***Standards listed in bold font are Utah Core Science Standards. Those that are not in bold are supplemental.**
****Words that are in bold font in the lesson are vocabulary words that your child should know by the end of the lesson.**
*****Cited Sources: OER Textbook, 7th Grade**

Title of Lesson 1: Cells: The Building Blocks of the Body

Standards Taught: 7.3.1		
Materials: Microscope Slides of several different types of cells from living organisms Non-living slides or samples (e.g. stuffed animal, coin, pen, bottle cap) Observation Sheet 1	**Preparation:**	**Implementing the Lesson:** Give your child the different slides and samples and ask them to look at each one under a microscope. Ask them to describe the differences between the way living and non-living things look through the microscope. Do they notice any patterns? Are there any structures that are similar? Are living and non-living samples organized the same way? Explain that all living things are made up of cells. Like building blocks, cells are the individual pieces that make up all living tissue, including organs. Different types of cells perform different functions in order to help the living thing survive. Ask your child to look at the samples again, watching for individual cell compartments in each living one. Point out that cells can be different colors, shapes, and sizes, depending on their function. The cells in the stem of a sunflower will look and function very differently from those in the stomach of a dog. Like building blocks, each shape, color, and size fills a different need in building a body. The number of cells in each organism can also vary greatly, from one single-cell (as in some types of bacteria) to several trillion cells (as in a human being). Explain that each organism has the number and types of cells it needs to survive. Cells constantly produce more cells, helping the body to heal and grow, and work with one another to produce normal functions. Allow your child to continue looking at living cells under the microscope, encouraging them to include a few items from your own home (e.g. leaves, flower petals, hair). Then, ask them to answer the questions on Observation Sheet 1.

Observation Sheet 1

1. What is a cell and what is made up of cells?

2. How are the cells of a living organism different than those of non-living things?

3. In what ways can different types of cells vary from one another?

4. What is the difference between single-celled and multicellular organisms?

5. Draw an example of what a living cell (or group of living cells) looks like under the microscope. Label it with the type of cell it is

Title of Lesson 2: Parts of a Cell: Plants

Standards Taught: 7.3.2

Materials:	**Preparation:**	**Implementing the Lesson:**
One of the images found here, printed (simplest is best)		Briefly review the previous lesson with your child, reminding them that all living things are made up of cells, the variances in the number, shape, size, color, and function of cells, and the concept that organisms may be single-celled or multicellular. Next, ask your child to describe a plant cell (or group of plant cells) they observed using the microscope in the previous lesson. What color, shape, or size were they? Did they show an organizational pattern? Did they look different than animal cells that were observed? How? Explain that, if you had a stronger microscope, it would be possible to see the parts of each cell. Plant and animal cells have different functions, which necessitates the need for different parts and organization. Ask your child to name some ways plants fill their needs vs. how animals do (e.g. photosynthesis). Point out that plants need cells that will allow them to perform this function to survive, while animals can gather their energy by eating food. Show your child the image of a plant cell, or eukaryotic cell, found in the materials section. Explain that this is what a plant cell would look like if we could see all of its parts. Point out that each of these parts work together to make the cell a living thing. Without one of these parts, the cell would die. Next, point out each of the following parts of the cell, explaining the function using the information below: The cell membrane is the "skin" of the cell. This membrane holds the parts together and controls what can go into and out of the cell. For example, food, water, and oxygen can pass through the membrane because the cell needs these things to survive. Waste can pass through as well, as the cell needs to get rid of harmful or unneeded things to stay healthy. The cell wall is unique to plant cells. This barrier is a protection for the cell. It acts as a type of skeleton, making the plant rigid and able to stand upright. It also prevents excessive movement. The nucleus, often at the center of the cell, is the "brain". The nucleus controls the other parts of the cell and all activity within the cell. It also stores information the cell needs, such as DNA. The mitochondria (the powerhouse of the cell) is the "stomach". It breaks down food the cell will use as energy. Breaking the molecules in food apart releases the energy within them, a process called cellular respiration, and allows the cell to use that energy to function. However, plants do not eat food. Plant cells have a part specifically for the creation of food.

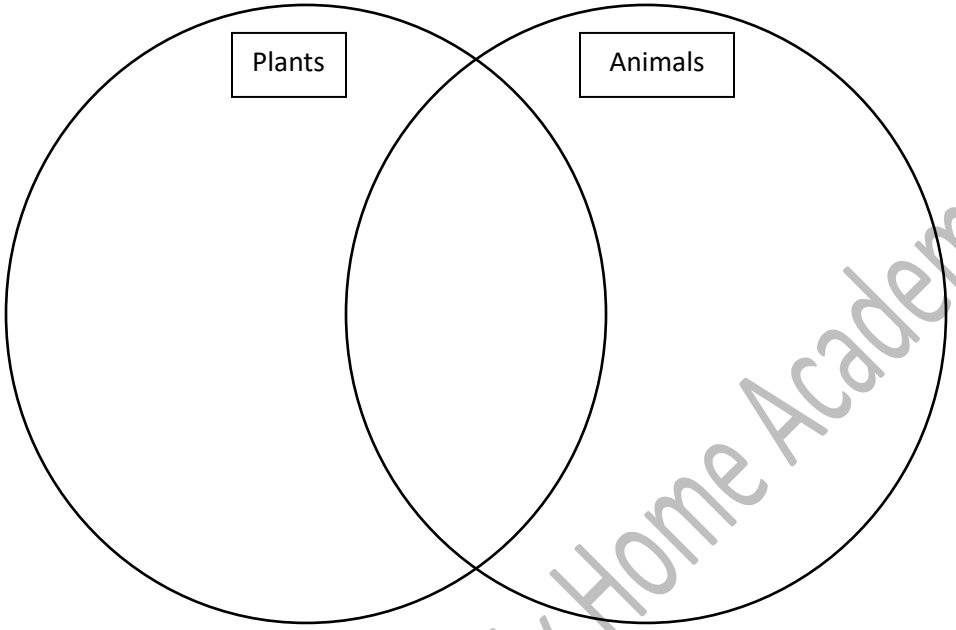
		The chloroplast is unique to plant cells and use the energy gathered from the sun to create food for the mitochondria to break down. Using carbon dioxide and water, the chloroplast convert sunlight into sugar in a process known as photosynthesis. The chloroplast are the part of the cell which makes some parts of plants appear green. Each part of the cell works together as a system, helping the cell to perform its specific function. Cells then come together to create tissues and help the plant grow, produce fruit, and adjust to the world around it. If a part of the cell were missing, the plant would not function correctly. *Note: The other parts of the cell listed in the image will be taught in a later grade. If your child is interested, take time to research the purpose and function of these. If not, simply explain that they are important parts which each have a function within the cell, but that we are not covering them now.

Title of Lesson 3: Parts of a Cell: Animals

Standards Taught: 7.3.2		
Materials: Observation Sheet 3 One of the images found here (simplest is best), printed	**Preparation:**	**Implementing the Lesson:** Review the previous lesson with your child, using the image of a plant cell to remind them of cell parts and functions. Then, show your child this image of an animal cell. Ask your child to note the differences between a plant cell and an animal cell on the Observation Sheet. Together, review the Venn-diagram, pointing out that the main differences are. Ask your child to read the second question on the Observation Sheet and guess why these differences exist. First, the animal cell does not need a cell wall. This would make the organism too rigid and unable to move. Instead, animals have a skeletal system of some kind, whether internal or an exoskeleton. Secondly, the animal cell does not contain chloroplasts, as they eat food to take in energy instead of using sunlight. Ask your child to study the plant parts discussed in the previous lesson and this one, memorizing their appearance, purpose, and location. *Note: The other parts of the cell listed in the image will be taught in a later grade. If your child is interested, take time to research the purpose and function of these. If not, simply explain that they are important parts which each have a function within the cell, but that we are not covering them now.

Observation Sheet 3

1. Use the Venn-diagram below to notes the similarities and differences between plant cells and animal cells



2. Why do you think plant cells and animal cells have some different parts? How would the cell wall and chloroplasts hinder or be unnecessary for animals?

Title of Lesson 4: Cellular Organization and Cooperation

Standards Taught: 7.3.3		
Materials: Image 1: Here Observation Sheet 4 O_2 (Pulse-Oxygen) Monitor	**Preparation:**	**Implementing the Lesson:** Review the previous lessons by showing your child Image 1 and asking them to appropriately label each part of a cell and say its purpose aloud. First, do this without help from previous lessons. If needed, correct and fill in blanks using the images from previous lessons. Next, point out that each of the parts of a cell perform their own functions. However, if one part of the cell did not work correctly, the entire cell would die, as all functions are needed. If the chloroplasts did not work, the mitochondria would not be able to convert sugar into energy, which would mean the entire cell would have no energy. In contrast, if the chloroplasts were working well, but the cell membrane was damaged, harmful materials could enter the cell and harm everything. A single cell is a system of parts, all working together. Likewise, cells gather together to create tissue, which create larger structures, such as body parts, organs, and muscles. These structures build systems within the body (e.g. the circulatory system, the skeletal system, the nervous system), which also work together to perform life-sustaining functions. Ask your child to make the observations requested in question one of the Observation Sheet. Then, ask them to do 100 jumping jacks and record the observations request in question two. Discuss the differences between the two, including any other feelings they notice. Ask your child to describe what is happening to their body. Explain that, on a cellular level, their body is helping them to get the things they need. At rest, the cells in their body only needed a certain amount of oxygen and energy. When they began to exercise, certain cells (such as those in their legs and arms) expended more energy and used oxygen at a higher rate. These cells, through the nervous system cells, sent a message to the brain. The brain, through nervous system cells, then send a message to the lungs to breath more quickly, bringing oxygen into the body at a higher rate. The respiratory system, consisting of lung cells, began to work harder. The brain also sent a message to the heart muscle cells, telling it to beat faster so that oxygen could travel more quickly to the cells that needed it. The heart and lung cells worked together with the blood cells to deliver oxygen and energy (produced in the digestive system – also made up of unique cells), to the areas in need. The automatic part of your nervous system also got the signal that the body was starting to warm up. It produced sweat to protect you from getting too hot and damaging your organs. Point out that trillions of cells worked together to get their body what it needed. If one system wasn't working well, the organism would be in danger of illness or death. Ask your child to answer the remainder of the questions on the Observation Sheet.

