OKLAHOMA ACADEMIC STANDARDS

SCIENCE
FRAMEWORK
GRADE 7: OVERVIEW

OKLAHOMA STATE DEPARTMENT OF EDUCATION
CHAMPION EXCELLENCE

The Oklahoma State Department of Education is excited to announce the release of the first resources being offered through the Oklahoma Academic Standards Science Frameworks. The Science Frameworks represent curricular resources developed by Oklahoma teachers to help teachers translate standards into classroom practice. The *Framework Overviews* represent how a group of Oklahoma teachers, at a given grade level, might bundle performance expectations/standards found in the Oklahoma Academic Standards for Science.[1] **Bundling** is how teachers would **group performance expectations/standards** for the purpose of developing **instructional units of study.**

Once bundled, the *Science Framework* writers were then charged with completing **four categories of information** that coincided with the bundle of performance expectations/standards. The categories provide insight into how the Science Framework writers collaborated to begin to translate standards into classroom instruction. The guidance provided in the categories does **not** represent a **directive** to teachers, schools or districts for classroom instruction and should not be viewed as such.

The Oklahoma State Department of Education would like to say a special thank you to the Oklahoma educators who participated in developing the Oklahoma Science Framework Overviews, Doug Paulson of the Minnesota State Department of Education who served as a consultant, Lawton Public Schools and to Quentin Biddy, the project director.

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> "The vision of the Overviews is to provide a resource for teachers that encourages them to embrace the new standards and implement them effectively in their classrooms. The suggestions provided by the frameworks project **do not** have to be implemented exactly as they are written and are **not required** to be a successful teacher, but **serve as a guide** to setting up effective lessons that will help students meet the necessary levels of success in a science classroom." - Oklahoma Science Framework Project Writer

[1] Download the Oklahoma Academic Standards for Science at http://sde.ok.gov/sde/science.

How To Read This Document

Below you will find short descriptions about each of the sections of information provided in this document. If you have questions regarding the *Framework Overviews*, please contact Tiffany Neill at 405-522-3524 or Tiffany.Neill@sde.ok.gov

Science Framework Overview: Sections

In Lay Terms

This section aims at providing a brief introduction to the goals outlined in the Performance Expectation Bundles/grouping of standards.

Three Dimensional Storyline

This section aims at providing a comprehensive instructional storyline of how the three dimensions represented in the Performance Expectation Bundles intertwine to support students engaging in science and engineering practices, crosscutting concepts and disciplinary core ideas. Keep in mind each performance expectation includes one **science and engineering practice**, one **crosscutting concept** and one **disciplinary core idea**. The **color-coding** in this section allows teachers to see where components of these three dimensions appear in the instructional storyline. To find out more about the three dimensions and how they are incorporated into the Oklahoma Academic Standards for Science, review pages 7-8 in the Oklahoma Academic Standards for Science[2] or check out the OKSci PD on Your Plan Module series, Transitioning to the Oklahoma Academic Standards for Science[3].

Lesson Level Performance Expectations

This section aims at providing **scaffolding three-dimensional learning targets** that teachers can design instruction around to meet the end goals of the Performance Expectation(s) represented in the bundles or units of study. Keep in mind the performance expectations represent the things students should know, understand and be able to do to show proficiency at the end of instruction they participate in. A teacher can **utilize** the **Lesson Level Performance Expectations** in each bundle **as a way to develop a series of instruction** to meet the end goals of the performance expectations. For example, a teacher can develop or use a lesson, which may allow students to participate in instruction that covers some of the Lesson Level Performance Expectations, but not all. In this case the teacher would then develop or conduct another lesson that covers other Lesson Level Performance Expectations in the bundle.

Misconceptions

This section aims at providing research-based misconceptions that students frequently have related to the science concepts (disciplinary core ideas) embedded in the Performance Expectation Bundles along with matching correct conceptions.

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[2] Download the Oklahoma Academic Standards for Science at http://sde.ok.gov/sde/science.

[3] Access the OKSci PD on Your Plan Modules at: https://www.evernote.com/l/AUXXlQC11VZDeLmUkOMPpjhKeJjqS-R8gww

Bundle: Matter and Its Interactions

MS-PS1-1

Students who demonstrate understanding can:

Develop models to describe the atomic composition of simple molecules and extended structures.

MS-PS-1-2

Students who demonstrate understanding can:

Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

In Lay Terms

Pure substances have identifying characteristics that are used to identify them. Using models, students should comprehend that substances are made from different type of atoms and that atoms form molecules ranging from small to very complex structures. If a chemical reaction occurs, the parts that make up the original substance is regrouped in a new way that makes a new substance with new properties. The students' understanding should increase as they work with models to know that if atoms are rearranged, that the ending result is a different substance.

