

5.1 - Traits & Genes Unit, Packet 1

Score
<input type="checkbox"/> Above & Beyond
<input type="checkbox"/> Meets Expectations
<input type="checkbox"/> Near Expectations
<input type="checkbox"/> Incomplete – fix the following pages:

First & Last Name: _____ Period/Hour: _____

NOTE: Packets are due after completing Part 5. Check each page to be sure all blanks are completed.

<p>Driving Question: What determines the traits of an organism?</p>	<p>Semester Schedule</p> <p>5. Traits & Genes</p> <p>5.1: What determines the traits of an organism?</p> <p>5.2: How are traits inherited from parents?</p> <p>5.3: Can we predict traits?</p> <p>5.4: Unit Assessment</p> <p>6. DNA & Proteins</p> <p>6.1: What is DNA and how does it work?</p> <p>6.2: How does DNA affect protein assembly?</p> <p>6.3: Unit Assessment</p> <p>6.4: How are genes modified? (<i>mini-unit</i>)</p> <p>7. Mutations & Change</p> <p>7.1: How does a protein get its shape & function?</p> <p>7.2: How do mutations change genes & proteins?</p> <p>7.3: How can mutations create new traits & species?</p> <p>7.4: Unit Assessment</p> <p>7.5: How Does Antibiotic Resistance Occur?</p> <p>8. Biodiversity</p> <p>8.1: How does biodiversity affect ecosystems? Why is biodiversity being lost?</p> <p><i>These materials were partly developed with assistance from artificial intelligence.</i></p>
<p>Anchoring Phenomenon: While most cells share common functions like respiration, there's considerable diversity among species and within species. What causes the observable traits of living organisms? And how does genetic information get passed from cell to cell as they divide? And how does an organism go from one cell to trillions of cells in a short period of time?</p>	
<p>Deeper Questions</p> <ol style="list-style-type: none"> How are the traits of an organism affected by DNA and proteins? How are the instructions for traits passed on as cells divide? How can one cell become trillions of cells in an organism? 	
<p style="text-align: center;">Schedule</p> <p>Part 1: Introduction</p> <ul style="list-style-type: none"> Initial Ideas & Data Dive - Scientific Discoveries Discussion & Developing Explanations <p>Part 2: Core Ideas</p> <ul style="list-style-type: none"> Core Ideas Revisions of Part 1 Explanations <p>Part 3: Investigation</p> <ul style="list-style-type: none"> A: Mitosis & Chromosomes B: Mitosis Microscopy <p>Part 4: Review & Assessment</p> <ul style="list-style-type: none"> Ranking Your Readiness Formative Assessment & Mastery Check <p>Part 5: Life Connections</p> <ul style="list-style-type: none"> Life Connections - Cancer & Mitosis 	
<p>NGSS Standards (<i>PEs & CCCs are summarized below. SEPs are noted throughout the packet.</i>)</p> <p>HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. HS-LS3-1 - Role of DNA/chromosomes as instructions for traits inherited from parents via meiosis. LS-LS3-3 - Predicting likelihood of different traits in a population/offspring. HS-LS1-4: How does mitosis and differentiation enable complex organisms?</p>	

Resource Links: [Class Website](#); [Core Ideas](#); [Summary Video](#); [Practice Test](#); [Mitosis GIF](#); [Part 5 Video](#);

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Part 1: Introduction – Scientific Discoveries (5.1.1)

Overview: You will begin by discussing your initial ideas about what determines the differences in visible traits across different species. You will then analyze data and work in teams to develop your initial explanations.

Initial Ideas - Record your ideas separately (e.g., on a white board or scratch paper).

SEP: Engaging in Argument from Evidence

1. Earth hosts an incredible variety of living species. While all cells share similarities in how they function, each species has its own unique combination of visible traits. Three students shared their ideas about the cause of the variety of traits among living species. **Do you agree or disagree with each student’s claim?**

- Mike: "I think that the variety of traits among living species are due to differences in how their cells function." *Agree / Disagree*
- Lucia: "I think that differences among living species are due to differences in the kinds of proteins produced inside their cells." *Agree / Disagree*
- Oscar: "I think that different traits among species are due to differences in DNA." *Agree / Disagree*



2. **Work in your small groups to discuss your ideas.** How are your ideas similar or different? Decide as a group whether each statement is correct (and why). Be prepared to present your ideas to the class.

