

Traits & Genes Unit – Week 1

Name: _____ Hour _____ Date: _____

Date Packet is due: after Part 5 Why late? _____

If your work was late, describe why

<u>Score</u>
<input type="checkbox"/> Above & Beyond
<input type="checkbox"/> Fully Complete
<input type="checkbox"/> Mostly Complete
<input type="checkbox"/> Incomplete – <i>fix the following pages:</i>

Driving Question: What determines the traits of an organism?

Anchoring Phenomenon: Previously we explored similarities across all living organisms, such as cell respiration and biosynthesis. However, we know that there is a large amount of diversity among species and even within species. Why do these differences exist and what is responsible for the observable traits among living organisms?

Deeper Questions

1. How are the traits of an organism affected by DNA and proteins?
2. How do processes at the cellular level determine the observable traits at the organismal level?
3. How are the instructions for an organism’s traits passed on as cells divide?
4. How can one cell become trillions of cells in an organism?

Weekly Schedule

Part 1: Introduction

- Initial Ideas – What causes different traits?
- Data Dive – Exploring Species
- Discussion & Developing Explanations

Part 2: Core Ideas

- Core Ideas
- Revisions of Part 1 Explanations

Part 3: Investigation

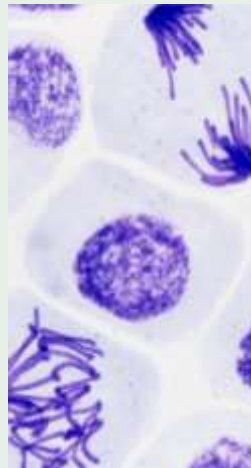
- Part 3A: Mitosis & Chromosomes
- Part 3B: Mitosis Microscopy

Part 4: Review & Assessment

- Ranking Your Readiness
- Assessment

Part 5: Life Connections

- Weekly Recap
- Life Connections – Cancer & Mitosis



NGSS Standards: 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?

Semester Schedule

Traits & Genes

- Week 1 - What determines the traits of an organism?
- Week 2 - How are traits inherited from parents?
- Week 3 – Can we predict traits?
- Week 4 - Assessment

DNA & Proteins

- Week 1: What is DNA and how does it work?
- Week 2: How does DNA affect protein assembly?
- Week 3: How does a protein determine traits?
- Week 4 - Assessment

Mutations & Change

- Week 1: How do mutations change genes & proteins?
- Week 2: How can mutations result in new traits?
- Week 3: How can mutations lead to new species?
- Week 4 - Assessment

Biodiversity & Extinctions

- Week 1: How does biodiversity affect ecosystems?
- Week 2: Why do some species go extinct?
- Week 3: How can human activity cause extinctions?
- Week 4 - Assessment

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Part 1: Introduction – Exploring Species

Overview: In this activity, you will begin by discussing ideas about how and why different species have different observable traits. You will then watch a short video about biodiversity. Next, you use an internet search engine to create a profile of traits for a few living species. You will conclude with an initial explanation to address what determines the wide variety of traits among species.



Figure 1 - Image Source: ICCS.org

Initial Ideas: The earth is home to an astonishing variety of different living species.

While all species share similarities in how they acquire and use matter and energy at the cellular level, no two species are identical. This week we are exploring the source of all of this diversity, and how different organisms acquire millions, billions, or even trillions of different cells.

1. 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
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.

Videos: Next, watch the following videos individually or as a class (based on your teacher's instructions):

Video 1 – https://www.youtube.com/watch?v=3EvV7VZSE_c

Video 2 - <https://www.youtube.com/watch?v=US58f-Sw00k>

Data Dive: In this data dive, you will work in small groups to profile the unique traits of a producer such as plants, algae, or phytoplankton, a consumer such as an animal, a decomposer such as a bacteria or fungus, and (if you have a 4th group member) another species of your choosing. You should collaboratively present your work using a program like PowerPoint or Google Slides.

For each species, you should use an internet search engine to acquire the following information:

- Species name, general appearance, and where it lives
- How it acquires matter and energy (e.g., does it photosynthesize, does it consumer other organisms, or does it break down dead/dying tissue?)
- Unique traits – what are some unique adaptations, behaviors, or characteristic specific to this species?

What is responsible for all the different traits among living species? Write down your initial explanation in the space below. Don't worry if you aren't completely sure about your answer! You will come back and revise this explanation as you gain more information during this unit.

Part 2: Core Ideas

Overview: In this activity, you will begin with a short slideshow presentation. This will provide you with core ideas that will help you clarify your initial ideas. Your instructor will decide on how to implement this portion depending on your previous experience and capabilities with this content.

You will then work in small teams to answer the questions listed below. You should take notes in a notebook, on a dry erase board, or on scratch paper so that you are prepared to deliver your responses during the class discussion that will follow. *Note: your instructor may assign specific questions to your group if time is limited.*

Core Ideas Presentation: <https://bit.ly/WUHS-Bio-TraitsGenesW1>

Driving Questions:

1. What are traits? What are examples of traits?
2. What directly determines an organism's traits?
3. Briefly summarize six different kinds of proteins and their roles in cells and the body.
4. What is DNA? What is a gene? What is a chromosome? How are these terms similar and different?
5. True or false: At times, animal cells will have four copies of each chromosome. Explain.
6. What is the primary purpose or function of packing DNA into a chromosome?
7. Summarize the steps of mitosis; explain how these steps ensure that duplicated cells each receive a complete copy of DNA.
8. What would happen if a typical cell did not receive a copy of an organism's DNA?
9. What are histones? What are spindles? How do these proteins help to ensure that every cell receives a copy of an organism's DNA?
10. What would happen if mitosis occurred too slowly or too rapidly?
11. What is apoptosis? How does this affect the rate of cell division?
12. How can a single cell become trillions of cells in only a short period of time? Include and explain the term *exponential growth* in your response.
13. 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? Include and explain the term *cellular differentiation* in your response.
14. **Revising Explanations:** Return to your original explanation that you created at the end of Part 1. Based on this new information, how would you now respond to this question?

What is responsible for all the different traits among living species? How are these traits determined?

Part 3A Investigation: Mitosis Images

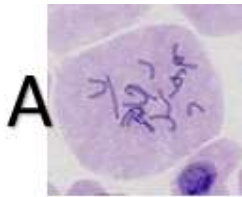
Pre-Investigation Questions: Work as a group to determine the best response to each question. Be prepared to provide verbal answers for some of these questions for your instructor before you complete the investigation.

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?*

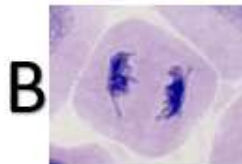
When you think you are ready, **raise your hand**. Your instructor will listen to your verbal responses.

This activity was successfully completed _____ (instructor signature)

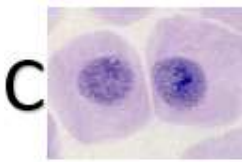
Mitosis Images: Next, observe each image below. Try to determine which aspect of mitosis is occurring in each image. Remember, mitosis consists of a few key steps, including... 1) duplicating DNA and assembling spindle proteins; 2) packing DNA into chromosomes using histones; 3) lining duplicated chromosomes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



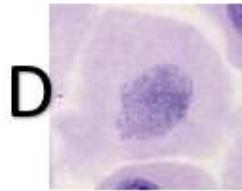
Which step (1-5) is occurring in this image? _____ How do you know? _____



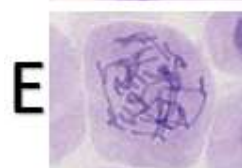
Which step (1-5) is occurring in this image? _____ How do you know? _____



Which step (1-5) is occurring in this image? _____ How do you know? _____



Which step (1-5) is occurring in this image? _____ How do you know? _____



Which step (1-5) is occurring in this image? _____ How do you know? _____

For the images above, **what would be the correct order from earliest step to last?** _____

Be prepared to discuss and defend your ideas in small groups and as a class.

Part 3B Investigation: Mitosis Microscopy

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?

Methods: Check each box as you complete each step.

- Acquire prepared microscope slides from your instructor.
- Place the microscope slide on the microscope's *stage* (the flat space with clips beneath the lenses).
 - Switch to the 4x lens. Use the coarse and then the fine adjustment knob to focus the image.
 - Try to identify examples of cells that are characteristic of the key steps of mitosis, including...
 - duplicating DNA and assembling spindle proteins;*
 - packing DNA into chromosomes using histones;*
 - lining duplicated chromosomes onto spindles;*
 - separating the chromosome copies; and...*
 - dividing the cell in half.*
- Switch to the 10x lens. Use the coarse and then the fine adjustment knob to focus the image.
 - Repeat the previous steps and attempt to identify each of the 5 steps above.
- Finally, switch to the high-power 40x objective lens. ONLY use the fine adjustment knob to focus.
 - Repeat the previous steps and attempt to identify each of the 5 steps above.
- Turn off your microscope's light.
- Return items where needed based on your teacher's instructions.

Part 4: Review & Assessment

Overview: Rank each Driving Question in Part 2 as a 1 (*completely unsure*), 2 (*somewhat unsure*), or 3 (*completely sure*) based on your comprehension. Then work in teams to review each item and prepare a response. Next, write a final explanation below. You will conclude by completing a formative assessment.

What is responsible for all the different traits among living species? How are these traits determined?

Part 5: Life Connections – Mitosis & Cancer

Directions: 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.*

Overview: Nina’s mom recently returned from an annual physical exam. While she was completely healthy, her doctor suggested that Nina’s mom should consider scheduling cancer screenings on a yearly basis. Nina has heard the term *cancer* before, but she does not completely understand the term. She knows it is a disease, but it seems very different from other more common diseases like the cold and flu. Nina also doesn’t fully understand why a healthy person would need to check for cancer every year.

During lunch, Nina and her friends discuss their ideas about cancer. Here’s what they thought:

Nina: I think that cancer happens when the body is attacked by a tumor, but I’m not sure where the tumor comes from.

Avery: I am pretty sure the cancer is caused by a person’s DNA. I think it has something to do with mutation.

Daryll: I think that DNA is caused by a virus. That’s why they have vaccines for some kinds of cancer.

Who do you agree with and why? It’s ok to pick more than one person. Explain your thinking. In your explanation, focus on resources and processes that support plant life and growth.

I most agree with the following: _____ because _____

Reading: Next, complete this reading and accompanying questions. Be prepared to discuss your ideas in small groups and as a class.

Cancer and the Cell Cycle

(adapted and modified from “Cell Cycle” from the NIH).

Cells divide only when they receive the proper signals from growth factor proteins that circulate in the bloodstream or from a cell they directly contact. When a cell receives the message to divide, it goes through a cell cycle. This includes the phases of mitosis as well as the periods in-between mitosis. Checkpoints along each step of the process make sure that everything goes the way it should.

Many processes are involved in cell reproduction. All these processes must take place correctly for a cell to divide properly. If anything goes wrong during this complicated process, a cell may become cancerous. A cancer cell is a cell that grows out of control. Unlike normal cells, cancer cells ignore signals to stop dividing, to specialize (or differentiate), or to die and be shed (apoptosis). Growing in an uncontrollable manner, the cancer cells may spread to areas of the body where they do not belong.

In a cancer cell, several genes change (or mutate) and the cell becomes defective. For example, a mutated gene can change a receptor protein in the cell membrane. Normally, the receptor protein receives signals from growth-factor

proteins for when to divide. The mutated protein perceives a constant message to divide, resulting in uncontrolled mitosis. This kind of mutated gene is often called an oncogene (*onco* = *cancer*).

Another example of a cancerous mutation involves a gene called *p53*. This gene produces a protein that turns "off" the cell cycle to control cell growth. The primary function of the *p53* gene is to repair or destroy defective cells that could become cancerous. This type of gene is called a tumor suppressor gene. If both copies of the *p53* genes are mutated, the "off" switch is lost, and the cell division is no longer under control.

Abnormal cell division can occur either when mutated oncogenes are expressed or when both copies of the tumor suppressor genes are mutated. For a cell to become malignant (or uncontrollably invasive), numerous mutations are necessary. A gene mutation may allow an already abnormal cell to invade the normal tissue where the cancer started or to travel in the bloodstream to remote parts of the body (metastasize), where it continues to divide.

A normal cell can become damaged in different ways. A cell can become abnormal when part of a gene is lost (deleted), when DNA is added to a gene (inserted), when the DNA code changes (substitution), and when part of a chromosome is rearranged during mitosis and ends up in the wrong place (translocation). All these changes can result in an abnormal DNA "blueprint", causing the production of defective proteins.

Damage to DNA can result from replication errors during mitosis or from environmental causes. For example, excess exposure to sunlight can result in mutations that cause skin cancer; similarly, excess consumption of some foods (like red meat or processed foods) increases the risk of some cancers. Abnormal cell division can also be caused by viruses. In this case, genes may be normal, but the resulting proteins may not function normally because the cell contains a cancer-producing virus.

How a specific cancer cell behaves depends on which processes are not functioning properly. Some cancer cells simply divide and produce more cancer cells; the tumor mass stays where it began. Other cancer cells can invade normal tissue, enter the bloodstream, and travel to a remote site in the body. These types of cancer cells tend to be more harmful.

In summary, cancer cells have defects in normal cellular functions that allow them to divide, invade the surrounding tissue, and spread to other parts of the body. These defects are the result of gene mutations, which can result from genetic or environmental causes, or are sometimes caused by infectious viruses.

Questions (*record your ideas using a whiteboard, scratch paper, an online document, or where instructed*).

1. What is the cell cycle? How does it related to mitosis? How is the cell cycle regulated?
 2. What is a cancer cell?
 3. What is a mutation? What are two ways in which mutations can result in cancer?
 4. What is a malignant cancer? How does it related to mutations?
 5. What does it mean for a cancer to metastasize?
 6. Summarize the different ways in which DNA can be mutated.
 7. Explain three potential causes of damage to DNA and how they occur.
 8. Return to your ideas on the previous page. Based on what you now know, how would you respond to these three claims?
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Traits & Genes Unit - Week 1 Formative Assessment

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, gene, chromosome, 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

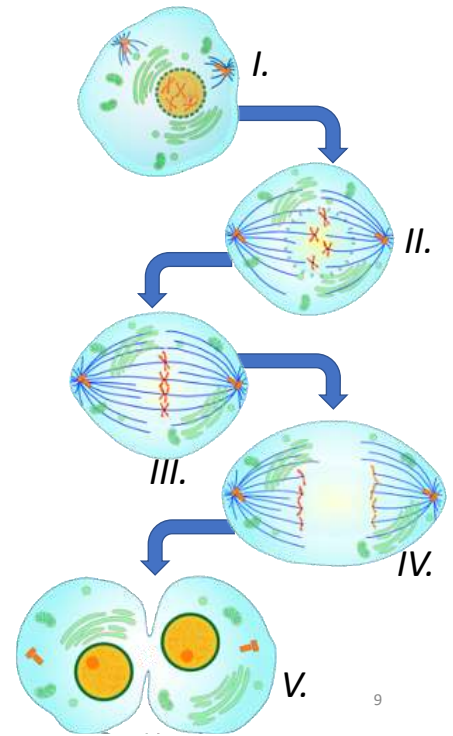
3. **Which claim seems most accurate?** _____ **Why?** _____

Writer's Name: _____

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

Writer's Name: _____

5. 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:

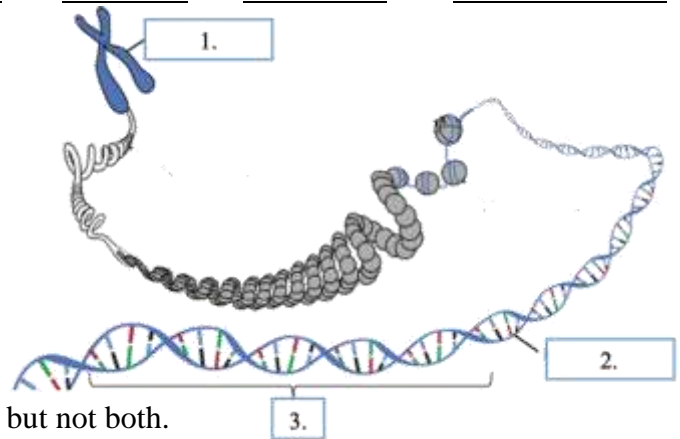
6. A) How can trillions of cells form from just a single cell in only a matter of weeks? B) How can such a wide variety of cells (e.g., nerves, muscles, skin, etc.) emerge from just a single cell?

Writer's Name:

Traits & Genes Unit - Week 1 Mastery Check

Name: _____ Hour _____ Date: _____ Score: _____ / 9

1. **In this image, this would be 1.**
a. DNA b. Gene c. Chromosome
2. **In this image, this would be 2.**
a. DNA b. Gene c. Chromosome
3. **In this image, this would be 3.**
a. DNA b. Gene c. Chromosome



4. **How does DNA relate to traits and proteins?**
 - a. Traits can be determined by DNA or proteins but not both.
 - b. DNA is turned into proteins, which determine traits.
 - c. DNA provides the instructions for assembling a protein, which determines an observable trait.
5. **What is a chromosome?**
 - a. A kind of protein.
 - b. A tightly coiled package of DNA.
 - c. The cell organelle where DNA is stored.
6. **What is the purpose of a chromosome?**
 - a. It is how DNA is stored most of the time.
 - b. It is the organelle that produces proteins from amino acids.
 - c. It ensures that DNA can be evenly separated between dividing cells.

7. **Which of the following steps is occurring in stage I in this image? →**
 - a. Dividing the cell in half.
 - b. Lining up chromosomes on spindles.
 - c. Evenly separating chromosomes copies.
 - d. Duplicating the DNA and forming chromosomes.

8. **Which of the following steps is occurring in stage III in this image? →**
 - a. Dividing the cell in half.
 - b. Lining up chromosomes on spindles.
 - c. Evenly separating chromosomes copies.
 - d. Duplicating the DNA and forming chromosomes.

9. **Which of the following steps is occurring in stage IV in this image? →**
 - a. Dividing the cell in half.
 - b. Lining up chromosomes on spindles.
 - c. Evenly separating chromosomes copies.
 - d. Duplicating the DNA and forming chromosomes.

