Norfolk Public Schools
Science Learning in Place Plan: Science 7 Honors Lessons

Week 10: May 18 – 22, 2020 (Review: Cytology)

Monday	Tuesday	Wednesday	Thursday	Friday
Reading & Text Annotation: • Read **"The Facts about Cells"** and use *Critical Reading Strategies* to make note of the key points in the passage. • Answer the questions on the handout **"The Facts about Cells Analysis Questions"**	Reading & Text Annotation: • Read **"Cells and the Versatile Functions of their Parts"** and use *Critical Reading Strategies* to make note of the key points in the passage. • Answer the questions on the handout **"Cells and the Versatile Functions of their Parts Analysis Questions"**	Concept Analysis: • Use the graphic organizer entitled, **"Cell Structure and Function"** to create a nickname for each cell structure. The nickname should help you remember the function of each structure.	Concept Analysis: • Review the **"Cell Division of Animal and Plant Cells"** PowerPoint to complete the following tasks on the worksheet provided: ○ Create a mnemonic phrase to remember the stages of the cell cycle ○ Write a sentence to summary the events of each stage of the cell cycle.	Concept Analysis: • Complete **"The Cell Cycle - Sharpen your Skills"** assignment.

Week 11: May 25 – 29, 2020 (Review: Photosynthesis)

Monday	Tuesday	Wednesday	Thursday	Friday
Reading & Text Annotation: • Read **"The Cycle of Photosynthesis and Cellular Respiration"** • Use *Critical Reading Strategies* to make note of the key points in the passage.	Concept Analysis: • Review the passage **"The Cycle of Photosynthesis and Cellular Respiration"** • Answer the questions on the handout **"The Cycle of Photosynthesis and Cellular Respiration Analysis Questions"**	Reading & Text Annotation: • Read **"Learn the Photosynthesis Formula"** • Use *Critical Reading Strategies* to make note of the key points in the passage.	Concept Analysis: • Review the passage **"Learn the Photosynthesis Formula"** • Answer the questions on the handout **"Learn the Photosynthesis Formula Analysis Questions"**	Concept Analysis: • **Analysis** the image entitled, **"Photosynthesis"** • **Write** a 5-sentence paragraph to describe the process of photosynthesis.

Week 9: May 11 – 15, 2020 (Review: Genetics)

Monday	Tuesday	Wednesday	Thursday	Friday
Reading & Text Annotation: • Read **"Gregor Mendel discovered Laws of Genetics"** • Use *Critical Reading Strategies* to make note of the key points in the passage.	Concept Analysis: • Review the passage **"Gregor Mendel discovered Laws of Genetics"** Answer the questions on the handout **""Gregor Mendel discovered Laws of Genetics Analysis Questions"**	Reading & Text Annotation: • Read **"How do Dominant Genes Work"** • Use *Critical Reading Strategies* to make note of the key points in the passage.	Concept Analysis: • Review the passage **" How do Dominant Genes Work "** • Answer the questions on the handout **" How do Dominant Genes Work Analysis Questions"**	Concept Analysis: • **Complete** the "**Punnett Square"** worksheet

CRITICAL READING *strategies*

Marking the Text

\# ⟹ Number the paragraphs

⟹ Circle key terms

⟹ Underline essential info

(...based on the reading purpose)

⟹ Box new vocab words

(...and define them in the margins)

Additional Ways to Mark the Text

⟹ [Bracket] information

(when underlining has been used for another purpose)

⟹ Write labels in the margins

(double underline labels to stand out from other marks)

Cytology Concept Analysis

<u>Directions</u>: Answer and justify each question. Justify your answer by indicating the paragraph that supports your answer.

The Facts about Cells Analysis Questions	**Justifications**
1. Approximately how many cells are in our bodies?	1.
2. What is the genetic material found in cells?	2.
3. Which organelle provides energy for the cell?	3.
4. What is a group of cells called?	4.
Cells and the Versatile Functions of their Parts Analysis Questions	**Justifications**
1. What are cells often known as?	1.
2. State at least three tasks performed by cells.	2.
3. What basic cell parts do bacteria contain?	3.
4. Describe the specific functions of the following specialized cells within multicellular organisms: a. Red blood cells:	4a.
b. White blood cells:	4b.

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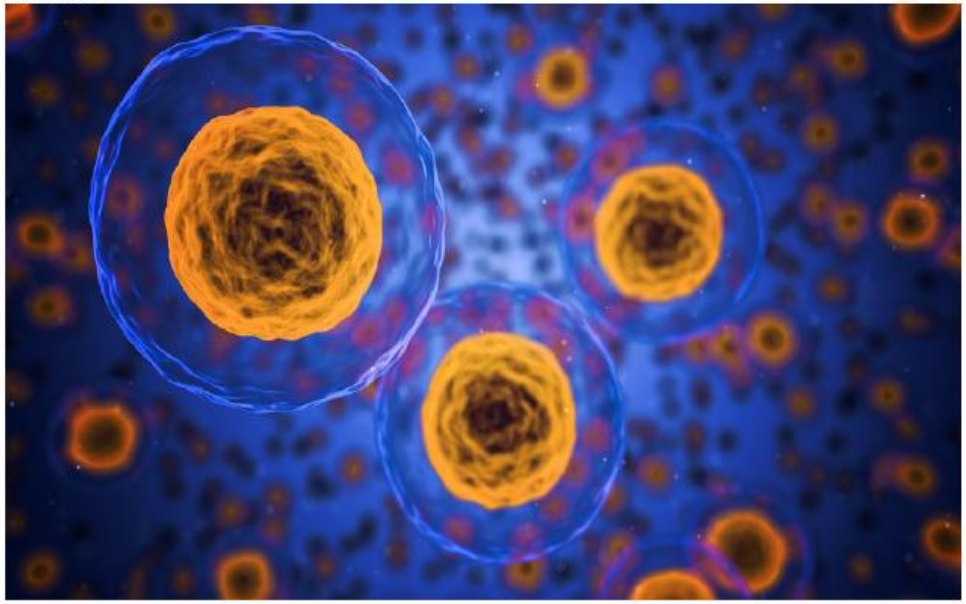
The facts about cells

By ThoughtCo.com, adapted by Newsela staff on 10.18.17
Word Count **904**
Level **930L**



An illustration of cells. Photo from Pixabay.

Cells are the basic building blocks of life. Some life forms, or organisms, are made out of a single cell, whereas others are made of millions.

Scientists estimate that our bodies contain anywhere from 75 to 100 trillion cells, which come in hundreds of different types. Cells do everything from providing energy to allowing animals to reproduce.