Observation Sheet 4

1. Note your "at rest" status for the following:

- Heart rate: _____bpm
-
- Breathing rate: _____ (slow, fast, regular)
-
- O_2 Saturation Level: _____%
-
- Skin Moisture Level: _____ (dry, mildly sweaty, very sweaty)

2. Note your after-exercise status for the following:

- Heart rate: _____bpm
-
- Breathing rate: _____ (slow, fast, regular)
-
- O_2 Saturation Level: _____%
-
- Skin Moisture Level: _____ (dry, mildly sweaty, very sweaty)

3. How do cells form tissues, which form body systems?

4. How do body systems work together to ensure the health of the organism? Give an example

Title of Lesson 5: The Cell Theory

Standards Taught: 7.3.1		
Materials:	**Preparation:**	**Implementing the Lesson:** Remind your child that every part of their, and other organisms' bodies, are made of cells. These cells clump together to create tissue, which then gathers to create organs and body systems. Then, ask your child where they think cells come from. Explain that each living thing begins as a fertilized egg (animals) or a seed (plants). Both carry all the genetic material they need to grow into a working organism. However, they do not yet show the different body parts and systems that they will need to survive on their own. Ask your child how they think an egg or a seed grow into an adult version, complete with developed tissues, organs, and systems. Explain that, in 1858, a man named Rudolf Virchow hypothesized that this happened through cell division of cells that already exist. This idea (along with the idea that all organisms are composed of cells, which are alive themselves) is known as the Cell Theory. Cell theory states that cells can only be created from existing cells. Single-celled bacteria, for example, reproduce by splitting its one cell in half, thereby creating two single-celled organisms, both alive and functioning independently from each other. Multicellular organisms develop using cells from their parents (found in the egg or seed), which then split and grow into different tissues, body parts, organs, and systems. Point out that a scientific theory is just that, a theory. It is an unproven guess that hasn't yet been proven wrong. However, as technology has advanced, scientists have been able to observe cell division, as well as the development of unborn organisms, which help add evidence that Virchow may be correct. Explain that even when our bodies are formed and born, they do not stop creating new cells. Ask your child to tell you what happens when they fall and skin their knee. What does it feel like? What does it look like? Is there blood? Ripped skin? Damaged tissue? Then, ask your child what it looked and felt like a week later. Was blood still coming out? Why or why not? Was their skin still open? Why or why not? Was the tissue still damaged as badly? Why or why not? Explain that the blood lost was replaced inside of their body by the creation of new cells. The blood cells they still had divided to create new, younger cells. Likewise, the skin that was ripped apart created and grew new cells and tissue to cover and repair the damage. This is why cuts and broken bones heal, hair grows, and your nails need to be trimmed. It's how our skin can go from tan to lighter-toned, our hearts get bigger as our bodies do, and how we get taller. Our cells are constantly diving and making copies of themselves. The old cells then die while the younger ones take their place. As we grow into adults, our bodies uses these new cells to grow, develop, and run new systems (such as the reproductive system). After we reach maturity, however, the copies our cells make begin to diminish in quality. Each reproduction

		gets a little weaker or contains a few more flaws. They are not perfect (or better) copies of the parent cell. As we age, our tissues and organs begin to falter in usage. Our eyes may need glasses, our skin may wrinkle, or our hearts may not beat as strong. Cell division explains development before birth/sprouting, growth, and aging. Ask your child the following questions and ensure they understand each concept: 1. What is the Cell Theory? 2. Has it been proven correct? Has it been proven wrong? 3. According to the cell theory, how do new cells form? 4. How does a new life form tissues, organs, and other body parts? 5. How does your body heal? 6. What happens to our cells as our bodies grow and develop into adults? 7. What happens to cells after an organism reaches maturity? Why? 8. Why do we get wrinkles?

Title of Lesson 6: An Analogy on Cells

Standards Taught: 7.3.1, 7.3.2, 7.3.3, ELA.W.HS.1, ELA.W.HS.1.b, ELA.W.HS.1.d, ELA.W.HS.1.e, ELA.W.HS.2, ELA.W.HS.2.a, ELA.W.HS.2.b, ELA.W.HS.2.d, ELA.W.HS.2.e, ELA.W.HS.2.f, ELA.W.HS.4, ELA.W.HS.5, ELA.W.HS.10

Materials:	**Preparation:**	**Implementing the Lesson:**
A computer they can type on		Today, ask your child to review what they've learned about cells in this unit. Then, explain that today they will be writing a short analogy that compares how the parts of cells, tissues, organs, and body systems work together to something with the same type of system in everyday life. They will need to explain the analogy, support their reasoning, and provide an introduction and conclusion. This should be written in a formal style. After they have finished writing, proofread their work using appropriate proofreader's marks, and ask them to create a final draft. This can be any length as long as requirements are fulfilled. Below is an example: An organism works like a kitchen. With its cells of cupboard and drawers, systems such as the kitchen sink, and with strict control by specific ingredients and instructions in recipes, it produces a desired result. Each cell, or cupboard and drawer, carries the items needed to create a finished meal. These may have different shapes, sizes, and purposes, but each is necessary. One cupboard may have knives, needed to cut ingredients. Another may have pots and pans, needed to hold the ingredients together. Yet another may contain food and spices, the things needed to give the final meal the specific flavoring needed. Each cupboard and drawer is isolated from the rest, safe within its own membrane, containing within it the things it needs. Each cell is organized for the most efficient usage. Some cells come together to create entire systems. The refrigerator, for example, has wires, fluids, and insulation needed to keep food cool. The stove and oven have heat elements, consisting of electric wires, fuses, and switches. The sink holds water pipes, soap, warm water, and sponges. Counters provide a flat, hard surface free of germs and cookbooks provide a variety of options, depending on what the needs are for that day. The tissues and systems work together when it is time to prepare a meal. The recipe, or nucleus, provides direction on how each cell should be used in relation to the others. The electricity or fire, like the mitochondria, provides the energy needed. Ingredients are brought out and prepared by knives, whisks, and bowls, each with their own purpose, but working together. They are placed in pots and pans, which keep them together where they are needed as energy is added to warm them. The nucleus recipe is strict to observe proper procedures and timing so that nothing is damaged. Adjustments are made as needed to produce the desired result. The outcome of so many cells and systems working together is a delicious meal, clean dishes, protected food (energy), and a healthy organism. Kitchens function much in the same way our bodies do, with coordination and cooperation between cells we rarely even think about.

Title of Lesson 7: Types of Reproduction

Standards Taught: S.7.4.1		
Materials: Observation Sheet 7	**Preparation:**	**Implementing the Lesson:** The production of offspring (or the organisms that create the next generation) is called reproduction. All living things reproduce, allowing life to continue on earth for millions of species of plants, animals, and insects, even after the original parent organisms have died. However, reproduction is not the same process for each species and some species can even reproduce in multiple ways. There are two types of reproduction found in living organisms: sexual and asexual. Sexual reproduction is the process of forming a new individual involving two parents: a male (father) and a female (mother). The male organism produces sperm, a tadpole-like cell, which carries the genetic material, or DNA, from the father. The female organism carries eggs, which carry the genetic material of the mother. See the image here of a sperm and egg cell meeting. When these two cells meet during reproduction, a new organism is formed, containing a mixture of the genetic traits of the mother and the father. In humans, both the sperm and the egg contain 23 chromosomes (molecules that hold genetic information in the center of each cell of an organism). The new organism created carries 46 chromosomes in each cell, half from the mother and half from the father. See the image here of a chromosome. This genetic material contains everything the offspring needs to grow into a unique organism containing traits from both its parents. It explains why you have some features from your mother and some from your father. Chromosomes carry sections, called genes. Both chromosomes and genes are made up of pieces of DNA, the programming an organism needs to decide factors like eye color, height, health, and all other aspects of how the organism will grow. See the image here. Some plants can also reproduce sexually, with the sperm located in the pollen and the egg contained in the ovary, a part within the flower. Wind and insects move the pollen to the ovary when they visit the flower to gather nectar. In this image you can see the pollen collected from other flowers on the bee's legs. This pollen drops off onto the stamen of flowers the bee lands on and travels to the egg. From this fertilized egg, the plant will grow a seed, containing the genetic material needed to create a new life (the DNA). Sexual reproduction offers the advantage of the offspring having two parents, which sometimes offers more protection and a better opportunity for being provided with ample food. At a genetic level, it also provides the ability to make up for damaged chromosomes as the healthy chromosome of one parent can provide where the unhealthy one cannot. However, it also takes more time. Parent organisms must find and choose a mate and gestation (growing of the offspring from the fertilized egg) takes time. Asexual reproduction is when offspring is created by a single parent organism. Bacteria reproduction is an example of asexual reproduction. Some species of plants, fish, insects, and reptiles also reproduce asexually. In this case, offspring

		will carry only the genetic material of a single parent. Asexual reproduction can be accomplished more quickly, as a mate does not need to be found. However, without two sets of DNA, it is difficult to compensate for damages or diseases present in the parent's DNA. In fact, the offspring carries the exact same DNA of the parent so it will inherit all traits of that parent, including harmful ones. Binary fission (the growing and division of one cell into two), regeneration (the cutting of one organism in half, with both sides surviving), budding (when a plant, like berries or potatoes, grows a new shoot which develops into a new plant), and parthenogenesis (the growth of an unfertilized egg cell into an new organism) are all examples of asexual reproduction. Read Genesis 1:11-12, 20-22, 24-25, and 26-30 and answer the questions on Observation Sheet 7.

Observation Sheet 7

1. What is reproduction and how does it ensure the survival of a species?

2. What would happen if organisms did not reproduce?

3. What are the two cells necessary for sexual reproduction?

4. What are the advantages and disadvantages of sexual reproduction?

5. Give an example of a species that reproduces sexually

6. What is the difference between sexual and asexual reproduction?

7. What are the advantages and disadvantages of asexual reproduction?

8. Give an example of a species that reproduces asexually and name the method (e.g. regeneration, binary fission, etc.)

9. Explain the role of chromosomes, genes, and DNA in reproduction

Title of Lesson 8: Reproductive Adaptations: Plants

Standards Taught: S.7.4.2, ELA.S.R.1, ELA.S.R.2, ELA.S.R.4, ELA.S.W.1, ELA.S.W.1.a, ELA.S.W.1.b, ELA.S.W.1.c, ELA.S.W.1.d, ELA.S.W.2, ELA.S.W.2.a, ELA.S.W.2.b, ELA.S.W.2.d, ELA.W.S.2.e, ELA.W.S.4, ELA.W.S.6, ELA.W.S.7, ELA.W.S.8, ELA.W.S.9, ELA.W.S.10

Materials:	**Preparation:**	**Implementing the Lesson:**
An example of a bur seed An example of a shelled nut An apple A strawberry A dandelion or other wind-traveling seed A coconut or other water-traveling seed A brightly colored flower		Reproduction allows for the survival of a species, even after a generation dies. Successful reproduction, the ability to produce offspring that live long enough to reproduce themselves, ensures that the species will continue for generations. Sexual reproduction, however, requires the ability to attract a mate, ensure fertilization, and grow viable offspring. Both plants and animals have developed adaptations which help to make reproduction more likely. Just as behavioral and physical adaptations ensure survival of the individual, those relating to reproduction ensure survival of the species. In sexual reproduction of plants, the flowers, fruit, and seeds are the most important parts. Flowers can carry strong scents, certain flavors of nectar, or petals of certain colors to attract insects and animals to them. These traits are physical adaptations which increase the likelihood of successful reproduction. As animals or insects are attracted to the flower and land on it, they collect pollen (sperm cells), which are then carried to the surrounding flowers where the eggs cells can be fertilized when the pollen falls from the animal or insect. An example of this is the monarch butterfly's favoritism of the milkweed plant's nectar. Observe the flower you have collected and discuss the scent, color, and nectar within it. Discuss with an adult what you think may make this flower attractive to pollinators. Fruit is another important part of plant reproduction. The sweet flavors and smells of the fruit attract animals, which can carry the seeds away from the parent plant and deposit them where there are enough resources for the seeds to grow. This can be done as an animal eats the fruit, along with the seeds, and they are passed through the animal's waste onto the ground. It is also done when an animal, such as a squirrel, picks up the fruit (or nut) and carries it to store at a different location. If not eaten, the seed will germinate and grow. The hard, outer shell of the nut protects the seed inside until the right conditions for growth are reached. Observe the apple, strawberry, and nut. Compare and contrast how each of these fruits carries and protects the seeds. Discuss with an adult how these traits may help or hinder successful reproduction. Other plants have adapted to grow seeds that can travel in other ways. Some plants create seeds with burs, or sharp spikes on the outside. This allows the seed to stick on a passing animal and move with them until it falls off. This includes plants such as the goat head weed, the burdock, and the sand bur. Some plants create seeds that have adapted to be carried by the wind, with wing or parachute-like structures attached. Dandelions and maple trees are examples of this. Still others are adapted to transport through water, with hard outer shells and nearly hollow insides, which allow it to float on water. The coconut is an example of this. Observe the bur seed, wind-traveling seed, and water-traveling seed. Discuss with an adult the physical aspects of each that make successful reproduction more likely. Finally, choose a plant you are interested in learning more about. Research the physical characteristics of this plant in relation to reproductive adaptations. Write a short report (1 page or less) outlining the ways these adaptations help in successful reproduction. Include cited sources, a formal style, and an introduction and conclusion.