Data Dive - Complete the reading below. Use the space on the right to annotate the text by recording your ideas, highlighting important points, and recording questions as you are reading.

SEP: Obtaining, Evaluating, and Communicating Information

Introduction: Why do butterflies have colorful wings? Why do trees have green leaves? Why do dogs wag their tails? About a century ago, we lacked these answers. By then, we did know that living organisms are made of cells, which can connect to form tissues, organs, and systems. Processes within cells, like cellular respiration and biosynthesis, enable organisms to function. The question remained: what was happening within cells to determine observable traits like hair color and body size?

Flemming Sees Chromosomes: In 1879, Walter Flemming used dye to make it easier to see a cell’s contents under a microscope. He observed that the cell’s nucleus condensed its contents into thread-like structures before dividing in half. After division, these 'threads' unraveled, and the nucleus reformed in both cells. We now know that these ‘threads’ are chromosomes containing tightly-packed DNA. [\(Image Source\)](#)



Chromosome Numbers Matter: In the 1880s and 1890s, Theodor Boveri noted that sperm and egg cells each had half the typical number of chromosomes. During conception, when a sperm fused with an egg, the chromosome count returned to normal. If the original chromosome numbers were not restored, it visibly altered traits or even caused death.

Sutton Finds Sex Chromosomes: In 1902, Walter Sutton discovered that an organism’s cells had consistent, matching chromosome pairs, except for one pair that differed between males and females. Compared to females,

Driving Question:

1. What determines an organism’s traits? (*Keep this in mind as your read & answer later*)
2. Make a claim based on Flemming’s work; underline supporting evidence & reasoning.
3. What is a chromosome?
4. Make a claim based on Boveri’s work; underline supporting evidence & reasoning.

males had one non-identical pair of chromosomes and they had less DNA. The differences between male vs. female traits correlated with this final pair of chromosomes. [\(Image Source\)](#)



Morgan Changes DNA: A decade later, Thomas Hunt Morgan altered the DNA in the chromosomes of fruit flies using x-rays and acids. This often resulted in changes to the fly's traits; for example, sometimes red-eyed flies were born with white eyes. These changes could be passed onto offspring. This indicated that the DNA in chromosomes determined traits. It also showed how traits are passed from parents to offspring via the chromosomes in sperm and egg cells.

Sturtevant Maps Genes: Alfred Sturtevant noticed that certain traits tended to be inherited together. This suggested that the DNA responsible for these traits was physically linked within the cell. The section of DNA in a chromosome associated with a specific trait came to be known as a gene. The closer two genes were located on a chromosome, the more likely they were to be inherited together when chromosomes are passed from parents to offspring in sperm and egg cells. By recording how frequently different traits occurred together, Sturtevant was able to map the order of genes on a chromosome. This provided compelling evidence that different traits were determined by the types of genes within the organism's chromosomes.

Benzer's Discoveries: In the early 1950s, Seymour Benzer made two important discoveries. First, he observed that if DNA within a gene changed (or mutated), it would also change how a cell produced a protein. This changed the trait associated with that specific protein and gene.

Benzer also observed that changing a gene and a protein could change both physical traits (like eye color) as well as behavioral traits. For example, Benzer observed that while most flies were attracted to light, some were not. Flies that were not attracted to light lacked a functional protein needed for light detection because of a mutated gene. Benzer also observed similar outcomes for traits such as perception of time and mating behaviors.

5. Make a claim based on Sutton's work; underline supporting evidence & reasoning.

6. Make a claim based on Morgan's work; underline supporting evidence & reasoning.

7. What is a gene?

8. Make a claim based on Sturtevant's work; underline supporting evidence & reasoning.

9. Make *two* claims based on Benzer's work; underline supporting evidence & reasoning.

10. What is a mutation?

11. How do DNA and proteins relate to an organism's traits? How do you know?

Discussion - Record your ideas in the spaces below. SEP: Asking Questions & Defining Problems

What are the ideas that most agreed on? Where did your ideas differ as a class? Record your ideas below.

We generally agree that...

We disagreed or were unsure if...

Initial Explanations - Record your ideas in the spaces below. SEP: Constructing Explanations & Designing Solutions

What determines the traits of an organism? Write down an initial explanation below. Don't worry if you aren't completely sure about this. You will revise this explanation as you gain more information.

