Middle School Phenomenon Model Course III

Narrative and Rationale: This course model arranges the Performance Expectations (PEs) outlined in the third year of the middle school conceptual progressions model from Appendix K of the Next Generation Science Standards into three different bundles of PEs using a phenomenon-based arrangement. The bundles in this model follow a conceptual flow throughout the year.

The first bundle focuses on effects of Earth processes on organisms and populations. The second bundle focuses on the ability of humans to influence the environment and other organisms. The third bundle focuses on the ability of humans to not only influence the Earth, but also to engineer solutions to help ensure that any negative influences on the Earth are mitigated. Each bundle is organized using the DCIs that would help students explain a unifying phenomenon and answer a guiding question.

It is important to note that the SEPs and CCCs described are intended as end-of-instructional unit expectations and not curricular designations. Additional SEPs and CCCs should be used throughout instruction toward each bundle.

Unit 1: How have Earth processes changed populations of organisms? **~ 12 weeks**	**Unit 2:** How can people influence other organisms? **~ 10 weeks**	**Unit 3:** How can people influence Earth? **~ 7 weeks**
MS-LS4-1. 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. **MS-LS4-2**. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. **MS-LS4-3**. Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. **MS-LS4-4.** Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. **MS-LS4-6.** Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.[1] **MS-ESS1-4.** Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. **MS-ESS2-5.** Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. **MS-ESS2-6.** Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.[1]	**MS-LS1-8.** Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. **MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-LS4-5.** Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. **MS-LS4-6.** Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. [1] **MS-ESS3-5.** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. **MS-ETS1-3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	**MS-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* **MS-ESS3-3**. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* **MS-ESS3-4.** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. **MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

1. The bundle only includes part of this PE; the PE is not fully assessable in a unit of instruction leading to this bundle.

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Middle School Phenomenon Model Course III Flowchart

Bundle 1

LS4.A as found in MS-LS4-1
- 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.

LS4.A as found in MS-LS4-2
- 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.

LS4.A as found in MS-LS4-3
- Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy.

LS4.B as found in MS-LS4-4
- Natural selection leads to the predominance of certain traits in a population, and the suppression of others.

LS4.C as found in MS-LS4-6
- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.

ESS1.C as found in MS-ESS1-4
- 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.

ESS2.C as found in MS-ESS2-5
- The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.

ESS2.C as found in MS-ESS2-6
- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.

Bundle 2

LS1.D as found in MS-LS1-8
- Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories.

LS2.C as found in MS-LS2-4
- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.

LS4.B as found in MS-LS4-5
- 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.

LS4.C as found in MS-LS4-6
- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.

ESS3.D as found in MS-ESS3-5
- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.

ETS1.B as found in MS-ETS1-3
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.
- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors.

Bundle 3

LS2.C as found in MS-LS2-5
- Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health.

LS4.D as found in MS-LS2-5
- Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling.

ESS3.C as found in MS-ESS3-3
- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.

ESS3.C as found in MS-ESS3-3 and MS-ESS3-4
- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

ETS1.A as found in MS-ETS1-1
- 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.

ETS1.B as found in MS-LS2-5 and MS-ETS1-2
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.

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ESS2.D as found in MS-ESS2-5
- Because these patterns are so complex, weather can only be predicted probabilistically.

ESS2.D as found in MS-ESS2-6
- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.

ETS1.B as found in MS-ETS1-4
- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.
- Models of all kinds are important for testing solutions.

ETS1.C as found in MS-ETS1-3
- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process - that is, some of the characteristics may be incorporated into the new design.

ETS1.C as found in MS-ETS1-4
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.

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