
|        | Ask students to compare the simulation results with real-world data, *and*  
|        | Write an argument for whether or not the simulation makes sense using the comparison as supporting evidence. |
| 6      | Present students with a large data set from an investigation, the question the data are intended to answer, and computer tools (e.g., a spreadsheet) for analyzing the data set, *then*  
|        | Ask students to develop statistical summaries of the data set that help them answer the question about the dataset. |
### Potential Task Formats: Constructing Explanations (Science)

**Relevant definition**
- “Scientific explanations are accounts that link scientific theory with specific observations or phenomena... Very often the theory is first represented by a specific model for the situation in question, and then a model-based explanation is developed.” (NRC Framework, 2012).

<table>
<thead>
<tr>
<th>Format</th>
<th>Task Requirements for Students</th>
</tr>
</thead>
</table>
| 1      | Describe a phenomenon to students along with relevant evidence (which can come from a media source), *then*  
Ask students to write an evidence-based account of what causes the phenomena. |
| 2      | Describe a phenomenon to students along with some related qualitative or quantitative data/observations, *then*  
Ask students produce an explanation about the mechanism for the phenomena using their interpretation of the data as evidence. |
| 3      | Describe a phenomenon to students and present qualitative or quantitative data for independent and dependent variables, *then*  
Ask students to produce a causal account that explains how the independent variables relate to the dependent variables. |
| 4      | Describe a phenomenon to students along with a related set of evidence and an explanation that includes multiple scientific principles, *then*  
Ask students to say which pieces of evidences support particular components of the explanation. |
| 5      | Present students with a model or representation of an observable scientific process or system, *then*  
Ask students to write a causal explanation for a relevant phenomenon using the model as supporting evidence. |
| 6      | Describe a phenomenon and present students with a causal explanation of it, *then*  
Ask students to identify gaps or weaknesses in how it scientifically explains the phenomenon based on their level of scientific understanding. |
| 7      | Describe a phenomenon and present students with a range of evidence obtained from a variety of sources (empirical investigations, models, theories, simulations, peer review), *then*  
Ask students to articulate (construct) a causal explanation for the phenomena, *and*  
Describe how the evidence relates to the mechanisms or principles they have included. |
### Potential Task Formats: Designing Solutions (Engineering)

<table>
<thead>
<tr>
<th>Format</th>
<th>Task Design for Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Describe or showcase a human problem, desire, or need along with design criteria and constraints, <em>then</em>&lt;br&gt;Ask students to sketch or describe a design approach that develops a possible solution to the problem.&lt;br&gt;and&lt;br&gt;Ask them to explain how the relevant scientific ideas are taken into account within their design.</td>
</tr>
<tr>
<td>2</td>
<td>Describe or showcase a human problem, desire, or need along with design criteria and constraints, <em>then</em>&lt;br&gt;Ask students to sketch and prototype a design that is a possible solution to the problem using relevant materials. <em>(Performance Task)</em></td>
</tr>
<tr>
<td>3</td>
<td>Describe a designed system and data from a failure scenario associated with the design, <em>then</em>&lt;br&gt;Ask them to analyze the data and identify the scientific causes of the failure. Possibly ask them to sketch or describe a design iteration that might be an improvement to the design.</td>
</tr>
<tr>
<td>4</td>
<td>Describe a design in active development and a scenario where the design team has encountered a design tension between two or more criteria perhaps also related to the project constraints, <em>then</em>&lt;br&gt;Ask students how they would proceed with the design work to develop a working system. <em>(The goal is to see if students think about considering trade-offs and prioritizing one design criteria over another in order to accomplish a working design.)</em></td>
</tr>
</tbody>
</table>
## Potential Task Formats: Engaging in Argument from Evidence

<table>
<thead>
<tr>
<th>Format</th>
<th>Task Requirements for Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Present two different arguments related to a phenomenon, one with evidence and one without, then Ask students to identify the argument that is more scientific and ask them why they think that is the case.</td>
</tr>
<tr>
<td>2</td>
<td>Describe a phenomenon to students, then Ask students to articulate (construct) a claim about that phenomenon, and Identify evidence that supports the claim, and Articulate the scientific principle(s) that connect each piece of evidence to the claim.</td>
</tr>
<tr>
<td>3</td>
<td>Present students with a claim about a phenomenon, then Ask students to identify evidence that supports the claim, and Articulate the scientific principle(s) that connect each piece of evidence to the claim.</td>
</tr>
<tr>
<td>4</td>
<td>Present students with a claim and evidence about a phenomenon, then Ask students to assess how well the evidence supports the claim.</td>
</tr>
<tr>
<td>5a, 5b</td>
<td>Present students with a claim and evidence and reasoning about a phenomenon, then Ask students to assess the reasoning of a given link between claim and evidence or Ask students to assess the logical link between claim and evidence.</td>
</tr>
<tr>
<td>6a, 6b</td>
<td>Describe a situation in which two or more explanations are offered for a phenomenon, then Ask students to identify the different claims at issue (easier), or Ask students to identify different claims and the evidence with each claim (harder).</td>
</tr>
<tr>
<td>7a, 7b</td>
<td>Present students with a claim, a list of data sources that are relevant to the claim (but not what the data say), then Ask students to identify (select from a list) a pattern of evidence from the data that would support the claim, or Ask students to identify (select from a list) what pattern of evidence from the data would refute the claim.</td>
</tr>
<tr>
<td>8a, 8b, 8c, 8d</td>
<td>Present students with a claim and a pattern of evidence relevant to the claim, then Ask students to assess whether the evidence is logically consistent with the claim, or Ask students to assess whether the evidence is consistent with a scientific theory or model they have studied, or Ask students to generate ideas about additional evidence needed to support the claim, or Ask students to generate ideas about additional evidence needed to support the claim.</td>
</tr>
</tbody>
</table>
### Potential Task Formats: Obtaining, Evaluating, and Communicating Information

**Relevant definitions**
- A “scientific text” is any form of scientific communication including but not limited to prose, graphs, videos, posters, symbols, and mathematics.

<table>
<thead>
<tr>
<th>Format</th>
<th>Task Requirements for Students</th>
</tr>
</thead>
</table>
| 1      | Present students with a set of grade-appropriate texts related to a scientific phenomenon, *then*  
  Ask students to synthesize the information from across the texts, *and/or*  
  Ask students to compare and contrast information across the texts to determine which are most relevant to explaining the phenomenon. |
| 2      | Present students with a set of grade-appropriate texts related to a scientific phenomenon, *then*  
  Ask students to construct an explanation of the phenomenon and/or ask questions about the phenomenon based on combined information from relevant texts. |
| 3      | Present students with textual description a scientific phenomenon or of an investigation of a scientific phenomenon, *then*  
  Ask students use multiple forms of scientific texts to communicate about the phenomenon to a given audience or an audience of their choosing. |
| 4      | Present students with a set of grade-appropriate scientific literature and/or media reports related to a scientific phenomenon, *then*  
  For each text, ask students to analyze and write about the validity and reliability of the information in the text (e.g., data, hypotheses, conclusions). |
Green anoles are a type of lizard that live in trees in Florida. In the 1950s, a similar species of lizards called brown anoles invaded Florida from Cuba. We know two things about the two species of anoles:

a. They live in similar habitats and eat similar food.
b. They are known to eat the newly hatched lizards of the other species.