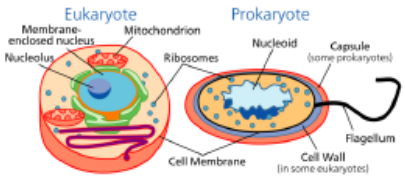
Below are 10 facts about cells, some of which are well-known while others may surprise you.

1. Cells are too small to be seen without magnification.

Cells come in a variety of sizes, ranging from 1 to 100 micrometers across. A micrometer is a millionth of a meter, and there are more than 25,000 micrometers in a single inch.

The study of cells is called cell biology. Because cells are so small, it would have been impossible to study them without the invention of the microscope. Thanks to this technology, cell biologists can study detailed images of even the smallest of cells.

2. There are two main types of cells.



Cells are divided into eukaryotic and prokaryotic cells. Eukaryotic cells have nuclei that are surrounded by membranes. A nucleus is a structure that stores genetic information such as DNA. Animals, plants and fungi are called eukaryotes because they are organisms that are made of eukaryotic cells.

Prokaryotes are creatures that are made of a single prokaryotic cell. Examples include bacteria and archaeans. Unlike a eukaryotic cell, the nucleus of a prokaryotic cell is not surrounded by a membrane. This region in the cell is called nucleoid.

3. Prokaryotic single-celled organisms were the earliest and most basic forms of life on Earth.

Prokaryotes can live in environments that would be deadly to most other organisms. Some archaeans are even able to live inside animal intestines. Others live in extreme environments such as hot springs, swamps and wetlands.

4. There are more bacterial cells in the body than human cells.

Some scientists have calculated that about 95 percent of all the cells in the body are bacteria. These bacteria help humans digest their food. In fact, most bacteria in humans can be found in the digestive tract, which are the organs that take in food and let out waste. Billions of bacteria also live on the skin.

5. Cells contain genetic material.

Cells contain DNA and RNA, which hold the information needed to tell the cells how to work. DNA, or deoxyribonucleic acid, and RNA, or ribonucleic acid, are known as nucleic acids.

In prokaryotic cells, the DNA is not contained inside a membrane but it is coiled in a region called nucleoid. In eukaryotic cells, DNA is found in the cell's nucleus, protected by the membrane.

Strands of DNA form structures called chromosomes. Human cells have 23 pairs of chromosomes, for a total of 46. These chromosomes contain information about how a person's body will look and develop, with one pair determining the person's sex.

6. Cells contain structures called organelles which carry out specific roles.

Organelles are units in a cell that have specific responsibilities. Eukaryotic cells contain several types of organelles, while prokaryotic cells contain a few organelles called ribosomes. In prokaryotic cells, the organelles are not surrounded by a membrane.

Here are a few examples of organelles in eukaryotic cells:

- The nucleus controls the cell's growth and how it reproduces.
- Mitochondria provide energy for the cell.
- The endoplasmic reticulum creates carbohydrates, like sugar, and fats.
- Ribosomes help create proteins.

• The Golgi complex packages and ships the proteins and fats produced by the cell.

• Lysosomes help with digesting substances inside the cell.

7. Different types of cells reproduce through different methods.

Most prokaryotic cells reproduce through binary fission. In binary fission, a single cell splits into two new copies of itself.

Eukaryotic organisms can reproduce in two ways. Single eukaryotic cells can split into two through a process called mitosis. Larger eukaryotic organisms, such as animals, reproduce by combining special cells called gametes. These gametes are made through a process called meiosis.

8. Groups of similar cells form tissues.

Tissues are groups of cells that have the same structure and behavior. In animal tissue, cells are sometimes woven or stuck together.

Different types of tissues can also be arranged together to form organs, which can, in turn, form organ systems. An example is the circulatory system, which includes the heart, lungs and veins. It allows animals to breathe and spread oxygen throughout their bodies.

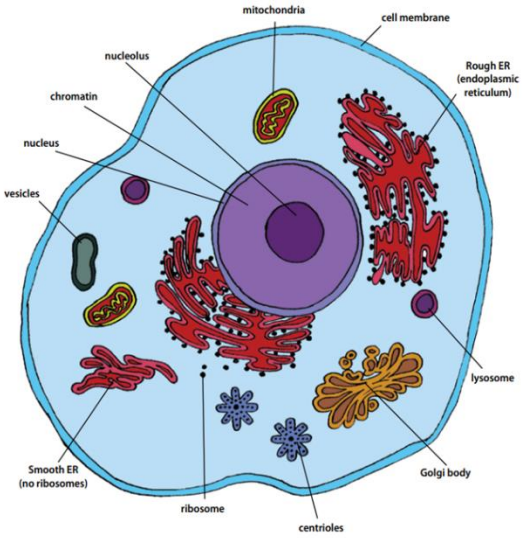
9. Cells have varying life spans.

Different cells have different life spans. They can live anywhere from a few days to a year. Certain cells in the digestive tract live for only a few days, while some of the cells in the immune system can live up to six weeks. The immune system is the group of cells and organs that defend the body from small organisms that can harm it. Brain cells can live for a whole lifetime.

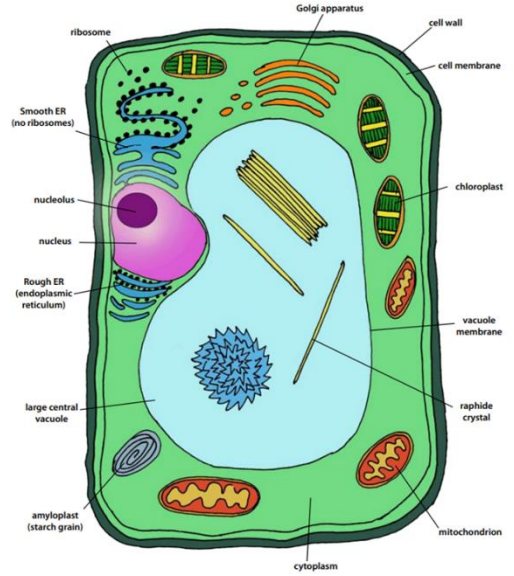
10. Cells commit suicide.

When a cell becomes damaged or infected, it will self-destruct by using a process called apoptosis. Apoptosis is a way of keeping the process of mitosis in check. Cells with cancer are not able to go through apoptosis, which is why they reproduce and spread uncontrollably.