Title of Lesson 9: Reproductive Adaptations: Animals

Standards Taught: S.7.4.2, ELA.S.R.1, ELA.S.R.2, ELA.S.R.4, ELA.S.W.1, ELA.S.W.1.a, ELA.S.W.1.b, ELA.S.W.1.c, ELA.S.W.1.d, ELA.S.W.2, ELA.S.W.2.a, ELA.S.W.2.b, ELA.S.W.2.d, ELA.W.S.2.e, ELA.W.S.4, ELA.W.S.6, ELA.W.S.7, ELA.W.S.8, ELA.W.S.9, ELA.W.S.10		
Materials:	**Preparation:**	**Implementing the Lesson:** Unlike plants, which rely mainly on physical adaptations to ensure successful reproduction, animals have both physical and behavioral adaptations which aid in attracting a mate, successfully producing offspring, and protecting offspring after birth. The first step of sexual reproduction in animals is attracting a mate. Attractive individuals are more likely to reproduce, and reproduce more often, resulting in more offspring. In turn, as attractive pairs mate, the genes containing information for those traits that make them attractive are passed to offspring, increasing the likelihood that offspring with be attractive as well. This helps ensure that offspring will also engage in successful reproduction. In most animal species, it is the female who choose the mate. Males work to be noticed by the female and compete for partners. For many species, certain physical traits are more attractive. In several bird species, for example, the males are more colorful than the females. This allows the males to attract females by making them more noticeable and helping them to appear healthier. In many animals, a female looks for strength and physical fitness in a mate. In humans, the number one physical feature that helps attract a mate is symmetry. The more symmetrical the face and body are, the more likely attraction is to occur. Behavioral adaptations, or changes to an individual's actions, can also help or hinder in the pursuit of a mate. Common courtship behaviors performed by males include: fighting with other males, offerings, dances, songs, and displays. Males sometimes display this by challenging and fighting against other males. The winner of the fight is proven strong enough to protect offspring. You can see an example of this here. The ability to provide is a strong indicator of a worthy mate, as well. In predators, this is often seen in hunting. In birds, it may be seen in males building nests or presenting females with certain trophies (such as the presentation of a rock in some penguin species). Several species of birds and spiders perform complicated dances in front of or with the female to court her. The female is then able to accept or reject the potential mate. These dances can show physical fitness as well as show off physical traits. See a courtship dance here. Singing and vocalizations are another way some species attract a mate. These songs may be complicated or simple repetitions, but they signal that the singer is looking for a mate and can use song to compete with other males. See an example of a mating song here. Finally, some animals exhibit behaviors which they believe display their best physical features. The peacock, for example, displays his tail, showing his bright colors and making himself look larger. This signals to the female that he is healthy and able to provide for himself. After attracting a mate and birthing offspring, many animals raise their children for a time. Depending on the species, this may be done by both parents or by one. However, the challenge of keeping small, weak babies alive in a world of predators, weather, and sickness is difficult. The behavioral adaptations of many species include different types of protection for the venerable offspring. For example, the nests built by most birds are designed to protect the babies from

		predators by hiding them high in a tree. They also provide protection from cold weather and keep the young contained. Most parent birds will attack any other animal that comes near its nest, as will several other species if young are threatened. See some examples here. In other species, the young are herded to the center of the family group when a predator approaches. An example of this can be seen here. Additionally, many animals are born with instincts, physical characteristics, and behaviors that help them to survive. Most species can walk within hours of being born, allowing them to move from place to place and away from predators. Some are born with camouflage that changes as they grow (as in the spots on a baby deer). Some skills are taught by the parent to the young (e.g. ducks swimming), which can protect them and increase their ability to provide for themselves. There are several ways parents and young are equipped to give the best chance at survival of the next generation. Choose an animal you are interested in learning more about. Research the physical and behavioral characteristics of this animal in relation to reproductive adaptations, both before and after birth. Write a short report (1 page or less) outlining the ways these adaptations help in successful reproduction. Include cited sources, a formal style, and an introduction and conclusion.

Title of Lesson 10: Genetic Variations and Mutations: Neutral and Beneficial

Standards Taught: S.7.4.3		
Materials: Observation Sheet 10	**Preparation:**	**Implementing the Lesson:** The passing on of genes from parents to child provides a protection for the young. Traits like agility, intelligence, or strength can be shared throughout generations. Choosing a worthy mate can improve the genes of the offspring by providing it with the genes needed to inherit desirable traits. A female bird who choose a mate with a strong mating dance, for example, has a better chance of having strong babies than one who chooses a male who is weak. Over time, this can result in entire groups of species improving survival traits through selective breeding. Genes, a part of the chromosomes that make up our DNA, help determine the way we look, how strong we are, our body type, and other physical characteristics. These genes are the programming for our body's development and growth. They tell the cells what to develop into. Genes are passed from parent to offspring during reproduction. This is why offspring produced during asexual reproduction look exactly like their parent- they share the same genes. It is why offspring produced during sexual reproduction look like a mixture of two parents- they inherit genes from both the mother and the father. Answer questions 1-2 on the Observation Sheet. However, not all offspring look the same. You probably don't look exactly the same as your siblings. You may have different eye colors, different hair colors, or a different nose shape. Though you have the same parents and inherited the same genes, you likely exhibit different characteristics. This is because of genetic variation. Your parents each have two copies of their own genes, which they inherited from their own parents. When offspring is created, you may inherit one copy while your sibling may inherit the other. Likewise, an offspring is a product of a mixture of genes from both parents. This means that the "recipe" can vary with one child inheriting more of the father's traits while another inherits more of the mother's. Genetic variations give offspring their own unique look because each has a unique combination of genes. One way to predict the genetic outcome of an offspring is to use Punnett Squares. This tool shows probability of a gene being expressed in offspring based on the traits of the parents. See this video for more information on Punnett Squares. Then answer questions 3-5 on the Observation Sheet. The different outcomes of genetic codes creating a new life are known as genetic variations. When a cell divides and creates a copy of itself, as in the cells used for reproduction, it usually results in an exact copy. In reproduction, this means that offspring is given an accurate copy of the parent's DNA. Occasionally, however, cells may encounter problems or errors in making copies, changing the code written in the genes. If this change in the code becomes permanent, it can cause a mutation. A mutation is simply a change in the code contained in the DNA of an

		organism. At times, they simply happen for unknown reasons. They can also be influenced by the environment, such as exposure to chemicals (such as tobacco), radiation, or infectious agents. At times, mutations have little to no effect on development, health, or growth. Though they may allow a species to display a different trait than their parents, this trait does not inhibit the ability of the offspring to survive in its natural environment. This is known as a neutral mutation. Red hair and blue eyes are a result of genetic mutations. Answer question 6 on the Observation Sheet. Mutations can also give offspring a beneficial effect. For example, if a butterfly has parents who are orange is born with a genetic mutation that changes its color to yellow, it may be better able to blend in with the yellow flowers and leaves in the environment than its parents. If there are several yellow flowers, this can provide better protection for the mutated butterfly, increasing its chances of survival. This butterfly would be better able to hide from predators and those without its camouflage may be targeted more often. The yellow butterfly would likely live longer than its orange counterparts, giving it the ability to reproduce and pass on its mutated, yellow genes. Over time, this may result in this particular species of butterfly changing color from orange to yellow as more and more yellow offspring are produced. This idea is the foundation of the Theory of Evolution: beneficial mutations can slowly change the genetics of a species, improving or adapting genetic traits in significant ways over time. The idea of survival of the fittest, or the strongest and most well adapted living the longest, comes from this theory. Answer the remainder of the questions on the Observation Sheet.

Observation Sheet 10

1. What physical traits do you share with your father?

2. What physical traits do you share with your mother?

3. What traits to you share with your siblings?

4. What traits do you differ with your siblings on? Do any of these traits match one parent or the other?

5. What is a genetic variation?

6. What is a genetic mutation? Why is it different than a variation?

7. What is a neutral mutation and how does it affect the organism?

8. What is a beneficial mutation and how does it defend the idea of evolution?

9. How could a species inherit one beneficial mutation over time?

Title of Lesson 11: Genetic Mutations: Harmful

Standards Taught: S.7.4.3, ELA.S.R.1, ELA.S.R.2, ELA.S.R.4, ELA.S.W.1, ELA.S.W.1.a, ELA.S.W.1.b, ELA.S.W.1.c, ELA.S.W.1.d, ELA.S.W.2, ELA.S.W.2.a, ELA.S.W.2.b, ELA.S.W.2.d, ELA.W.S.2.e, ELA.W.S.4, ELA.W.S.6, ELA.W.S.7, ELA.W.S.8, ELA.W.S.9, ELA.W.S.10		
Materials: Observation Sheet 11	**Preparation:**	**Implementing the Lesson:** In the previous lesson, you learned about genetic mutations, or changes in the genetic code of an organism. These mutations can cause offspring to express traits that the parents do not have. You learned about neutral and beneficial traits and how they can affect the survival of individuals. However, some genetic mutations can also be harmful to the individual. In the example of the butterflies, the offspring of two orange butterflies mutated to create a yellow butterfly. As the flowers in their environment were all yellow, the mutation provided a benefit to the offspring. However, if the flowers had been orange in the example given, the yellow butterfly would be at a disadvantage. His color would make him easily visible to predators and he likely wouldn't survive for very long. Likewise, this color may convince females that he is unsuitable for mating and his gene mutation would not be passed on. In this case, the butterfly has a harmful mutation. One real-life example of a skin color change is albinism, a mutation that causes the body to be unable to produce melanin (a pigment that protects organisms from the sun). People with more melanin have darker skin, and usually live (or had ancestors who did) near the equator, where the sun exposure is strongest. Most people, no matter the skin tone, have some melanin in their body to protect their skin from the sun. However those with albinism are unable to produce it, causing a white skin, which is susceptible to skin burning and cancer, and poor eye sight. This can affect the ability of an animal to camouflage, hunt, and find a mate that will accept them. See the image here for an example. Other harmful mutations can change characteristics such as how many fingers and toes an individual has, how tall they can grow, what diseases they carry, a lack of immunity to certain illnesses, a change to bone or muscle structure, or issues with behavior or mental abilities. Below is a list of a few genetic mutations that can be harmful. Choose one to research. Then, answer the questions on the Observation Sheet: sickle cell anemia, polyploidy, cancer, cleft lips, congenital heart disorders, spina bifida.

