SCIENCE GRADE 7

SPRING BREAK LEARNING

MARCH 10-14

2025

The Department of Curriculum & Instruction

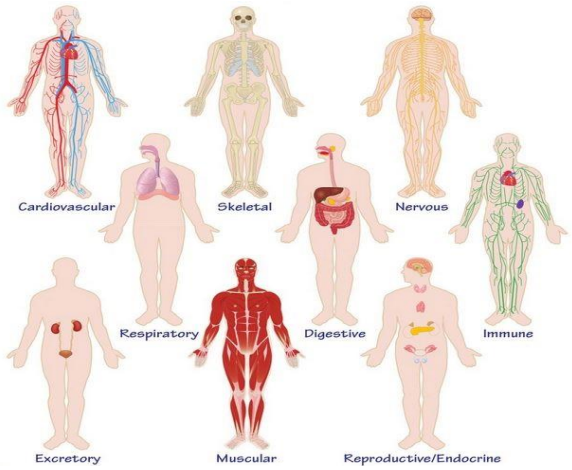
Hello MSCS Family,

This resource packet was designed to provide students with activities that can be completed during the Spring Break Academy independently or with the guidance and supervision of family members or other adults. The activities are aligned to the TN Academic Standards for Science and will provide additional practice opportunities for students to develop and demonstrate their knowledge and understanding.

A suggested pacing guide is included; however, students can complete the activities in any order over three days. Below is a table of contents that lists each activity.

Table of Contents

Working Together	
Grade Level Standard(s)	**7.LS1.5** Explain that body is a system comprised or subsystems that maintain equilibrium and support life through digestion, respiration, excretion, circulation, sensation (nervous and integumentary) and locomotion (musculoskeletal).
Caregiver Support Option	Provide support as needed with reading and discussing questions.
Materials Needed	writing utensil (pencil, paper, etc.)
Essential Question(s)	How do body systems work together to support life?
Student Directions	Directions for you to follow are provided. Answer any questions for which space is not provided on a separate sheet of paper.



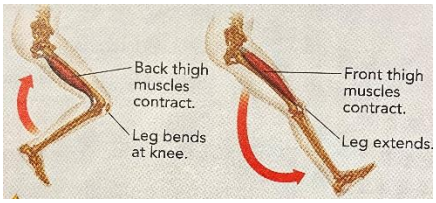
How Do You Move?

Carefully coordinated movements let you thread a needle, ride a bicycle, brush your teeth, and dance. These movements, and all your body's other movements, happen because of the interactions between body systems. Your muscular system is made up of all the muscles in your body. Your skeletal system, or skeleton, includes all the bones in your body. Muscles and bones work together, making your body move. The nervous system tells your muscles when to act.

Muscles and Bones

Skeletal muscles are attached to the bones of your skeleton and provide the force that moves your bones. Muscles contract and relax. When a muscle contracts, it shortens and pulls on the bones to which it is attached.

As this dancer's muscles pull on his leg bones, he can make rapid, skillful moves.



1. An octopus has no bones. Explain how you think it moves.

_____
_____
_____

Bones and Joints

What happens when you wiggle your fingers or touch your toes? Even though your bones are rigid, your body can bend in many ways. Your skeleton bends at its joints. A joint is a place in the body where two bones come together. For example, your elbow and shoulder are two joints that move when you raise your hand.

Making Movement Happen

Muscles make bones move at their joints. Try standing on one leg and bending the other leg at the knee. Hold that position. You can feel that you are using the muscles at the back of the thigh. Now straighten your leg. You can feel the muscles in the back of your leg relax, but the muscles in the front of your leg are at work. Your nervous system controls when and how your muscles act on your bones.

Which Systems Move Materials in Your Body?

The trillions of cells that make up your body need materials to function. Cells also produce wastes that must be removed. If the processes of moving these materials were made into a movie, your nervous system would be the director. The movie set would include the muscular and skeletal systems. The main characters would be some of your other systems. The circulatory, respiratory, digestive, and excretory systems play key roles in moving materials in your body.

Transporting Materials

Your circulatory system includes your heart, blood vessels, and blood. Blood vessels are found throughout your body. Blood that flows through these vessels carries materials such as water, oxygen, and food to every cell. Materials that your cells must get rid of, such as carbon dioxide and the other cell wastes, are also moved through the body in the blood.

Breathing In, Breathing Out

Can you imagine doing something more than 20,000 times a day? Without even realizing it, you already do. You breathe! You don't usually think about breathing because this process is controlled automatically by your nervous system. Breathing also depends on your muscular system. Muscles in your chest cause your chest area to expand and compress. These changes make air move in and out of your lungs.

When you breathe in, that breath of air goes into your lungs, which are part of your respiratory system. Oxygen from the air moves from your lungs into your bloodstream. You respiratory and circulatory system systems work together, delivering oxygen to all your cells. Your cells give off carbon dioxide as a waste product. Carbon dioxide is carried in the blood to the lungs, where you breathe it out.

Getting Food

Your respiratory system takes in oxygen, and your circulatory system delivers it to your cells. Oxygen is used in cells to release energy from sugar molecules that come from the food you eat. But how do sugar molecules get to your cells? Your digestive system helps to break down foods into sugars and other nutrient molecules that your body can use. A nutrient is a substance that you get from food and that your body needs to carry out processes, such as contracting muscles. Through a process called absorption, nutrients move from the digestive system into the bloodstream. The

circulatory system then delivers the nutrients to all cells in your body. In this way, your digestive system and circulatory system work together to get food to your cells.

Moving Wastes

The excretory system eliminates wastes from your body. Your respiratory, circulatory, and digestive systems all have roles in the excretory system. You already read that carbon dioxide passes from the circulatory system into the respiratory system and leaves the body when you exhale. Other cellular wastes also pass into the blood. These wastes are filtered out of the blood by the kidneys. This process produces urine, which then carries wastes out of your body. Materials that are not used by the digestive system leave the body as solid waste.

1. Name four body systems that are involved in getting oxygen to your cells.
   _____

2. How does the circulatory system help other systems function?
   _____
   _____
   _____
   _____

<u>Which Systems Control Body Functions?</u>

To function properly, each part of your body must be able to communicate with other parts of your body. For example, if you hear a phone ring, that message must be sent to your brain. You brain then directs your muscles to move your bones so you can answer the phone. These actions are controlled by the nervous system, which is made up of the brain, spinal cord, and nerves. In your nervous system, information travels through nerve cells.

Other messages are sent by chemical signals that re produced by the endocrine system. The endocrine system is made up of organs called glands that release chemical signals directly into the bloodstream. For example, when you exercise, your endocrine system sends signals that make you perspire, or sweat. AS sweat evaporates, it helps cool you down. The nervous system and the endocrine system work together to control body functions.

Nervous System

Your eyes, ears, skin, nose, and taste buds send information about your environment to your nervous system. Your senses let you react to bright light, hot objects, and freshly baked cookies. A signal in the environment that makes you react is called a stimulus. A response is what your body does in reaction to a stimulus. Responses are directed by your nervous system bit often involve other body systems. For example, your muscular and skeletal systems help you reach for a cookie. And your digestive system releases saliva before the cookie even reaches your mouth.

Among the drugs that affect the nervous system, caffeine is one of the most used worldwide. Caffeine is found in coffee, tea, soda, other beverages, and even chocolate.

1. How does caffeine reach the brain after someone drinks a cup of coffee or tea? In your answer, be sure to identify the systems involved.
   _____
   _____
   _____

2. Caffeine is addictive, which means that the body can become physically dependent on the drug. Which body system do you think would be the most involved in an addiction? Explain your answer.

_____
_____
_____

Endocrine System

The chemical signals released by the endocrine system called hormones. Hormones are transported through your body by the circulatory system. These chemicals affect many body processes. For example, one hormone interacts with the excretory system and the circulatory system to control the amount of water in the bloodstream. Another hormone interacts with the digestive system and the circulatory system to control the amount of sugar in the bloodstream. Hormones also affect the reproductive systems in males and females.

System Interactions Enrich

You know that the nervous system and endocrine system work together to control body functions. All the body's systems interact with the nervous system in some way. Read the passage and study the table. Then answer the questions that follow.

Nervous System Interactions

The nervous system, containing the brain, spinal cord, and nerves, controls the body's reactions to its environment. To do this, the nervous system must send information to and receive information from other systems in the body. The table below explains how the nervous system interacts with some of the other systems in the body.

System	Interactions with Nervous System
Skeletal	• Bones provide calcium that helps nervous system function. • Bones protect nervous system organs from injury.
Cardiovascular	• Brain regulates heart rate and blood pressure. • Endothelial cells prevent materials in the blood from entering the brain.
Muscular	• Brain controls contraction of skeletal muscle.
Respiratory	• Brain monitors volume of lungs and blood gas levels. • Brain regulates respiratory rate.
Digestive	• Brain controls drinking and feeding. • Brain controls muscles for eating and elimination.

1. Which systems provide a benefit to the nervous system? Explain.

_____
_____
_____

2. Which systems receive a benefit from the nervous system? Explain.

_____
_____
_____

3. Choose a body system from the table and name an interaction that is not listed.

_____
_____
_____

4. Name a system not listed in the table and explain how it interacts with the nervous system.

_____
_____
_____

Dividing to Multiply	
Grade Level Standard(s)	**7.LS1.8** Construct an explanation demonstrating that the function of mitosis for multicellular organisms is for growth and repair through the production of genetically identical daughter cells.
Caregiver Support Option	Provide support as needed with reading and discussing questions.
Materials Needed	writing utensil (pencil, pen, etc.)
Essential Question(s)	How do cells divide?
Student Directions	Directions are provided for you to follow. Answer any questions for which space is not provided on a separate sheet of paper.

Cell Cycle

What Are the Functions of Cell Division?