Three Dimensional Storyline

In this bundle, students can develop models and analyze and interpret data relating to simple molecules and changes in these molecules due to chemical reactions. Since microscopic atoms are difficult to understand, models of simple molecules developed by students can be used to understand the composition of simple molecules and the phenomenon of microscopic atomic structures including scale, proportion and quantity. **Students at this level are not expected to balance chemical equations.**

All matter is made up of atoms which have their own substructures. They have a small central region or nucleus that contains protons and neutrons that are surrounded by a larger region containing electrons. Students should have a general understanding of the structure of atoms and their components by the end of grade 5. Pure substances have physical and chemical properties that can be used to identify them. Pure substances are made of a single type of atom, such as two oxygen atoms bonding together to make a molecule of oxygen (i.e. O_2), or single types of molecules, such as table sugar (sucrose). A pure substance has the same properties no matter the amount of the substance present. As students begin to understand basic atomic structure, they can analyze chemical and physical properties of various substances and determine similarities and differences among substances.

Atoms bond together with other atoms to form molecules and can range in size from two to thousands of atoms. Students can develop models to

demonstrate how they think different combinations of atoms bond together to form substances. Student molecular models could include drawings or other visual representations, ball and stick models, other physical models, or computer representations. Students can analyze data, including the proportion and quantity of atoms in a molecule, to understand that different combinations of atoms make different substances (e.g. H_2O, water is 2 hydrogen atoms bonded with 1 oxygen atom). Students can then make connections between the patterns of atoms in molecules at the microscopic level and properties observable at the macroscopic level. For example, solids may be formed from molecules, or they may be extended structures with repeating subunits (These repeating subunits can create crystal structures, which are a unique arrangement of molecules in a solid characteristic of crystals. **Students are not expected to know different crystalline configurations at this level, only that crystals are a solid because they have linked repeating subunits in their structure.**)

Once students have an understanding of atomic and molecular structure, they can explore how substances react with one another in characteristic ways. A chemical reaction is the process by which atoms which make up a specific substance interact with other atoms of another specific substance to form new substances with different compositions and properties. Chemical reactions can be introduced by describing the reaction of $Na_{(s)} + Cl_{(g)} \rightarrow NaCl_{(s)}$. The atoms of $Na_{(s)}$ and $Cl_{(g)}$ (reactants) will rearrange to create a new molecule of $NaCl_{(s)}$ (product) commonly called table salt. When a reaction occurs, atoms are simply rearranged to create a different substance. (**The concept of Conservation of Mass is not introduced until grade 8.)** Even though reactions cannot be seen, evidence that a chemical reaction has occurred can be observed to determine if a reaction has occurred. Students can plan and conduct investigations, such as burning sugar or steel wool, reacting baking soda with vinegar, mixing zinc with hydrochloric acid (HCl), or mixing fat with sodium hydroxide (NaOH) in order to collect data. Students can analyze data, including the properties of the substances both before (reactants) and after (products) the chemical reaction, from these investigations to determine if a chemical reaction has occurred and new substances are formed. Common evidence that a chemical reaction has occurred includes color change, temperature change, formation of a gas, or formation of a precipitate (a solid formed from mixing of solutions).

Lesson level Performance Expectations

- Students can obtain and evaluate information from a variety of sources to understand that substances are made from different types of atoms.
- Students can develop a model to demonstrate that atoms form molecules of different scales and proportions.
- Students can construct an explanation that some solids may be formed from molecules, while other solids, such as crystals, are formed from extended structures with repeating subunits.
- Students can analyze and interpret data about the characteristics of pure substances that can be used for identification.
- Students can plan and conduct investigations to collect data about the characteristic ways that substances react chemically.
- Students can use a model to explain that in a chemical reaction, the atoms that make up the original substances are regrouped into different molecules.
- Students can analyze and interpret data to determine patterns in how the properties of substances change when they chemically react.
- Students can construct explanations to describe the properties before and after a chemical reaction.

- Students can engage in argument from evidence to describe when substances have undergone a chemical reaction.
- Students can make a claim and support it with evidence that when a chemical reaction has occurred, new substances (products) are formed that have different properties than the original substances (reactants).

Misconceptions	Accurate Concept
1. Cells are not made up of atoms. 2. Atoms or molecules are embedded in matter. 3. Solids are not made up of atoms; especially those without visible granularity. 4. Matter exists only when there is perceptual evidence of its existence. 5. Gases are not made up of atoms. 6. Biological materials are not matter. 7. Substances can change their characteristic properties but maintain their identity. 8. The products of a chemical reaction are the same substances as the reactants but with different properties. 9. After a chemical reaction, the product is a mixture in which the old substances persist, and is not a new substance.	1-6. All matter is made up of atoms. 7-9. When substances interact to form new substances, the atoms that make up the molecules of the original substances rearrange into new molecules.

References

- (Herrmann-Abell & DeBoer, 2008), http://assessment.aaas.org
- (Renstrom et al., 1990; Griffiths et al., 1992; Lee et al., 1993; Johnson, 1998c), http://assessment.aaas.org
- (Johnson, 1998c; Nakhleh et al., 1999; Nakhleh et al., 2005; Nakhleh et al., 2006), http://assessment.aaas.org/misconceptions/AMM020/29
- (Stavy, 1990), http://assessment.aaas.org/misconceptions/AMM022/29
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- (Solomonidou et al., 2000) http://assessment.aaas.org/misconceptions/AMM031/29
- (Johnson, 2000b; Solomonidou & Stavridou, 2000) http://assessment.aaas.org/misconceptions/AMM031/29

Bundle: Energy

MS-PS3-6

Students who demonstrate understanding can:

Construct, use and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object

In Lay Terms

Students will understand kinetic energy within a system. Energy is neither lost nor destroyed so that when energy in an object appears to leave the system, it actually is transferred to another object within a given system at the same time.