Observation Sheet 11

1. Which mutation did you choose?

2. What harmful effect does this mutation have on individuals?

3. Why aren't harmful mutations usually passed to the next generation?

4. What have humans done that has increased the likelihood of harmful mutations being passed down?

5. Can you cure a harmful genetic mutation?

6. Are there treatments for the mutation you chose?

Title of Lesson 12: Human Influence on Genetic Variations

Standards Taught: S.7.4.4		
Materials:	**Preparation:**	**Implementing the Lesson:** In nature, mutations occur often, though many are unnoticed. They can be neutral, beneficial, or harmful. Beneficial mutations tend to become a part of the species over time while harmful mutations are not passed on. Those with harmful mutations often do not live to maturity or are not selected as mates if they are, giving little chance to the mutated genes to be shared with the next generation. Beneficial mutations, however, give an individual an increased chance of survival and reproduction. This process is known as natural selection. Over time, natural selection can result in a stronger, more adequately adapted species. It can also allow for changes as a reaction to changes in the climate or environment. Humans, however, often have control over plants and animals. Plants are put in homes, gardens, fields, and yards, cultivated to look nice and provide us with certain needs. Animals are kept them as pets, use them for agriculture, and keep them in zoos. Not all plants animals are given the opportunity to live in their natural environment. This means that humans have, in some ways, controlled the process of natural selection. Over time, humans have imposed several different technologies upon other species which have adapted them to better fit our needs. Artificial selection is one example of how humans have affected the reproduction of plants and animals. By choosing the parent plants themselves, humans can help increase the probability that the offspring will have certain desired traits. This is best seen in agriculture. Plants which exhibit certain traits (cold-hardy, fruit flavor, drought-hardy, or fast growing) have been selectively bred with each other in order to produce those traits in the offspring. This is why there are so many flavors of peaches, apples, and cucumbers. Each type has been created through artificial selection. Likewise, certain animals with certain traits (produce more meat, produce more milk, are larger, stronger, or better at a certain job) have been chosen to breed. Over time, this artificial selection has given humans animals specifically bred for each task. One example can be seen here, an image showing the increase in chickens which provide meat over time. Genetic modification is another technology humans have used to increase the odds of beneficial mutations and variations. With the discovery of DNA and genes, scientists have also found ways to change those genes independent of natural methods. Manually altering DNA can cause mutations in the offspring long before it is fully developed. As in artificial selection, this has led to an increase in efficient and weather-resistant crops and larger, more productive animals. It has also sparked medical discoveries that improve the lives of humans with certain diseases. One example of this is insulin creating for those with diabetes. People who have diabetes do not create enough insulin, a chemical needed to process sugars in the body and create energy. With genetic alterations, scientists discovered a way to create insulin using bacteria. This gives those with diabetes the ability to inject insulin into their body and lead a healthier life. Scientists have also begun to successfully clone some animals. Cloning uses female egg cells to produce offspring that has a single copy of DNA from its female parent. This creates a genetic "twin", though the parent and offspring were born at different times.

		Gene therapy, or the insertion of genes into a person's cells, has given scientists the ability to cure some genetic disorders. This method gives the organism a second, healthy copy of genes, allowing for it to compensate for genes that carry the disorder and eliminate its effects. Gene therapy is a very new technology and still in testing stages in many cases. Choose your favorite breed of dog. List the physical characteristics of that breed of dog and why you like them. Then, research the genetic history of the breed, looking for instances in which humans chose those characteristics and selectively bred the dogs which carried them to create your favorite breed. Discuss this with an adult.

Title of Lesson 13: Genetic Mutation and the Probability of Survival

Standards Taught: 7.5.1		
Materials: Observation Sheet 13 This image	**Preparation:**	**Implementing the Lesson:** Plants and animals interact with and change in accordance to changes in their environment. If they are unable to, the ultimate result is extinction. As the world goes through changes, organisms which are able to adjust their behaviors or benefit from genetic mutations have a higher rate of survival, which in turn leads to a higher rate of reproduction. Over time, these beneficial changes in an individual result in changes to entire populations. Likewise, changes that are harmful decrease the likelihood that an individual will survive and reproduce, causing a decrease in those genes and characteristics in the general population. Within a population, genetic differences may also result in the expression of different traits. Though many plants or animals in a certain population have the same basic characteristics, traits such as hair color, eye color, flower color, height, weight, or speed and agility may vary throughout the population. It is unlikely you have the same hair and eye color as your entire family, though you may share some traits with them. These variations in traits can also lead to changes in a population over time as certain traits become more or less desirable for survival. An example of this is the Great Horned Owl. This owl's coloring allows it to camouflage within the tree it lives for its entire life. Individuals that are too dark or too light in color don't camouflage as well, making them easier for prey to spot and decreasing their chances of survival. The wrong variation of a single trait may mean the difference between life and death. See Image 1 on the Observation Sheet and not the variations that are more or less likely to survive. After a few generations, those with the most favorable trait make up most of the population because those genetics survived to reproduce. However, if the environment changes, what was once a harmful genetic mutation may become a beneficial one. For example, if the bark of the trees that the Great Horned Owl live in changes color in some way (e.g. disease, insects, the outer layer peeling off), those owls that were protected most by their camouflage may now be in danger of being more easily seen. Certain mutations may now benefit the owls that were less likely to survive before. See Image 2 of the Observation Sheet. Note that the less favorable mutation from Image 1 is now (because of a change in bark color) more likely to reproduce, which eventually results in a different color variation being dominant in the population. Finally, read the story below. On a blank paper, create a four-generation chart that explains how a genetic mutation could be passed on or die out in a population based on how helpful or harmful it is during a certain environmental change. Use the images from the Observation Sheet to guide you: In a rainforest, a seed drops to the ground. The next year it sprouts. As it grows in the warm, wet conditions, it is evident that this tree has thinner, smaller leaves than its parent plants. The little tree struggles with photosynthesis as its leaves are less broad. However, before it fully matures, the rainforest experiences a drastic change in weather. The hot, wet weather changes to cold, wet weather. The bigger-leaved trees break under the weight of the snow that is now falling. The little tree, however, thrives in this new climate.

Observation Sheet 13

Image 1

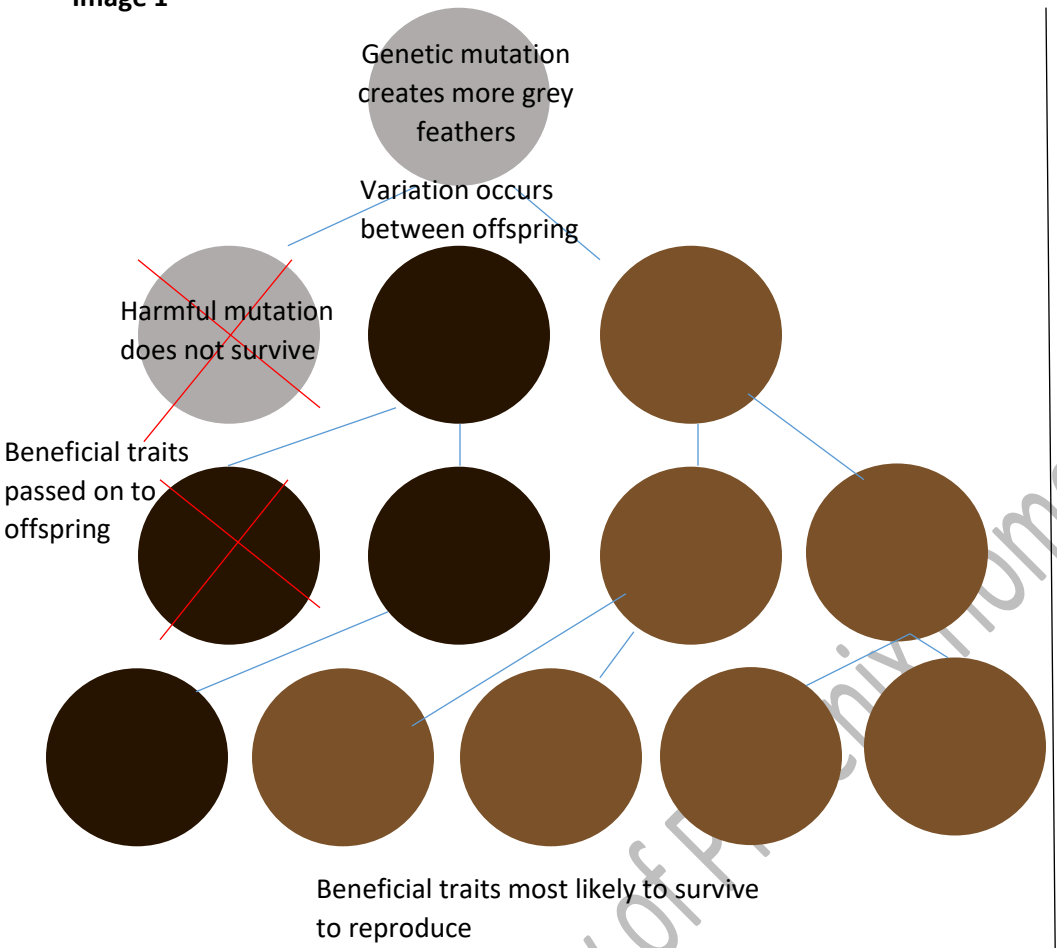
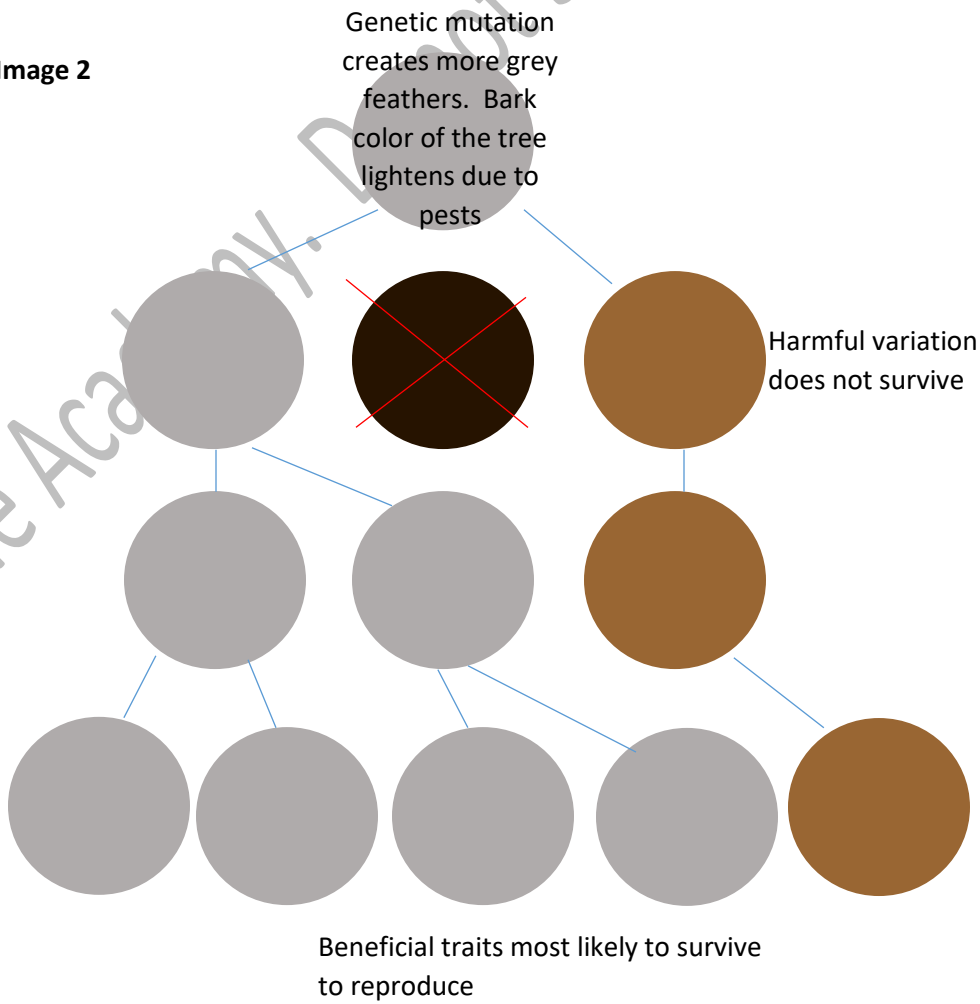


Image 2



Title of Lesson 14: Survival Mutation Patterns

Standards Taught: 7.5.2, 7.2.6

Materials:	**Preparation:**	**Implementing the Lesson:**
Observation Sheet 14 Internet Access		Charles Darwin traveled to the Galapagos Islands to study the phenomenon of differing traits in individuals and how they affect the population as a whole. He was fascinated with differences and changes in species based on their environment. On the islands, he observed that one population of a particular species on one island may have distinct variations from populations of the same species on other nearby islands. In particular, Darwin studied finches, a type of small bird (see image here). He observed that the same species of finch, when studied on four different islands, displayed different beak characteristics, such as shape and length. He believed that each bird population came from a common ancestor, as they shared several traits. However, as the populations lived on different islands with access to different food sources, the populations evolved and adapted to best suit their environment. Bird one has a large beak as there are large seeds and nuts on the island and those finches need a strong beak to be able to access the food. Bird 4, however, has a smaller, more pointed beak to reach the tiny seeds found on their island. Darwin's theory of evolution was published in *The Origin of Species*, which describes his observations from years of research and travel around the world. It suggests that natural selection (also known as survival of the fittest) is what created the variety of life found on earth today. Through natural selection, those with beneficial mutations within their own environment survive and reproduce, leading to entire populations that carry beneficial adaptations. If an adapted population is moved or their environment changes, the adaptation may become harmful. For example, if the large-beaked finches suddenly lived on the island with small seeds, they would not be optimally adapted to secure a food source. Through this theory and the idea of the Big Bang, some scientists believe that all life on earth began with a single species, which evolved and adapted as the world did. As organisms became more complex, more and more species were created through natural selection, eventually ending in human beings coming into existence. Though most people accept that animals adapt and change over time, there are many who contradict this idea, pointing out that the odds of current life existing as a product of random and unlikely organization are astronomical, that there are several gaps in the evolutionary chain between some species (including humans), and that certain species remain unchanged after thousands (or even millions) of years. One point of evidence scientists uses to establish support for the Theory of Evolution is the fossil record. Scientists have found fossils in sedimentary layers of the earth for years, using them to make inferences about life in the past, extinct animals, and possible ancestors to current species. Fossils may be organic material (something that was once living) that has undergone chemical reactions in which minerals slowly replace the softer tissue, hardening it, imprints, which leave behind an impression of the organic material (such as a leaf print), or casts, impressions left behind in softer ground which hardened and preserved the impression (such as footprints). Fossils taken from lower layers are older than those taken from the layers on top of them. Fossils from different layers can be compared to each other, providing evidence of change over time in both the environment and individual species.

		One example of support for evolution in the fossil record is the modern-day horse. Throughout different layers of rock, fossils of a horse-like species have been found. Scientists believe that horses once were about the size of a modern-day fox. As time progressed, corresponding bones began to increase in size, leading to larger and larger individuals. See the image of the horse fossil record here. Fossils found of other plants and animals also show a trend of adaptation as environments change. The fossil record, however, contains large gaps between differences in species which have not yet been adequately explained. How animals changed from one stage to the next is largely unknown, as fossils are rare and vast amounts of time exist between those we do have. When questioned, Darwin himself stated in a letter that 'I fully agree with your comments on the lack of direct illustration of evolutionary transitions in my book. If I knew of any, fossil or living, I would certainly have included them. You suggest that an artist should be used to visualise such transformations, but where would he get the information from? I could not, honestly, provide it, and if I were to leave it to artistic licence, would that not mislead the reader? Yet Gould [Stephen J. Gould—the now deceased professor of paleontology from Harvard University] and the American Museum people are hard to contradict when they say there are no transitional fossils. … You say that I should at least "show a photo of the fossil from which each type of organism was derived." I will lay it on the line—there is not one such fossil for which one could make a watertight argument." (Sunderland, L., *Darwin's Enigma*, Master Books, Arkansas, USA, pp. 101–102, 1998.) First, research the fossil record/ timeline of scientifically accepted human evolution and discuss it with an adult. Then, answer the questions on Observation Sheet 14. If necessary, research your answers online, in books, or discuss them with an adult. Consider arguments both for and against the theory of evolution.

Observation Sheet 14

1. In the picture to the left, what do you notice about the different layers of this mountain? What might that tell you about its history?

2. How are fossils used to prove that the earth, plants, and animals changed over time?

3. Name at least two examples of evidence that support the Theory of Evolution?

4. Name at least two examples of evidence that contradict the Theory of Evolution

5. What is the fossil record and what does it teach us? Give an example of a species we've learned about through fossils.

6. What is one of the flaws in learning from the fossil record?

7. Do you believe in evolution? Why or why not? Support your answer with evidence.

Title of Lesson 15: Genetic Mutations and Evolution: Then and Now

Standards Taught: 7.5.3		
Materials: A fossil kit (like the one found here) Several colors of highlighters Blank paper and pen Internet access Observation Sheet 15	**Preparation:**	**Implementing the Lesson:** The fossil record is not the only evidence scientists have to support the Theory of Evolution. The idea of common decent (living things having a common ancestor) is also seen when we compare fossils from ancient animals or plants to modern-day ones. Scientists believe that, as the earth changed and plants and animals became more widespread in a broader range of areas, species had two choices: adapt or die out. Those species that could not adapt (or did not adapt quickly enough) simply went extinct. However, those that could survive long enough to add mutations to the gene pool were able to evolve as a population, leading to permanent changes to the entire population in each area. This, in turn, led to separate species being created in the same family. Darwin's finches are an example of this- all the birds were finches, but each population had a distinct feature adapted to its environment. With information from fossils of past plants and animals, scientists can compare the ancient to the modern. Though these comparisons, especially when observing bone structure, they have concluded that several modern species likely had a common ancestor with or evolved from those that lived anciently. Using the fossil kit listed in the materials section, observe the fossils provided. Read the information found on the cards, using them to classify each fossil and organize them into a chronological timeline. Next, search for any similarities between the fossil examples. Note the size, shape, and environment of each on a blank paper. Highlight those that you believe are related in some way in matching colors using highlighters. Next, search online for a modern-day relative of each fossil type. List the name of the species on your notes, as well as observations about similarities and differences between them. Answer questions 1-2 on the Observation Sheet. Finally, research (find images of the bone structure of) the animals on the Observation Sheet chart, noting similarities and differences between the species. Answer the remainder of the questions on the Observation Sheet.

Observation Sheet 15

1. What inferences can you make about sharks based on the fossil you observed and its modern-day ancestor you found?

2. What inferences can you make about trilobites and the modern-day ancestor you found based on your observations?

Name of Species	Ancient or Modern	Similarities	Differences	Are they likely relatives?
Crocodile	Modern			
Megalania	Ancient			
Whale	Modern			
Uintatherium	Ancient			
Asian Elephant	Modern			

3. How does comparing past and present bone structures support the Theory of Evolution, especially the idea of common decent?

4. What arguments could you make against common decent?

Title of Lesson 16: Studying Embryos

Standards Taught: 7.5.4		
Materials: Observation Sheet 16	**Preparation:**	**Implementing the Lesson:** Darwin's observations, the fossil record, and comparisons of ancient and modern bone structures point out undeniable similarities between certain species. The idea of natural selection and common decent are widely accepted in the scientific world, though evolution remains a theory with unexplained gaps. The idea that living organisms can, over time, change and adapt helps ensure survival or seal the fate of extinction dependent upon what changes occur. Another study, embryology, provides more clues into evolution and a common ancestor. Embryology is the study of embryos and their developmental patterns. An embryo is the very earliest formation of life, beginning after conception (when the sperm and egg meet). During this stage, the organism develops organs and other critical body structures. It creates dedicated cell structures, which will eventually grow into various body parts. In humans, the embryo stage lasts until the 9th week of pregnancy. This timing varies in other animals, as developmental timelines vary. By comparing the way an embryo looks and the order in which it develops, scientists gain insight into evolutionary ties between species that cannot be seen after individuals are fully developed. By the 4th week, a human embryo has a heartbeat, grows buds that will turn into arms, and has from a liver, pancreas, spleen, and gall bladder. The next week, the embryo gains eyes, leg buds, hands, blood circulation, and facial features. By week 6, lungs begin to form and fingers and toes grow. Week 7 brings hair, elbows, and toes. In the final week of embryo development, humans have recognizable facial features and ears. View the image here and answer the questions on the Observation Sheet.

Observation Sheet 16

1. What is embryology?

2. What happens to an organism when it is in the embryo stage?

3. In humans, when is a baby considered an embryo?

4. At what week or day does the human embryo show signs of spinal development?

5. When do human embryos develop eyes?

6. Describe the head shape of a human embryo and how it changes as the embryo develops

7. What body part does a young embryo have that disappears by 9 weeks?

Title of Lesson 17: Studying Embryos II: Compare and Contrast

Standards Taught: 7.5.4		
Materials: Observation Sheet 17	**Preparation:** Have an adult print this image twice. Ask them to cut the images from one copy and mix them up while hiding the second, uncut copy from you.	**Implementing the Lesson:** The study of embryos has provided scientists with a wealth of information that has saved lives, prevented illnesses, and allowed humans to detect problems in development early on. Understanding how a life is created and how it develops provides information that can help scientific and medical teams better understand the inner workings of the body. Embryology has also allowed scientists to compare species in ways they couldn't before. When comparing fossils, scientists were limited to their own understanding and guesses about life during that time. They never saw the ancient plants and animals themselves so information was always inferences, rather than concrete evidence. Embryology allows scientists to see, in real time, the earliest stages of each animal's development and compare them side-by-side. Ask the adult who prepared this lesson for the images they've cut out. Here, there are embryos of six different species, each shown at three different stages. The species are: fish, salamander, tortoise, chick, rabbit, and man. Try to place the correct embryos together in the right developmental order. You should have six rows and three columns. When you are satisfied with your work, continue the lesson. Ask your adult to give you the uncut copy of the comparative embryology. Analyze your own work, noting which you placed correctly and which you got wrong. Discuss with an adult why these mistakes were easy to make. Note the similarities between the embryos, though they eventually develop into very different creatures. Observe that all the listed species begin with gills, tails, and a backbone. However, as development progresses, these features become more pronounced or disappear entirely based on what the organism will need to survive in its environment. By pointing out the early similarities between species, many scientists have cited embryology as evidence that they once shared a common ancestor. Why would a baby human need gills at all? What in their genetic code would tell them to grow a tail? It is suggested that these are remnants of the genetic code of an ancient ancestor. Answer the questions on the Observation Sheet.

Observation Sheet 17

1. What is embryologic comparison and how has it helped improve human life?

2. What evidence is present in embryologic comparison that points towards evolution and common decent?

3. At what stage are embryos the most alike? What features do they all share?

4. Why do you think certain features disappear in some animals and stay in others as they develop?

5. What did you once have in common with a rabbit?

6. What logical fallacies are present in the idea that similarities between species point to common decent? What evidence is solid?