Part 2: Core Ideas (5.1.2)

Overview: In this activity, you will use a [short presentation](#) to provide you with information that will help you improve and revise your initial ideas. Your instructor will decide on how to implement this portion. You will then work in small teams to address the questions listed below.

Driving Questions - Record your ideas separately (e.g., on a white board or scratch paper).

SEP: Developing & Using Models

- | | |
|---|--|
| <ol style="list-style-type: none">1. What are traits? What are examples of traits? What determines an organism's traits?2. What are examples of different functions of proteins, and how do proteins affect traits?3. Compare and contrast the following terms: <i>DNA, gene, chromosome.</i>4. During mitosis, does each resulting cell receive an equal amount of DNA? If so, how?5. Is DNA always packed into chromosomes? What is the purpose of doing this?6. Summarize the steps of mitosis; explain how these steps ensure that duplicated cells each receive a complete copy of DNA.7. What would happen if a typical cell did not receive a copy of an organism's DNA? | <ol style="list-style-type: none">8. What are histones? What are spindles? How do these proteins help to ensure that every cell receives a copy of an organism's DNA?9. What would happen if mitosis occurred too slowly or too rapidly?10. What is apoptosis? How does this affect the rate of cell division?11. How can a single cell become trillions of cells in only a short period of time? Include and explain the term <i>exponential growth</i> in your response.12. How can a wide variety of different kinds of cells in a body (e.g., muscle, bone, nerves, skin, etc.) emerge from a single cell? Explain using the term <i>cellular differentiation</i>. |
|---|--|

Revising Explanations - Record your ideas in the spaces below. SEP: Constructing Explanations & Developing Solutions

What determines the traits of an organism? Based on this new info, how would you now respond?

Part 3A: Mitosis Images (5.1.3a)

Pre-Investigation Questions - *Work as a group to prepare verbal responses for these questions. When you think you are all ready to provide responses, raise your hand. Your instructor will listen to your explanations, provide feedback, and determine if you are ready to move on to the investigation.*

SEP: Developing & Using Models

1. How are the traits of an organism affected by DNA and proteins?
2. What is DNA? What is a gene? What is a chromosome? How are these terms similar and different?
3. Summarize how the steps of mitosis ensure that duplicated cells each receive a complete copy of DNA.
4. What are histones? What are spindles? How are these proteins necessary for mitosis to occur?
5. How can one cell become trillions of cells in an organism in a short period of time?

This activity was completed _____ (instructor signature)

Overview: Observe each image below. Try to determine which aspect of mitosis is occurring in each image. Remember, mitosis consists of a few key steps, including: 1) duplicating DNA and assembling spindle proteins; 2) packing DNA into chromosomes using histones; 3) lining duplicated chromosomes onto spindles; 4) separating the chromosome copies; and 5) dividing the cell in half.

Mitosis Images. *SEP: Engaging in an Argument from Evidence.*

<p>A) Which step (1-5) is occurring in this image? _____ How do you know?</p>	
<p>B) Which step (1-5) is occurring in this image? _____ How do you know?</p>	
<p>C) Which step (1-5) is occurring in this image? _____ How do you know?</p>	
<p>D) Which step (1-5) is occurring in this image? _____ How do you know?</p>	
<p>E) Which step (1-5) is occurring in this image? _____ How do you know?</p>	

Part 3B Investigation: Mitosis Microscopy (5.1.3b)

Overview: In this investigation, you will be examining mitosis in prepared slides under a microscope at varying magnifications. You will try to identify examples of cells at different points in mitosis.

Materials needed (per group of 4): A light microscope, prepared microscope slides.

Discuss the following as a class before beginning:

- Where does your instructor want you to get your microscopes from?
- How should you carry your microscopes?
- Where has your instructor placed your needed materials?
- What do you need to do to prevent damage to the microscope while working?
- What should you do when you think you are done?

Mitosis Images. *SEP: Engaging in an Argument from Evidence.*

1. Acquire prepared microscope slides from your instructor.
2. Place the microscope slide on the microscope's stage (the flat space with clips beneath the lenses).
3. Switch to the lowest-power lens. Use the coarse and then the fine adjustment knob to focus.
4. Try to identify examples of cells that are characteristic of the key steps of mitosis, including... 1) duplicating DNA and assembling spindle proteins; 2) packing DNA into chromosomes using histones; 3) lining duplicated chromosomes onto spindles; 4) separating the chromosome copies; and 5) dividing the cell in half.
5. Switch to the middle-power lens. Use the coarse and then the fine adjustment knob to focus the image.
6. Repeat the previous steps and attempt to identify each of the 5 steps above.
7. Finally, switch to the highest-power lens. **ONLY** use the fine adjustment knob to focus.
8. Repeat the previous steps and attempt to identify each of the 5 steps above.
9. Turn off your microscope's light.
10. Return items where needed based on your teacher's instructions.