How do tiny frog eggs become big frogs? Cell division allows organisms to grow larger. One cell splits into two, two into four, and so on, until a single cell becomes a multicellular organism. How does a broken bone heal? Cell division produces new healthy bone cells that replace the damaged cells. Similarly, cell division can replace aging cells and those that die from disease.

Growth and repair are two functions of cell division. A third function is reproduction. Some organisms reproduce simply through cell division. Many single-celled organisms, such as amoebas, reproduce this way. Other organism can reproduce when cell division leads to the growth of new structures. For example, a cactus can grow new stems and roots. These structures can then break away from the parent plant and become a separate plant.

Most organism reproduce when specialized cells from two different parents combine, forming a new cell. This cell then undergoes many divisions and grows into a new organism. Cell division has more than one function in living things. Cell division allows organism to grow, repair damaged structures, and reproduce.

Each picture below represents at least one function of cell division.

1. Label each photo below as (A) growth, (B) repair, or (C) reproduction.
2. Which photo(s) represents more than one function and what are they?

_____
_____

_____ _____ _____

What Happens During the Cell Cycle?

The regular sequence of growth and division that cells undergo is known as the cell cycle. During the cell cycle, a cell grows, prepares for division, and divides into two new cells, which are called "daughter cells." Each of the daughter cells then begins the cell cycle again. The cell cycle consists of three main stages: interphase, mitosis, and cytokinesis.

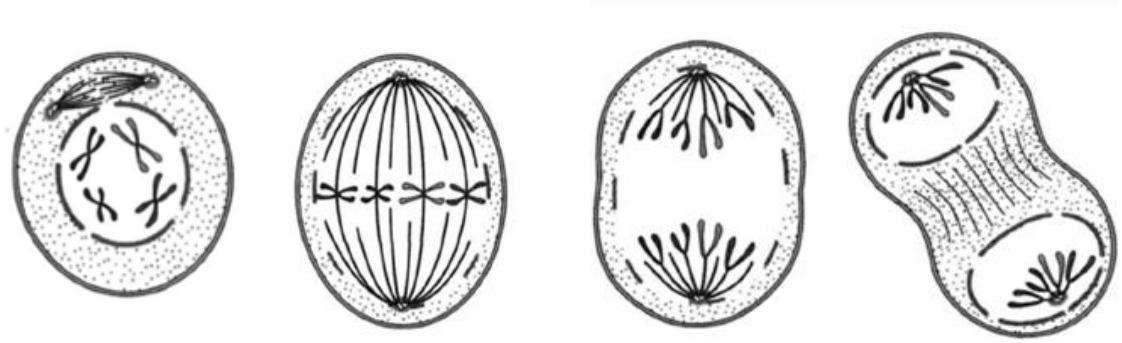
Mitosis

1. What must happen to the cells and the chromosomes of an organism for them to help the organism grow or replace damaged cells?

   _____
   _____
   _____

2. A. Diagram 1: Mitosis in animal cells (a) and in plant cells (b).

a.



Prophase Metaphase Anaphase Telophase

b.

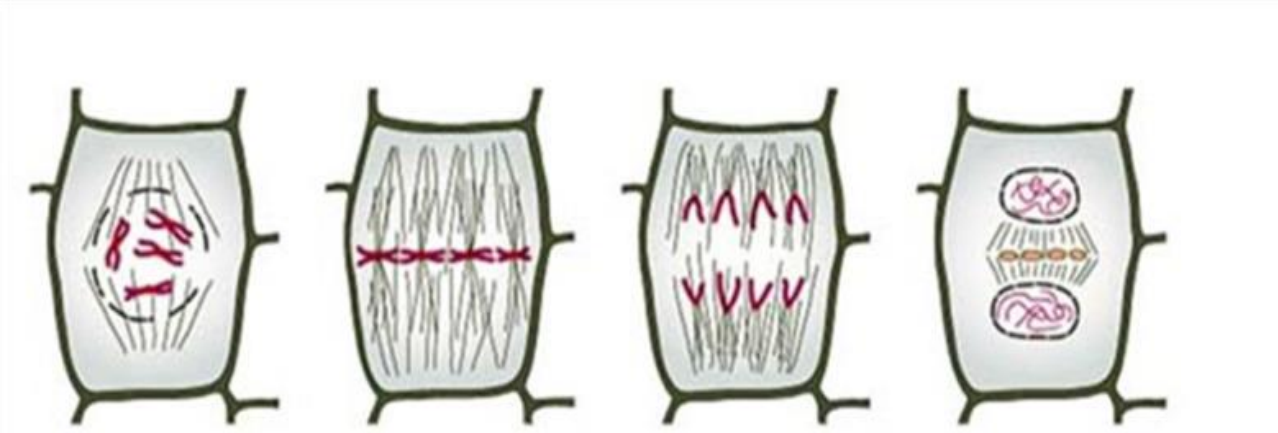
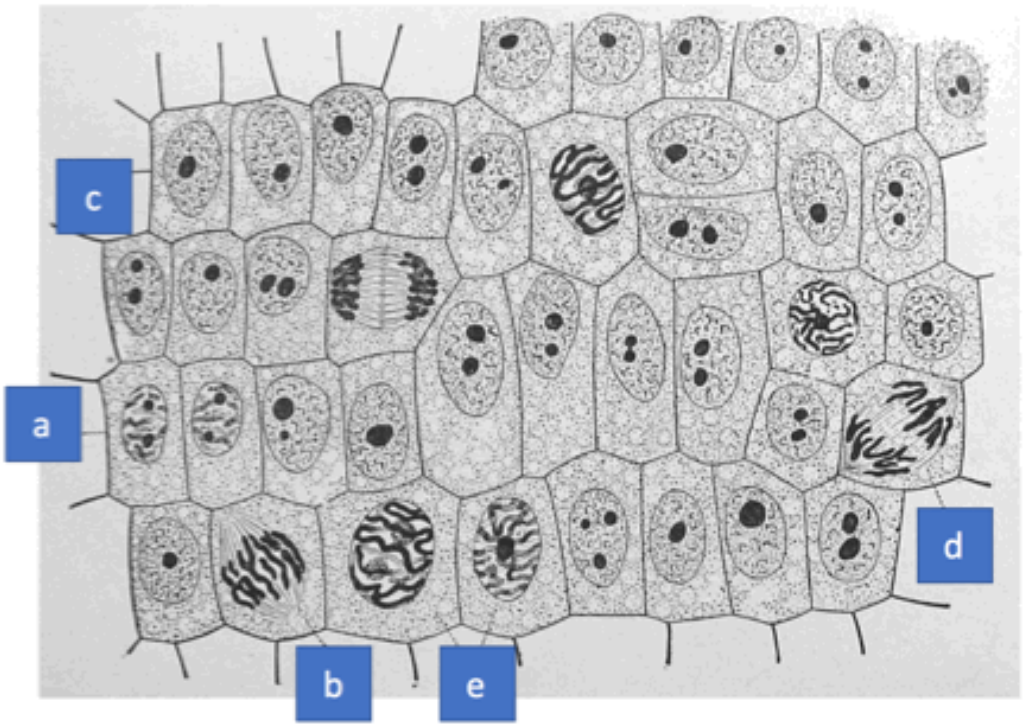


Table 1: Observations of similarities and differences in what is happening to cell structures, particularly as the chromosomes prepare to divide:

Phase of Mitosis	Plant Cell	Animal Cell
Prophase		
Metaphase		
Anaphase		
Telophase		

B. Growth in an organism is carefully controlled by regulating the cell cycle. In plants, the roots continue to grow as they search for water and nutrients. These regions of growth are good for studying the cell cycle because at any given time, you can find cells that are undergoing mitosis. A computer-enhanced photograph of onion root tip cells is shown below. Compare the phases of cell division in 2.A to the onion tip cells you see in the diagram. Below the diagram, identify the phases by either labeling the diagram or listing below it. Also, put the events (a-e) occurring in these onion cells in chronological order.



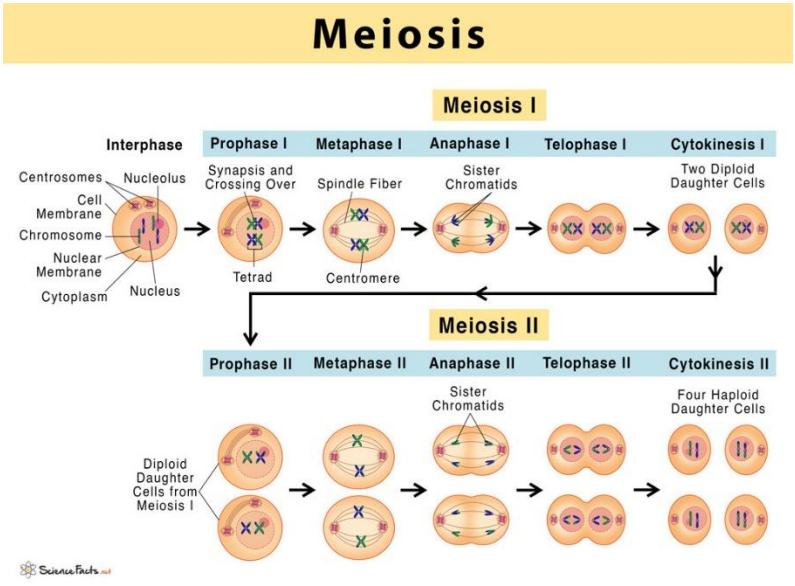
a. _____
b. _____
c. _____
d. _____
e. _____

C. Explain in your own words using scientific vocabulary what changes occur in the cells of a multicellular organism (especially the chromosomes) to provide new cells when the organism needs them during growth or repairing of damaged or dead tissues.

_____
_____
_____
_____
_____

Mitosis vs. Meiosis	
Grade Level Standard(s)	**7.LS3.2** Distinguish between mitosis and meiosis and compare the resulting daughter cells.
Caregiver Support Option	Provide support as needed with reading and discussing questions.
Materials Needed	• writing utensil (pencil, pen, etc.) • construction paper • 4 different color chenille sticks (4 of each color)
Essential Question(s)	How do cells divide in meiosis compared to mitosis?
Student Directions	Directions are provided for you to follow. Answer any questions for which space is not provided on a separate sheet of paper.

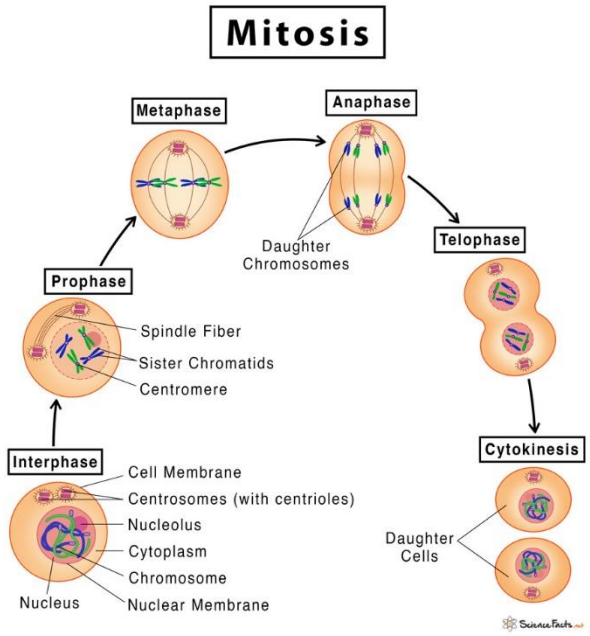
What Happens During Meiosis?



How do sex cells end up with half the number of chromosomes as body cells? The answer to this question is a form of cell division called meiosis. Meiosis is the process by which the number of chromosomes is reduced by half as sex cells form. During meiosis, a cell divides into two cells. Then each of these cells divides again, forming a total of four cells. The chromosomes duplicate only before the first cell division. Each of the four sex cells receives two chromosomes, one chromosome from each pair in the original cell. When two sex cells join at fertilization, the new cell that forms has the full number of chromosomes. In this case, the number is four. The organism from this cell got two of its chromosomes from one parent and two from the other parent.

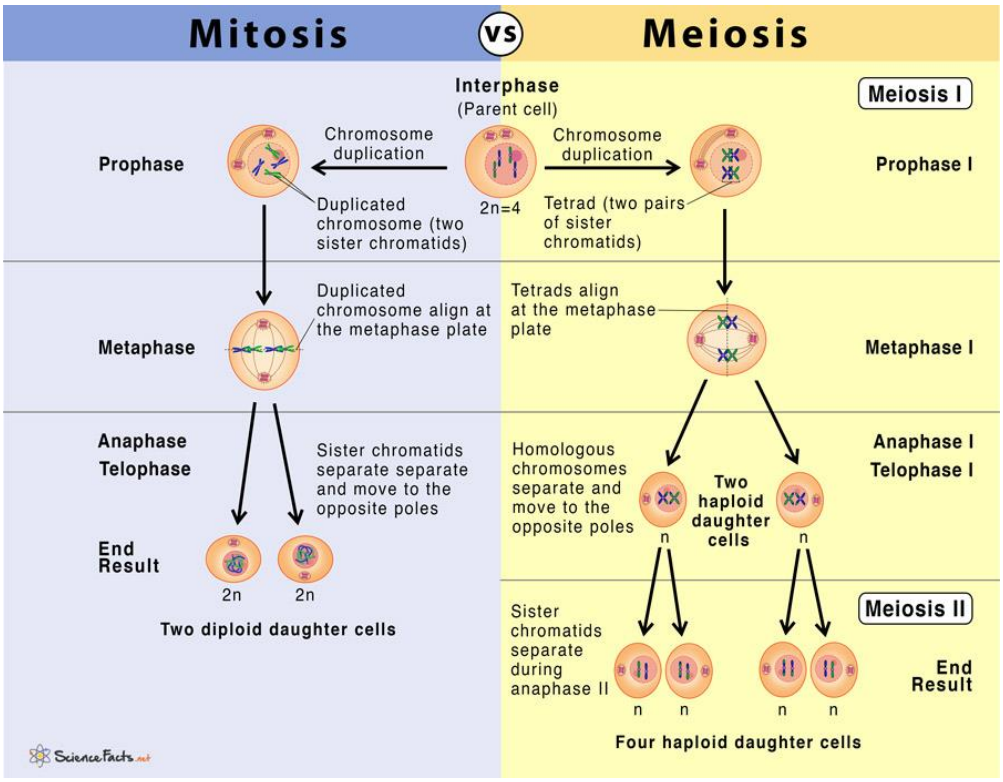
What Happens During Mitosis?

Mitosis is the process through which body cells divide to produce new cells. This process is essential for organisms to grow or repair damaged tissue. Just as in meiosis, our parent cells have four chromosomes arranged in two pairs. But there are some important differences between mitosis and meiosis. After mitosis, there are two identical body cells.



Differences Between Meiosis and Mitosis

Meiosis and mitosis have many similarities: both are processes that result in new cells. Both begin with making copies of chromosomes in the parent cells, and both involve separating chromatids to produce new chromosomes in daughter cells. But there are important differences. If your body contains a damaged skin cell, it will need to replace it with another skin cell. It's important for mitosis to result in daughter cells that are identical to the parent cells, and then to have the same number of chromosomes. Remember that the sex cells produced in meiosis had half the number of chromosomes as the parent cells. This makes sense because two sex ells will combine during sexual reproduction to form the same number of chromosomes as the parent cell. Also, no two daughter cells produced in meiosis are identical, which why siblings can have a very different traits even when they have the same parents. The number and type of daughter cells produced from meiosis versus mitosis goes hand and hand with the function of sex cells versus body cells.



Modeling Mitosis Quick Lab

Procedure

1. Construct a model of a cell that has four chromosomes. Use a piece of construction paper to represent the cell. Use different colored chenille sticks to represent the chromosomes.
2. Make sure that the chromosomes look like double rods because they have already duplicated during interphase.
3. Position the chromosomes in the cell where they would be during prophase. Use the figure of mitosis above as a guide.
4. Repeat Step 3 for metaphase, anaphase, and telophase.

Think It Over

1. How did the model help you understand the events of mitosis?

_____
_____
_____

Modeling Meiosis Quick Lab

Procedure

1. In this activity, you will model the steps of meiosis. The chenille sticks will represent chromosomes.
2. Lay two chenille sticks of each color in front of you to illustrate a cell that contains two different pairs of chromosomes. One pair of chromosomes is represented by one color of chenille stick. The other pair of chromosomes is represented by the other color chenille sticks.
3. Use the remaining chenille sticks to model the process of meiosis. You may use the beads to hold duplicated chromosomes together, or you simply twist the chenille sticks around each other so they stay together.

Think It Over

1. How does the number of chromosomes in a sex cell produced by meiosis compare with the number of chromosomes in the parent cell? Why is this difference important?

_____
_____
_____

2. What are the similarities and differences between mitosis and meiosis? Think about the Modeling Mitosis Quick Lab.

_____
_____
_____

Telomeres & Starfish	
Grade Level Standard(s)	**7.LS1.7** Evaluate and communicate evidence that compares and contrasts the advantages and disadvantages of sexual and asexual reproduction. **7.LS3.3** Predict the probability of individual dominant and recessive alleles to be transmitted from each parent to offspring during sexual reproduction and represent the genotypic and phenotypic patterns using ratios.
Caregiver Support Option	Provide support as needed with reading and discussing questions.
Materials Needed	writing utensil (pencil, pen, etc.)

Essential Question(s)	How do organisms reproduce? How are patterns of inheritance studied?
Student Directions	Directions are provided for you to follow. Answer any questions for which space is not provided on a separate sheet of paper.

Phenomenon: *Some organisms, like starfish, can reproduce both sexually and asexually.*

1. List your questions about this phenomenon.

   _____
   _____
   _____
   _____

2. What would be the advantages and disadvantages of reproducing both sexually and asexually?

	Asexual Reproduction	**Sexual Reproduction**
Advantage		
Disadvantage		

3. How would the genetic probability of each type of reproduction be different?

   _____
   _____
   _____

Punnett Square Review

1. **TT**/**Tt** shows the dominant trait for tongue rolling.
   Tt shows the recessive trait for non-tongue rolling.
   Complete the Punnett Square below.

	T	**T**
T		
t		

2. Parent 1 is homozygous dominant for dimples (D). Parent 2 is homozygous recessive for dimples (d). Complete the Punnett Square below to see the offspring's diversity.

Sexual vs. Asexual Reproduction Review

Label the following characteristics as sexual (s) or asexual (AS) reproduction.

_____ Requires 2 parents
_____ DNA different from parents
_____ DNA identical to parents
_____ Uniform population
_____ Requires more time and energy to reproduce
_____ One parent
_____ Mutations remain in population
_____ Diverse population
_____ Ability to remove mutations from the population over time
_____ Uniform population

Telomeres and Starfish

In 2015, a group of scientists at the University of Gothenburg in Sweden studied populations of the starfish, *Coscinasterias tenuispina*, living in four locations. Two of the locations were in the Mediterranean Sea - Llanca, Costa Brava and Taomina, Sicily. Two of the locations were in the Atlantic Ocean - Bocacangrejo, Tenerife and Abades, Tenerife.

This research group was looking at telomere length in the starfish and trying to determine which population had a longer telomere length. Telomeres, a portion on the chromosome, can be indicators of the lifespan and the general health of an organism. Telomeres usually shorten during an organism's lifespan and have thus been used as an aging and health marker.

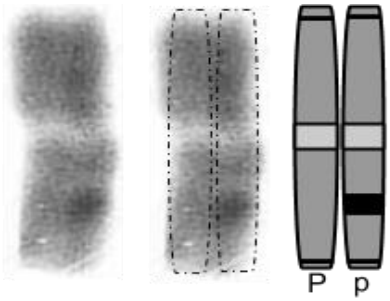
Below is a chart that organizes some of the data the scientists collected and researched.

Location	Number of Starfish Populations Studied	Number of Genotype Variations in the Population	Average Telomere Value
Llanca, Costa Brava (Mediterranean Sea)	17	1	.086
Taomina, Sicily (Mediterranean Sea)	15	4	.083
Bocacangrejo, Tenerife (Atlantic Ocean)	13	8	.081
Abades, Tenerife (Atlantic Ocean)	13	7	.080

1. What patterns of genetic variation do you notice about the starfish population that were studied?

_____
_____
_____
_____

Another research group in Japan studied chromosomes found in *Asterina pectinifera*, a starfish found in the Pacific Ocean near Japan and Russia. This starfish can reproduce asexually by fission, which is splitting into fragments and regenerating. This starfish also reproduces sexually, where the female lays eggs and the male fertilizes the eggs.



The image on the left contains one of the pairs of chromosomes the research group in Japan studied. A model representation of the chromosomes is also included and labeled P and p. The lines on the chromosomes represent genes. Use the information in this image to complete the two models below.

2. Develop a model (e.g., Punnett squares, diagrams, etc.) of an *Asterina pectinifera* parent (Pp) reproducing **asexually** and the genetic variation in the offspring. When creating your model ask yourself: How many parents will there be? What is the genetic diversity, if any, with offspring? How many chromosome pairs will contribute to the offspring from the parent?

3. Develop a model (e.g., Punnett squares, diagrams, etc.) of two *Asterina pectinifera* parents (Pp) reproducing **sexually** and the genetic variation in the offspring. This model must include parents, offspring, and chromosome pairs.

4. Describe how each of your models show cause-and-effect relationships between the type of reproduction and the resulting genetic variation in offspring.

_____
_____
_____
_____
_____

5. The research group in Sweden, studying starfish populations in the Mediterranean Sea and Pacific Ocean claimed that their research showed "a clear positive link between long telomeres and the level of clonality (being genetically identical to one's parent)." Use the data from the table on page 15 and your models to explain what type of starfish reproduction may be found in the starfish populations in Llanaca, Costa Brava and the type of starfish reproduction in Abades, Tenerife.

Llanaca, Costa Brava	Abades, Tenerife
Type of Reproduction: _____ Use your model to explain your answer. _____ _____ _____ _____ _____ _____ _____ _____ _____	**Type of Reproduction:** _____ Use your model to explain your answer. _____ _____ _____ _____ _____ _____ _____ _____ _____

Mutations	
Grade Level Standard(s)	**7.LS3.1** Hypothesize that the impact of structural changes to genes (i.e., mutations) located on chromosomes may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
Caregiver Support Option	Provide support as needed with reading and discussing questions.
Materials Needed	writing utensil (pencil, pen, etc.) green construction paper white paper scissors (Use with caution and under the supervision of an adult)
Essential Question(s)	How can mutations affect organisms?
Student Directions	Directions are provided for you to follow. Answer any questions for which space is not provided on a separate sheet of paper.

Every mammal, from mice to monkeys to whales, drinks milk as a baby. But humans are the only mammals that can digest milk and other dairy products throughout their lifetime. Humans have a mutation (a change in DNA that allows their bodies to break down lactose, a sugar in dairy products. However, not all people can digest dairy products. Many people are lactose intolerant, meaning their bodies cannot break down lactose. Lactose intolerant people have the original DNA without the mutations. While many bother mutations are considered harmful, this mutation is helpful to humans.

1. Do you think lactose intolerance is a serious condition? Explain.

   _____
   _____
   _____

2. Do you think people with this condition can never have milk?

   _____
   _____
   _____

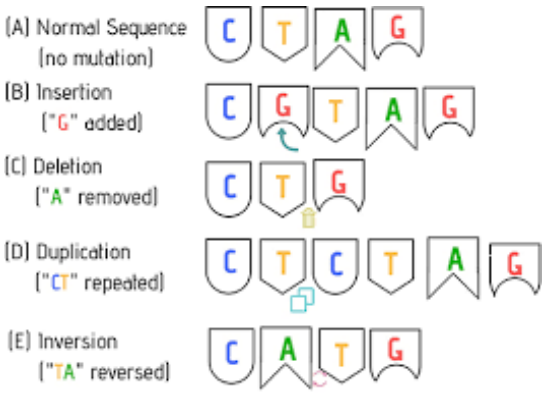
How Can Mutations Affect an Organism?

Some traits are not inherited from parent organisms. Traits can also be a result of a change in DNA. A mutation is any change in the DNA of a gene or chromosome. For example, instead of the base sequence AAG, the DNA might have the sequence ACG. Mutations can cause a cell to produce an incorrect protein during protein synthesis. As a result, the organism's trait may be different from what it normally would be.

If a mutation occurs in a body cell, such as skin cell, the mutation will not be passed on to the organism's offspring. But if a mutation occurs in a sex cell (egg or sperm), the mutation can be passed on to an offspring and affect the offspring's traits.

Types of Mutations

Some mutations are the result of small changes in an organism's DNA. For example, a base pair may be added, a base pair may be substituted for another, or one or more bases may be deleted from a section of DNA. These types of mutations can occur during the DNA replication process. Other mutations may occur when chromosomes don't separate correctly during the formation of sex cells. When this type of mutation occurs, a cell can end up with too many or too few chromosomes. The cell can also end up with extra segments of chromosomes.



Effects of Mutations

Mutations introduce changes in an organism. Mutations can be harmful, helpful, or neither harmful nor helpful. A mutation is harmful if it reduces the organism's chance for survival and reproduction.

Whether a mutation is harmful or not depends partly on the organism's environment. The mutation that led to this alligator's white color would probably be harmful to it in the wild. A white alligator is more visible to its prey. This alligator may find it difficult to catch prey and may not get enough food to survive. An alligator in a zoo has the same chance for survival as a green alligator because it does not hunt. In a zoo, the mutation neither helps nor harms the alligator.

Helpful mutations increase an organism's ability to survive and reproduce. Mutations have allowed some bacteria that are harmful to humans to become resistant to drugs. The drugs do not kill the bacteria with the mutations, so they continue to survive and reproduce.

Drug resistance in bacteria is a beneficial mutation for the bacteria, but how can it be harmful for humans?

_____

_____

Effects of Mutations

Mutations can have a variety of effects on organisms. The effect of a mutation can depend on the environment of the organism.

Procedure: (You will need a partner for this activity.)

1. Cut small "animals" out of the sheets of green construction paper. Cut another 10 small "animals" out of the white paper. All animals should be about the same shape and size. Assume that the white animals represent individuals with a mutation that has changed their color.
2. Make a prediction about which color animals can be more successfully "hunted" on a green background.

   _____

   _____
3. One partner will be a predator and the other will record observations. While the predator looks away, the recorder will randomly scatter all the animals onto the other sheet of green construction paper.
4. The predator will then look for one second, and then "capture" one animal. Next, the predator will close his or her eyes for a second, and then repeat the "hunt." The partner will count seconds and record the colors of the animals the predator selected one at a time. Repeat the "hunt" until 10 animals have been captured.

Think It Over

1. How many of each color animal did the predator pick up? Was the prediction you made in step 3 correct? Explain your answer.

   _____
   _____
   _____

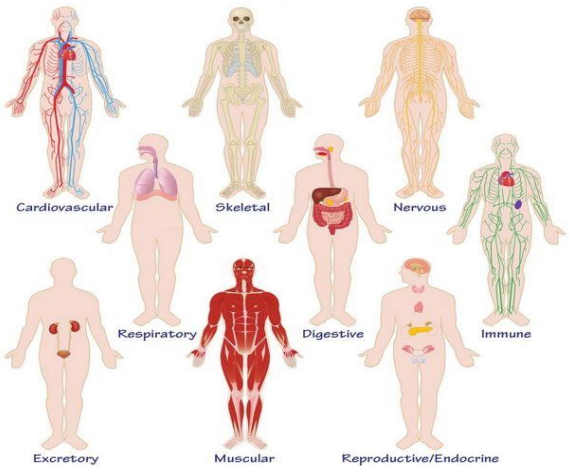
2. Which color animals were not well camouflaged in their environment? Was the white mutation harmful, beneficial, or neutral? Why?

   _____
   _____
   _____

3. If the paper animal's environment suddenly became snow-covered, would the white mutation now be harmful, beneficial, or neutral? Why?

   _____
   _____
   _____

Working Together	
Grade Level Standard(s)	**7.LS1.5** Explain that body is a system comprised or subsystems that maintain equilibrium and support life through digestion, respiration, excretion, circulation, sensation (nervous and integumentary) and locomotion (musculoskeletal).
Caregiver Support Option	Provide support as needed with reading and discussing questions.
Materials Needed	writing utensil (pencil, paper, etc.)
Essential Question(s)	How do body systems work together to support life?
Student Directions	Directions for you to follow are provided. Answer any questions for which space is not provided on a separate sheet of paper.



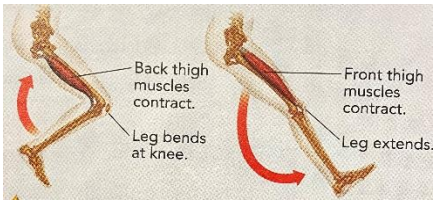
How Do You Move?

Carefully coordinated movements let you thread a needle, ride a bicycle, brush your teeth, and dance. These movements, and all your body's other movements, happen because of the interactions between body systems. Your muscular system is made up of all the muscles in your body. Your skeletal system, or skeleton, includes all the bones in your body. Muscles and bones work together, making your body move. The nervous system tells your muscles when to act.

Muscles and Bones

Skeletal muscles are attached to the bones of your skeleton and provide the force that moves your bones. Muscles contract and relax. When a muscle contracts, it shortens and pulls on the bones to which it is attached.

As this dancer's muscles pull on his leg bones, he can make rapid, skillful moves.



1. An octopus has no bones. Explain how you think it moves.

The octopus uses muscles to squeeze water out of its body like a jet stream, which propels the octopus through the water.

Bones and Joints

What happens when you wiggle your fingers or touch your toes? Even though your bones are rigid, your body can bend in many ways. Your skeleton bends at its joints. A joint is a place in the body where two bones come together. For example, your elbow and shoulder are two joints that move when you raise your hand.

Making Movement Happen

Muscles make bones move at their joints. Try standing on one leg and bending the other leg at the knee. Hold that position. You can feel that you are using the muscles at the back of the thigh. Now straighten your leg. You can feel the muscles in the back of your leg relax, but the muscles in the front of your leg are at work. Your nervous system controls when and how your muscles act on your bones.

Which Systems Move Materials in Your Body?

The trillions of cells that make up your body need materials to function. Cells also produce wastes that must be removed. If the processes of moving these materials were made into a movie, your nervous system would be the director. The movie set would include the muscular and skeletal systems. The main characters would be some of your other systems. The circulatory, respiratory, digestive, and excretory systems play key roles in moving materials in your body.

Transporting Materials

Your circulatory system includes your heart, blood vessels, and blood. Blood vessels are found throughout your body. Blood that flows through these vessels carries materials such as water, oxygen, and food to every cell. Materials that your cells must get rid of, such as carbon dioxide and the other cell wastes, are also moved through the body in the blood.

Breathing In, Breathing Out

Can you imagine doing something more than 20,000 times a day? Without even realizing it, you already do. You breathe! You don't usually think about breathing because this process is controlled automatically by your nervous system. Breathing also depends on your muscular system. Muscles in your chest cause your chest area to expand and compress. These changes make air move in and out of your lungs.

When you breathe in, that breath of air goes into your lungs, which are part of your respiratory system. Oxygen from the air moves from your lungs into your bloodstream. You respiratory and circulatory system systems work together, delivering oxygen to all your cells. Your cells give off carbon dioxide as a waste product. Carbon dioxide is carried in the blood to the lungs, where you breathe it out.

Getting Food

Your respiratory system takes in oxygen, and your circulatory system delivers it to your cells. Oxygen is used in cells to release energy from sugar molecules that come from the food you eat. But how do sugar molecules get to your cells? Your digestive system helps to break down foods into sugars and other nutrient molecules that your body can use. A nutrient is a substance that you get from food and that your body needs to carry out processes, such as contracting muscles. Through a process called absorption, nutrients move from the digestive system into the bloodstream. The circulatory system then delivers the nutrients to all cells in your body. In this way, your digestive system and circulatory system work together to get food to your cells.

Moving Wastes

The excretory system eliminates wastes from your body. Your respiratory, circulatory, and digestive systems all have roles in the excretory system. You already read that carbon dioxide passes from the circulatory system into the respiratory system and leaves the body when you exhale. Other cellular wastes also pass into the blood. These wastes are filtered out of the blood by the kidneys. This process produces urine, which then carries wastes out of your body. Materials that are not used by the digestive system leave the body as solid waste.

1. Name four body systems that are involved in getting oxygen to your cells.
   Nervous, muscular, respiratory, and circulatory systems

2. How does the circulatory system help other systems function?
   Carries nutrients absorbed by the digestive system and oxygen absorbed by the respiratory system to cells; takes wastes to the lungs and kidneys for excretion by the respiratory and excretory systems.

Which Systems Control Body Functions?

To function properly, each part of your body must be able to communicate with other parts of your body. For example, if you hear a phone ring, that message must be sent to your brain. You brain then directs your muscles to move your bones so you can answer the phone. These actions are controlled by the nervous system, which is made up of the brain, spinal cord, and nerves. In your nervous system, information travels through nerve cells.

Other messages are sent by chemical signals that re produced by the endocrine system. The endocrine system is made up of organs called glands that release chemical signals directly into the bloodstream. For example, when you exercise, your endocrine system sends signals that make you perspire, or sweat. AS sweat evaporates, it helps cool you down. The nervous system and the endocrine system work together to control body functions.

Nervous System

Your eyes, ears, skin, nose, and taste buds send information about your environment to your nervous system. Your senses let you react to bright light, hot objects, and freshly baked cookies. A signal in the environment that makes you react is called a stimulus. A response is what your body does in reaction to a stimulus. Responses are directed by your nervous system bit often involve other body systems. For example, your muscular and skeletal systems help you reach for a cookie. And your digestive system releases saliva before the cookie even reaches your mouth.

Among the drugs that affect the nervous system, caffeine is one of the most used worldwide. Caffeine is found in coffee, tea, soda, other beverages, and even chocolate.

1. How does caffeine reach the brain after someone drinks a cup of coffee or tea? In your answer, be sure to identify the systems involved.
   It is absorbed through the digestive system into the blood and carried to the brain by the circulatory system.

2. Caffeine is addictive, which means that the body can become physically dependent on the drug. Which body system do you think would be the most involved in an addiction? Explain your answer.
   The nervous system: it controls body functions.

Endocrine System

The chemical signals released by the endocrine system called hormones. Hormones are transported through your body by the circulatory system. These chemicals affect many body processes. For example, one hormone interacts with the excretory system and the circulatory system to control the amount of water in the bloodstream. Another hormone interacts with the digestive system and the circulatory system to control the amount of sugar in the bloodstream. Hormones also affect the reproductive systems in males and females.

System Interactions Enrich

You know that the nervous system and endocrine system work together to control body functions. All the body's systems interact with the nervous system in some way. Read the passage and study the table. Then answer the questions that follow.

Nervous System Interactions

The nervous system, containing the brain, spinal cord, and nerves, controls the body's reactions to its environment. To do this, the nervous system must send information to and receive information from other systems in the body. The table below explains how the nervous system interacts with some of the other systems in the body.

System	Interactions with Nervous System
Skeletal	• Bones provide calcium that helps nervous system function. • Bones protect nervous system organs from injury.
Cardiovascular	• Brain regulates heart rate and blood pressure. • Endothelial cells prevent materials in the blood from entering the brain.
Muscular	• Brain controls contraction of skeletal muscle.
Respiratory	• Brain monitors volume of lungs and blood gas levels. • Brain regulates respiratory rate.
Digestive	• Brain controls drinking and feeding. • Brain controls muscles for eating and elimination.

1. Which systems provide a benefit to the nervous system? Explain.
   The skeletal system provides nourishment and protection to the nervous system. The cardiovascular system provides protection to the brain.

2. Which systems receive a benefit from the nervous system? Explain.
   The muscular, respiratory, and digestive systems are regulated and controlled by the nervous system.

3. Choose a body system from the table and name an interaction that is not listed.
   Sample answer: The muscular system sends information about movement and body position to the nervous system.

4. Name a system not listed in the table and explain how it interacts with the nervous system.
   Sample answer: Receptors in the skin in the integumentary system send information to the nervous system.

Dividing to Multiply	
Grade Level Standard(s)	**7.LS1.8** Construct an explanation demonstrating that the function of mitosis for multicellular organisms is for growth and repair through the production of genetically identical daughter cells.
Caregiver Support Option	Provide support as needed with reading and discussing questions.
Materials Needed	writing utensil (pencil, pen, etc.)
Essential Question(s)	How do cells divide?
Student Directions	Directions are provided for you to follow. Answer any questions for which space is not provided on a separate sheet of paper.

Cell Cycle

What Are the Functions of Cell Division?

How do tiny frog eggs become big frogs? Cell division allows organisms to grow larger. One cell splits into two, two into four, and so on, until a single cell becomes a multicellular organism. How does a broken bone heal? Cell division produces new healthy bone cells that replace the damaged cells. Similarly, cell division can replace aging cells and those that die from disease.

Growth and repair are two functions of cell division. A third function is reproduction. Some organisms reproduce simply through cell division. Many single-celled organisms, such as amoebas, reproduce this way. Other organism can reproduce when cell division leads to the growth of new structures. For example, a cactus can grow new stems and roots. These structures can then break away from the parent plant and become a separate plant.

Most organism reproduce when specialized cells from two different parents combine, forming a new cell. This cell then undergoes many divisions and grows into a new organism. Cell division has more than one function in living things. Cell division allows organism to grow, repair damaged structures, and reproduce.

Each picture below represents at least one function of cell division.

1. Label each photo below as (A) growth, (B) repair, or (C) reproduction.
2. Which photo(s) represents more than one function and what are they?
   A or C; Reproduction and growth

A

B

C

What Happens During the Cell Cycle?

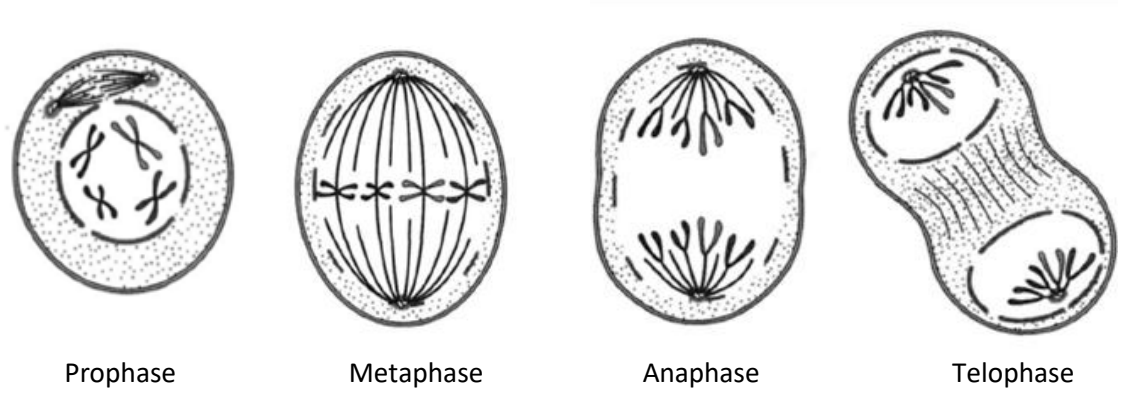
The regular sequence of growth and division that cells undergo is known as the cell cycle. During the cell cycle, a cell grows, prepares for division, and divides into two new cells, which are called “daughter cells.” Each of the daughter cells then begins the cell cycle again. The cell cycle consists of three main stages: interphase, mitosis, and cytokinesis.

Mitosis

1. What must happen to the cells and the chromosomes of an organism for them to help the organism grow or replace damaged cells?
   Assist students in making connections to the conservation of mass, identical chromosomal information, and how the cell/system is to remain stable. Cells must duplicate their mass as well as the chromosomes inside to ensure that the two daughter cells will be composed of the same amount and type of matter and the same information that existed in the original parent cell.

2. A. Diagram 1: Mitosis in animal cells (a) and in plant cells (b).

a.



Prophase Metaphase Anaphase Telophase

b.

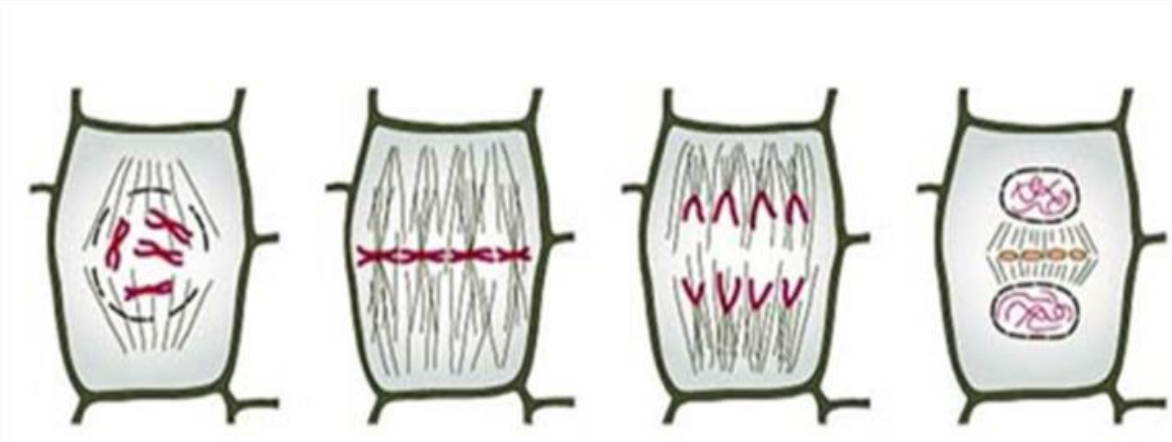
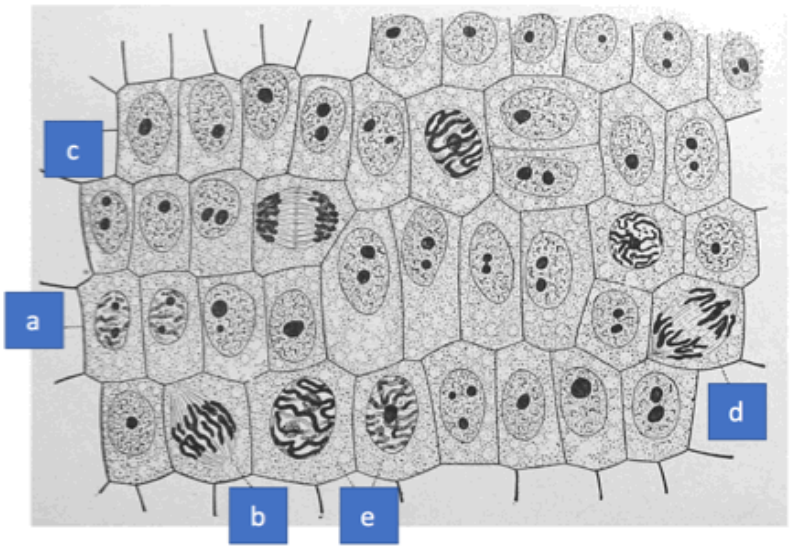


Table 1: Observations of similarities and differences in what is happening to cell structures, particularly as the chromosomes prepare to divide:

Phase of Mitosis	Plant Cell	Animal Cell
Prophase	Chromosomes now have 2 sets; nuclear membrane seems to be disappearing	Chromosomes now have 2 sets.
Metaphase	Chromosomes have lined up in the middle of the cell. Fibers might be causing them to move to their locations.	Chromosomes have lined up in the middle of the cell. Fibers might be causing them to move to their locations.
Anaphase	Chromosomes are moving toward opposite ends of the cell.	Chromosomes are moving toward opposite ends of the cell, and the cell membrane is stretching/growing larger or longer.

Telophase	It appears two new nuclear membranes are forming around the sets of chromosomes that traveled to opposite ends of the cell. A structure is forming between the two new nuclei.	It appears two new nuclear membranes are forming around the sets of chromosomes that traveled to opposite ends of the cell. The cell membrane is pinching in the middle to become two new cells.

B. Growth in an organism is carefully controlled by regulating the cell cycle. In plants, the roots continue to grow as they search for water and nutrients. These regions of growth are good for studying the cell cycle because at any given time, you can find cells that are undergoing mitosis. A computer-enhanced photograph of onion root tip cells is shown below. Compare the phases of cell division in 2.A to the onion tip cells you see in the diagram. Below the diagram, identify the phases by either labeling the diagram or listing below it. Also, put the events (a-e) occurring in these onion cells in chronological order.



a. Interphase
b. Prophase
c. Metaphase
d. Anaphase
e. Telophase

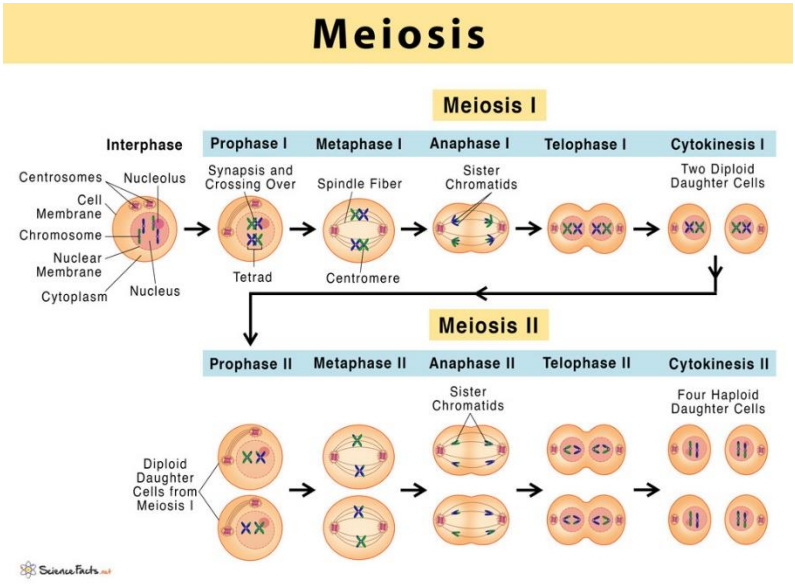
C. Explain in your own words using scientific vocabulary what changes occur in the cells of a multicellular organism (especially the chromosomes) to provide new cells when the organism needs them during growth or repairing of damaged or dead tissues.

Answers should include the following reasons for the chromosomal movement and cell's structural changes to obtain two identical daughter cells:
Interphase - chromosomes must be copied because there are two of each in the next phase
Prophase - lines or fibers are forming that must control the chromosomes and the nuclear membrane must disappear because it is gone in metaphase
Metaphase - the pairs of chromosomes line up in the middle/equator of the cell

Anaphase - single sets of chromosomes split and move to opposite sides of the elongating cell
Telophase - new nuclear membranes form around each set of chromosomes, and the cell membrane begins to pinch closed

Mitosis vs. Meiosis	
Grade Level Standard(s)	**7.LS3.2** Distinguish between mitosis and meiosis and compare the resulting daughter cells.
Caregiver Support Option	Provide support as needed with reading and discussing questions.
Materials Needed	• writing utensil (pencil, pen, etc.) • construction paper • 4 different color chenille sticks (4 of each color)
Essential Question(s)	How do cells divide in meiosis compared to mitosis?
Student Directions	Directions are provided for you to follow. Answer any questions for which space is not provided on a separate sheet of paper.

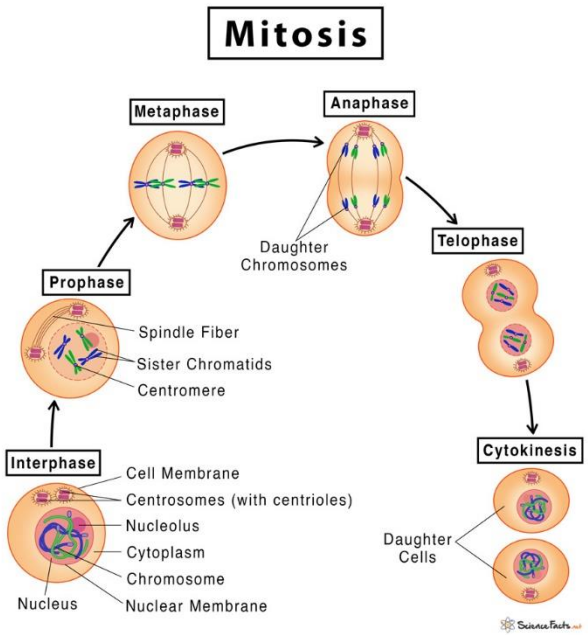
What Happens During Meiosis?



How do sex cells end up with half the number of chromosomes as body cells? The answer to this question is a form of cell division called meiosis. Meiosis is the process by which the number of chromosomes is reduced by half as sex cells form. During meiosis, a cell divides into two cells. Then each of these cells divides again, forming a total of four cells. The chromosomes duplicate only before the first cell division. Each of the four sex cells receives two chromosomes, one chromosome from each pair in the original cell. When two sex cells join at fertilization, the new cell that forms has the full number of chromosomes. In this case, the number is four. The organism from this cell got two of its chromosomes from one parent and two from the other parent.

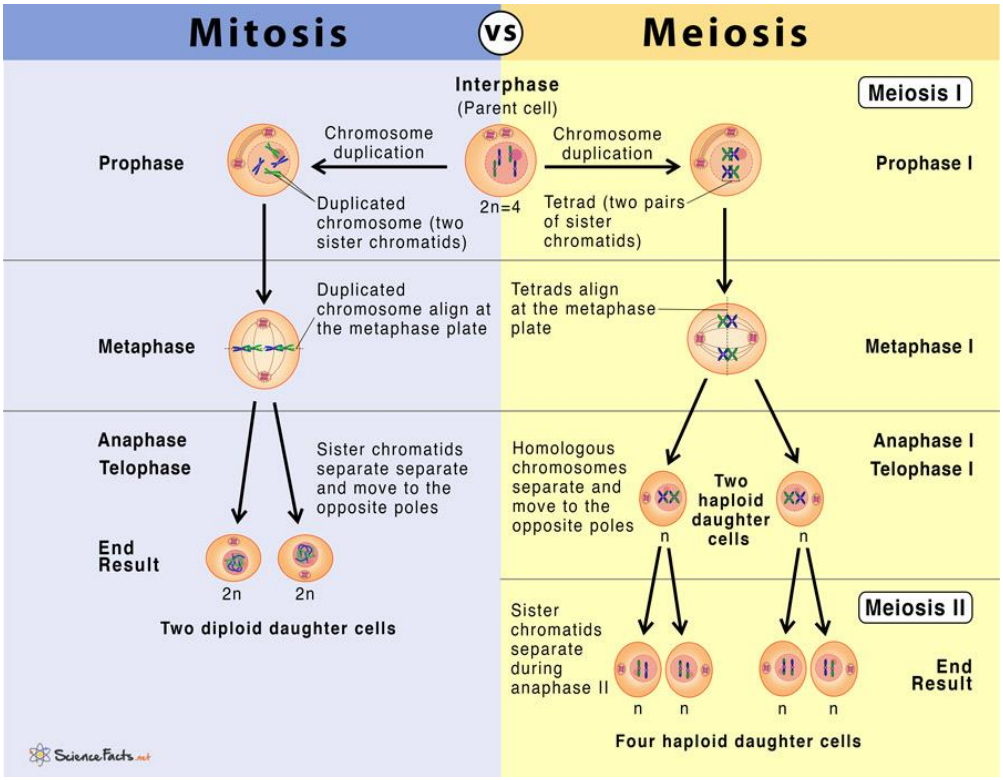
What Happens During Mitosis?

Mitosis is the process through which body cells divide to produce new cells. This process is essential for organisms to grow or repair damaged tissue. Just as in meiosis, our parent cells have four chromosomes arranged in two pairs. But there are some important differences between mitosis and meiosis. After mitosis, there are two identical body cells.



Differences Between Meiosis and Mitosis

Meiosis and mitosis have many similarities: both are processes that result in new cells. Both begin with making copies of chromosomes in the parent cells, and both involve separating chromatids to produce new chromosomes in daughter cells. But there are important differences. If your body contains a damaged skin cell, it will need to replace it with another skin cell. It's important for mitosis to result in daughter cells that are identical to the parent cells, and then to have the same number of chromosomes. Remember that the sex cells produced in meiosis had half the number of chromosomes as the parent cells. This makes sense because two sex ells will combine during sexual reproduction to form the same number of chromosomes as the parent cell. Also, no two daughter cells produced in meiosis are identical, which why siblings can have a very different traits even when they have the same parents. The number and type of daughter cells produced from meiosis versus mitosis goes hand and hand with the function of sex cells versus body cells.



Modeling Mitosis Quick Lab

Procedure

1. Construct a model of a cell that has four chromosomes. Use a piece of construction paper to represent the cell. Use different colored chenille sticks to represent the chromosomes.
2. Make sure that the chromosomes look like double rods because they have already duplicated during interphase.
3. Position the chromosomes in the cell where they would be during prophase. Use the figure of mitosis above as a guide.
4. Repeat Step 3 for metaphase, anaphase, and telophase.

Think It Over

1. How did the model help you understand the events of mitosis?
   Sample Answer: The model helped me to see mitosis as a continuous process. Being able to move the chenille-stick chromosomes helped me to visualize the events.

Modeling Meiosis Quick Lab

Procedure

1. In this activity, you will model the steps of meiosis. The chenille sticks will represent chromosomes.
2. Lay two chenille sticks of each color in front of you to illustrate a cell that contains two different pairs of chromosomes. One pair of chromosomes is represented by one color of the chenille stick. The other pair of chromosomes is represented by the other color chenille sticks.
3. Use the remaining chenille sticks to model the process of meiosis. You may use the beads to hold duplicated chromosomes together, or you simply twist the chenille sticks around each other so they stay together.

Think It Over

1. How does the number of chromosomes in a sex cell produced by meiosis compare with the number of chromosomes in the parent cell? Why is this difference important?
   Sample Answer: Each sex cell has half the number of chromosomes as the parent cell. This difference is important because it ensures that when two sex cells (an egg and sperm) combine, the new organism that forms will have one complete set of chromosomes.

2. What are the similarities and differences between mitosis and meiosis? Think about the Modeling Mitosis Quick Lab.
   Look for answers explaining that mitosis and meiosis are similar because they both involve cell division that occurs after the chromosomes have been copied and line up in the center of the cell. Mitosis and meiosis have differences as well. In meiosis, there are two cell divisions, resulting in four cells, each of which has half the number of chromosomes as the parent cell. In mitosis, there is one cell division, resulting in two cells that are identical in chromosome number of the parent cell.

Telomeres & Starfish	
Grade Level Standard(s)	**7.LS1.7** Evaluate and communicate evidence that compares and contrasts the advantages and disadvantages of sexual and asexual reproduction. **7.LS3.3** Predict the probability of individual dominant and recessive alleles to be transmitted from each parent to offspring during sexual reproduction and represent the genotypic and phenotypic patterns using ratios.
Caregiver Support Option	Provide support as needed with reading and discussing questions.
Materials Needed	writing utensil (pencil, pen, etc.)
Essential Question(s)	How do organisms reproduce? How are patterns of inheritance studied?
Student Directions	Directions are provided for you to follow. Answer any questions for which space is not provided on a separate sheet of paper.

Phenomenon: *Some organisms, like starfish, can reproduce both sexually and asexually.*

1. List your questions about this phenomenon.
   Sample Questions:
   - Do all starfish reproduce sexually and asexually?
   - If the offspring reproduce by asexual reproduction, would they then be able to reproduce by sexual reproduction?
   - Through asexual reproduction, does the arm of the starfish grow back that has been broken off?
   - Through asexual reproduction, does the arm that has been broken off grow into a completely new starfish?

2. What would be the advantages and disadvantages of reproducing both sexually and asexually?

	Asexual Reproduction	Sexual Reproduction
Advantage	One parent can quickly reproduce many identical offspring.	The offspring may have characteristics that help them survive changes in the environment.
Disadvantage	The offspring have the same DNA as the parent and may not survive changes in the environment.	Parents must find a mate and the development of offspring takes a longer time.

3. How would the genetic probability of each type of reproduction be different?

   - Those starfish that reproduce by asexual reproduction will be uniform or have the same genetic make-up of the parent.
   - Those starfish that reproduce by sexual reproduction will have genetic differences creating a more diverse population.

Punnett Square Review

1. **TT**/**Tt** shows the dominant trait for tongue rolling.
   Tt shows the recessive trait for non-tongue rolling.
   Complete the Punnett Square below.

	T	**T**
T	TT	TT
t	Tt	Tt

2. Parent 1 is homozygous dominant for dimples (D). Parent 2 is homozygous recessive for dimples (d).
   Complete the Punnett Square below to see the offspring's diversity.

	D	**D**
d	Dd	Dd
d	Dd	Dd

Sexual vs. Asexual Reproduction Review

Label the following characteristics as sexual (s) or asexual (AS) reproduction.

S Requires 2 parents
S DNA different from parents
A DNA identical to parents
A Uniform population
S Requires more time and energy to reproduce
A One parent
A Mutations remain in population
S Diverse population
S Ability to remove mutations from the population over time
A Uniform population

Telomeres and Starfish

In 2015, a group of scientists at the University of Gothenburg in Sweden studied populations of the starfish, *Coscinasterias tenuispina*, living in four locations. Two of the locations were in the Mediterranean Sea - Llanca, Costa Brava and Taomina, Sicily. Two of the locations were in the Atlantic Ocean - Bocacangrejo, Tenerife and Abades, Tenerife.

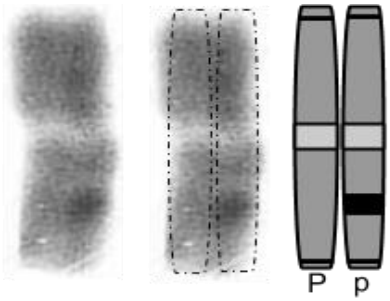
This research group was looking at telomere length in the starfish and trying to determine which population had a longer telomere length. Telomeres, a portion on the chromosome, can be indicators of the lifespan and the general health of an organism. Telomeres usually shorten during an organism's lifespan and have thus been used as an aging and health marker.

Below is a chart that organizes some of the data the scientists collected and researched.

Location	Number of Starfish Populations Studied	Number of Genotype Variations in the Population	Average Telomere Value
Llanca, Costa Brava (Mediterranean Sea)	17	1	.086
Taomina, Sicily (Mediterranean Sea)	15	4	.083
Bocacangrejo, Tenerife (Atlantic Ocean)	13	8	.081
Abades, Tenerife (Atlantic Ocean)	13	7	.080

1. What patterns of genetic variation do you notice about the starfish population that were studied?
   - Those starfish that live in the Atlantic Ocean had a greater genetic diversity than those that lived in the Mediterranean Sea.
   - The Mediterranean Sea had the most studied populations but the least amount of genotype variation.
   - Those starfish living in the Mediterranean Sea have a longer life span due to the longer average telomere. These starfish have lower generic variation in their populations indicating that these starfish could possibly reproduce asexually.

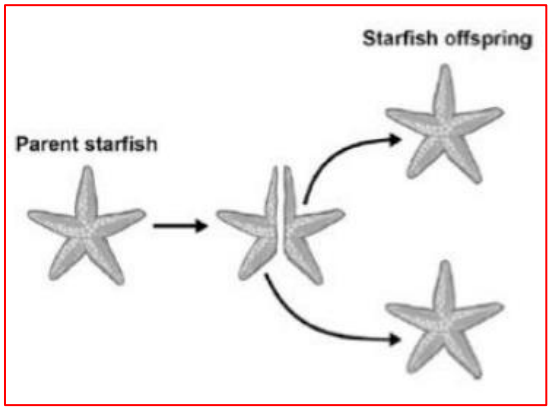
Another research group in Japan studied chromosomes found in *Asterina pectinifera*, a starfish found in the Pacific Ocean near Japan and Russia. This starfish can reproduce asexually by fission, which is splitting into fragments and regenerating. This starfish also reproduces sexually, where the female lays eggs and the male fertilizes the eggs.



The image on the left contains one of the pairs of chromosomes the research group in Japan studied. A model representation of the chromosomes is also included and labeled P and p. The lines on the chromosomes represent genes. Use the information in this image to complete the two models below.

2. Develop a model (e.g., Punnett squares, diagrams, etc.) of an *Asterina pectinifera* parent (Pp) reproducing **asexually** and the genetic variation in the offspring. When creating your model ask yourself: How many parents will there be? What is the genetic diversity, if any, with offspring? How many chromosome pairs will contribute to the offspring from the parent?

In sexual reproduction, there is only one parent passing on genetic information. The offspring will be genetically identical to the parent. The offspring will have an identical and equal amount of chromosomes as the parent.



3. Develop a model (e.g., Punnett squares, diagrams, etc.) of two *Asterina pectinifera* parents (Pp) reproducing **sexually** and the genetic variation in the offspring. This model must include parents, offspring, and chromosome pairs.

	P	**p**
P	PP	Pp
p	Pp	pp

Probability of Offspring	
PP, (homozygous dominant)	25%
Pp, (heterozygous dominant)	50%
Pp, (homozygous recessive)	25%

4. Describe how each of your models show cause-and-effect relationships between the type of reproduction and the resulting genetic variation in offspring.

   Answers may vary. Question two represents asexual reproduction because there is only one parent. The result is genetically identical offspring. Question three represents a model of sexual reproduction, the data from the Punnet square shows offspring varying in genetic diversity.

5. The research group in Sweden, studying starfish populations in the Mediterranean Sea and Pacific Ocean claimed that their research showed "a clear positive link between long telomeres and the level of clonality (being genetically identical to one's parent)." Use the data from the table on page 15 and your models to explain what type of starfish reproduction may be found in the starfish populations in Llanaca, Costa Brava and the type of starfish reproduction in Abades, Tenerife.

Llanaca, Costa Brava	**Abades, Tenerife**
Type of Reproduction: Asexual Reproduction Use your model to explain your answer. In the model, we explained there is a correlation between the average telomere value or length and the likelihood that this starfish reproduces by asexual reproduction that has a greater telomere value.	**Type of Reproduction:** _____ Use your model to explain your answer. In the model, we explained there is a correlation between the average telomere value or length and the likelihood that these starfish reproduce by sexual reproduction due to lower telomere value. The data from the table also shows a genetic diversity which indicated these starfish reproduce by sexual reproduction.

Mutations	
Grade Level Standard(s)	**7.LS3.1** Hypothesize that the impact of structural changes to genes (i.e., mutations) located on chromosomes may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
Caregiver Support Option	Provide support as needed with reading and discussing questions.
Materials Needed	writing utensil (pencil, pen, etc.) green construction paper white paper scissors (Use with caution and under the supervision of an adult)
Essential Question(s)	How can mutations affect organisms?
Student Directions	Directions are provided for you to follow. Answer any questions for which space is not provided on a separate sheet of paper.

Every mammal, from mice to monkeys to whales, drinks milk as a baby. But humans are the only mammals that can digest milk and other dairy products throughout their lifetime. Humans have a mutation (a change in DNA that allows their bodies to break down lactose, a sugar in dairy products. However, not all people can digest dairy products. Many people are lactose intolerant, meaning their bodies cannot break down lactose. Lactose intolerant people have the original DNA without the mutations. While many bother mutations are considered harmful, this mutation is helpful to humans.

1. Do you think lactose intolerance is a serious condition? Explain.
   Sample Answer: Yes; people can get sick from it.

2. Do you think people with this condition can never have milk?
   Sample answer: It depends on the strength of their reaction.

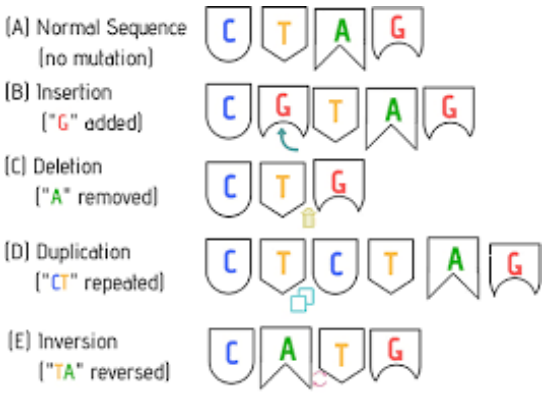
How Can Mutations Affect an Organism?

Some traits are not inherited from parent organisms. Traits can also be a result of a change in DNA. A mutation is any change in the DNA of a gene or chromosome. For example, instead of the base sequence AAG, the DNA might have the sequence ACG. Mutations can cause a cell to produce an incorrect protein during protein synthesis. As a result, the organism's trait may be different from what it normally would be.

If a mutation occurs in a body cell, such as skin cell, the mutation will not be passed on to the organism's offspring. But if a mutation occurs in a sex cell (egg or sperm), the mutation can be passed on to an offspring and affect the offspring's traits.

Types of Mutations

Some mutations are the result of small changes in an organism's DNA. For example, a base pair may be added, a base pair may be substituted for another, or one or more bases may be deleted from a section of DNA. These types of mutations can occur during the DNA replication process. Other mutations may occur when chromosomes don't separate correctly during the formation of sex cells. When this type of mutation occurs, a cell can end up with too many or too few chromosomes. The cell can also end up with extra segments of chromosomes.



Effects of Mutations

Mutations introduce changes in an organism. Mutations can be harmful, helpful, or neither harmful nor helpful. A mutation is harmful if it reduces the organism's chance for survival and reproduction.

Whether a mutation is harmful or not depends partly on the organism's environment. The mutation that led to this alligator's white color would probably be harmful to it in the wild. A white alligator is more visible to its prey. This alligator may find it difficult to catch prey and may not get enough food to survive. An alligator in a zoo has the same chance for survival as a green alligator because it does not hunt. In a zoo, the mutation neither helps nor harms the alligator.

Helpful mutations increase an organism's ability to survive and reproduce. Mutations have allowed some bacteria that are harmful to humans to become resistant to drugs. The drugs do not kill the bacteria with the mutations, so they continue to survive and reproduce.

Drug resistance in bacteria is a beneficial mutation for the bacteria, but how can it be harmful for humans?
People with diseases caused by the bacteria won't be helped by certain drugs taken for treatment.

Effects of Mutations

Mutations can have a variety of effects on organisms. The effect of a mutation can depend on the environment of the organism.

Procedure: (You will need a partner for this activity.)

1. Cut small "animals" out of the sheets of green construction paper. Cut another 10 small "animals" out of the white paper. All animals should be about the same shape and size. Assume that the white animals represent individuals with a mutation that has changed their color.
2. Make a prediction about which color animals can be more successfully "hunted" on a green background.
   I predict that more white animals will be "hunted".
3. One partner will be a predator and the other will record observations. While the predator looks away, the recorder will randomly scatter all the animals onto the other sheet of green construction paper.
4. The predator will then look for one second, and then "capture" one animal. Next, the predator will close his or her eyes for a second, and then repeat the "hunt." The partner will count seconds and record the colors of the animals the predator selected one at a time. Repeat the "hunt" until 10 animals have been captured.

Think It Over

1. How many of each color animal did the predator pick up? Was the prediction you made in step 3 correct? Explain your answer.
   Sample Answer: The predator picked up 3 green animals and 8 white animals. I had predicted that more white animals would be picked up, so my answer was correct.
2. Which color animals were not well camouflaged in their environment? Was the white mutation harmful, beneficial, or neutral? Why?
   Look for answers indicating that the white animals were not well camouflaged and that the white mutation was harmful. It made white animals easier for predators to see and reduced their ability to survive in the wild.
3. If the paper animal's environment suddenly became snow-covered, would the white mutation now be harmful, beneficial, or neutral? Why?
   If the paper animal's environment suddenly became snow-covered, the white mutation would be beneficial. It would make the white animals harder for predators to see and increase their ability to survive in the wild.