Animal Cell



Plant Cell



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Cells and the versatile functions of their parts

By National Geographic Society, adapted by Newsela staff on 04.01.19
Word Count **1,055**
Level **1060L**

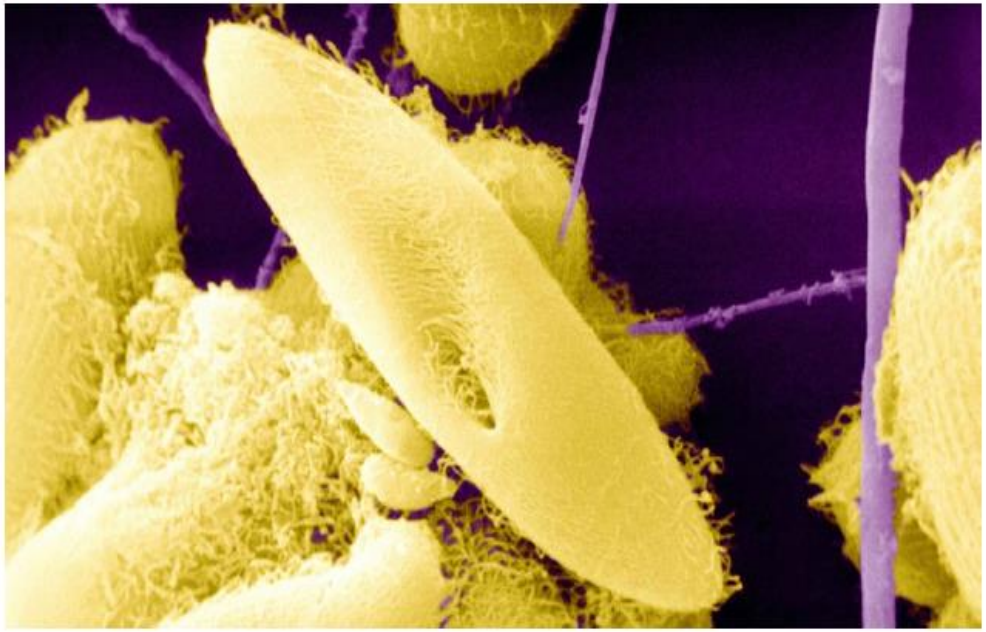


Image 1. Microscopic view of paramecia, single-celled organisms often found in ponds. Paramecia feed on other small organisms, such as bacteria. Each component of these tiny creatures, from the genetic material in its nucleus to the cilia it uses to swim, performs special functions that allow it to survive. Photo by: BSIP/UIG Via Getty Images

As is often repeated, cells are the basic building blocks of all life. They are responsible for generating the energy that sustains life. They also eliminate waste and quickly replicate themselves to replace damaged tissues.

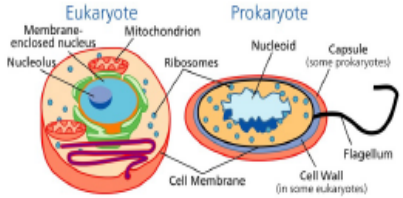
NATIONAL GEOGRAPHIC

Cells are fascinatingly complex organisms, able to perform a wide variety of tasks. This is true from single-celled organisms up to multicellular organisms, such as humans.

Bacteria: In Sickness And Health

Some organisms consist of a single cell with only the most basic parts: genetic material (DNA), ribosomes, cytoplasm and a cell membrane. Bacteria, for example, mainly consist of these basic cell parts, and may also have a cell wall.

Bacteria are capable of causing human illnesses, from mild food poisoning to deadly tuberculosis. They are also capable of promoting human health. For example, bacteria living in the human gut aid in digestion and absorbing nutrients, among other things.



Specialized Cells In Plants And Animals

In true multicellular organisms, a variety of organelles allow equally incredible feats. Chloroplasts in plant cells allow the organism to capture the sun's energy and produce food. In a growing animal, the cytoskeleton sorts critical parts and molecules within the cell. It defines which end of the cell is which to enable specific functions as the tiny animal embryo grows bigger.

Following development, specialized cells within multicellular organisms perform specific functions to support the body. Meanwhile, organelles help cells accomplish various tasks. For example, mature red blood cells in mammals lack a nucleus. This helps them clear out as much cellular space as possible for a protein called hemoglobin. This protein allows the cell to carry oxygen from the lungs to the rest of the body.

White blood cells are part of the body's immune system. They use lysosomes to engulf and destroy bacteria, preventing infection.

Cell Structures and Functions

Organelle	Function/Description	How can I remember it?
Cell Membrane	Controls what comes into and out of a cell; found in plant and animal cells	
Cell Wall	Ridged outer layer of a plant cell	
Cytoplasm	Gel-like fluid where the organelles are found	
Mitochondria	Produces the energy a cell needs to carry out its functions	
Lysosome	Uses chemicals to break down food and worn our cell parts	
Vacuoles	Stores food, water, waste, and other materials	
Golgi Bodies	Received proteins and materials from the ER, packages them, and distributes them	
Chloroplasts	Captures energy from the sunlight and uses it to produce food in plant cells	
Endoplasmic reticulum	Has passageways that carry proteins and other materials from one part of the cell to another	
Ribosomes	Assembles amino acids to create proteins	
Nucleus	Contains DNA, which controls the functions of the cell and production of proteins	
Nucleolus	Found inside the nucleus and produces ribosomes	
Chromatin	Tiny strands inside the nucleus that contain the instructions for directing the cell's functions	

Cell Division of Animal & Plant Cells

Directions: Review the "Cell Division of Animal and Plant Cells" PowerPoint to complete the following tasks:

A. Create a mnemonic phrase to remember the stages of the cell cycle.

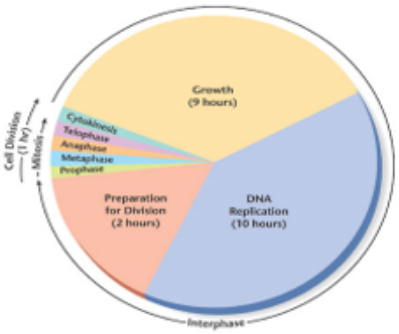
I	
P	
M	
A	
T	
C	

B. Write a sentence to summary the events of each stage of the cell cycle.

Interphase	
Prophase	
Metaphase	
Anaphase	
Telophase	
Cytokinesis	

C. Complete the "Sharpen your Skills" assignment. Write your responses in the space provided below.

The Cell Cycle



The main stages of the cell cycle are interphase, mitosis, and cytokinesis.

This graph shows the average length of each stage in a human liver cell.