Three Dimensional Storyline

In this performance expectation, students are expected to construct, use, and present arguments from evidence to prove that within a system, energy is transferred from one object to another. These arguments may be constructed by investigating various forms of energy (e.g. energy in fields, thermal energy, or energy of motion).

Energy can only be transferred from object to object within a given system. In order to fully understand this law, students must analyze phenomena associated with the various types of energy that exist.

Kinetic energy is the energy of motion. An object has kinetic energy when the object itself is moving (e.g. a ball rolling), but kinetic energy also relates to thermal energy. When an object moves, friction slows it down and energy is transferred from motion (kinetic energy) to heat (thermal energy).
Potential energy is the energy an object has due to its position within a system. The larger the mass of an object or the higher the object rests, the more potential energy the object has. For example, a boulder resting on top of a cliff has more potential energy than a pebble resting next to it due to its larger mass. Likewise, the pebble resting on top of a house has more potential energy than it does if it rests on a windowsill, due to the difference in its height.

Students can plan and conduct investigations to collect data about kinetic and potential energy of objects in a system. Students can analyze this data to uncover patterns regarding the relationship between potential and kinetic energy. An object that has potential energy can transfer that energy into kinetic energy when the object begins to move, due to its mass or position. More potential energy can result in more kinetic energy that an object may possess when motion begins to occur. For example, a person jumping on a trampoline has potential energy when they reach the peak of a jump, and their force changes direction from upward to downward. When the person begins falling back down, their potential energy is converted into kinetic.

Students can begin to use evidence from their investigations to construct arguments and use scientific reasoning that when the motion energy of an object changes, there is inevitably some other change in energy that results in the system. Students can ask further questions about objects and their interactions within a system in order to plan and conduct further investigations about energy transfer within a system. These types of inquiry investigations allow students to develop a deeper understanding that when one object is in motion and comes in contact with another object, the energy from the first object does not simply disappear or leave the system, it must be transferred someplace else within the system. The energy might be transferred to the second object by various means. For example, the first object may transfer kinetic energy to the second object and cause it to move. There might also be a transfer of thermal energy through friction to the second object or the surface upon which the object is rolled. This transfer would decrease the thermal energy of the first object, and transfer the energy to another object or surface. Depending on the object's composition, the first object's energy could even be transferred into sound or light.

Lesson Level Performance Expectations

- Students can plan and carry out an investigation to demonstrate that when kinetic energy of an object changes, it is either transferred to or from that object and does not disappear.
- Students can construct and defend an explanation that in a closed system, kinetic (motion) energy can be transferred from one object to another within the closed system.
- Students can gather evidence from investigations that kinetic energy can be converted to thermal energy within the system.
- Students can argue from evidence that kinetic energy can be converted into thermal energy.
- Students can develop and use a model to explain how energy, both potential and kinetic, can never be lost but is transferred between objects within a closed system.

Misconceptions	Accurate Concept
1. Energy is truly lost in many energy transformations.	1. Energy cannot be created or destroyed, only transferred between objects within a system.
2. If energy is conserved, why are we running out of it?	2. Energy and energy sources are different terms.
3. Things use up energy.	3. Energy cannot be created or destroyed, only transferred between objects within a system.
4. Energy is a thing.	4. Energy is not a physical object or "thing", rather it is energy is required to make things happen.
5. The terms "energy" and "force" are interchangeable.	5. Energy is related to forces, but is not the same thing as a force. Energy is required to apply a force and/or forces cause energy to be transferred within a system.
6. Energy often disappears and is lost.	6. Energy cannot be created or destroyed, only transferred between
7. Energy is a type of matter or substance that can flow like a liquid.	
8. Food and fuel are energy rather than sources of energy.	

objects within a system.

7. Energy is not a physical object or "thing", rather it is energy is required to make things happen.
8. Food and fuel are only sources of energy. When they are consumed or used, stored energy is converted to a more usable form of energy such as motion or thermal energy.

References

- *education.ohio.gov/getattachment/Topics/Ohio-s-New-Learning-Standards/Science/Science_Standards.pdf*
- http://amasci.com/miscon/opphys.html

Bundle: Biological Unity and Diversity

MS-LS1-4

Students who demonstrate understanding can:

Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

MS-LS1-5

Students who demonstrate understanding can:

Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

MS-LS4-4

Students who demonstrate understanding can:

Construct an explanation based on evidence that describes how genetic variations of traits in population increase some individuals' probability of surviving and reproducing in a specific environment.

MS-LS4-5

Students who demonstrate understanding can:

Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

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MS-LS4-6

Students who demonstrate understanding can:

Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

In Lay Terms

Within every population, there are variations of organisms. Some of these variations exhibit traits and behaviors that will favor the chance to survive and reproduce, while others will decrease the likelihood to survive and reproduce. Through technology, humans have found ways to enhance the rate at which some beneficial traits in some organisms occur.

Three Dimensional Storyline

All species of organisms have certain characteristics that allow individuals to survive in its environment. Adaptations are the favorable traits and

behaviors which allow organisms to survive in a given environment. For example, some prey animals travel in herds for protection, some organisms build nests to protect their young, some organisms are brightly colored to either attract a mate or to warn predators they are poisonous. Plants can also have traits favorable for survival, such as brightly colored flowers to attract pollinators or thorns for protection. Environmental conditions change over time, which also result in changes of the population of a specific species. The distribution of traits in a population will change as a result of changes in the species' environmental conditions and can be explained by using mathematical representations, like simple probability statements and proportional reasoning. The traits and/or behaviors that allow a species to survive and reproduce will increase in frequency in the species as time goes on. The less favorable traits will decrease in frequency and can possibly disappear This is the idea of natural selection. Natural selection is a key mechanism to showing how species change over time. Those individuals within populations that contain favorable traits will survive, reproduce and pass on the favorable adaptations at a higher rate than those without favorable adaptations. For example, during the Industrial Revolution, the color of tree bark changed due to soot from pollution resulting in darker colored moths being able to be more effectively camouflaged and light-colored more easily seen and eaten by birds. Students can use cause and effect relationships to construct an explanation based on evidence on how these traits increase their chances of survival. The students can construct explanations that include qualitative and quantitative evidence that describe the phenomena of why some traits are suppressed and other traits become more prevalent for those individuals better at finding food, shelter, or avoiding predators.

Traits in a species can be purposefully influenced by humans. Artificial selection influences characteristics by selective breeding. Artificial selection is the breeding of plants and animals to produce desirable traits. One example might be raising competition or show animals such as horses, dogs, or farm animals. To produce the desired offspring that will catch the show judge's attention, a human may select the parents with the desired phenotypic (visible) traits to breed to get a more desirable offspring. Students can gather, research, evaluate, synthesize, and communicate many different uses of artificial selection and the ways in which technology has assisted humans to influence the inheritance of desired traits. These technologies may include concepts such as genetic modification, animal husbandry, and gene therapy. Students should be able to demonstrate and communicate ideas about how technology affects both individuals and society in relation to genetics and heredity.

Lesson Level Performance Expectations

- Students can analyze data about embryological development of different species to determine similarities and relationships among different organisms.
- Students can construct an explanation using evidence that ancestral relationships not evident from analysis of fully formed organisms can be determined from embryological data analysis.
- Students can engage in argument from evidence that certain characteristic behaviors of animals can increase the odds of reproduction.
- Students can construct scientific explanations based on valid and reliable evidence from sources to explain that plants reproduce in a variety of ways.
- Students can engage in argument from evidence, using cause and effect relationships to explain that plants sometimes depend on animal behavior for reproduction.

- Students can develop and use models to show how genetic factors affect the growth of plants and animals.
- Students can analyze and interpret data to show how local conditions can affect the growth of a plant or animal.
- Students can construct an explanation using mathematical evidence to show that natural selection leads to the predominance or suppression of certain traits in a population over time.
- Students can gather and synthesize information to determine that humans have the capacity to influence certain characteristics of organisms through artificial selection by selective breeding, animal husbandry, genetic modification, and/or gene therapy.
- Students can develop a model to explain that through selective breeding, humans can choose desired parental traits of organisms, determined by the genes, which are then passed on to offspring.
- Students can use mathematical representations to support explanations that adaptation by natural selection acts over many generations.
- Students can engage in arguments from evidence that species change over time in response to changes in environmental conditions.
- Students can construct explanations that traits which are less successful for survival and reproduction become less common over time, resulting in a change in the distribution of traits in a population.
- Students can analyze graphs, charts, and images to make a comparison of the embryological development of different species.
- Students can engage in argument from evidence that similarities in embryological development show relationships not evident in the fully-formed anatomy.

Misconceptions	Accurate Concept
1. Species that are distantly related organisms share no similarities.	1-4. Similarities and differences in inherited characteristics of organisms alive today or in the past can be used to infer the relatedness of any two species, changes in species over time, and lines of evolutionary descent.
2. Members of different species do not share a common ancestor.	
3. Species that are similar can share a common ancestor.	
4. Species that have no apparent, obvious, or superficial similarities cannot share a common ancestor.	
5. Natural Selection is sometimes interpreted as a random process.	5. The genetic variation that occurs in a population because of mutation is random— but selection acts on that variation in a very non-random way. Genetic variants that aid survival and reproduction are much more likely to become common, than variants that don't.
6. Every individual organism is identical if it is in the same species.	6-7. Organisms of the same species can have different variations, even though they are the same species.
7. Visible differences between individuals indicate that they are not the same species.	

References

- http://assessment.aaas.org/topics/EN#/,tabs-262/2,tabs-265/2
- http://evolution.berkeley.edu/evolibrary/article/evo_32
- Doing Good Science in Middle School, Expanded 2nd Edition: A Practical STEM Guide, By Olaf Jorgenson, Rick Vanosdall, Vicki Massey, Jackie Cleveland

Bundle: Heredity

MS-LS3-1

Students who demonstrate understanding can:

Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

MS-LS3-2

Students who demonstrate understanding can:

Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

MS-LS4-3

Students who demonstrate understanding can:

Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in fully-formed anatomy.

In Lay Terms

Within this bundle, students learn the difference between sexual and asexual reproduction. Sexual Reproduction is the production of new living organisms by combining genetic information from two individuals of different types (sexes). Genetic information is transferred to the offspring through egg and sperm cells. Variations of those inherited traits between the parent and offspring arise from those genetic differences. Using a Punnett square to show those differences would be beneficial. In asexual reproduction, the offspring results in identical genetic information.

Three Dimensional Storyline

A crosscutting concept in this science bundle is the understanding of complex and microscopic structures and systems. Since genes are too small to be seen with the bare eye, it is important for students to create models to both assist in and demonstrate their understanding of inheritance of traits and mutations. Models can include pedigrees and/or Punnett squares. Students analyze patterns of inheritance to determine the possible effects of inheritance. When discussing inheritance of traits, students first need a thorough understanding of sexual and asexual reproduction.

Inheritance is the acquisition of traits genetically transmitted from parents to offspring and is the reason that there is a similarity among individuals in a species population. Through inheritance, traits are passed from one generation to the next; therefore, when organisms reproduce, genetic information is transferred to their offspring. A trait is a genetically determined characteristic. An example of a genetic trait is attached earlobe vs free earlobes, rolling tongue vs non-rolling tongue or curly hair vs straight hair. For better understanding, students can use Punnett

squares, diagrams, and simulations to model how those traits are passed from parent(s) to offspring and predict the possible resulting traits of that genetic transfer. Students can also use models to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.

Two methods of reproduction in organisms include sexual reproduction and asexual reproduction. In species that reproduce sexually, each cell contains two variants of each chromosome, one inherited from each parent. These variants are called alleles. An allele is defined as one of a pair of genes that appear at a particular location on a particular chromosome and control the same characteristic. Each parent contributes half of the gene, or one allele, acquired at random by the offspring. 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. Sexual reproduction promotes genetic diversity among organisms. Students can use mathematical reasoning to predict and communicate how sexual reproduction can promote genetic diversity.

In organisms that reproduce asexually, a single organism reproduces without the genetic input of another. This process allows for replication of an almost exact copy of the parent genetic information. While genetic diversity is not served through asexual reproduction, there are some advantages. One is that once an organism is well suited to its environment, it can quickly reproduce many copies to form many new individuals with that specific gene pattern. This rapid reproduction makes it successful. One example of asexual reproduction involves budding. Budding is a process in plants where an offspring grows out of the body of the parent. Students can gather information from various resources, including models and simulations, to determine the function of genes in encoding and expressing an organism's inheritable traits during sexual and asexual reproduction.

Mutations can introduce variations in traits in both sexual and asexual reproduction, which can be harmful, neutral, or an advantage for an organism. A mutation is a permanent change in the sequence of DNA whereby, genetic information is altered. Changes (mutations) to genes result in changes to proteins, which affect the structures and resulting functions of the organism's trait characteristics. These traits that have changed are then passed from parent to offspring therefore, mutations in the DNA can be inherited. Mutations that are not passed down are either lost or become fixed.

Hereditary diseases, illnesses or sicknesses, are examples of a harmful mutations. There are some mutations that are considered beneficial. Beneficial mutations can over time, produce brand new alleles (variants of genes) that can create genetic diversity, improving an organism's chances of survival in a particular environment. Color pigments or beak changes of organisms may allow it to better survive in a specific environment. Mutations that have no effect at all are called silent or neutral mutations because they are neither harmful nor helpful. They either make no change in the expression of any gene or the changes made do not affect the function of any gene product. A neutral mutation can be explained by just being dormant, but could be used to trace ancestry. Students can determine cause and effect relationships when studying mutations.

Because of mutations and genetic variation, life on Earth is very diverse. Diversity ranges from archaea bacteria to protozoa, from plants to animals. When studying life, we use patterns to identify similarities and differences among organisms. Students can use graphs, charts, and images to compare patterns used to determine ancestry among organisms. Students can analyze displays of pictorial data when comparing both genetic relatedness and embryological development of different species. Through the comparisons of similarities in the genetic relatedness and embryological development across multiple species, patterns can be used to identify relationships among organisms which are not evident in the fully formed anatomy.

Lesson Level Performance Expectations

- Students can use a model to describe that genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes.
- Students can synthesize information from various sources to describe how distinct genes chiefly control the production of specific proteins, which in turn affects the traits of the individual.
- Students can develop and use a model to describe changes (mutations) to genes that can result in changes to proteins, which can affect both the structures and as a result, their function of an organism and thereby change traits.
- Students can analyze and interpret data to describe variations that arise from sexual reproduction.
- Students can communicate that genetic information can be altered because of the mutation.
- Students can apply scientific reasoning to show the effects of both asexual and sexual reproduction.
- Students can create a model to describe how genetic information is transferred to their offspring by using a Punnett square.
- Students can develop and use a model to describe sexually reproducing organisms and show how each parent contributes half of the genes acquired (at random) by the offspring.

Misconceptions	Accurate Concept
1. Dominant traits are the most common traits in a population.	1. Describing a trait as dominant does not mean it is the most common; it means that it is expressed over the recessive trait. How frequently a trait is observed in a population is not related to whether or not it is dominant or recessive.
2. Mutations are always bad.	2. Only some mutations are harmful. Most mutations that occur in our DNA sequence are changes in single nucleotides that do not cause harm to the individual. Mutations can even be beneficial to an individual.
3. If a family has a ¼ chance of their offspring having a disease, if their first-born has the disease, their other offspring will not have it.	3. Each offspring has a ¼ chance of having that disease.
4. Genes are only determined by traits.	4. Traits are determined genes and the environment.
5. The genetic changes due to need, desire, and environment can be passed down to the organism's progeny.	5. Traits gained over a lifetime cannot be passed down to offspring.
6. An organism's genetic code can change during their	

lifetime, according to their needs, desires and environment.

6. Genetic code cannot be changed over a lifetime by environmental forces or an organism's need.

References

- http://knowgenetics.org/common_misconceptions/#3
- www.lifescied.org/content/suppl/2013/08/16/.../CombinedSupMats2.pdf Supplemental Material CBE—Life Sciences Education; Sadler et al. Appendix

Bundle: Sensory Receptors

MS-LS1-8

Students who demonstrate understanding can:

Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

In Lay Terms

In response to environmental stimuli, signals are transmitted along nerve cells to the brain, which are then processed by the brain. The brain then produces memories and/or behaviors as a result of the processed stimuli. Students should be able to understand this process and explain that memories or behaviors are a result of sensory receptors responding to environmental stimuli by sending messages to the brain.

Three Dimensional Storyline

Students are expected to gather and synthesize information about the sensory receptors that respond to stimuli. Stimuli include, anything that incites or induces an action to a response. In turn, nerve cells transmit this stimuli input as signals to the brain. When the brain receives these signals, they are processed and can result in either a behavior or storage of a memory. A crosscutting concept that can be utilized to aid in the understanding of information processing is cause and effect relationships. For example, a stimulus, such as touching a hot stove, will be detected as input through sensory receptors in skin cells. A signal is sent to the brain via nerve cells where the brain interprets this signal as pain resulting in an immediate response or behavior such as pulling the hand away from the hot object. This example can also result in a memory being stored regarding hot objects and pain.

Inquiry based investigations allow students to gather and synthesize information that pertains to various sense receptors and the type of input that can occur (electromagnetic, mechanical, chemical). Stimuli is obtained through the various senses of an organism. An investigation might include having students close their eyes as they listen to a variety of different sounds or music. The stimuli may evoke different behaviors or memories in students.

Sometimes, the stimuli may cross over into more than one sense. For instance, the relationship between the sense of taste and smell are very related and have a cause and effect relationship. The understanding of active membrane receptors, neural systems for taste and smell, and odor receptors in the upper nasal cavity can aid each other. Students can investigate this relationship. At this grade level, students should be able to explain that past experiences (memories) allow us to perceive and interpret stimuli, such as sights and smells, in unique ways.
Students should be able to provide a basic and conceptual explanation that sensory cells respond to stimuli in the environment.

Lesson Level Performance Expectations

- Students can plan and carry out an investigation to show that a stimulus can cause a behavior to occur.
- Students can analyze data, including first hand experiences, to show that a stimulus can cause a memory to form.
- Students can effectively communicate information to explain that sensory receptors respond to stimuli resulting in immediate behaviors and/or memories.
- Students can develop a model to show how sensory receptors respond to different inputs and transmit signals along the nerve cells.
- Students can use a model to explain that nerve signals are received and processed in the brain, which results in behavior or memories.

Misconceptions	Accurate Concept
1. Everyone has the same reaction/response rate to stimuli.	1. Reaction/response rates to stimuli can vary from person to person.
2. There is no difference in reaction time using different stimuli.	2. Different stimuli can result in different reaction/response times.
3. Lack of sleep has no effect on reaction time.	3. Lack of sleep can result in slower processing and slower reaction/response times.
4. Stress does not affect reaction time.	4. Stress can have a negative effect on reaction/response time.

References

- http://library.marist.edu/sotm/

Bundle: Earth's Place in the Universe

MS-ESS1-1

Students who demonstrate understanding can:

Develop and use a model of the Earth-Sun-Moon system to describe the cyclic patterns of the lunar phases, eclipses of the sun and moon, and seasons.

MS-ESS1-2

Students who demonstrate understanding can:

Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.

MS-ESS1 1-3

Students who demonstrate understanding can:

Analyze and interpret data to determine scale properties of objects in the solar system.

MS-PS2-4

Students who demonstrate understanding can:

Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

In Lay Terms

Patterns in the motion of objects in the solar system can be observed, described, predicted and explained. These patterns are responsible for seasons, tides, eclipses, moon phases, day and night, and the apparent relative motion of objects in the sky. Even though the planets, moons, and the sun are vastly different in size and scale, each has its own gravity, which acts on all these objects. The sun's gravity keeps all planets in a predictable orbit around it. The gravitational force of Earth acting on objects near Earth's surface pulls objects toward the planet's center.

Three Dimensional Storyline

Our galaxy is the Milky Way, which is one of many in the universe. Within the Milky Way, Earth exists as part of our solar system. The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit due to gravity around the sun an appears to have formed from a disk of dust and gas, drawn together by gravity. The sun's gravity keeps Earth in its orbit around the sun and the Earth's gravity holds our moon in its orbit. Patterns of the apparent motion of the sun, the moon, and the stars in the sky can be observed, described, predicted and explained with models. 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.

Every object in the universe has mass and mass exerts a gravitational pull on other objects. Gravitational forces are always attractive and the mass of an object determines how strong the gravitational pull is. The gravitational force between any two masses depends on the size of the masses, th larger the mass, the larger the gravitational force. An example of two large masses is the Earth and the moon. Because Earth and the moon are both relatively large, they have a great gravitational force between them and cannot move independently of one another. The gravitational pull or the moon toward the center of the earth and the forward speed of the moon's original motion causes the moon to move in an elliptical pattern around the Earth. The same relationship is true for the sun and the other planets that orbit it.

The orbits of the planets and moons are predictable and students should be able to detect their patterns by analyzing their motion. Students should be able to create and use a model to explain gravity's role in the orbits of the planets around the sun and moons around the planets. Emphasis for the model is on gravity as the force that holds together the solar system, Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as their school or state).

Arguments can be constructed and presented that support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. For example, students can research and gather information about the masses of each planet in a system and provide an explanation for the placement of each planet in relation to Earth. Examples of evidence for arguments could include data generated from simulations or digital tools, and charts displaying mass, strength of interaction, distance from the sun, and orbital periods of objects within the sola system.

Students can use models to describe the patterns of the lunar phases and cycle. This includes the moon's orbit around the earth and how the sun illuminates the moon. It takes 27 days for the moon to orbit one complete time around the Earth. The moon is always half lit by the sun even though it appears that the sun is illuminating it differently. This is because it depends on how the earth and moon are positioned at that point in time. Students can explain why the moon appears to change over time in a predictable pattern and how this phenomenon occurs.

When the sun, moon and Earth are in straight alignment, a solar eclipse occurs. All types of solar eclipses are rare. A partial eclipse is when the moon casts a partial shadow on the Earth. When a total eclipse happens, the moon's shadow falls on the Earth. This can last up to several minutes in a small part of the Earth. When the alignment is sun, Earth and then moon, a lunar eclipse is visible. In a partial lunar eclipse, the moon will pass through the Earth's shadow. When a full lunar eclipse happens, a full moon must past through the Earth's shadow because the Earth is blocking th sun's light, but indirect light still hits the moon. A red moon appears when the Earth's atmosphere filters out most of the blue light waves in the sunlight leaving the remaining light waves that are orange in color. This orange light illuminates the full moon giving us the "blood moon". Students can use physical models or simulations to collect data about each of these scenarios and what would be observed on Earth.

On Earth, we have four seasons which are spring, summer, fall, and winter. These seasons occur because Earth is tilted in its orbit around the

sun. As the Earth spins on its axis and orbits the sun, the amount of sunlight the earth is receiving changes. For instance, in the Northern Hemisphere, in the summer, Earth is tilted toward the sun, so we receive more of the sun's energy for a longer amount of time. In the winter, the northern hemisphere is tilted away from the sun and receives less energy for a shorter amount of time each day. Seasons in the southern hemisphere are also predictable, but are generally opposite of the northern hemisphere. Students should be able to construct an explanation for why the Earth experiences different seasons at different times of the year.

Scale properties of objects in the solar system can be analyzed and interpreted from data collected from various sources. There is an emphasis on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.

Lesson Level Performance Expectations

- Students can develop and use a model of the Earth-sun-moon system to explain the patterns of the motion of the sun, the moon, and stars in the sky.
- Students can construct an explanation of the solar system to explain solar and lunar eclipses of the sun and moon.
- Students can construct a logical explanation of why the Earth spins on its axis in a fixed direction over the short-term, but tilted relative to it orbit around the sun.
- Students can analyze and interpret data to show the seasons are a result of that tilt of the earth on its axis.
- Students can compare and contrast how seasons are caused by the differential intensity of sunlight on different latitudes of the Earth across the year.
- Students can develop and use a model to describe how the Earth and its solar system are part of the Milky Way.
- Students can develop and use a model to describe that the solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids.
- Students can analyze and explain that planets, moons, and asteroids are held in orbit around the sun by its gravitational pull on them.
- Students can engage in a argument from evidence that gravitational forces are always attractive.
- Students can develop and use models to show that there are gravitational forces between different masses and recognize the strengths and limitations of their design.
- Students can construct an explanation as to why the moon looks as if it changes shapes throughout the month and why it has a specific pattern.

Misconceptions	Accurate Concept
1. The seasons are caused by Earth at times being closer to the sun (summer) and being further away from the sun	1. As the Earth orbits around the sun, the angle at which the sun's rays strike Earth's surface changes due to the position of Earth's tilted axis

(winter).
2. The moon creates its own light.
3. The moon can only be seen at night.
4. The moon's phases are caused by the moon's rotation on its axis.

relative to the sun. Earth's tilt does not change, only its position relative to the Sun.
2. The moon does not create its own light, but the moon's surface reflects light from the Sun.
3. Depending on the location of the moon relative to the Earth, the moon can sometimes be seen during the daytime.
4. The moon's phases are caused by the relative positions of the Earth, moon and sun to each other. One half of the moon is always reflectin light, the portion of this reflected surface visible from Earth changes due to the relative positions of the Earth, moon and sun to each othe

References

- http://sciencenetlinks.com
- http://www.lpi.usra.edu/

Bundle: Weather and Climate

MS-ESS2-5

Students who demonstrate understanding can:

Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

MS-ESS2-6

Students who demonstrate understanding can:

Develop and use a model to describe unequal heating and rotation of the Earth causes patterns of atmospheric and oceanic circulation that determine regional climates.

In Lay Terms

Weather can change in a short amount of time and factors such as, air pressure, temperature, humidity, precipitation, and wind can cause those changes. Weather can be predicted, but weather forecasting has not been perfected. Data from weather maps, diagrams, and other visualizations can be used to detect and predict weather patterns. The sun drives all weather patterns on Earth. Ocean currents can redistribute energy from the sun, which can affect regional climates. Your location on the planet (i.e. Latitude and longitude) will determine the weather and climate experienced. Large bodies of water can also affect the weather patterns in a given area.

Three Dimensional Storyline

When teaching the disciplinary core ideas such as weather, climate, and differential heating of the Earth integrated into this bundle of performance expectations, students need to understand the difference between the phenomena and possible causes. Some cause and effect relationships, like the heating of the Earth and the redistribution of that energy, influence much of the weather on the planet. Students can use models to represent complex weather systems and their interactions. An example of this would be the transfer of energy through convection.

Weather consists of short term atmospheric conditions, which can vary from day to day. Weather is the condition of the atmosphere at any given time. Students can analyze data such as weather maps, diagrams, and visualizations and interpret weather patterns to help them understand the atmospheric changes that can occur daily in weather. Air masses always flow from a high pressure area to a low pressure area (which is created by differences in temperatures due to unequal heating of Earth's surface). This air movement creates weather (defined as temperature, precipitation, pressure, and wind) that changes over time, dependent on location. Students can develop models for air masses through planning and conducting investigations to collect data about convection and convection currents. Fluids with a lower density can be used to model a low pressure area and fluids with a greater density can be used to model a high pressure area. Weather conditions can result from different types of air masses colliding thereby creating storms. Differences in pressure at different areas can cause different types of weather. Students can analyze

weather data for a period of time and interpret how differences in temperature and air pressure can result in changes in weather.

Sunlight unevenly heats the Earth's surface, both land and oceans, which releases it over time and redistributes it through ocean currents, which in turn heats the atmosphere (i.e. differential heating). The resulting temperature patterns, together with the Earth's rotation (e.g. Coriolis effect) and location of continents and oceans, create large-scale patterns of atmospheric circulation. Our Earth has an atmosphere, it creates a blanket o gases that regulates the average surface temperature of our planet. Students can conduct investigations and analyze the resulting data from different Earth materials that are submitted to thermal energy via sunlight or heat lamp to determine how thermal radiation affects these materials. Students can use models to explain how differential heating of Earth's materials works through the heating and cooling of different Earth materials. They can analyze data to see the patterns.

Bodies of water influence weather and climate for areas near to them. Water absorbs energy much slower that other Earth materials. It takes five times more heat energy to raise an amount of water one degree than it takes to raise the temperature of an equal amount of dry soil or sand. Because of this, it creates low and high pressure areas, which in turn influences the weather (sea and ocean breezes). Wind is caused from these pressure differences. Areas near the equator have very low pressure areas, so this creates the Coriolis effect (wind created because of Earth's rotation).

Lesson Level Performance Expectations

- Students can obtain, evaluate, and communicate how weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things.
- Students analyze and interpret data to show that interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.
- Students can ask questions and define problems on how the ocean exerts a major influence and collect and analyze weather and climate data to predict future weather patterns.
- Students can use mathematical thinking to explain that weather patterns are complex and can only be predicted using probabilities.
- Students can develop and use a model to describe that oceanic densities vary due to temperature and salinity.
- Students can plan and carry out investigations to show that density, temperature, and salinity variations drive an interconnected global pattern of ocean currents.
- Students can ask questions and define problems related to how 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.

Misconceptions	Accurate Concept

1. The infrared radiation from the Sun is what is responsible for warming the Earth.
2. The Sun sends heat directly through space to Earth.
3. As one goes higher into the atmosphere (for example, climbing a mountain), the atmospheric pressure does not decrease.

1-2. The visible and infrared sunlight are absorbed by the Earth's surface.
3. As altitude increases, atmospheric pressure decreases.

References

- (http://www.lpi.usra.edu/)
- (http://www.neisd.net/curriculum/SchImprov/sci/program/misconceptions_inter.htm#propmatt)

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