7. Many scientists believe life began in the ocean with a single-celled organism whose ancestors eventually adapted to life on land. What evidence supports this idea?

8. Why do you think human embryos have gills, though they do not have them at birth?

Title of Lesson 18: Earth's Layers

Standards Taught: 7.2.4		
Materials: Maple syrup, water (dyed blue with food coloring), olive oil, dish soap, vegetable oil, and light corn syrup Clear cylinder, jar, or glass	**Preparation:**	**Implementing the Lesson:** Ask your child to remind you what they know about density and how it affects the way different materials organize themselves in layers. Remind them that density is the mass of a substance per unit volume, or the amount of matter in a uniform sample of a substance. Some materials, such as honey, are very dense and have more mass in a unit. Others, like ice, are less dense (less mass per unit). This causes honey to sink in water while ice floats. Give your child the cylinder and liquids. Point out that each of these liquids has a different density. Ask your child what they think will happen if all the liquids are added to the same container. Then, allow your child to carefully add each liquid, one at a time. Allow the liquids to settle into layers and point out that the densest layer ended up at the bottom while the others organized themselves based on density. Using this image, ask your child to review what they know about the layers of the Earth. What might the fact that the Earth is made of layers tell you about the density of each material? Why might the materials have arranged themselves in this way? Explain that the Earth follows the same rules on density as the liquids in the cylinder. Scientists have used seismic waves (earthquake waves) to study the density of different parts of the Earth. Waves move at different speeds through materials based on their density. Some waves slow down in liquids while others stop completely. Waves speed up as they reach denser materials. By watching how waves interact with the materials in different locations and depths, scientists can make guesses about the structure of the Earth, even if they can't see it directly. The middle of the Earth, or core, contains the densest materials. The inner core is iron and nickel, two very dense minerals. Scientists believe that the inner core is in a solid state because of the immense pressure of everything on top of it pushing down. The outer core is believed to be liquid iron and nickel. In a liquid form, these materials are less dense and, therefore, float above the inner core. The mantle is the thickest layer of the Earth. This is where magma from volcanos comes from. By studying volcanic flow, scientists have discovered that the mantle is made up of magnesium, silicon, and oxygen. The lower mantle is believed to be solid rock, which the upper mantle is made up of a semi-sold rock that has a slow flow (peanut butter consistency). The heat in this layer creates a constant process of heating, rising, cooling, and falling rock. This current is what moves the tectonic plates (see the image here). The least dense layer of the Earth is the crust. This is the part of the earth that we live on. Continental crust makes up the dry land while oceanic crust is found under the ocean. The oceanic crust is denser than the continental crust. Oxygen, silicon, and aluminum are found on Earth's crust, as well as several other materials. The final layer of density is found not on, but around the Earth. Above the crust, the atmosphere surrounds the planet. This layer contains gas forms of oxygen and nitrogen. In this state, it is the least dense of all the layers, floating above the others.

Title of Lesson 19: Plate Tectonics (2 pages)

Standards Taught: 7.2.5, 7.2.5.1, 7.2.5.2, 7.2.5.3		
Materials:	**Preparation:**	**Implementing the Lesson:** Review the previous lesson with your child, discussing each of the layers of the Earth and how they interact with each other to make life possible. Remind your child that the Earth's crust is the layer on which we live. Ask your child to look at this image of the Earth. Discuss how it looks different than other images they've seen before. Point out that in this image the continents are closer together than they are today. Explain that this is an image of Pangea, a theoretical form the Earth's surface is believed to have been in thousands of years ago. According to the theory, each of the continents were connected to others at some time, creating one giant landmass. When looking at the image, it is easy to imagine this was possible as all of them fit together like puzzle pieces. Explain that Earth's crust is broken into plates. These plates float on the magma and melted rocks in the layer below, moving around on currents created as the magma is cooled and warmed. The theory of Pangea states that, over time, the plates which the continents rest were once pushed together. After a long period of time, the natural movement of the plates (drift) moved the continents and oceans to the places we see today. Movement included convergent boundaries (where the plates moved together), divergent boundaries (where they moved away from each other), and transform plate boundaries (where they slide past each other). See the image here and note the plates, comparing it to the image of Pangea. Try to trace the movement of each continent. Further evidence of Pangea and plate drift includes the fact that fossils of certain plants and animals have been found on continents that are now great distances apart. These fossils indicate that species lived on both continents before they drifted apart. Some examples of this are Lystosaurs (found in South Africa, India, and Antarctica), Glossopteris flora (found in areas from the polar circle to the equator), and Mesosarus (found in Brazil and West Africa). Likewise, certain types of rocks can be found in differing continents though they are now far apart. These rocks have been dated as being formed at similar times, contain the same minerals and show the same types of wear (e.g. scratches from icebergs) at the same periods, indicating they were once a uniform structure. Next view the image here of earthquakes and volcanos from the 20th century. Compare it to the image of plate locations today, noting the fact that where the edges of two or more plates meet, activity is higher. Discuss the process of earthquakes, pointing out that plates must crash into or rub against each other to create the shaking. Depending on how deep the plates are in the crust when they meet and how close the location is to humans, the earthquake will feel stronger (closer and more shallow) or weaker (further away and deeper) to the people above. Volcanos occur when magma heated below the crust rises and flows out of openings in the crust. Many of these openings exist along continental or oceanic fault lines. Volcanos exist and erupt both on land and under the ocean, sending magma outwards where it cools and turns into rocks, hills, and mountains.

		Though many think of plate tectonics in relation to land, plate boundaries exist under the oceans as well. Here, many plates are divergent, or moving away from each other. This creates trenches in the ocean floor known as fissures. Magma often escapes through these fissures, forming mountain ranges, islands, and new sea floor. Study the image here for more information about the ocean floor and how it is created.

Title of Lesson 20: The Rock Cycle

Standards Taught: 7.2.1

Materials:	**Preparation:**	**Implementing the Lesson:**
This image An example of an igneous rock with crystals and one without, metamorphic rocks, and sedimentary rock with layers and one without Observation Sheet 21		Ask your child to review the three previous lessons, discussing the layers of the Earth, Earth's energy sources (heat from the core and the sun), and plate tectonics. Explain that the layers, energy, and movement of different parts of the Earth create the rock cycle. Show your child the image of the rock cycle listed in the materials section. Remind them that rocks are heated below the Earth's crust and melted into magma. This magma travels upwards, cooling as it reaches the surface. Cooled magma creates igneous rocks, which either form pockets under the Earth's crust and push the surface upwards (intrusive) or escape through the crust (e.g. volcanos, ocean trenches, extrusive) and create rocks on the surface. Movement of the Earth's plates can also cause uplift, pushing the surface into mountains and hills. Study the examples of igneous rocks, noting characteristics such as texture, weight, uniformity, and shape. Discuss the fact that, depending on the minerals within the melted magma, crystallization may occur as igneous rocks cool and begin to form. Those rocks that contain the correct minerals and cool slowly will have large crystals (e.g. granite) while fast cooling creates small crystals (e.g. basalt). On the surface, rocks are exposed to weathering and erosion, which break them into smaller pieces. Rain, wind, ice, chemical interactions, rubbing from other materials, plant roots, and other forms of weathering slowly break down mountains, boulders, and rocks over time creating sediment. Erosion takes these small pieces and moves them to another area, usually with the help of gravity. Sediment is transported (e.g. along a river) and deposited in a new area. Here, the layers of sediment build upon each other. As layer after layer is added, pressure builds, causing the sediment to be compacted together into sedimentary rock. Study the examples of sedimentary rocks, noting characteristics such as texture, weight, uniformity, and shape. Note whether or not you can observe the layers of differing material in this particular specimen. Finally, the rocks below the surface come in contact with both high temperatures and high amounts of pressure. Those that do not melt completely, but soften, can be pushed together to create metamorphic rocks. These rocks experience stretching, bending, deformation, and can change the minerals they contain. The original rock is known as the parent rock. The rock formed after metamorphic transformation is known as the daughter. Study the examples of metamorphic rocks, noting characteristics such as texture, weight, uniformity, and shape. Note evidence of stretching, deformation, and/or inclusion of new minerals in these daughter rocks. Look up an image of the parent form of each example and compare it to the metamorphic rock. They cycle of warming, cooling, weather, erosion, sedimentation, deposition, compaction, and deformation is known as the rock cycle. The energy for this cycle comes from the heat at the core of the Earth, weather on the surface, and movement and pressure from gravity. It creates a constant, but very slow, change to the earth's surface in most cases. Answer the Questions on the Observation Sheet for this lesson.

Observation Sheet 21

1. Draw an image of the rock cycle below, labeling the three types of rocks and indicating how they are formed and affected by each other.

2. Observe the images below and label the type of rock formed in each. Explain your reasoning.

3. Give an example of weathering and erosion from your study of Utah's natural landmarks. Explain how this landmark was formed.

4. View an image of the Grand Canyon (here) and explain the processes that created it.

Title of Lesson 21: Changes to the Surface

Standards Taught: 7.2.2, 7.2.3		
Materials: Internet Access Observation Sheet 21	**Preparation:**	**Implementing the Lesson:** Review the Earth's layers, movement of faults, and formation of different types of rocks with your child. Discuss earthquakes and volcanoes. Then, ask your child to name ways these events may change the surface of the Earth. Point out that plate tectonics cause slow movement of continents and oceans. Openings in the ocean's floor can create islands and island chains as magma piles above the ocean water levels. Likewise, uplift (upwards pressure from the rock cycle) can cause the Earth's surface to be pushed upwards, forming hills and mountains. Weathering, erosion, and deposition can cause these hills and mountains to be worn down, built higher, or moved to a different location over time as well. Point out that each of the examples discussed occur over very long periods of time and changes are not easily noticed in daily life. However, some processes create changes to the Earth's surface fairly quickly. Earthquakes, volcanic eruptions, and landslides can change the surface quickly and violently. Earthquakes caused by convergent plates may lead to uplift, pushing the edges of each plate into each other and creating mountain ranges. They may also cause landslides, bringing large pieces of earth, rock, and soil downwards quickly, cutting a trench into the earth as it goes and depositing materials elsewhere. Volcanic eruptions may pile lava on previously flat landscapes or break down existing mountains. Take time to research the following events and how they changed the landscape around them. Then, answer the questions on the Observation Sheet for this lesson: Eruption of Mt. Saint Helens, the Thistle Landslide, Laramide Orogeny, and the Glamis Sand Dunes. Next, point out that events that change the Earth's surface can sometimes affect humans in a very negative way. Movement and change of landscape can be dangerous during the event (e.g. things falling during an earthquake, floods) and after it (e.g. water and food supplies blocked after a landslide). Homes may be destroyed, people may be injured or killed, and rebuilding a normal life may seem impossible as the result of these changes. Though changes still occur, humans have found ways to mitigate, or reduce, the risk of injury, death, and other negative outcomes, especially in areas where these events are common. Some examples of this include: soil testing for stability where buildings are planned, anchoring large buildings to bedrock which is more stable, housing materials used should bend and sway with movement from earthquakes rather than breaking, layers of steel and rubber or rollers can be placed below buildings to mitigate movement of a building, houses may be raised on stilts where floods are common, freeways and bridges can be retrofitted or updated with better materials to prevent collapse, water and gas lines are broken into sections with a series of valves, allowing breaks to be isolated, public trainings (such as those presented in schools) help citizens understand what actions to take before, during, and after an event to minimize the danger.

Observation Sheet 21

1. What happened to Mt. Saint Helens? How did it change the mountain and the landscape around it? What effects are still being felt from this change today? Was this a fast or a slow change? Explain the process and why this happened.

2. What happened during and after the Thistle Landslide? How did it change the houses and landscape around it? What effects are still being felt from this change today? Was this a fast or a slow change? Explain the process and why this happened.

3. What happened during the Lamamide Orogeny? What was created? What effects are still being felt from this change today? Was this a fast or a slow change? Explain the process and why this happened.

4. What is happening that forms the Glamis sand dunes? Are these dunes permanent? What effects are still being felt from this change today? Was this a fast or a slow change? Explain the process and why this happened.

Title of Lesson 22: Dating Layers and Fossils

Standards Taught: 7.2.6		
Materials: Internet Access	**Preparation:**	**Implementing the Lesson:** Remind your child what they learned about evolutionary patterns found in fossils from different layers of sedimentary rocks and mountains in Lesson 14. Point out that the fossil record, along with dated layers from around the Earth, show changes to the surface of the Earth, weather and climate patterns and changes, and changes to plants and animals over a long period of time. By comparing different layers (older with newer), scientists can piece together a theory of what different areas of Earth looked like and experienced at different times. Understanding the rock cycle can help determine the age of the Earth by allowing scientists to understand whether changes were quick or slow and what types of things had to happen to bring about each change. Sedimentary rocks and formations are especially useful for determining the age of a particular specimen. Deposition happens over time and adds new layers on top of the old as time goes by (superposition). Therefore, the oldest layer will be on the bottom with the newest on top. Sediments are always horizontal so a vertical change in layers would indicate some kind of event occurring (e.g. ash falls from a volcano would land vertically), giving clues about quick changes. Each layer tends to be uniform, created by the same types of materials being deposited at the same times. Changes between materials can be one indicator that a new layer was formed. Sedimentary layers, however, may contain disconformities in which a layer is missing for a certain period of time. This places a much older layer in direct contact is a much younger one, skipping a layer completely. This may occur when weathering and erosion carry away a layer before another is placed on top. These are often recognized by layers that do not follow the parallel pattern of those around them, but have a jagged and uneven area produced by weathering. They may also be found when the fossil record for the area shows a gap. Disconformities can also be caused by a lack of deposition during a time period. Nonconformities may occur when uplift pushes older rock up into newer layers, creating an area where the older layers protrude, or push up into, newer ones. It may also be recognized as weathering and erosion on the surface of an older rock that should have been buried. Unconformities come in many forms such as angular, in which layers dip and peak rather than lay parallel and signaling uplift and metamorphosis. Visit this website to learn more and view images of each disconformity type.

Title of Lesson 23: Forces and Motion

Standards Taught: 7.1.1		
Materials: Observation Sheet 23 Cup or bowl for objects to fall into Several different round objects Small piece of cardboard Empty cardboard tube (e.g. toilet paper roll) Small box or bowl filled with sand A small metal ball A small marble PVC pipe and elbow fitting String 2 small posts to attach PVC Ruler	**Preparation:** Gather supplies and prepare the PVC ramp as shown in the second video	**Implementing the Lesson:** Sir Isaac Newton was born in 1642 in England. Throughout his life, Newton was fascinated by physics and math. He lived in a time when society was reevaluating what it knew about forces, motion, and other scientific concepts. Today, Newton is best known for his three laws of motion. Newton knew that everything is affected by forces. A force is a push or a pull on an object. Gravity is a constant force on objects. However, it is not the only force that acts on them. At times, forces on an object are balance and cancel each other out, leaving the object at rest. At other times the balances are not equal, causing motion. Newton's First Law states that an object at rest tends to stay at rest and an object in motion tends to stay in motion. This is known as inertia. A ball sitting on a desk won't move unless a new force is exerted upon it. It will stay at rest where it is. If the ball is pushed, however, a new force is introduced and it will roll away because the new pushing force is greater than the force that was keeping it still (gravity). According to Newton's First Law, all motion is caused by unbalanced forces. Additionally, Newton states that motion can only slow down, speed up, or change direction if forces are unbalanced as well. In the example of our ball on a desk, the ball will slow and, eventually, stop again because a force known as friction pushes against the movement and slows the ball until it is once again at rest. It will only speed up if a new force pushes it forwards at a greater speed or downwards or one of the forces disappears. For example, when the ball reaches the end of the desk, it loses the upwards push of the desk surface and gravity is allowed to fully pull on it. The ball accelerates as it falls to the ground. Imbalances in force can also change direction of the ball. We see this clearly in baseball as a batter hits the ball pitched towards them. The force of the bat changes the direction of the ball, sending it away from the batter instead. Newton's Second Law states that force is equal to mass times acceleration (F = ma). This means that the mass of an object affects the way forces act upon it. An object with lesser mass requires smaller amounts of force to create or change movement. An object with a greater mass will require more force to affect movement. This is why it is very easy to push an empty chair across a room with little effort. However, pushing a chair with an adult sitting in it is more difficult. The person adds mass (or weight) to the chair, requiring more force to overcome the gravity and friction working against the push. Watch the video here and try the experiment shown. Then answer questions 1-4 on the Observation Sheet for this lesson. Next, watch the video here and conduct the experiment as shown. Measure the depth and width of the hole after each ball is dropped, comparing the measurements to each other. Then, answer the remainder of questions on the Observation Sheet.

Observation Sheet 23

1. What forces are acting on the object when they are at rest on top of the paper roll? (hint, there is more than one force)

2. Why does the object stay at rest until you push on the cardboard?

3. The force on the cardboard pushes it sideways. However, the object falls downwards. Draw an image of the experiment below and label the forces at work, explaining the movement of each object.

4. How does this show Newton's First Law of motion?

5. What forces are at work as the ball fall?

6. What were the measurements of the hole for each ball (large and small)?

7. How does the impact of the balls show Newton's Second Law?

Title of Lesson 24: Action and Reaction

Standards Taught: 7.1.2

Materials:	**Preparation:**	**Implementing the Lesson:**
Newton's Cradle Several hard-boiled eggs Various materials such as: bubble wrap, tissue paper, balloons, feathers, tape, scrap paper, foam packaging, and other packing materials		Take time to review Newton's First and Second Laws before beginning this lesson. Newton stated that forces are constantly working on any object with mass. Balances in forces leave the object at rest while imbalances create or change motion. Additionally, he stated that an object's mass affects the impact a force will have upon the object. Newton's Third Law states that for every action there is an equal and opposite reaction. In simple terms, when a force is applied to an object, the object applies the same force in an equal amount but the opposite direction to the object applying the force. For example, when a baseball is pitched and hit by a batter, the force of the bat pushes the ball in the direction of the batter's swing. However, the ball also exerts a force against the bat, pushing it toward the batter. This is why a bat pushes against the batter's hands on impact. This concept is also why a car crash results in damage to both the car and the item it hit, a rocket can take off by forcing hot gas downwards, and two people hitting heads hurts them both. Watch this video to review the Three Laws of Motion. Then, place your Newton's Cradle on a desk or tabletop and let the balls come to a rest. Pull one of the end balls upwards and outwards. Drop the ball so it hits the next ball in line and observe what happens. The force of the ball being dropped transfers to the others and the ball at the opposite end is pushed upwards. The energy transfers back and forth, pushing the single ball on either end upwards. The balls have the same mass so the force equally pushes each of them. Over time, the force of air and friction slows the balls. However, if the cradle were not exposed to these opposing forces the force would continue to travel back and forth between the two end balls. Next, try dropping two balls and observe the amount of balls that move on the opposite end. Continue this experiment, trying different amounts of balls or one ball on either end at the same time. Note the reaction each time, applying the idea that an equal and opposite reaction should occur for each of your initial actions. Next, hold one boiled egg in either hand. Keeping one egg still, crash the other into it. Note the damage on both eggs, an example of Newton's Third Law. The force from the moving egg damaged the still egg. However, the opposite and equal reaction force damaged the moving egg as well. Use the materials provided to create a solution that will protect both eggs from impact and result in no damage. Try different materials, different placements, and different amounts of materials until you can repeat the experiment with no cracked eggs after impact.

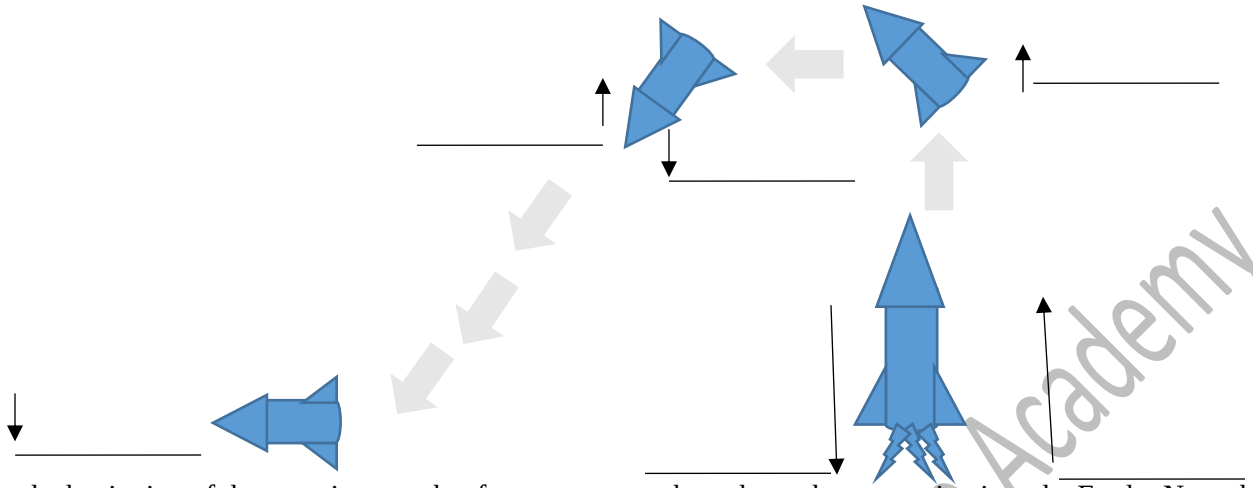
Title of Lesson 25: Gravity

Standards Taught: 7.1.5

Materials:	**Preparation:**	**Implementing the Lesson:**
Empty 2 liter bottle Bicycle Pump Cork Cardboard Construction Paper Playdoh or Clay Cork Water Large Area for launch Observation Sheet 25		In the previous lessons, you learned Newton's Laws of Motion which are: the law of inertia (an object in motion tends to stay in motion and an object at rest tends to stay at rest unless acted upon by another force), that the mass of an object affects the amount of change a force can exert on it, and that for every action there is an equal and opposite reaction. You also learned that a force is defined as a push or pull on an object. One of the most constant and easily recognizable forces is gravity. Though many people associate gravity with the reason we don't float off of Earth and into space, it affects each and every object that has mass. Gravity is the general attraction between anything with mass. Everything that has mass (e.g. a pencil, the Sun, and you) has a gravitational pull. However, two factors greatly impact the amount of pull an object has: the amount of mass and the distance between the object it is pulling on. The greater the mass of an object, the greater its gravitational pull. The Sun, for example, has a very large mass. Therefore, it has a gravitational pull strong enough to hold the planets in orbit. However, planets don't orbit around you because your mass is much smaller than the Sun's. Likewise, the Earth's mass gives it a pull strong enough to hold you and other objects down on its surface. However, you don't stick to every pencil you pass by because the pull of the pencil's gravity is much smaller. A pencil dropped travels towards the pull of Earth, landing on the ground, instead of you. The mass of an object also affects how much force is needed to overcome its gravitational pull. For example, a golf ball is easily picked up off the ground because the upward force needed to overcome Earth's gravity is very small. However, a bowling ball is more difficult to live. The mass of the bowling ball is greater and the attraction between it and the Earth is stronger. This means a larger force is required to pull them apart. The amount of gravitational force changes, however, with changes in distance. The Sun has a very large mass but planets outside our solar system are not pulled into its orbit. This is because outside planets are too far away from the Sun and it cannot exert a force strong enough to overcome this distance. Earth's moon, for example, orbits around the Earth rather than being pulled into its own orbit around the Sun. This is because the pull of the Earth is much stronger than the pull of the Sun on the moon due to distance. The Earth is closer to the moon and large enough to exert a gravitational pull upon it. This keeps the moon orbiting around Earth. With an adult's help carry out the experiment found here (Building a Bottle Rocket). Then, complete the Observation Sheet for this lesson.