Sharpen your Skills

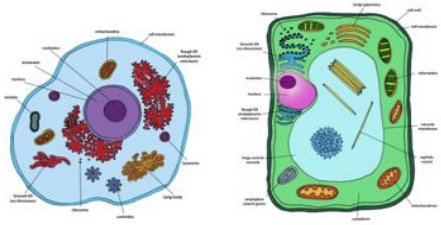
Interpreting Data

Use the circle graph above to answer the following questions.

1. How long is the cell cycle shown in the graph?
2. Which stage of the cell cycle would you expect more of the cells to be in at any given time—interphase, mitosis, or cytokinesis? Explain.

1.
2.

Cell Division of Animal & Plant Cells



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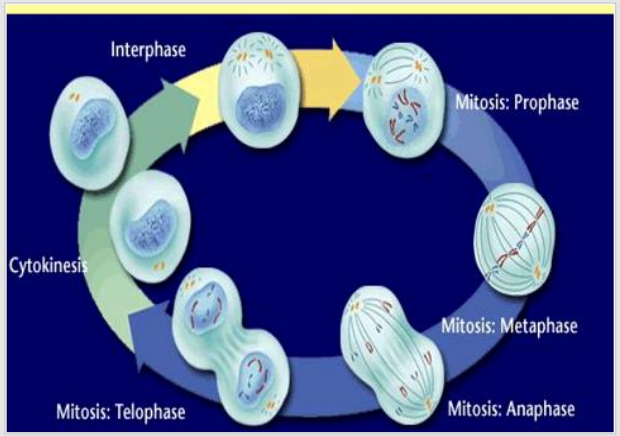

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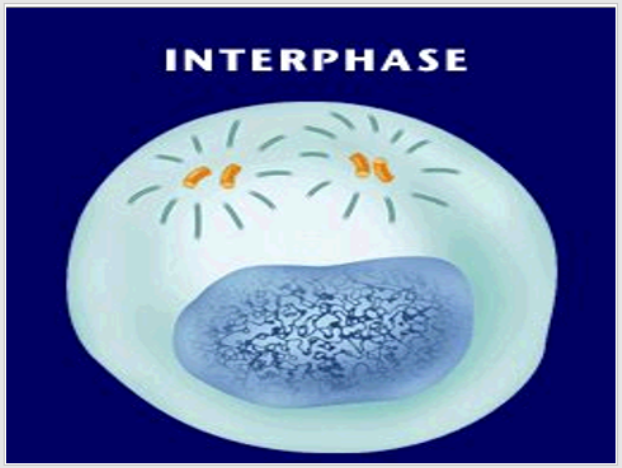
The Cell Cycle

- The regular sequence of growth and division that cells undergo is known as the **cell cycle**, which outlines the events that occur as one "parent" cell divides to form two identical "daughter" cells.
- The cell cycle is made up of three stages:
  1. Interphase
  2. Mitosis
  3. Cytokinesis

The Cell Cycle	
Interphase	
Mitosis	Prophase
	Metaphase
	Anaphase
	Telophase
Cytokinesis	

3



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Stage 1: Interphase

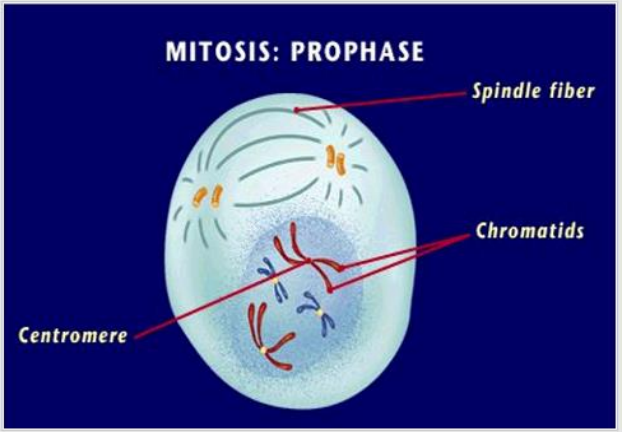
- The first stage of the cell cycle is called interphase. **Interphase** is the period before cell division occurs.
- During interphase, the cell grows to its mature size, makes a copy of its DNA, and prepares to divide into two cells.
- **Growth**
  - During the first part of interphase, the cell doubles in size and produces all the structures needed to carry out its functions.
  - The cell matures to its full size and structure.
- **DNA Replication**
  - The cell makes a copy of the DNA in its nucleus in a process called **replication**.
  - The cell contains two identical sets of DNA, one set will be distributed to each daughter cell.
- **Preparation for Division**
  - The cell produces structures that it will use to divide during the rest of the cell cycle.
  - At the end of interphase, the cell is ready to divide.

5

Stage 2: Mitosis

- **Mitosis**
  - The stage during which the cell's nucleus divides into two new nuclei.
- There are four parts, or phases:
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase
- **Activity**
  - Create a mnemonic phrase
    - Write a phrase that will help you to remember the phases of the cell cycle.
    - Example: **I** p**l**ay **m**usic **a**t **t**he **c**oncert.

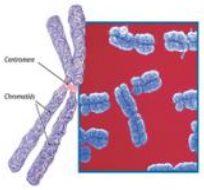
6



7

Prophase

- During **prophase**,
  - spindle fibers form a bridge between the ends of the cell
  - the nuclear membrane breaks down
  - the threadlike chromatin in the cell's nucleus begins to condense and coil
- **Chromosomes**
  - Scientists call each doubled rod of condensed chromatin a **chromosome**.
  - Each identical rod of the chromosome is called a **chromatid**.
  - The two strands are held together by a structure called a centromere.



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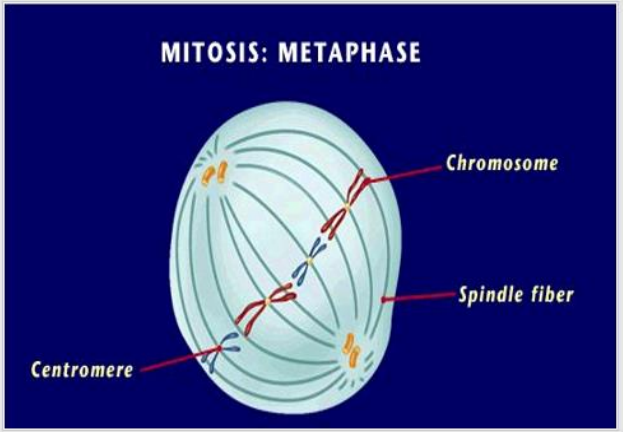
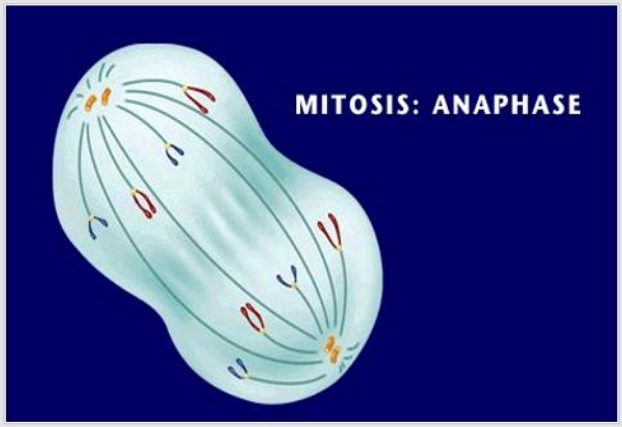


9

Metaphase

- During **metaphase,**
  - there is no distant nucleus
  - The chromosomes have lined up along the spindle with each centromere attached in the middle of the cell.
  - M = metaphase (middle)

10

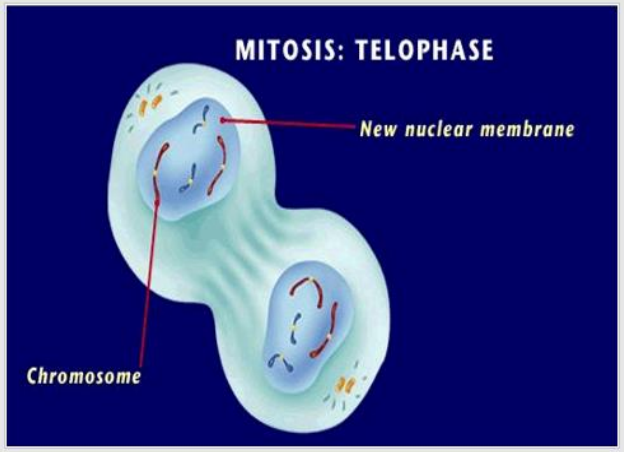


11

Anaphase

- During **anaphase,**
  - The two chromatids separate and move away on a spindle fiber to the ends of the cell
  - The cell becomes stretched out
  - A = Anaphase (away)

12

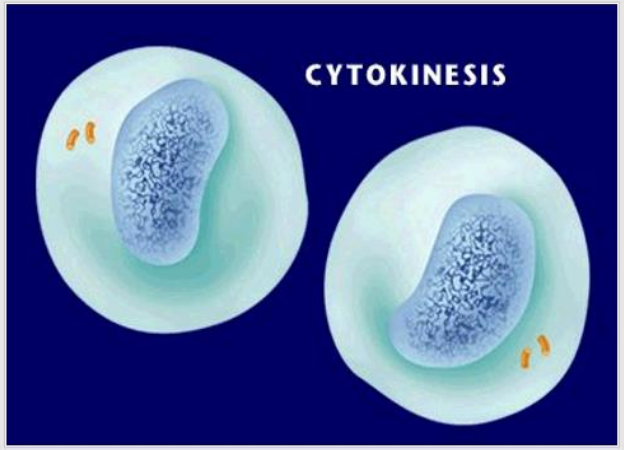


13

Telophase

- During **telophase,**
  - The chromosomes become longer and thinner.
  - A new nuclear membrane forms around each region of chromosomes.

14



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Stage 3: Cytokinesis

- Usually starts at about the same time as telophase.
- **The cytoplasm divides, distributing the organelles into each of the two new cells.**
- Each daughter cell has the same number of chromosomes as the original parent cell.
- These cells enter interphase, and the cycle begins again.
- In animal cells, the cell membrane squeezes together around the middle of the cell forming a furrow.
- A plant cell's rigid cell wall cannot squeeze together in the same way that a cell membrane can.
- Instead, a structure called a cell plate forms across the middle of the cell.

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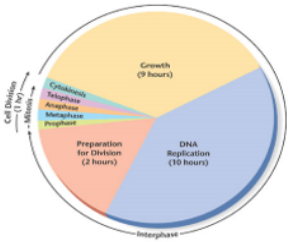
Length of the Cell Cycle

- Depends on the type of cell:
  - In a young sea urchin, for example, one cell cycle takes about 2 hours.
  - In contrast, a human liver cell completes one cell cycle in about 22 hours, as shown in the graph below.
  - Some cells, such as human brain cells, never divide—they remain in the first part of interphase for as long as they live.

17

The Cell Cycle



The main stages of the cell cycle are interphase, mitosis, and cytokinesis.

This graph shows the average length of each stage in a human liver cell.

Sharpen your Skills

Interpreting Data

Use the circle graph above to answer the following questions.

1. How long is the cell cycle shown in the graph?
2. Which stage of the cell cycle would you expect more of the cells to be in at any given time—interphase, mitosis, or cytokinesis? Explain.

18

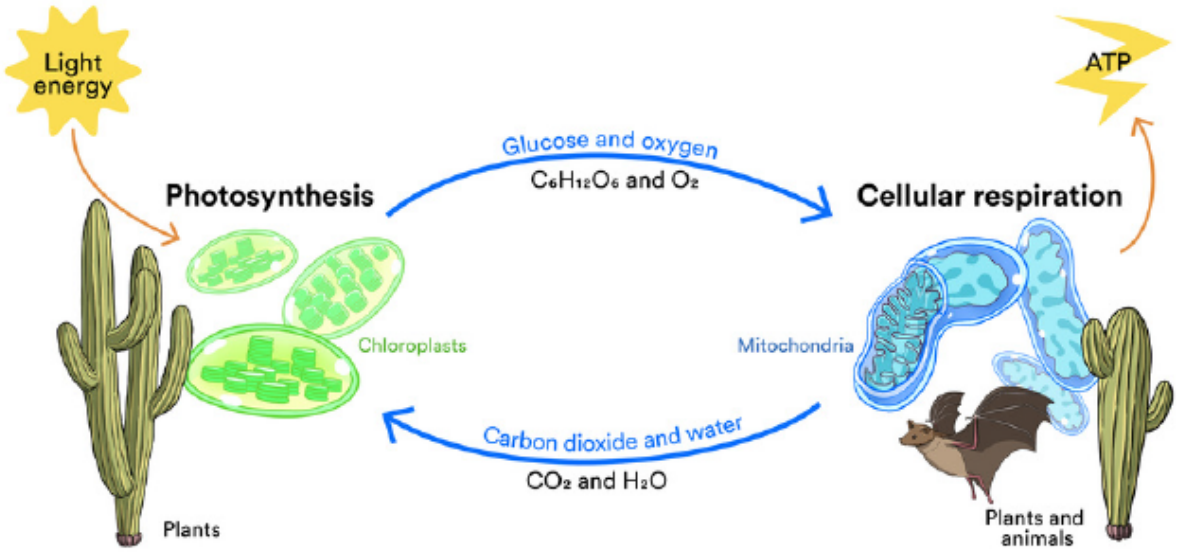
Photosynthesis Concept Analysis

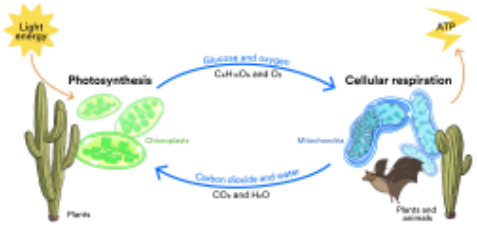
Directions: Answer and justify each question. Justify your answer by indicating the paragraph that supports your answer.

The Cycle of Photosynthesis and Cellular Respiration Analysis Questions	**Justifications**
1. Why are photosynthesis and cellular respiration described as "vital" interconnected reactions?	1.
2. What are the raw materials (reactants) of photosynthesis?	2.
3. Where does photosynthesis take place?	3.
4. Where does cellular respiration take place?	4.
Learn the Photosynthesis Formula Analysis Questions	**Justifications**
1. What is the purpose of photosynthesis?	1.
2. What is the equation for photosynthesis?	2.
3. In what part of the plant does photosynthesis take place?	3.
4. What is produced by photosynthesis?	4.

The cycle of photosynthesis and cellular respiration

By Newsela staff on 02.03.20
Word Count **159**
Level **MAX**





Photosynthesis and cellular respiration are two interconnected reactions that are vital for all living organisms. Together, they act as a cycle that helps cells make and store energy. The cycle also controls the amounts of oxygen and carbon dioxide in the atmosphere.

The photosynthesis process happens in plants and bacteria. These organisms make chemical fuel using three ingredients: carbon dioxide (CO_2), water (H_2O) and sunlight. The ingredients are then turned into the sugar glucose ($C_6H_{12}O_6$) and oxygen (O_2). The photosynthesis reaction happens within the plants' chloroplasts.

All living organisms such as plants, bacteria and animals like you, use cellular respiration to obtain the energy that they need to survive. Most of the reactions in cellular respiration happen in parts of the cell called mitochondria. The reactions release carbon dioxide, water and chemical energy in the form of the molecule adenosine triphosphate (ATP). This molecule is the main source of energy for cells in all living organisms.

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Learn the photosynthesis formula

By ThoughtCo.com, adapted by Newsela staff on 10.16.17
Word Count **786**
Level **1020L**

Image 1. In plants, photosynthesis occurs mainly within the leaves. Photo from the public domain

Living things need energy to survive. Some organisms can take in energy from sunlight and use it to make sugar and other chemicals. The sugars are then used to provide fuel for the organism. This process, called photosynthesis, is used by organisms such as plants, algae and some types of bacteria.

Photosynthesis Equation

Photosynthesis turns energy from the sun (solar energy) into chemical energy, providing the fuel for plants to grow. Chemical energy is stored in molecules like glucose, which is a sugar.

For photosynthesis to take place, three ingredients are needed: carbon dioxide, water and sunlight.

These three ingredients combine and create three chemicals: glucose, oxygen and water.

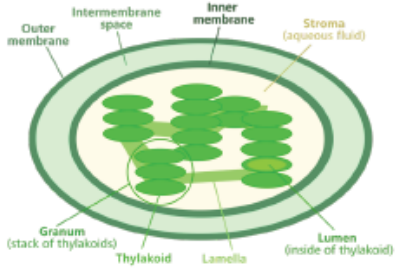
The chemical equation for the process is:

$6CO_2 + 6H_2O + \text{light energy} = C_6H_{12}O_6 + 6O_2$

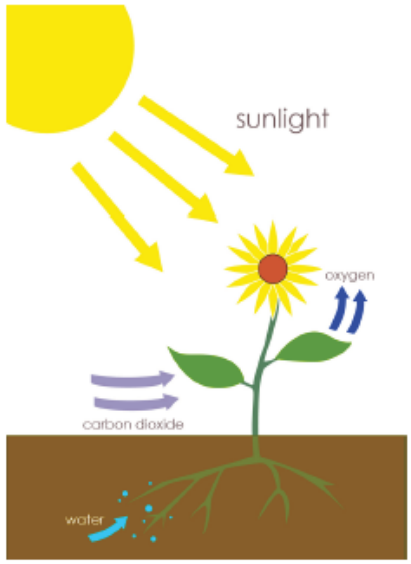
Six molecules of carbon dioxide ($6CO_2$) and six molecules of water ($6H_2O$) are used up in the process. Glucose ($C_6H_{12}O_6$) and six molecules of oxygen ($6O_2$) are produced.

Photosynthesis In Plants

In plants, photosynthesis happens mainly within the leaves, which are designed to bring together carbon dioxide, water and sunlight.



Leaves can take in carbon dioxide from the air. They do it through tiny holes called stomata. It is also through stomata that plants give off oxygen.



Water is taken up by the plant through its roots and delivered to the leaves through a system of veins, similar to those that carry blood throughout our bodies.

Sunlight is taken in by chlorophyll, a green chemical located in plant cell structures called chloroplasts. Chloroplasts are where photosynthesis happens. There are several smaller structures within a chloroplast, each serving a different purpose:

- The outer and inner membranes are coverings that keep chloroplast structures enclosed.
- Stroma is a dense fluid within the chloroplast where carbon dioxide gets turned into sugar.
- Thylakoids look like flattened sacks and are where light energy is turned into chemical energy.
- Grana are composed of thick stacks of thylakoids.
- Chlorophyll is a chemical within the chloroplast that takes in light energy and gives plants their green color.

Stages Of Photosynthesis

Photosynthesis happens in two stages, which are the light reactions and the dark reactions. The light reactions take place in the presence of light, whereas dark reactions do not require direct light.

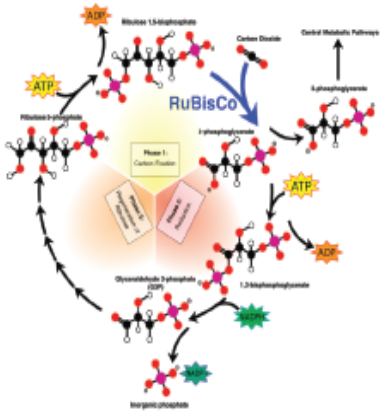
Light reactions happen mostly in the thylakoid stacks of the grana, which is the place where sunlight is turned into chemical energy in the form of ATP and NADPH. ATP stands for adenosine triphosphate and is an important molecule that transfers energy between cells. NADPH stands for

nicotinamide adenine dinucleotide phosphate, and is an important molecule for the storage of energy.

During photosynthesis, chlorophyll takes in energy from the sunlight, and this starts a chain of steps that result in the production of ATP and NADPH. In photosynthesis, water molecules (H_2O) have to split. When the water molecules split, they release oxygen through the stomata.

Both ATP and NADPH are used in the dark reactions to produce sugar. These reactions happen in the stroma.

This process is known as carbon fixation, or the Calvin cycle. It has three main stages: carbon fixation, reduction and regeneration.



There are many different kinds of sugars, and sugar molecules can have a different number of carbon molecules. During the process of carbon fixation, carbon dioxide is combined with a 5-carbon sugar [ribulose1,5-biphosphate (RuBP)], making a 6-carbon sugar.

ATP and NADPH produced in the light reaction stage are used to turn the 6-carbon sugar into two 3-carbon molecules called glyceraldehyde 3-phosphate. Glyceraldehyde 3-phosphate is used to make glucose and fructose, and these two molecules then come together to make sucrose, a common sugar.

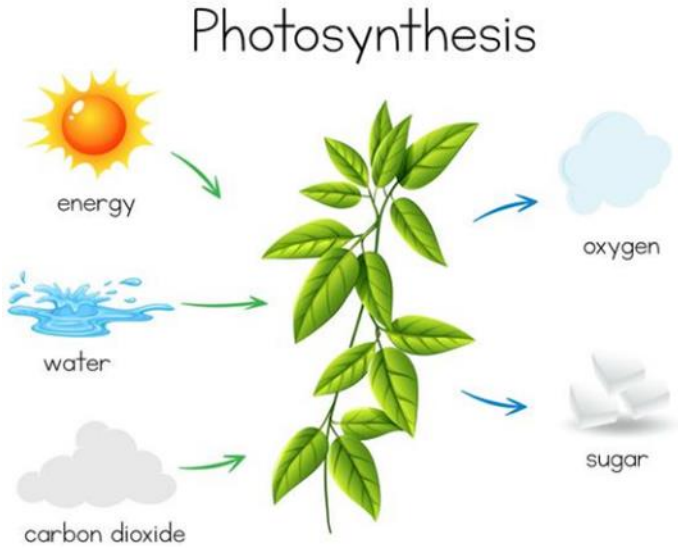
In the regeneration stage, some molecules of glyceraldehyde 3-phosphate are combined with ATP. They are then turned back into the 5-carbon sugar RuBP, completing the cycle.

Next, RuBP can combine with carbon dioxide, starting the cycle over again.

Photosynthesis Summary

In summary, photosynthesis is a process in which light energy is turned into chemical energy, which is then used by plants and other organisms to turn the power of the sun into fuel.

In plants, photosynthesis happens in the chloroplasts, which are found on the leaves. There are two main stages to the process, which are the light reactions and the dark reactions. The light reactions turn light into energy (ATP and NADHP) and the dark reactions use the energy and carbon dioxide to produce sugar.



Genetics Concept Analysis

Directions: Answer and justify each question. Justify your answer by indicating the paragraph that supports your answer.

Gregor Mendel Discovered Laws of Genetics Analysis Questions	**Justifications**
1. What is heredity?	1.
2. What system did Gregor Mendel create?	2.
3. What are chromosomes?	3.
4. Describe the three laws of inheritance.	4.

How do Dominant Genes Work Analysis Questions	**Justifications**
1. What plant and plant traits did Gregor Mendel use to study heredity?	1.
2. What is a Punnett square?	2.
3. Define the following terms: genes, alleles, dominant, recessive, co-dominance.	3.

Gregor Mendel discovered laws of genetics: Mendelian inheritance

By Encyclopaedia Britannica, adapted by Newsela staff on 10.16.19
Word Count **371**
Level **1010L**

A color plate from "Breeding and the Mendelian Discovery" by A.D. Darbishire, published in 1912, illustrates the Mendelian inheritance of flower color in the edible pea. To the left is a sample of a pink-flowered race, to the right a sample of a white-flowered race, and in the center a cross between the two. Image by: Oxford Science Archive/Print Collector/Getty Images

Gregor Mendel was an Austrian-born botanist, teacher and monk. He created principles of heredity in 1865. Heredity is how characteristics, or traits, are passed on from parents to future generations.

Mendel studied pea plants, and laid the groundwork for modern genetics. He created a system of particulate inheritance by units, which we know today as genes. Particulate inheritance introduced the idea that offspring inherit individual markers from parents. It's also known as Mendelism. Before Mendel, it was assumed that an offspring's traits were a blend of traits from parents.

Mendel's work was supported by later scientific research and the discovery of chromosomes. Chromosomes are carriers of genetic units made up of DNA. Mendel's work is further explained below, using our understanding of inheritance today.

First Law: Segregation

You inherit half of your genetic information from your mother and half from your father. Mendel's first law is the law of segregation, which states that genes are transferred as separate and distinct units from one generation to the next.

Humans have 46 chromosomes. These chromosomes are sorted into 23 pairs. Each pair includes one chromosome from the mother, and one chromosome from the father. Each chromosome contains one allele, or a different form of a gene. You inherit 23 chromosomes from your mother and 23 from your father.

Second Law: Independent Assortment

The second law is the law of independent assortment, which states that alleles that are passed down aren't related to each other. This means individual alleles can be passed down independently.

The second law means that offspring can have different combinations of traits, which include things such as hair color or eye color. For example, an offspring could have blond hair and blue eyes, or brown hair and brown eyes. Other mixtures of traits are also possible, such as blond hair with brown eyes or brown hair with blue eyes.

Third Law: Dominance

Mendel also developed his third law of dominance, which states that one allele exerts greater influence than the other on the same gene. Mendel developed the concept of dominance from his experiments with pea plants. It was based on the uncertain belief that each plant carried two trait units, one of which dominated the other.

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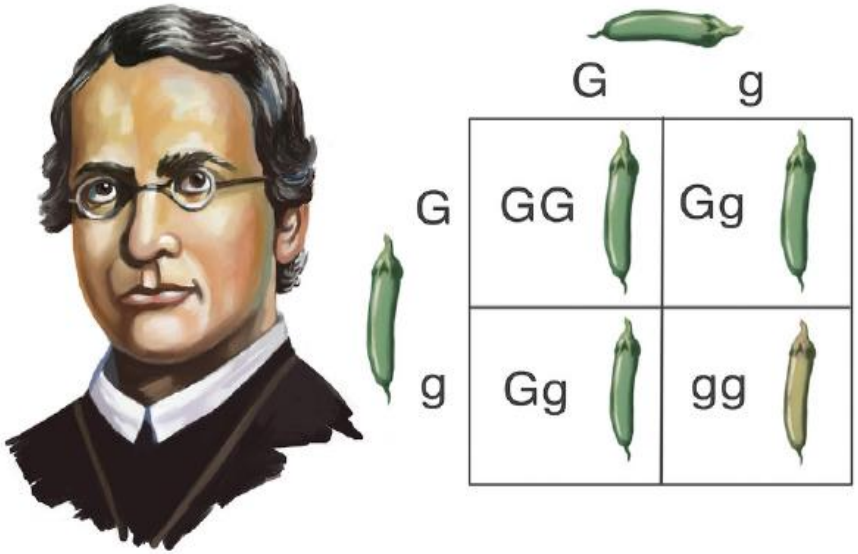
How do dominant genes work?

By Washington Post, adapted by Newsela staff on 11.26.19
Word Count **987**
Level **1060L**



An illustration of Gregor Mendel at left, and the Punnett square at right. The Punnet square is a visual representation of Mendelian inheritance. The diagram is used by biologists to determine the probability of an offspring having a particular genotype. Image by: Spencer Sutton/Science Source

Why are some genes dominant over others, such as those for brown eyes over blue eyes? Or do they actually blend in some way?

In the 19th century, Austrian monk Gregor Mendel famously crossed pea plants. He showed how traits — such as plant height and flower color —could be determined by parents. Two parents with one trait could produce offspring with another trait. For example, two tall plants would produce mostly tall plants. But a percentage of their offspring might turn out short.

What Mendel discovered was that traits are controlled by genes, and individual genes come in different "flavors," or forms, known as alleles. You get one copy of each gene from your dad and one copy from your mom. So you can end up with two different alleles of the same gene.

Pea Plants And The Punnett Square

A pea plant could have one copy of the height gene that coded for "tall" and one copy of the height gene that coded for "short." The tall allele is "dominant," and this means that it can mask the other allele. The short allele is called "recessive." The allele combination of tall-short would result in a tall plant since the tall allele is dominant.

Let's say two tall plants that both carried short alleles (tall-short). If they are crossed, some of their offspring are likely to be short. A Punnett square is used to predict the percentage of allele combinations from two parents. In this example, the Punnett square would show that roughly 25 percent of the offspring would get a short allele from both parents. These offspring would have two short alleles, so they would be short.

What Determines Eye Color?

Why do some alleles mask others?

There is not a single, simple answer. Many traits, such as eye color, are influenced by several genes. Many different alleles will produce the same proteins. The result will be the same physical eye color, even if you didn't get the same set of genes from mom and dad. So not every trait can be calculated with a Punnett square.

Genes carry the instructions for making proteins. When we talk about genes being dominant or recessive, we're talking about traits controlled by the amount of a protein produced. Science communicator Joe Hanson describes this as "dosage": A dominant gene will often produce enough of its protein on its own to result in its special trait. So when it is paired with the recessive allele, the physical result is the same as if it were paired with another dominant allele. This is because the recessive alleles wouldn't signal the body to produce the protein. With two recessive alleles, however, the body is only getting a low dose or no dose of the protein.

Eye color is a good example in humans. The genes for eye color produce proteins that make a pigment, or coloring, called melanin. If the genes that control melanin production in the eye are recessive, then the protein will be turned off — there will be zero dosage — resulting in eyes with no melanin. This trait shows up as blue eyes, just like the colorless sky that deflects light to appear blue. Several genes influence eye color so it isn't as simple as "brown" and "blue." People can have green, gray or hazel eyes, too. However, the dosage is a big factor, which is why we often see eye color presented as a simple trait, like Mendel's pea height.

How Sickle Cell Anemia Is Inherited

Some dominant traits work a little differently. For example, let's say genes control a process where all of the alleles need to work together for protein production. In this case, the one that breaks the process will be the dominant gene. Here's an example: Suppose genes are churning out bricks to build a wall. One allele produces round bricks because of a missing protein. It doesn't matter how many solid, rectangular bricks your other alleles give you — that wall isn't going to stay up. In this case, the allele that gives the round bricks is considered the dominant one because that is the trait that will show up.

To understand how complicated dominance can be, consider sickle cell anemia. This is a condition that causes red blood cells to become misshaped, so there is a shortage of healthy blood cells that can carry oxygen throughout the body. This can cause painful and life-threatening health problems. People with two copies of the sickle cell allele end up with misshaped shaped red blood cells, and therefore health problems. People with just one copy of the sickle cell allele have some irregular red blood cells, but the normal cells can usually maintain healthy body functions.

What Is Co-Dominance?

You can think about a trait in different ways. For example, you could think of the trait as whether or not you have sickle cell anemia. In this case, the allele for sickle cell is recessive because it requires two copies to make you sick. The dominant allele is not making enough of the healthy proteins to cover up the bad allele's effects in every single blood cell. Instead, it's producing enough healthy blood cells to overcome any damage by the misshapen ones. So really, this is an example of co-dominance. It is like an allele for red flowers combining with a low-dose allele for white flowers to produce a pink flower.

You could also think of the sickle cell gene as dominant. A single copy of the allele protects against malaria, so that trait is actually a dominant one. Malaria is a serious infection passed through mosquito bites. The allele's protection against malaria is probably why the sickle cell gene has never died out of the population.

"Dominant" and "recessive" are very simple words used to describe a very complicated process. Surely, it is wilder than Mendel ever imagined.

Punnett Squares

- In humans, the gene B is for brown eyes and the gene b is for blue eyes. Any combination with B results in brown eyes. Which gene is dominant? _____

- Fill in the Punnett Square if both the mother and the father carry both genes.

	B	b
B		
b		

- Now, complete this chart to describe the gene make up and physical appearance for each gene combination.

Genotypes	Phenotypes

- Can a person have blue eyes if both their parents have brown eyes? _____