What do you already know?

With a partner, discuss and record what you already know about a slinky...
Check this out!

What do you notice? Anything weird? What surprises you?
Record your observations with your partner.
Now, it’s your turn. Repeat the demonstration and gather more information and observations with your partner.
What questions do you have about what you saw? Generate questions you will explore with your partner.
Explain

Work together to construct an explanation of your question and a visual model to show your thinking.
Collaborate

Share your explanation and model with another group. Suggest adjustments to other’s explanations and models. Adjust your explanation and model based on other’s suggestions.
Communicate

Share your explanation and model with the large group.
Make any last adjustments to your explanation and model with your partner.
The Science Explanation

The Slinky Drop
You were able to experience the process of scientific inquiry in a real, engaging, exciting and meaningful way. Through this experience, you created a powerful new understanding of science!
Discrepant Events As A Starting Point

With your experience, thoughtful questioning and the template/lesson outline provided, you can walk your students through a taste of science inquiry using a discrepant event of your choice.
It is time for a change
The NYSSLS requires us to pivot learning experiences away from direct delivery of content (worksheets/lecture) and toward inquiry, science processes, interconnectedness and solving high quality, contextualized problems.

Research shows people construct scientific knowledge best when given the chance to investigate a puzzling phenomena!
Today’s Science Students
Shift from students simply regurgitating facts to solving problems and explaining phenomena using scientific knowledge.

It’s not Magic, It’s Science.
The Three Dimensions of the NYSSLS/NGSS

This is a shift to an environment where students use

- disciplinary core ideas
- crosscutting concepts
- scientific and engineering practices

to explore, examine, and explain how and why *phenomena* occur and to design solutions to problems

Source: [http://www.activatelearning.com/3-dimensional-learning/](http://www.activatelearning.com/3-dimensional-learning/)
The NYSSLS
Performance Expectations: Combine DCI, S/E Practices and Crosscutting Concepts

Students who demonstrate understanding can:

**HS-LS1-1.** Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. [Clarification Statement: Emphasis should be on how the DNA code is transcribed and translated in the context of proteins. Types of proteins involved in performing functions include enzymes, structural proteins, cell receptors, hormones, and antibodies.] [Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific molecular structures, and functions, or the detailed biochemical structure of proteins and enzymes.]”

**HS-LS1-2.** Develop and use a model to understand the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [Clarification Statement: Emphasis is on functions at the organism’s level such as nutrient uptake, water delivery, immune response, and organism response to stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [Assessment Boundary: Assessment does not include interactions and functions at the molecule or chemical reaction level.]”

**HS-LS1-3.** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. [Clarification Statement: Examples of investigations could include heart rate response to exercise; stimulus response to moisture and temperature, and root development in response to water level.] [Assessment Boundary: Assessment does not include cellular processes involved in the feedback mechanism.]”

The performance expectations above were developed using the following elements from the NCCE document: A Framework for K-12 Science Education.

**Connections across Grade Bands:**

**Common Core State Standards Connections:***

<table>
<thead>
<tr>
<th>EA/Ubiquit -</th>
<th>RST.11-12.1</th>
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</thead>
<tbody>
<tr>
<td>WHST.9-12.2</td>
<td>WHST.9-12.7</td>
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<td>WHST.11-12.8</td>
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<tr>
<td>WHST.9-12.9</td>
<td>SL.11-12.5</td>
</tr>
</tbody>
</table>

| WHST.11-12.8 |

Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS1-1)

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (HS-LS1-1)

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under study. (HS-LS1-3)

WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-LS1-3)

WHST.9-12.9 Draw evidence and make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS2-2)
Before we go any further.....

You are probably doing most of these things right now!

Just like evolution, we just need to tinker...


- We are asking students to learn differently.
- This means that the way we teach and what we teach will change.
Disciplinary Core Ideas are built from Core and Component Ideas for each of the disciplines.

- Life Sciences
- Earth and Space Sciences
- Physical Sciences
- Engineering, Technology and Application of Science and the Nature of Science
Disciplinary Core Ideas (DCIs) are based on the following Core Ideas:

<table>
<thead>
<tr>
<th>Life Science</th>
<th>Earth and Space Science</th>
<th>Physical Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS1: From Molecules to Organisms: Structures and Processes</td>
<td>ESS1: Earth’s Place in the Universe</td>
<td>PS1: Matter and Its Interactions</td>
</tr>
<tr>
<td>LS2: Ecosystems: Interactions, Energy, and Dynamics</td>
<td>ESS2: Earth’s Systems</td>
<td>PS2: Motion and Stability: Forces and Interactions</td>
</tr>
<tr>
<td>LS3: Heredity: Inheritance and Variation of Traits</td>
<td>ESS3: Earth and Human Activity</td>
<td>PS3: Energy</td>
</tr>
<tr>
<td>LS4: Biological Evolution: Unity and Diversity</td>
<td></td>
<td>PS4: Waves and Their Applications in Technologies for Information Transfer</td>
</tr>
</tbody>
</table>
**Disciplinary Core Ideas**

**LS4.A: Evidence of Common Ancestry and Diversity**
- Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1)

**LS4.B: Natural Selection**
- Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS-LS4-2), (HS-LS4-3)
- The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3)

**LS4.C: Adaptation**
- Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment’s limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2)
- Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3), (HS-LS4-4)
- Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)
- Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline and sometimes the extinction of some species. (HS-LS4-5)
- Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species’ evolution is lost. (HS-LS4-5)

**PS1.A: Structure and Properties of Matter**
- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
- The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1)
- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3), (secondary to HS-PS2-6)
- (NYSED) The concept of an ideal gas is a model to explain behavior of gases. A real gas is most like an ideal gas when the real gas is at low pressure and high temperature. (HS-PS1-9)
- (NYSED) Solutions possess characteristic properties that can be described qualitatively and quantitatively. (HS-PS1-10)

**PS1.C: Nuclear Processes**
- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PS1-8)

**PS2.B: Types of Interactions**
- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (secondary to HS-PS1-1), (secondary to HS-PS1-3), (HS-PS2-6)
Science and Engineering Practices

Dispels the misperception that science is just a bunch of facts

Requires that “students not only know science facts but can also apply them to explain phenomena or solve problems using the science and engineering practices”

Science and Engineering Practices are language intensive and promote language learning.
LS4 Natural Selection and Evolution

Science and Engineering Practices

- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Obtaining, Evaluating and Communicating Information
- Science Models, Laws, Mechanisms and Theories Explain Natural Phenomena

Science and Engineering Practices

- Analyzing and Interpreting Data
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- Science Models, Laws, Mechanisms and Theories Explain Natural Phenomena
Seven Cross Cutting Concepts
LS4 Natural Selection and Evolution

Crosscutting Concepts

Patterns
- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-LS4-1), (HS-LS4-3)

Cause and Effect
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-2), (HS-LS4-4), (HS-LS4-5)

Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-LS4-1), (HS-LS4-4)
<table>
<thead>
<tr>
<th>5E Model Phase</th>
<th>Science and Engineering Practice (SEP) Crosscutting Concepts (CC)</th>
<th>What students did</th>
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</thead>
</table>
| **Engage**     | **SEP** Analyzing and Interpreting Data Constructing Explanations and Designing Solutions  
                 **CC** Patterns  
                 Scientific Knowledge Assumes an Order and Consistency in Natural Systems | ● Students observed pictures of various organisms and group them based on criteria they establish; Review other students groupings and revise  
● Students observe bone structure of forelimbs of various organisms; predict habitat and function; predict relationships based on similarities/differences |
| **Explore**    | **SEP** Analyzing and Interpreting Data Obtaining and Communicating Information  
                 **CC** Patterns; Cause and Effect | ● Introduction to Galapagos Is. climate and geology; Introduce Grant’s Finch Study  
● Students measure samples of beak variations from Grant’s study; summarize and analyze the data to look for trends in beak/tarsus size; present results  
● How could differences in beak size and tarsus size help or hurt individual birds? |
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<tr>
<td>Explain</td>
<td><strong>SEP</strong>&lt;br&gt;Connections to the Nature of Science&lt;br&gt;Engaging in Arguments from Evidence&lt;br&gt;<strong>CC</strong>&lt;br&gt;Cause and Effect</td>
<td>● Students examine Grant’s on data beak sizes; food supply; rainfall&lt;br&gt;● Students use evidence to explain the change in beak sizes</td>
</tr>
<tr>
<td>Elaborate</td>
<td><strong>SEP</strong>&lt;br&gt;Science Models, Laws, Mechanisms and Theories&lt;br&gt;Explain Natural Phenomena&lt;br&gt;<strong>CC</strong>&lt;br&gt;Cause and Effect</td>
<td>● Students examine phylograms and cladograms of organisms to interpret evolutionary relationships&lt;br&gt;● Students examine physiological data for humans and apes and construct phylograms illustrating possible evolutionary relationships&lt;br&gt;● Students examine DNA sequences for apes and humans and revise their phylograms&lt;br&gt;● Students construct phylogram to illustrate possible evolutionary relationships between Galapagos Is. finches</td>
</tr>
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<tr>
<td>Evaluate</td>
<td>SEP</td>
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<td>Cause and Effect</td>
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</tr>
</tbody>
</table>
Resources


Muppets “Phenomena” Song

- Phenomena are events in nature
- Phenomena: Let’s Investigate

That scientists

And students

Investigate

And then try to explain
What Makes For Good Phenomenon

1. **Feasible**: Can students design and perform investigations to make sense of phenomena

2. **Worthwhile**: Will students build understanding toward various PEs

3. **Contextualized**: Is phenomenon anchored in real world issues

4. **Meaningful**: Will learners find making sense of the phenomena interesting and important

5. **Ethical**: Will learners not harm living organisms or the environment

6. **Sustainable**: Can learners pursue exploration of the phenomena over time
Review Process and Principles For Identifying Phenomenon

Review Process:

1. The lesson or unit builds toward the PE or bundle of PE’s

2. The lesson or unit engages the children in an element of a DCI, SEPs, and crosscutting concepts as they make sense of phenomena or design a solution to a problem

3. Student learning is driven by making sense of a phenomena or finding a solution to a problem

4. The phenomena or problem related to children’s lived experiences community, home life and prior knowledge
Students Will Develop Explanations Of Scientific Phenomena Based on Evidence

Group Discussion
- Carefully examine the photograph above of 36 day old clams

Individually / then in small groups:
- Describe the phenomena as a system
- Formulate questions and construct an explanation for the behavior of the system
- Develop evidence that supports your explanation.

Use disciplinary core ideas, crosscutting concepts with scientific practices to explore, examine, and explain how and why phenomena occur and to design solutions to the problems you observe.

You will pursue an explanatory account that provides a reason to understand each of the systems and the role it plays.
Teams Brainstorm Artifacts

- What makes a good artifact?
- What do good artifacts have in common?
- How do artifacts provide a thread of learning throughout the unit?
- How does the artifact engage students in collaborative work?
- How does the artifact make use of the DQ?
The highest compliment that you can pay me is to say that I work hard every day, that I never dog it.

— Wayne Gretzky —