Scientists conducted two investigations to determine whether or not the population of green anoles was evolving due to the invasion of brown anoles. First, they introduced brown anoles to three islands and left three islands alone. Then they measured the average height green anoles could be found in the trees (perch height) before and after introducing the invasive brown anoles. Here is a graph of the data they collected on perch height:
Next, scientists knew that living higher in the trees was associated with larger footpads and more sticky scales on the anoles’ feet. So in 2010, the scientists collected data on the populations of green anoles that had been invaded by brown anoles and those that had not been invaded to investigate whether or not the population of green anoles adapted because of the invasion. Below is a summary of the data the scientists collected:

<table>
<thead>
<tr>
<th>Average Perch Height in Trees</th>
<th>Green Anoles on an Island WITHOUT Brown Anoles</th>
<th>Green Anoles on an Island WITH Brown Anoles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>70cm</td>
<td>120 cm</td>
</tr>
<tr>
<td>Average Size of the Toe pads (Standardized for body size)</td>
<td>1.27cm</td>
<td>1.33cm (4.5% increase)</td>
</tr>
<tr>
<td>Average Number of Sticky Scales on the Feet (Standardized for body size)</td>
<td>51 sticky scales</td>
<td>54 sticky scales (6.5% increase)</td>
</tr>
</tbody>
</table>

1. What pattern do you see in the perch height data?
   *After the brown anoles invaded, over time, the green anoles average perch height increased.*

2. When the brown anoles invaded, scientists noted that they ate similar food and lived in similar habitats as the green anoles, why does this matter for the survival of the green anoles?
   *The brown anole competed for space and food resources of the green anole thus the green anoles that were able to live in higher in the trees with larger and stickier feet were able to survive.*

3. Why might being able to go higher in trees be an advantage for survival?
   *Higher up in the trees the green anoles experience less competition for resources and greater safety from the brown anoles eating their offspring.*

4. The scientists noted that the anoles did adapt because of variation in foot pads and sticky scales. Describe the pattern of the average number of sticky scales and average foot pad size traits of anoles on invaded and uninvaded islands.
   *The anoles’ foot pads are larger and the anoles have more sticky scales on islands that were invaded by brown anoles. These are the same islands in which the green anoles have a higher average perch height.*

5. Complete the graphs below showing how you think the proportion of green anoles with larger foot pads in the population changed over time on the invaded and uninvaded islands.
Using your graphs and the data above, what explains the patterns you see between invaded and uninvaded islands?

The green anoles on the invaded islands survived if they were able to climb and perch at higher heights. They could do this because they had larger foot pads and more sticky scales on their feet. Therefore over time, the population of green anoles that survived and reproduced had a higher average foot pad size and a larger number of sticky scales on their feet.

6. Write an explanation for how natural selection led to the adaptation of the population of green anoles when the brown anoles invaded their habitats in Florida.

When the brown anoles invaded the habitats of the green anoles in Florida, they competed for food and habitat therefore impacting the survival of the green anoles. The green anoles that were able to survive could climb higher. Therefore they passed on those traits to the next generation and over time the population of green anoles could climb higher on average because of larger toe pads and more sticky scales on their feet.

The story and data (journal article and supplemental materials) were adapted from study of brown and green anoles by Yoel Stuart and colleagues at the University of Texas Austin. Yoel Stuart researches ecology and evolution, including how the two interact over time. Many species today cope with dramatic changes in their environment brought about by climate change, habitat destruction and the introduction of invasive species. In response to ecological changes such as these, Stuart examines the role of rapid evolution.
Utah Assessment Phenomena “YES” Test

Is it a phenomenon?

✓ Is “it” observable to students?
✓ Does “it” stimulate the curiosity in the student?
✓ Will “it” have relevant and accessible data, images, simulations, and/or text with which students could use science and engineering practices to demonstrate science knowledge through investigations and/or assessment clusters?
✓ Does “it” support students in making sense of or build on other’s ideas?
✓ Will “it” require students to develop an understanding of the assessed SEEd standard?
✓ Is “it” compelling to students from non-dominant communities (e.g. English language learners, students with special needs, students from cultural groups underrepresented in STEM, etc.)?

If you are unable to answer “YES” to any of the statements, then perhaps what you are considering is not a phenomenon. Each additional “YES” strengthens “it” for use on the assessment.

(Adapted from Phenomena “YesTest”, Next Gen Education, LLC – December, 2016)
3-D Science and Common Core Overlap

Math
- MP1. Make sense of problems and persevere in solving them
- MP2. Reason abstractly and quantitatively
- MP6. Attend to precision
- MP7. Look for and make use of structure
- MP8. Look for and express regularity in repeated reasoning
- MP4. Model with mathematics
- MP5. Use appropriate tools strategically
- EP1. Support analysis of a range of grade-level complex texts with evidence
- EP2. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience
- EP3. Construct viable and valid arguments from evidence and critique reasoning of others
- EP4. Build and present knowledge through research by integrating, comparing, and synthesizing ideas from text
- EP5. Build upon the ideas of others and articulate their own clearly when working collaboratively
- EP6. Use English structures to communicate context specific messages
- EP7*. Use technology and digital media strategically and capably
- SP1. Ask questions and define problems
- SP2. Develop and use models
- SP3. Plan and carry out investigations
- SP4. Analyze and interpret data
- SP5. Use mathematics and computational thinking
- SP6. Construct explanations and design solutions
- SP7. Engage in argument from evidence
- SP8. Obtain, evaluate, and communicate information

Science
ELA
Preparing Students for a Lifetime of Success

How will we prepare students for academic success?

Many states have adopted new standards based on the Next Generation Science Standards (NGSS) because they understand that a robust science education in middle school will pave the way for increased opportunities in high school, college, and future careers.

The NGSS enable teachers to offer all students interactive instruction that promotes analysis and interpretation of data, critical thinking, problem solving, and connections across science disciplines—with a high set of expectations for achievement in grades 6–8.

What is our vision for science education?

The NGSS reflect the latest research and advances in modern science. In order to equip students to think critically, analyze information, and solve complex problems, the standards are arranged such that—from elementary through high school—students have multiple opportunities to build on the knowledge and skills gained during each grade, by revisiting important concepts and expanding their understanding of connections across scientific domains. Parents should understand that while some content might be similar to the past, it may look different from how they were taught.

As the science standards are implemented in schools and districts, they will enable students to:

- Develop a deeper understanding of science beyond memorizing facts, and
- Experience similar scientific and engineering practices as those used by professionals in the field.

A quality science education can help expand opportunities for all students.

The science standards complement English/Language Arts and mathematics standards, enabling classroom instruction to reflect a clearer picture of the real world, where solving problems often requires skills and knowledge from multiple disciplines. Further, these standards are designed to benefit and engage all students, whether they currently lack access to a quality science education or already excel in science subjects.
How will students learn science in the classroom?

Each year, students should be able to demonstrate greater capacity for connecting knowledge across, and between, the physical sciences, life sciences, earth and space sciences, and engineering design.

During grades 6–8, your child will begin to form deeper connections between concepts previously learned in grades K–5, such as collecting evidence and drawing conclusions, understanding relationships between objects, and critical thinking that leads to designing effective solutions for problems.

Upon completion of grades 6–8, your child should have a deeper understanding of:

- Physical and chemical interactions that affect the world around us;
- Factors that affect organism survival and reproduction;
- Factors that influence the Earth and our solar system; and
- How to optimize design solutions.

Physical Sciences

Physical sciences during grades 6–8 may explore topics including atomic chemistry, forces and fields, thermal energy, and the wave model. Such lessons will help prepare students for advanced classes—like physics, forensics, or chemistry—that they might encounter in high school and/or college.