Part 4: Review & Assessment (5.1.4)

Step 1: Rank each Driving Question in Part 2 based on your comprehension (you can rank them as 1,2,3 or green/yellow/red, or any other method). Then work in teams to review anything that is still unclear.

Step 2: Identify any remaining areas of confusion or concern. Then review these topics with your instructor.

Step 3: Complete the Formative Assessment (*last page of the packet*). Your instructor will determine if you will work individually, in pairs, or in small groups. Then compare and evaluate your responses as a class.

Step 4: Individually complete a Mastery Check. If your performance indicates that additional support is needed, your instructor will determine how to help you move forward.

Part 5: Life Connections – Mitosis & Cancer (5.1.5)

Overview: For this activity, you will consider three claims about cancer. You will then use a one-page reading to determine if your initial ideas are supported by evidence. *Note: this can be a sensitive topic, particularly if you have personal experiences with it. If needed, speak with your instructor about potential alternative work.*

Initial Ideas - Record your ideas separately (e.g., on a white board or scratch paper).

SEP: Engaging in Argument from Evidence

1. Nina’s mom recently returned from an annual physical exam. While she was healthy, the doctor suggested that Nina’s mom should schedule annual cancer screenings. Nina has heard the term *cancer* before, but she doesn’t fully understand what it means. Cancer seems very different from other diseases like the cold and flu. Nina also doesn’t fully understand why a healthy person would need to check for cancer yearly. During lunch, Nina and her friends discuss their ideas about cancer. **Do you agree or disagree with each student’s claim?**

- Nina: I think that cancer happens when the body is attacked by a tumor, but I’m not sure where the tumor comes from. *Agree / Disagree*
- Avery: I am pretty sure the cancer is caused by a person’s DNA. I think it has something to do with mutation. *Agree / Disagree*
- Daryll: I think that cancer is caused by a virus. That’s why they have vaccines for some kinds of cancer. *Agree / Disagree*

2. **Work in your small groups to discuss your ideas.** Decide as a group whether each statement is correct (and why). Be prepared to present your ideas to the class. If time allows, consider watching this [video](#) as a class.

Reading - Complete the reading below. Use the space on the right to annotate the text by recording your ideas, highlighting important points, and recording questions as you are reading. *Adapted and modified from “Cell Cycle”*

from the NIH. SEP: Obtaining, Evaluating, and Communicating Information

Background: Cells divide when they get signals from proteins in the blood or from neighboring cells. These signals start the *cell cycle*, which includes *mitosis* (cell division) as well as the periods between division. The cell cycle is crucial for proper cell division. Checkpoints along each step of the process make sure that everything goes the way it should.

For a cell to divide correctly, various processes must happen flawlessly. Mistakes in the cell cycle can cause cells to grow & divide uncontrollably; this is known as *cancer*. Cancer can occur if cells ignore signals to stop, to differentiate, or to die. Cancer cells can spread to other parts of the body where they can cause other cells to become cancerous.

Cancer is often caused by *mutations* (changes to genes). For example, our cells have proteins that receive signals for when to divide. If the gene for these receptor proteins is mutated, it may result in dysfunctional proteins that tell the cells to divide even when they shouldn’t.

Mutations to the *p53* gene can also cause cancer. The *p53* gene produces proteins that repair or destroy cells that divide uncontrollably. If the *p53* gene is mutated, these proteins may be unable to destroy cancerous cells.

Driving Questions:

1. **What is cancer?**

2. **How does mitosis relate to cancer?**

3. **What is a mutation? How does it relate to cancer?**

Mutations can occur if DNA in a gene is deleted, added, or rearranged. This frequently occurs during mitosis. DNA must be duplicated before cell division so that each cell receives a complete copy of each chromosome. Mistakes sometimes occur as DNA is copied, resulting in mutations.