Observation Sheet 25

Label the forces at work in the diagram below. Account for gravity, the downwards push of the water, the upward motion of the rocket, and the air resistance as it falls. Then, answer the questions below.



1. At the beginning of the experiment, what forces are at work on the rocket, attracting it to the Earth. Name both forces and the direction and strength of each.

2. As the rocket launches, the water pushes against gravity resulting in lift-off. Which of these two forces (gravity or the push of the water) is stronger at lift-off? Explain how you know this.

3. As the rocket flies through the air, what forces are pulling slowing it down? Why? (hint: there are two forces pushing or pulling the rocket downwards)

4. As the rocket falls, what is pushing against gravity? Which force is stronger (gravity or the other force) and how do you know?

5. Which force eventually wins? How do you know?

6. How does this experiment demonstrate all of Newton's Three Laws?

7. Why do you think rockets sent into space don't need the same amount of force after leaving Earth's orbit? What concept does this demonstrate?

Title of Lessons 26: Electricity and Magnetism I (2 pages)

Standards Taught: 7.1.3

Materials:	**Preparation:**	**Implementing the Lesson:**
Balloon, blown up and tied closed Magnet set, including two bar magnets Iron Powder Fillings		In recent lessons, you learned that force is a push or pull between objects with mass. You learned that gravity is an attraction force between any objects that have a mass and that every object has its own gravity. However, the strength of this force is affected by the amount of mass of the objects and the distance between them. Today, you will learn about two more forces of attraction: electrical force and magnetic force. In the past, you've learned about electricity and the forces it exerts on objects. Electric charge can occur between particles or objects and cause them to attract or repel each other. All mass is made up of atoms, the basic building block of everything around us. Within these atoms are tiny pieces called protons, neurons, or electrons. Protons carry a positive electric charge (+) while electrons carry a negative charge (-). The composition of each atom (how many protons, neurons, and electrons) are a recipe for what the atom will be. Different types of atoms have different amounts of each particle within them. See the image of a basic atom structure here. The charge of electrons and protons create a force that affects the matter they come close to. When two opposite charges come together (an electron and a proton) they are attracted to each other and pull together. When two like charges come together (an electron and an electron or a proton and proton), they repel, or push against each other as illustrated in the bottom of the image. This push or pull is known as electric force. While we cannot see the small electrons or protons, we can see the results of the forces they exert. Static electricity is one example of this force. Use the blown up balloon to demonstrate this. While standing in front of a mirror, place the balloon close to your head. Note that few hairs move as a reaction to this. Then, begin to rub the balloon on your head. Notice that your hair becomes attracted to the balloon and will stand up, even as the balloon is pulled a short distance away. This is because the rubbing of the balloon caused a negative charge in the balloon. As the balloon is rubbed, the electrons in your hair transfer to the balloon. This creates an excess of negative electrons in the balloon and increases the ratio of positive protons in your hair. The opposite charges attract each other, causing your hair to be pulled towards the balloon. This is known as static electricity, which can also be seen when you "shock" someone after walking on a carpeted floor. The rubbing of your feet charges you with electrons, which then transfer to your positively charged friend who has not rubbed their feet on the carpet. Another force that works in the same manner as electricity is magnetic force. Magnetic force is an attraction or repulsion of two objects based upon their poles. Like electric force, magnets carry a positive and negative aspect. However, rather than a charge, these forces are separated into poles. At one end of a magnet is a positive pole while at the other is a negative pole. Opposite poles attract each other while like poles repel each other. Like electric force, magnetic force does not require objects to touch each other for a force to be exerted. The pull of static electricity from the balloon still

		forces the hair on your head towards it even when the two are not touching. Two magnets can be attracted to or repelled from each other long before they touch. Using two different magnets, place one on the table in front of you while holding the other in your hand. Without touching, slowly bring the magnet in your hand towards the still magnet on the table. Note what happens and the charges of each pole that result in this. Repeat the experiment, this time changing the pole of the magnet in your hand. The magnets did not touch, but acted upon each other, repelling like poles and attracting when the poles matched. However, the magnets did not react until they were a specific distance apart. If the magnets were kept further than this distance, nothing happened. This is because each magnet creates a magnetic field, or area in which its forces can reach and impact things around them. Outside of this field, magnetic forces do not work. See the image here of the magnetic field of a bar magnet. Then, place one of your bar magnets on a flat surface. Sprinkle the iron powder fillings around the magnet and observe what happens. How does the movement and pattern of the iron powder match the image of the magnetic field? Why do you think the powder gathers more densely around the poles? The powder arranges itself according to the magnetic field of the bar magnet. The poles are more densely covered because the magnetic pull is stronger in those areas. The magnetic field of two magnets can interact with each other and change the pattern of the push or pull force of each other. See this image of the magnetic fields created when two bar magnets are placed within each other's magnetic fields. Note the differences between the first image and the second. The magnetic field of the second magnet has changed the force of the first. Clear your working area and place the two magnets close to each other, but no so close they are pulled together. Then, sprinkle the iron powder over both, noting the difference in the pattern created as its particles interact with the magnetic fields created. Note that the pattern matches the one in the image. Repeat the experiment again, this time reversing the pole of one of the magnets. How does this change the magnetic field? How does the iron powder demonstrate the repulsion between the poles rather than the attraction you saw before? Continue to experiment with the powder and different types of magnets and combinations, noting the different patterns you see in each experiment.

Title of Lessons 27: Electricity and Magnetism II

Standards Taught: 7.1.4

Materials:	**Preparation:**	**Implementing the Lesson:**
2 9V Batteries Copper Wire Nails Paper clip The magnet set and iron filling powder from the previous lesson Observation Sheet 27		Review the previous lesson on electric and magnetic forces before beginning this lesson. In the last lesson, you learned that electricity and magnets can exert a push (repelling) force or a pull (attracting) force on other objects based on electrical charge or the magnetic pole. You also learned that these forces can act on other objects without touching them, within certain distances, because they create a field in which their force is strong enough to overcome the other forces acting on the object. In previous years, you've learned about insulators (which block the transfer of electricity) and conductors (which allow the transfer of energy). Electromagnets combine the forces created by electricity and magnets into one area. This increases the magnetism of the magnet and provides a method in which it can be switched on and off. Electromagnets every day to move and control very heavy metal objects, power cars, run generators and motors, and make our televisions work. These items would not function properly without both electric and magnetic forces at work. Place the nails in front of you. Pick one of the nails up and try to gather the other nails using its magnetic force. Can the nail pick up the others? Why or why not? Repeat this experiment, trying to pick up various magnets and the iron powder. Is the magnetic force of the nail strong enough to pick up any items? Next, watch this video on how to make an electromagnet. Follow the instructions on the video, counting the number of coils you put into the copper wire around the nail. Note the amount on the Observation Sheet. When your electromagnet is complete, experiment with picking up the nails, the paper clip, various magnets, and the iron powder. Note which items you were able to pick up on the Observation Sheet chart. Then, repeat the experiment four more times, each time making the changes noted on the Observation Sheet chart. Note which versions are stronger or weaker than others. Then watch this video which explains how electric currents and magnetism is used to create electricity. Then answer the remaining questions on the Observation Sheet.

Observation Sheet 27

	Number of Coils	**Amount Picked Up**
Experiment 1 (Your choice in number of coils)		
Experiment 2 (Remove 5 coils)		
Experiment 3 (Add 15 coils)		
Experiment 4 (Connect only one end of the wire to the battery)		
Experiment 5 (Connect both ends of the wire to the first battery, then add a second battery)		

1. Which version of the electromagnet was strongest? Why do you think this is?

2. What do the changes teach you about the strength of an electromagnet relative to the amount of electricity put into it? What do you think would happen to an electromagnet with a stronger power source?

3. What happens when the coils are decreased? Why do you think this is?

4. Briefly explain why both electricity and magnets are needed to create energy in a generator

Title of Lessons 28: Science Report (4 weeks)

Standards Taught: Review, ELA.W.ST.1, ELA.W.ST.2, ELA.W.ST.3, ELA.W.ST.4, ELA.W.ST.5, ELA.W.ST.6, ELA.W.ST.7, ELA.W.ST.8, ELA.W.ST.9, ELA.W.ST.10		
Materials: Internet and library access A computer on which to type the report	**Preparation:**	**Implementing the Lesson:** Over the next four weeks, choose a topic you've learned about this year (plant and animal cells, organization and cooperation of cells, Cell Theory, types of reproduction, adaptations, Genetic mutations and variations, human-produced mutations, evolution, embryology, Earth's layers, plate tectonics, the Rock Cycle, geological changes, geological dating, forces and motion, Newton's Laws, gravity, electricity, magnetism, electromagnetism) that you are interested in learning more about. Review the information you've already learned and the experiments you've already done. Next, narrow your field of study down to a specific topic and gather materials to be used for research. These should include credible sources such as online articles and websites, physical books and printed publications, videos, and/or your own experimentation. Remember to record your sources as you will be creating a bibliography. As you research, gather central ideas of text and discuss the conclusions presented with supporting evidence. Consider the structure of the text used by the author and how that structure can help you gather needed information (e.g. topics, chapters, headings). Account for author bias and/or purpose in their writing, adding only facts (rather than opinion) to your own writing. Include data from graphs, charts, and/or models presented. When using your own experiment, detail the specific steps taken and the outcomes. Finally, create a research paper compiled from the information gathered in your own experiments as well as through the research you have done. Include an introduction and conclusion, appropriate structure, correct spelling and grammar, and a formal tone. Cite sources in ALA style with a bibliography at the end of your paper. Include clear conclusions and evidence of these supported by your research. This paper should be at least 2 pages long in Times New Roman 12 pt. font with 1 inch margins and include a title and the name of the author (you). The final product should be proof-read and polished to omit errors.

Title of Lessons 29-30: Exploration

Standards Taught: Varies		
Materials: Vary depending on the experiments you choose	**Preparation:** Vary depending on the experiments you choose	**Implementing the Lesson:** Part of science is being willing to ask questions and work to find answers. Ask your child to tell you what they would like to learn about or build in science this month. Maybe they've seen an experiment someone else did. Perhaps they've been wondering how something works. Or maybe they have a new book full of engineering ideas. Allow your child to choose two science experiments based on their own interests. Collect supplies, prepare, and carry out these experiments with your child. Spend time researching the science behind them and teach your child what you learn. Chart, graph, record, and collect and present data from your experiments. Encourage your child to share what they learn with family, friends, or others. *This is a great time for a co-op science fair