Life Sciences

Life Sciences during grades 6–8 may explore topics including cells, gene variation, biodiversity, and adaptation. Such lessons will help prepare students for advanced classes—like biology, physiology, and genetics—that they might encounter in high school and/or college.

Earth and Space Sciences

Earth and space sciences during grades 6–8 may explore topics including the solar system, the Earth’s history, and energy flows. Such lessons will help prepare students for advanced classes—like astronomy, environmental science, or geology—that they might encounter in high school and/or college.

Engineering Design

Engineering design during grades 6–8 may explore how students can refine criteria and constraints when designing engineering solutions. Such lessons will help prepare students for advanced classes—like mechanics, robotics, or engineering-enriched science courses—that they might encounter in high school and/or college.

How can you support your child’s success?

Although this new approach to teaching and learning K–12 science is different than the past, you can still actively support your child’s success in the classroom!

1. Speak to your child’s teacher(s) or principal about how these important changes affect your school.
2. Ask your child’s teacher thoughtful questions based on the information provided in this brochure.
3. Learn how you can help the teacher(s) reinforce classroom instruction at home.
<table>
<thead>
<tr>
<th>Classroom activities in Middle School will look less like this:</th>
<th>And look more like this:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Sciences</strong></td>
<td><strong>Physical Sciences</strong></td>
</tr>
<tr>
<td>Students memorize Newton’s Law of Gravity.</td>
<td>Students gather and analyze evidence about gravity’s effect on objects with different masses.</td>
</tr>
<tr>
<td>Students follow scripted chemistry experiments.</td>
<td>Students use chemistry knowledge to design and explain a heat pack.</td>
</tr>
<tr>
<td>Students memorize the difference between Fahrenheit and Celsius.</td>
<td>Students construct arguments about the relationship between particle motion and temperature.</td>
</tr>
<tr>
<td><strong>Life Sciences</strong></td>
<td><strong>Life Sciences</strong></td>
</tr>
<tr>
<td>Students memorize the equation for photosynthesis.</td>
<td>Students explain the chemistry behind photosynthesis and how it relates to the growth of a plant.</td>
</tr>
<tr>
<td>Students build a model of a cell out of gelatin and label its parts.</td>
<td>Students design a new cell to optimize a particular function, such as energy production.</td>
</tr>
<tr>
<td>Students draw an ecosystem on paper.</td>
<td>Students conduct research to identify significant changes in local ecosystem(s).</td>
</tr>
<tr>
<td><strong>Earth &amp; Space Sciences</strong></td>
<td><strong>Earth &amp; Space Sciences</strong></td>
</tr>
<tr>
<td>Students memorize the water cycle.</td>
<td>Students analyze real data to determine how water moves through the cycle.</td>
</tr>
<tr>
<td>Students build a papier-mâché volcano.</td>
<td>Students conduct research to learn how scientists observe and monitor volcanic activity on a continuous or near-real-time basis.</td>
</tr>
<tr>
<td>Students paint and position Styrofoam balls to represent planets in the solar system.</td>
<td>Students give presentations describing evidence that gravity controls the motion of the planets around the sun.</td>
</tr>
<tr>
<td><strong>Engineering Design</strong></td>
<td><strong>Engineering Design</strong></td>
</tr>
<tr>
<td>Students learn engineering separately from other science disciplines.</td>
<td>Students consider or apply engineering design principles throughout each science course.</td>
</tr>
<tr>
<td>Engineering lessons are only offered to some students.</td>
<td>Engineering lessons are offered to all students and each student is encouraged to connect lessons to their own personal experiences.</td>
</tr>
<tr>
<td>Students use trial and error to build a bridge out of popsicle sticks.</td>
<td>Students research various bridge designs, select a design that best aligns to their scientific knowledge about forces, and finally test their selected design.</td>
</tr>
</tbody>
</table>
About NGSS: Reshaping Science Education for All Students

To better prepare American students for college and careers, schools need to ensure that quality science education is accessible to all students—regardless of ethnicity or zip code.

In an effort to bolster America’s competitive edge in an increasingly global economy, 26 states led the development of the Next Generation Science Standards (NGSS) by working with teachers, higher education, business, and practicing scientists. This collaborative process produced a set of high quality, college- and career-ready K-12 academic standards that set meaningful expectations for student performance and achievement in science. The NGSS are rich in both content and practice and arranged in a coherent manner across all disciplines and grades.

Fact: “Standards” are not “curriculum”. “Standards” provide clarity about what students should know and be able to do by the end of each grade level. “Curriculum” refers to how students meet those expectations. Please contact your child’s teacher or school if you have questions about their curriculum.

Three Dimensions of Science Learning

The NGSS emphasizes three distinct, yet equally important dimensions that help students learn science. Each dimension is integrated into the NGSS and—combined—the three dimensions build a powerful foundation to help students build a cohesive understanding of science over time.

Support your child’s success in the classroom!
# Community Resource Panel

## 6th Grade

**Great Salt Lake Institute**

<table>
<thead>
<tr>
<th>Name: Jaimi Butler</th>
<th>Title: Coordinator</th>
<th>Organization: Great Salt Lake Institute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Website: greatsaltlakeinstitute.org</td>
<td>Email: <a href="mailto:gslinstitute@westminstercollege.edu">gslinstitute@westminstercollege.edu</a></td>
<td>Phone: 801-834-1209</td>
</tr>
</tbody>
</table>

### Which best describes your resource?
Out-of-classroom teacher professional development, Field trip/s, 3D-aligned curriculum, interactive informational resources

### Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.
Great Salt Lake Institute at Westminster College loves to help our local teachers! Our resources include online interactive curriculum with worksheets and wet lab ideas, 6th grade 3D curriculum created by district science specialists in partnership with GSL experts, web-quests and more. Most importantly, we want to help you take your students to the lake. Use field trip guides modeled after successful trips to various lake locations to plan your own field trip. We will lend you supplies if you need (but we think you will have everything you need). If you have further questions or need other ideas please call or e-mail and we can help connect you with our salty neighbor!

### What real-world phenomenon/a does your resource help bring into classrooms? (please feel free to list, if more than one):
Many! The Great Salt Lake in itself is a phenomenon, and it’s full of others that you can bring into your classroom for investigation - brine shrimp alone could support many, many science experiences!

### Cost:
Free

### When is the best time to schedule your resource?
No scheduling necessary (web-based resource)

### What Science and Engineering Practice/s does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?
Asking questions and defining problems., Developing and using models., Planning and carrying out investigations., Analyzing and interpreting data., Engaging in argument from evidence.

### What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?
Asking questions and defining problems., Developing and using models., Planning and carrying out investigations., Analyzing and interpreting data., Engaging in argument from evidence.

### What cross-cutting concepts are the most useful for understanding your resource?
Cause and effect, Systems and system models, Stability and change
**ASPIRE (U OF U PHYSICS)**

<table>
<thead>
<tr>
<th>Name: Julie Callahan</th>
<th>Title: Project Coordinator</th>
<th>Organization: Aspire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charlie Ju</td>
<td></td>
<td></td>
</tr>
<tr>
<td>John Matthews</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Website: aspire.cosmic-ray.org | Email: cosmic.callahan@gmail.com | Phone: 801-971-2055 |

**Which best describes your resource?**
Out-of-classroom teacher professional development, Field trip/s, Guest lecturer, Classroom kits/toolboxes to check out, Guest classroom lab/activity facilitation

**Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.**
The Lunar Phases activity is a hands-on model, activity and lesson plan developed for the 6th grade. Students partner to model and observe the apparent change of the shape of the moon through a lunar month, depending on the perspective of the viewers. Immersive activities are supplemented with manipulative cards and lessons that broaden understanding of the Lunar Phases and their relationship to the Lunar Calendar. This lesson is available with a visiting presenter, as a professional teacher development workshop (we help you develop your own kit), or a kit you may check out from us. Models, lessons and supplemental online resources complete this lesson and activity. Additional Seasons activities also available.

**What real-world phenomenon/a does your resource help bring into classrooms?** (please feel free to list, if more than one)
Lunar Phases, Lunar Calendar

**Cost:** $0-$40

**Standard:** 6.1.1

**When is the best time to schedule your resource?** No scheduling necessary (web-based resource), Fall, Winter, Spring

**What is the best method to schedule your resource?** Email, Call

**What Science and Engineering Practice/s does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?**
Asking questions and defining problems., Developing and using models., Planning and carrying out investigations., Engaging in argument from evidence., Obtaining, evaluating, and communicating information.

**What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?**
Asking questions and defining problems., Developing and using models., Planning and carrying out investigations., Obtaining, evaluating, and communicating information.

**What cross-cutting concepts are the most useful for understanding your resource?**
Scale, proportion, and quantity, Systems and system models
### 7TH GRADE

#### RESEARCH QUEST (NHMU)

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonnie Jean Knighton Madlyn Runburg</td>
<td>Education Program Specialist</td>
<td>Research Quest, Natural History Museum of Utah</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Website</th>
<th>Email</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>researchquests.org; nhmu.edu/educators</td>
<td><a href="mailto:bknighton@nhmu.utah.edu">bknighton@nhmu.utah.edu</a></td>
<td>801-587-5707</td>
</tr>
</tbody>
</table>

Which best describes your resource? 3D-aligned curriculum, Digital Resource

Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.

Research Quest is an exciting new program created by the Museum that gives middle school students the chance to engage in authentic online investigations. We bring real research questions and actual artifacts from our collections to students, thanks to incredible 3D and game technologies every bit as cool as the newest smartphone apps. Students explore fossils from the Cleveland-Lloyd Dinosaur Quarry, videos of our paleontologists, and more as they analyze evidence and develop their own theories.

What real-world phenomenon/a does your resource help bring into classrooms? (please feel free to list, if more than one):

- Fossil evidence from NHMU's collection

Cost: Free

<table>
<thead>
<tr>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2.2, 7.5.3</td>
</tr>
</tbody>
</table>

When is the best time to schedule your resource? No scheduling necessary (web-based resource)

What is the best method to schedule your resource? No scheduling necessary (web-based resource)

What Science and Engineering Practice/s does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?

- Asking questions and defining problems.
- Analyzing and interpreting data.
- Constructing explanations and designing solutions.
- Engaging in argument from evidence.
- Obtaining, evaluating, and communicating information.

What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?

- Asking questions and defining problems.
- Analyzing and interpreting data.
- Engaging in argument from evidence.
- Obtaining, evaluating, and communicating information.

What cross-cutting concepts are the most useful for understanding your resource?

- Cause and effect
- Structure and function
## GENETIC SCIENCE LEARNING CENTER - 7.4.1

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molly Malone</td>
<td>Sr. Education Specialist Director</td>
<td>Genetic Science Learning Center</td>
</tr>
<tr>
<td>Louisa Stark</td>
<td>Director</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Website</th>
<th>Email</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://learn.genetics.utah.edu/content/basics/inheritance/">http://learn.genetics.utah.edu/content/basics/inheritance/</a></td>
<td><a href="mailto:molly.malone@utah.edu">molly.malone@utah.edu</a></td>
<td>801-585-3470</td>
</tr>
<tr>
<td><a href="http://learn.genetics.utah.edu/content/basics/reproduction/">http://learn.genetics.utah.edu/content/basics/reproduction/</a></td>
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<td></td>
</tr>
<tr>
<td><a href="http://learn.genetics.utah.edu/content/evolution/heredity/Build-a-Bird_16-10-18.pdf">http://learn.genetics.utah.edu/content/evolution/heredity/Build-a-Bird_16-10-18.pdf</a></td>
<td></td>
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</tr>
</tbody>
</table>

### Which best describes your resource? 3D-aligned curriculum

### Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.

- The following collection of activities from the Learn.Genetics website can be used together to compare asexual and sexual reproduction, and the resulting genetic variation that each type of reproduction generates (or not).
- What is Inheritance? (http://learn.genetics.utah.edu/content/basics/inheritance/) is a brief multimedia piece that introduces inheritance that visually tracks genetic variation.
- Sexual vs. Asexual Reproduction (http://learn.genetics.utah.edu/content/basics/reproduction/) tasks students with reading short descriptions of the reproductive strategies of several different organisms and choosing which type of reproduction, asexual, sexual, or both, the organism employs. It can be helpful for students to create a Venn diagram upon which to list key features of asexual and sexual reproduction and which of those features overlap.
- Build a Bird (http://learn.genetics.utah.edu/content/evolution/heredity/Build-a-Bird_16-10-18.pdf) This paper model of sexual reproduction uses real pigeon traits to demonstrate how two parents can produce highly varied offspring. Students recombine parental chromosomes, make gametes, then randomly combine two gametes. Finally, they decode the resulting allele combinations to draw the traits of a pigeon offspring. A typical classroom generates quite a lot of genetic variation in the resulting pigeon population.

### What real-world phenomenon/does your resource help bring into classrooms? (please feel free to list, if more than one)

- Sexual and Asexual reproduction, Genetic Variation in Pigeons

### Cost: Free

<table>
<thead>
<tr>
<th>Standard:</th>
<th>7.4.1</th>
</tr>
</thead>
</table>

### When is the best time to schedule your resource? No scheduling necessary (web-based resource)

### What is the best method to schedule your resource? No scheduling necessary (web-based resource)

### What Science and Engineering Practice/s does your resource allow TEACHERS to engage in? Developing and using models., Obtaining, evaluating, and communicating information.

### What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?

- Developing and using models.

### What cross-cutting concepts are the most useful for understanding your resource?

- Cause and effect
### GENETIC SCIENCE LEARNING CENTER - 7.2.3

<table>
<thead>
<tr>
<th>Name: Molly Malone</th>
<th>Title: Sr. Education Specialist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Louisa Stark</td>
<td>Director</td>
</tr>
<tr>
<td>Website: <a href="http://learn.genetics.utah.edu/content/cells/">http://learn.genetics.utah.edu/content/cells/</a>; <a href="http://teach.genetics.utah.edu/content/cells/">http://teach.genetics.utah.edu/content/cells/</a></td>
<td>Email: <a href="mailto:molly.malone@utah.edu">molly.malone@utah.edu</a></td>
</tr>
</tbody>
</table>

#### Website:
- [http://learn.genetics.utah.edu/content/cells/](http://learn.genetics.utah.edu/content/cells/)
- [http://teach.genetics.utah.edu/content/cells/](http://teach.genetics.utah.edu/content/cells/)

**Which best describes your resource?** 3D-aligned curriculum

**Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.**

The Amazing Cells curriculum module on the Learn.Genetics and Teach.Genetics websites includes online multimedia and printable paper-based activities that explore the dynamic world of the cell. The module’s activities engage students in learning about the structure and function of cell organelles, how cells communicate and respond, and include the popular Cell Size and Scale interactive that compares the size of the cell to various biological structures. The Teach.Genetics website ([http://teach.genetics.utah.edu/content/cells/](http://teach.genetics.utah.edu/content/cells/)) includes downloadable worksheets that are associated with the online multimedia pieces or interactive activities on Learn.Genetics ([http://learn.genetics.utah.edu/content/cells/](http://learn.genetics.utah.edu/content/cells/)) to guide student learning and help highlight important information about the cell. Also included are instructions for a quick kinesthetic model of cell communication (Pathways with Friends). All of the materials in the Amazing Cells curriculum module can be used together, or independently, in any configuration or series.

**What real-world phenomenon/a does your resource help bring into classrooms?** (please feel free to list, if more than one)

- Cells
- Cell Communication
- The Fight or Flight Response

**Cost:** Free

**Standard:** 7.2.3

**When is the best time to schedule your resource?** No scheduling necessary (web-based resource)

**What is the best method to schedule your resource?** No scheduling necessary (web-based resource)

**What Science and Engineering Practice/s does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?**

- Obtaining, evaluating, and communicating information

**What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?**

- Developing and using models

**What cross-cutting concepts are the most useful for understanding your resource?** Structure and function, Stability and change
**8TH GRADE**

**GENETIC SCIENCE LEARNING CENTER - 8.3.2**

| Name: | Molly Malone  
| Louisa Stark | Title: Sr. Education Specialist  
| Director | Organization: Genetic Science Learning Center |
| Website: | http://learn.genetics.utah.edu/content/metabolism/  
| and http://teach.genetics.utah.edu/content/metabolism/ | Email: molly.malone@utah.edu |
| Phone: | 801-585-3470 |

**Which best describes your resource?** 3D-aligned curriculum

**Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.**

- What happens to food after we eat it and how exactly does it fuel the body? What processes happen inside the body at the cellular and molecular level that enable us to obtain and use the energy we need to live? The From Food to Fuel online curriculum supplement materials explore the molecular physiology of digestion, metabolism and energy, and the regulation of these processes by hormones. The materials emphasize the cellular processes that assemble and disassemble molecules from food sources, creating and using energy in the process. In addition, the materials explain the molecular signaling by hormones that direct the uptake and storage of energy and what makes us feel hungry.

- The materials include interactive animations, activities, and graphics-rich web pages. Supplemental materials for teachers provide background information, classroom activities that support and extend the online learning and ideas for classroom implementation.

**What real-world phenomenon(s) does your resource help bring into classrooms? (please feel free to list, if more than one)**

- Digestion and Metabolism

| Cost: | Free |
| Standard: | 8.3.2 |

**When is the best time to schedule your resource?** No scheduling necessary (web-based resource)

**What is the best method to schedule your resource?** No scheduling necessary (web-based resource)

**What Science and Engineering Practice(s) does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?**

- Asking questions and defining problems., Obtaining, evaluating, and communicating information.

**What Science and Engineering Practice(s) does your resource allow STUDENTS to engage in?**

- Asking questions and defining problems., Developing and using models., Obtaining, evaluating, and communicating information.

**What cross-cutting concepts are the most useful for understanding your resource?**

- Energy and matter
**U of U Physics Outreach**

<table>
<thead>
<tr>
<th>Name:</th>
<th>Adam Beehler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title:</td>
<td>Lecture Demonstration Specialist</td>
</tr>
<tr>
<td>Organization:</td>
<td>Department of Physics and Astronomy, University of Utah</td>
</tr>
<tr>
<td>Email:</td>
<td><a href="mailto:beehler@physics.utah.edu">beehler@physics.utah.edu</a></td>
</tr>
<tr>
<td>Phone:</td>
<td>801-581-6602</td>
</tr>
</tbody>
</table>

**Which best describes your resource? Field trip/s**

Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.

The Lecture Demonstration Facility exists to aid in the teaching of physics and astronomy to undergraduate and graduate students in the field of physics and astronomy, as well as non-majors taking physics and astronomy here on campus. When this wonderful resource of demonstration equipment is not being used for university courses, there is potential for it to be shared with others. Adam Beehler has offered many a lecture presentation where he uses the demonstration equipment to give folks a glimpse into how physics and astronomy can help us understand the world around us in new ways. These presentations will reveal how science can open our eyes to the beauty and excitement of the natural world.

**What real-world phenomenon/a does your resource help bring into classrooms? (please feel free to list, if more than one)**

Physics is the science of how things work, so my demonstrations try to emphasize that physics IS life. I have demonstrations that reveal the science behind the following real-world topics: MECHANICS (forces, motion, momentum, energy, etc.); FLUIDS (density, pressure, liquids, gases, fluid dynamics, etc.); OSCILLATIONS & WAVES (pendula, sound, instruments, resonance, superposition, etc.); THERMODYNAMICS (heat, heat transfer, gas laws, entropy, etc.); ELECTRICITY & MAGNETISM (charges, circuits, fields, forces, etc.); OPTICS (reflection, refraction, diffraction, interference, color, eye, etc.); MODERN PHYSICS (photonic effect, MRIs, X-rays, radioactivity, etc.); and ASTRONOMY (orbits, eclipses, telescopes, etc.).

**Cost?**

Free

**6th Grade Standards:**

6.1.1, 6.1.2, 6.2.2, 6.2.3, 6.2.4, 6.3.4

**7th Grade Standards:**

7.1.1, 7.1.2, 7.1.3, 7.1.4, 7.1.5

**8th Grade Standards:**

8.1.5, 8.2.1, 8.2.2, 8.2.3, 8.2.4, 8.2.5, 8.2.6

**When is the best time to schedule your resource?** Fall, Winter, Spring

**What Science and Engineering Practice/s does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?**

Asking questions and defining problems., Planning and carrying out investigations., Analyzing and interpreting data., Engaging in argument from evidence., Obtaining, evaluating, and communicating information.

**What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?**

Asking questions and defining problems., Planning and carrying out investigations., Analyzing and interpreting data., Engaging in argument from evidence., Obtaining, evaluating, and communicating information.

**What cross-cutting concepts are the most useful for understanding your resource?**

Patterns, Cause and effect, Energy and matter, Structure and function, Stability and change
<table>
<thead>
<tr>
<th><strong>Name:</strong></th>
<th>Jaimi Butler</th>
<th><strong>Title:</strong></th>
<th>Coordinator</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organization:</strong></td>
<td>Great Salt Lake Institute</td>
<td><strong>Website:</strong></td>
<td>greatsaltlakeinstitute.org</td>
</tr>
<tr>
<td><strong>Email:</strong></td>
<td><a href="mailto:gslinstitute@westminstercollege.edu">gslinstitute@westminstercollege.edu</a></td>
<td><strong>Phone:</strong></td>
<td>801-832-2308</td>
</tr>
</tbody>
</table>

**Which best describes your resource?** Thinking partner to help create curriculum and field trips to Great Salt Lake

**Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.**
We have extensive knowledge of Great Salt Lake art, research and history but are a small organization with no capacity or expertise to build curriculum. We would love to help you as you plan your field trips and lessons to incorporate the PHENOMENal GSL!

**What real-world phenomenon/a does your resource help bring into classrooms? (please feel free to list, if more than one)**
Great Salt Lake: ecosystems, industry, art, history, science research, recreation, field trips, birds,

| **Cost:** | Free | **Standard:** | applies to many |

**When is the best time to schedule your resource?** Winter

**What is the best method to schedule your resource?** Email, Call

**What Science and Engineering Practice/s does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?**
Asking questions and defining problems., Developing and using models., Planning and carrying out investigations., Analyzing and interpreting data., Constructing explanations and designing solutions., Engaging in argument from evidence., Obtaining, evaluating, and communicating information.

**What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?**

**What cross-cutting concepts are the most useful for understanding your resource?**
Patterns, Cause and effect, Scale, proportion, and quantity, Systems and system models, Energy and matter, Stability and change
## U OF U - SCIENCE OUTREACH

<table>
<thead>
<tr>
<th>Name: Samantha Davis</th>
<th>Title: Director of Student Success</th>
<th>Organization: University of Utah</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark Hale</td>
<td>Seismograph Station</td>
<td></td>
</tr>
<tr>
<td>Wil Mace</td>
<td>Geology and Geophysics</td>
<td></td>
</tr>
<tr>
<td>Pam Hofmann</td>
<td>Mining Engineering</td>
<td></td>
</tr>
<tr>
<td>Krista Carlson</td>
<td>Metallurgical Engineering</td>
<td></td>
</tr>
<tr>
<td>Website: <a href="http://www.cmes.utah.edu">www.cmes.utah.edu</a>; <a href="https://www.cmes.utah.edu/outreach/index.php">https://www.cmes.utah.edu/outreach/index.php</a></td>
<td>Email: <a href="mailto:Samantha.j.davis@utah.edu">Samantha.j.davis@utah.edu</a></td>
<td>Phone: 801-585-5176</td>
</tr>
</tbody>
</table>

**Which best describes your resource?**
Field trip/s, Guest lecturer, Classroom kits/toolboxes to check out, Guest classroom lab/activity facilitation

**Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.**
Let us introduce your students to new and exciting scientific research occurring in the College of Mines and Earth Sciences. The Classroom Experience can be tailored to support your curriculum and can be adjusted for junior high through high school students. We can provide meaningful classroom discussion about degrees within the College of Mines and Earth Sciences and the benefits of pursuing a career in the related fields. We can also provide Classroom Experiments, which our outreach team will bring to your classroom and complete with your students! In addition we also invite you to bring your students for field trips or encourage individual students to come visit our campus, buildings, and laboratories to learn about the College of Mines and Earth Sciences. Students will be able to experience our cutting edge equipment as well as learn about our degree programs and future career possibilities!

**What real-world phenomenon/a does your resource help bring into classrooms? (please feel free to list, if more than one)**
We educate students and the community with the knowledge of discovering, managing, and transforming the world’s resources while maintaining the world’s atmosphere to create a sustainable planet. Students will learn about our atmosphere, specifically weather and inversion, geology though the study of solid Earth, the rocks of which it is composed, and the processes by which they change, metallurgical engineering teaches how rocks are transformed into metals and products we use everyday, and mining engineering help students determine the safest, most effective, sustainable methods of recovering the earth’s mineral resources to sustain modern civilization.

**Cost? Free**

<table>
<thead>
<tr>
<th>6th Grade Standards:</th>
<th>7th Grade Standards:</th>
<th>8th Grade Standards:</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3.1, 6.3.2, 6.3.3</td>
<td>7.2.1, 7.2.2, 7.2.3, 7.2.4, 7.2.5, 7.2.6</td>
<td>8.1.1, 8.1.2, 8.1.4, 8.2.5, 8.4.1, 8.4.2, 8.4.3, 8.4.4, 8.4.5</td>
</tr>
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</table>

**When is the best time to schedule your resource?** Fall, Winter, Spring

**What is the best method to schedule your resource?** Email

**What Science and Engineering Practice/s does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?**
Asking questions and defining problems.

**What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?**
Asking questions and defining problems, Developing and using models, Planning and carrying out investigations, Analyzing and interpreting data, Using mathematics and computational thinking, Constructing explanations and designing solutions, Engaging in argument from evidence, Obtaining, evaluating, and communicating information.

**What cross-cutting concepts are the most useful for understanding your resource?**
Cause and effect, Scale, proportion, and quantity
### Water Runs Through This Book

**Title:** Water Runs Through This Book

**Author:** Nancy Bo Flood

**Photographer:** Jan Sonnenmair

**Description:**
- Creates a sense of wonder and mystery about water, presenting unusual information - regional, global and astronomical - and then describes ways to conserve this resource that is essential to life - from birth to death.
- Written for readers young and old who are interested in participating through art or action to increase water awareness and water conservation. Through photographs, verse, and narration, this book celebrates the most essential ingredient to life: water.
- Author and educator Nancy Bo Flood and award-winning photographer Jan Sonnenmair combine imagination and information to explore this ever-changing yet essential element in a book that strengthens and promotes an educated, inclusive and water-wise community in Utah.
- Water Runs Through This Book is much more than an exploration of how water impacts life on Earth. It is a guide for how readers of all ages can become conservationists and protectors of this endangered resource.
- Free online teacher resources include a book guide, discussion questions, Reader's Theater, and additional recommended reading.

**Cost:**
- The book is $19.95, the online teacher resources are free (also iUTAH has copies of the book that can be provided for free to workshop attendees)

**6th Grade Standards:**
- 6.2.1, 6.2.2, 6.3.1, 6.3.2, 6.3.3, 6.3.4, 6.4.1, 6.4.2, 6.4.3, 6.4.4, 6.4.5

**8th Grade Standards:**
- 8.4.1, 8.4.2, 8.4.3, 8.4.4

**When is the best time to schedule your resource?**
- No scheduling necessary (web-based resource)

**What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?**
- Asking questions and defining problems, Engaging in argument from evidence, Obtaining, evaluating, and communicating information.

**What Science and Engineering Practice/s does your resource allow TEACHERS to engage in?**
- Asking questions and defining problems, Engaging in argument from evidence.

**Cross-cutting concepts:**
- None - my resource doesn't involve teacher PD.
| **U OF U SEISMOGRAPH STATION** |
|------------------------|------------------------|------------------------|
| **Name:** | Name: John Hale  
Paul Roberson | **Title:** | Earthquake Information Specialist  
Earthquake Information Specialist |
| **Website:** | quake.utah.edu, ussc.utah.gov,  
http://www.iris.edu/hq/audience/educators | **Email:** | jmhale@seis.utah.edu |
| **Organization:** | | **Phone:** | 801-581-6274 |
| **Which best describes your resource?** | Field trip/s |
| **Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.** | Tours are open for grades 5 and up. Most tours last 45-60min for up to 25 participants at a time. Tours are available Monday – Friday 9am- 3pm |
| Topics covered during most tours include: | |
| What is a Seismograph Station and where are they? | |
| Why we use different types of instruments and telemetry? | |
| How do we locate an earthquake? | |
| How do we determine magnitudes? | |
| Where do we have earthquakes in Utah and Yellowstone, how many, and how big? | |
| Earthquake hazard in Utah and Yellowstone. | |
| UUSS role in earthquake response through ShakeMap and the Utah Department of Public Safety. | |
| Earthquake safety and preparedness. | |
| **What real-world phenomenon/a does your resource help bring into classrooms? (please feel free to list, if more than one)** | |
| **Cost:** | Free |
| **Standard:** | 7.2.2, 7.2.3, 7.2.5 |
| **When is the best time to schedule your resource?** | Fall, Winter, Spring |
| **What is the best method to schedule your resource?** | Call |
| **What Science and Engineering Practice/s does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?** | Asking questions and defining problems., Analyzing and interpreting data. |
| **What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?** | Analyzing and interpreting data., Engaging in argument from evidence., Obtaining, evaluating, and communicating information. |
| **What cross-cutting concepts are the most useful for understanding your resource?** | Patterns, Cause and effect, Scale, proportion, and quantity, Stability and change |
# TRACY AVIARY - PROFESSIONAL DEVELOPMENT

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Organization</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michelle Mileham</td>
<td>Director of Education</td>
<td>Tracy Aviary</td>
<td>801-596-8500 ext.116</td>
</tr>
<tr>
<td>Anne Terry</td>
<td>Education Manager, General Inquiries &amp; Teacher PD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annie Young</td>
<td>Senior Educator, Guided Tour &amp; Field Trips</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marina Astin</td>
<td>Educator, School and Community Outreach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Website: <a href="http://tracyaviary.org/learning/">http://tracyaviary.org/learning/</a></td>
<td>Email: <a href="mailto:michellem@tracyaviary.org">michellem@tracyaviary.org</a></td>
<td></td>
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</tbody>
</table>

**Which best describes your resource?** Out-of-classroom teacher professional development

**Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.**

This fun-filled, interactive educator training is ideal for classroom teachers, environmental educators, school administrators, after-school program staff, youth group/service organization leaders, or anyone who loves birds and wants to teach others about them. The Flying WILD program trains formal and non-formal educators to facilitate hands-on, standards-based activities that promote understanding of scientific concepts and engage students in environmental stewardship. Workshop attendees will receive their own copy of the 350+ page Flying WILD: An Educator’s Guide to Celebrating Birds and more.

**What real-world phenomenon/a does your resource help bring into classrooms? (please feel free to list, if more than one)**

- Ecosystems, interactions between humans and wildlife

**Cost?** $30

**6th Grade Standards:** 6.4.1, 6.4.2, 6.4.3, 6.4.4

**7th Grade Standards:** 7.4.1, 7.4.2, 7.5.3

**8th Grade Standards:** 8.3.3

**When is the best time to schedule your resource?** Fall, Spring

**What is the best method to schedule your resource?** Sign-up/register via website

**What Science and Engineering Practice/s does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?**

- Asking questions and defining problems.
- Planning and carrying out investigations.
- Analyzing and interpreting data.
- Using mathematics and computational thinking.
- Engaging in argument from evidence.
- Obtaining, evaluating, and communicating information.

**What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?**

- Asking questions and defining problems.
- Developing and using models.
- Planning and carrying out investigations.
- Analyzing and interpreting data.
- Using mathematics and computational thinking.
- Constructing explanations and designing solutions.
- Engaging in argument from evidence.
- Obtaining, evaluating, and communicating information.

**What cross-cutting concepts are the most useful for understanding your resource?**

- Patterns, Scale, proportion, and quantity
- Systems and system models
- Stability and change
**TRACY AVIARY - FIELD TRIPS**

| Name: | Michelle Mileham  
|       | Anne Terry  
|       | Annie Young  
|       | Marina Astin |
| Title: | Director of Education  
|        | Education Manager, General Inquiries & Teacher PD  
|        | Senior Educator, Guided Tour & Field Trips  
|        | Educator, School and Community Outreach |
| Organization: | Tracy Aviary |
| Website: | [http://tracyaviary.org/learning/](http://tracyaviary.org/learning/) |
| Email: | michellem@tracyaviary.org |
| Phone: | 801-596-8500 ext.118 |

**Which best describes your resource? Field Trip/s**

Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.

Join Tracy Aviary educators for guided tours and programs while visiting our grounds. Programs are typically 45-60 minutes and focus on birds with unique conservation stories, wetlands and birds that flourish in these important habitats, and more! You are also welcome to book a custom tour so the program can match what students are learning in the classroom.

What real-world phenomenon/a does your resource help bring into classrooms? (please feel free to list, if more than one)

Habitats and animals that rely on healthy habitats, conservation

**Cost?** $30-50 per program + admission; some scholarships available

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<thead>
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<tbody>
<tr>
<td>6.4.1, 6.4.2, 6.4.3, 6.4.4, 6.4.5</td>
<td>7.4.2, 7.4.4, 7.5.1</td>
<td>8.1.4, 8.3.3</td>
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</table>

When is the best time to schedule your resource? Fall, winter, Spring

What Science and Engineering Practice/s does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?

Asking questions and defining problems., Constructing explanations and designing solutions., Engaging in argument from evidence., Obtaining, evaluating, and communicating information.

What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?

Asking questions and defining problems., Analyzing and interpreting data., Constructing explanations and designing solutions., Obtaining, evaluating, and communicating information.

What cross-cutting concepts are the most useful for understanding your resource?

Patterns, Cause and effect, Systems and system models, Structure and function, Stability and change
### Tracy Aviary - Guest Classroom Lab/Activity Facilitation

| Name: | Michelle Mileham  
|       | Anne Terry  
|       | Annie Young  
|       | Marina Astin | Title: | Director of Education  
|       | Education Manager, General Inquiries & Teacher PD  
|       | Senior Educator, Guided Tour & Field Trips  
|       | Educator, School and Community Outreach | Organization: | Tracy Aviary  
| Website: | [http://tracyaviary.org/learning/](http://tracyaviary.org/learning/) | Email: | michellem@tracyaviary.org | Phone: | 801-596-8500 ext.118 |

Which best describes your resource? Guest classroom lab/activity facilitation

Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.

During our Soaring Science Programs, Tracy Aviary educators bring hands-on activities to your classroom or community group to explore topics such as adaptations through art, how extraordinary eggs are, migration, and wetlands and how to protect these incredible habitats. You can also book one of our Nature in the City programs, during which educators bring activities to school yards or local parks to help students explore and discover the nature right in their backyards through eco-art, stream exploration, nature walks, and map-making. All programs are 45-60 minutes long and are limited to groups of 30 participants (back-to-back programs can be scheduled to accommodate larger classes).

What real-world phenomenon/a does your resource help bring into classrooms? (please feel free to list, if more than one)

- Ecosystems
- Migration
- Conservation
- Environmental stewardship

Cost? $60 for first program; $25 for additional simultaneous or consecutive programs. Some scholarships available.

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<td>8.3.3</td>
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</table>

When is the best time to schedule your resource? Fall, Winter, Spring

What is the best method to schedule your resource? Email, Call, Sign-up/register via website

What Science and Engineering Practice/s does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?

- Asking questions and defining problems.
- Analyzing and interpreting data.
- Constructing explanations and designing solutions.
- Obtaining, evaluating, and communicating information.

What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?

- Asking questions and defining problems.
- Developing and using models.
- Analyzing and interpreting data.
- Constructing explanations and designing solutions.
- Engaging in argument from evidence.
- Obtaining, evaluating, and communicating information.

What cross-cutting concepts are the most useful for understanding your resource?

- Patterns
- Cause and effect
- Systems and system models
- Structure and function
- Stability and change
### CENTER FOR THE LIVING CITY - TEACHING OBSERVATION

| Name: | Kat Nix  
| Chelsea Gauthier | Title: Jane Jacobs Fellow  
|  | Associate Director  
| Website: | centerforthelivingcity.org  
| Email: | kat@centerforthelivingcity.org  
| Organization: | Center for the living city  
| Phone: | 801-645-1432 |

#### Which best describes your resource? curriculum to be adapted

Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.

Engage students in observing their community through the lens of urban ecology! This program uses the power of observation to teach students science and engineering concepts, utilize systems thinking, and asks the students to see the interconnectedness of the ecosystems they are a part of. As students observe phenomena, they begin to understand cities and communities as living breathing ecosystems. With the ebb and flow of energy, water, waste, and food systems within cities, the opportunities for observation and creative problem solving are endless. Cities are constantly evolving; through observation students will see the design and engineering practices that are already in place and propose their own solutions for challenges and opportunities for the future. As the population of Utah is growing at unprecedented rates, we will need our future students and change-makers to understand and propose solutions to challenges such as rapid urbanization, housing, water and air quality, and the preservation of our night skies. In the efforts of becoming the change-makers of tomorrow, today students will have the opportunity to host a Jane Jacobs walk to connect with members of their community and discuss ways to preserve, heal, repair, or transform the places they care about.

**What real-world phenomenon/a does your resource help bring into classrooms? (please feel free to list, if more than one)** Communities as a living organism and ecological system, Ecological systems, Energy flows, Dark Skies (light pollution)

**Cost?** Free

**6th Grade Standards:** 6.4.5

**7th Grade Standards:** N/A

**8th Grade Standards:** 8.2.5, 8.3.3

#### When is the best time to schedule your resource? No scheduling necessary (web-based resource)

#### What is the best method to schedule your resource? No scheduling necessary (web-based resource)

**What Science and Engineering Practice/s does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?**

- Asking questions and defining problems.
- Planning and carrying out investigations.
- Analyzing and interpreting data.
- Constructing explanations and designing solutions.
- Engaging in argument from evidence.
- Obtaining, evaluating, and communicating information.

**What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?**

- Asking questions and defining problems.
- Planning and carrying out investigations.
- Analyzing and interpreting data.
- Constructing explanations and designing solutions.
- Engaging in argument from evidence.
- Obtaining, evaluating, and communicating information.

**What cross-cutting concepts are the most useful for understanding your resource?**

- Patterns
- Cause and effect
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter
- Structure and function
- Stability and change
<table>
<thead>
<tr>
<th><strong>U OF U SCIENCE AND ENGINEERING FAIR</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name:</strong> Jody Oostema</td>
</tr>
<tr>
<td><strong>Website:</strong> New Website Coming Soon</td>
</tr>
</tbody>
</table>

**Which best describes your resource?** Out-of-classroom teacher professional development, Student and parent resources

**Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.**

The sky is the limit to what we can provided! I offer teacher trainings in the fall and will come to any school to do a private science fair workshop. Email questions about student projects can be sent in and if you can come up with a plan or idea, I will help you implement it!

**What real-world phenomenon/a does your resource help bring into classrooms? (please feel free to list, if more than one) N/A**

**Cost:** Free  **Standard:** Can apply to all

**When is the best time to schedule your resource?** no scheduling necessary (web-based resource)

**What Science and Engineering Practice/s does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?**

- Asking questions and defining problems.
- Developing and using models.
- Planning and carrying out investigations.
- Analyzing and interpreting data.
- Using mathematics and computational thinking.
- Constructing explanations and designing solutions.
- Engaging in argument from evidence.
- Obtaining, evaluating, and communicating information.

**What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?**

- Asking questions and defining problems.
- Developing and using models.
- Planning and carrying out investigations.
- Analyzing and interpreting data.
- Using mathematics and computational thinking.
- Constructing explanations and designing solutions.
- Engaging in argument from evidence.
- Obtaining, evaluating, and communicating information.

**What cross-cutting concepts are the most useful for understanding your resource?**

- Cause and effect
- Scale, proportion, and quantity
- Stability and change
## U of U Physics Observatory

<table>
<thead>
<tr>
<th>Name:</th>
<th>Paul Ricketts</th>
<th>Julie Callahan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title:</td>
<td>Observatory Director</td>
<td></td>
</tr>
<tr>
<td>Organization:</td>
<td>South Physics Observatory, University of Utah</td>
<td></td>
</tr>
<tr>
<td>Website:</td>
<td>web.utah.edu/astro</td>
<td></td>
</tr>
<tr>
<td>Email:</td>
<td><a href="mailto:observatory@physics.utah.edu">observatory@physics.utah.edu</a></td>
<td></td>
</tr>
<tr>
<td>Phone:</td>
<td>801-597-1442</td>
<td></td>
</tr>
</tbody>
</table>

**Which best describes your resource?** Out-of-classroom teacher professional development, Field trip/s, Guest lecturer, Guest classroom lab/activity facilitation.

**Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers.**

Astronomy based lectures and demos as well as telescope use for star parties and solar viewing. Also physics based demos and hands on learning.

**What real-world phenomenon/a does your resource help bring into classrooms?** (please feel free to list, if more than one)

- physics, astronomy

**Cost?** Free

**6th Grade Standards:**
- 6.1.1, 6.1.2, 6.1.3, 6.2.1, 6.2.2, 6.2.3

**7th Grade Standards:**
- 7.1.1, 7.1.2, 7.1.3, 7.1.4, 7.1.5

**8th Grade Standards:**
- 8.1.1, 8.1.2, 8.1.3, 8.1.4, 8.1.5, 8.2.1, 8.2.2, 8.2.3, 8.2.4, 8.2.5, 8.2.6, 8.3.1, 8.3.2

**When is the best time to schedule your resource?** Fall, Winter, Spring

**What Science and Engineering Practice/s does your resource allow TEACHERS to engage in?** (if your resource includes teacher PD)
- Asking questions and defining problems.
- Developing and using models.
- Analyzing and interpreting data.
- Using mathematics and computational thinking.
- Constructing explanations and designing solutions.
- Engaging in argument from evidence.
- Obtaining, evaluating, and communicating information.

**What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?**
- Asking questions and defining problems.
- Developing and using models.
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- Obtaining, evaluating, and communicating information.

**What cross-cutting concepts are the most useful for understanding your resource?**
- Cause and effect, Scale, proportion, and quantity
- Systems and system models
- Energy and matter
- Structure and function
- Stability and change
<table>
<thead>
<tr>
<th><strong>Name:</strong></th>
<th>Nikki Wayment</th>
<th><strong>Title:</strong></th>
<th>Education and Outreach Director</th>
<th><strong>Organization:</strong></th>
<th>Hawkwatch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Janet Nelson</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annette Hansen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Website:</strong></td>
<td>hawkwatch.org; hawkcount.org; allaboutbirds.org</td>
<td><strong>Email:</strong></td>
<td><a href="mailto:nwayment@hawkwatch.org">nwayment@hawkwatch.org</a></td>
<td><strong>Phone:</strong></td>
<td>801-484-6808</td>
</tr>
</tbody>
</table>

**Which best describes your resource?** Out-of-classroom teacher professional development, Classroom kits/toolboxes to check out, Guest classroom lab/activity facilitation, 3D-aligned curriculum

Please provide a brief (200 word) description of your resource for the summary document that we will give to teachers. We use actual HawkWatch International data with specific activities to help teachers understand how and why data is collected, why it's valuable and how it is used in the real world. Our activities help students understand how data is organized, how to look for patterns, and how to make predictions or statements based on the data.

**What real-world phenomenon/a does your resource help bring into classrooms?** (please feel free to list, if more than one) N/A

**Cost?** depends on multiple variables

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<td>N/A</td>
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</table>

**When is the best time to schedule your resource?** Fall, Winter, Spring

**What is the best method to schedule your resource?** Email, Call, Sign-up/register via website

**What Science and Engineering Practice/s does your resource allow TEACHERS to engage in (if your resource includes teacher PD)?**
Asking questions and defining problems., Planning and carrying out investigations., Analyzing and interpreting data., Using mathematics and computational thinking., Obtaining, evaluating, and communicating information.

**What Science and Engineering Practice/s does your resource allow STUDENTS to engage in?**

**What cross-cutting concepts are the most useful for understanding your resource?**
Patterns, Cause and effect, Energy and matter