DNA damage can also occur because of environmental factors. Sun overexposure can lead to mutations causing skin cancer, while excessive consumption of certain foods (such as red meat or processed foods) elevates the risk of stomach & intestinal cancers.

Pollutants can also contain mutation-causing compounds; for example, fossil fuel combustion from automobiles and power plants increases the risk of lung cancer. Viruses can also cause abnormal cell division by changing the shape and function of regulatory proteins after infecting a cell.

3. How and why do mutations occur?

Questions - Answer the following questions based on the reading below.
SEP: Obtaining, Evaluating, and Communicating Information

In the 1970s, a research team led by [Albert DeLeo](#) was uncertain whether the proteins found in cancerous cells differed from the proteins found in regular cells. They suspected that cancerous cells produced different kinds of proteins. They thought this because the bodies of laboratory mice will attack tumor cells but will leave healthy cells alone. This suggested that the immune systems of mice were able to detect unique proteins only found in tumors; this is similar to how white blood cells detect & destroy viruses and bacteria. To test their ideas, they exposed some mice to pollutants known to cause cancer. They then compared the proteins found in tumors to those found in regular cells. They discovered high amounts of a protein called *p53* in the tumor cells. They later determined the *p53* protein helps repair or destroy cancerous cells.

1. Briefly summarize Dr. DeLeo's research question (RQ), hypothesis, and rationale:

RQ: _____

Hypothesis: _____

Rationale: _____

2. What were Dr. DeLeo's independent and dependent variables in this experiment?

Ind. Var.: _____

Dep. Var.: _____

3. What was Dr. DeLeo's control in this experiment?

Control: _____

4. What was Dr. DeLeo's key finding in this experiment?



Traits & Genes Packet 1 Formative Assessment (5.1.4)

Name: _____ Hour _____ Date: _____ Score: _____

Directions: A 3x5 notecard with *handwritten* notes can be used to guide your answers. Your instructor may allow you to work in assigned groups. If so, have a different person write each response while others assist.

1. **There are many different kinds of living organisms. Each has different observable traits. What is responsible for the differences in traits among living organisms?** In your response, include and underline the following terms: *DNA*, *protein*, and *trait*.

Writer's Name:

2. **Three students shared their ideas about the cause of the variety of traits among living species. Do you agree or disagree with each student's claim?**
 - a. Mike: "I think that the variety of traits among living species are due to differences in how their cells function." *Agree/ Disagree*
 - b. Lucia: "I think that differences among living species are due to differences in the kinds of proteins produced inside their cells." *Agree / Disagree*
 - c. Oscar: "I think that different traits among species are due to differences in DNA." *Agree / Disagree*

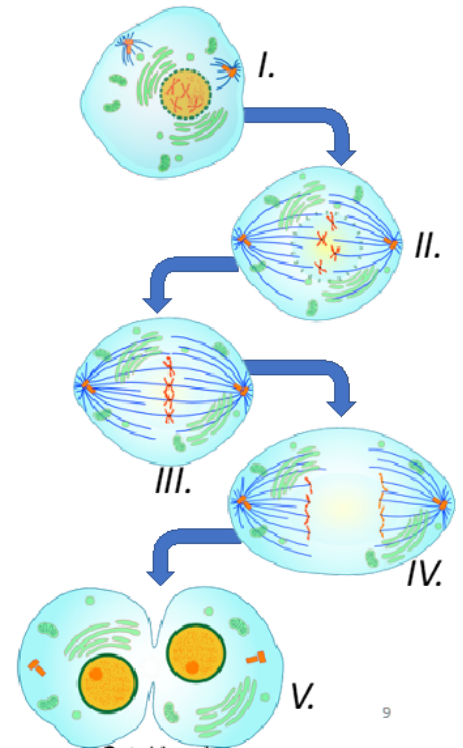
Which claim(s) seems most accurate? _____ Why? _____

Writer's Name::

3. **What is the role of histones, spindles, and regulatory proteins during mitosis? How do these proteins ensure that copied DNA is evenly divided so that mitosis occurs in an organized manner?**

4. Using the image at the right, explain the processes that are occurring as a cell undergoes mitosis to ensure that each cell obtains a complete copy of DNA as it divides.

Writer's Name:



5. A) How can trillions of cells form from just a single cell in only a matter of weeks? B) How can such a wide variety of cells (e.g., nerves, muscles, skin, etc.) emerge from just a single cell?

Writer's Name: