5.2 - Traits & Genes Unit, Packet 2

Score
□ Above & Beyond
□ Meets Expectations
□ Near Expectations
□ 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.

Driving Question: How are traits inherited from parents?

Anchoring Phenomenon: How do traits get passed from parents to offspring? And why are organisms slightly different from their parents and from each other? In this packet, we will focus on a black Labrador retriever named Zola, who gave birth to a wide variety of puppies. How is this possible? And how did her genes get passed on to her puppies?

Deeper Questions

1. How do parents transfer their genes to their offspring?
2. How do reproductive cells (like sperm and egg cells) form?
3. Why do offspring look similar but not identical to their parents?

Schedule

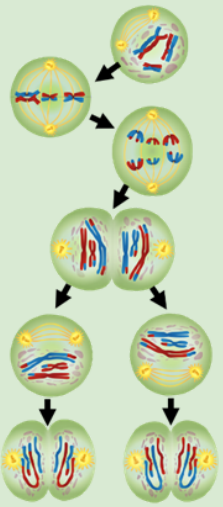
Part 1: Introduction
- Initial Ideas & Data Dive - Zola's Puppies
- Discussion & Developing Explanations

Part 2: Core Ideas
- Core Ideas
- Revisions of Part 1 Explanations

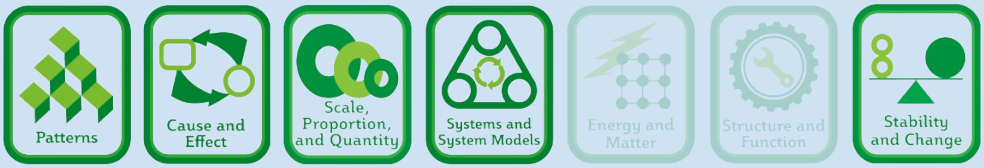
Part 3: Investigation
- Meiosis Simulation

Part 4: Review & Assessment
- Ranking Your Readiness
- Formative Assessment & Mastery Check

Part 5: Life Connections
- Life Connections - Sex-linked Traits



NGSS Standards (*PEs* & *CCCs are summarized below. SEPs are noted throughout the packet*).
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

5. Traits & Genes
5.1: What determines the traits of an organism?
5.2: How are traits inherited from parents?
5.3: Can we predict traits?
5.4: Unit Assessment

6. DNA & Proteins
6.1: What is DNA and how does it work?
6.2: How does DNA affect protein assembly?
6.3: Unit Assessment
6.4: How are genes modified? *(mini-unit)*

7. Mutations & Change
7.1: How does a protein get its shape & function?
7.2: How do mutations change genes & proteins?
7.3: How can mutations create new traits & species?
7.4: Unit Assessment
7.5: How Does Antibiotic Resistance Occur?

8. Biodiversity
8.1: How does biodiversity affect ecosystems? Why is biodiversity being lost?

These materials were partly developed with assistance from artificial intelligence.

Resource Links: Class Website; Core Ideas; Summary Video; Practice Test; Simplified Meiosis Image; Meiosis GIF; Cells to Gametes Image; Meiosis Video 1; Meiosis Video 2; Meiosis Simulation

Part 1: Introduction – Scientific Discoveries (5.2.1)

Overview: You will begin by discussing your initial ideas about how offspring inherit genes from their parents. 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

A black Labrador retriever named Zola recently gave birth to a litter of puppies after mating with a yellow lab. What was surprising was this litter contained black, yellow, and chocolate labs. How could it be possible for a black lab and a yellow lab to produce three different kinds of Labrador puppies?

(Image source). To learn more, use this link to view a news article.

1. Three students shared their ideas. Do you agree or disagree with each student's claim?

- Avery: " I think that some puppies inherited the mother's genes, some inherited the father's genes, and some had mutations." *Agree / Disagree*
- Bristol: "I think that both parents had genes for all of these traits but whether or not the genes are used by a cell is completely random." *Agree / Disagree*
- Chandra: "I think that maybe some genes skipped a generation but I don't really understand what that means." *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: People have always noticed similarities between parents and offspring. Throughout centuries, key experiments have offered compelling evidence to explain why offspring exhibit similar but not identical traits as their parents.

Preformism: Initially, some believed that sperm cells contained a miniature fully-formed human with the father's traits. This idea, called "preformism", emerged because offspring often have some of their father's traits. This suggested that these traits are predetermined and are passed down unchanged through generations. However, this idea had problems. If this were true, how would offspring have traits from *both* parents? Second, offspring are similar but not identical to their biological fathers. Improved microscopes later confirmed there weren't preformed babies within sperm cells. *(Image Source)*

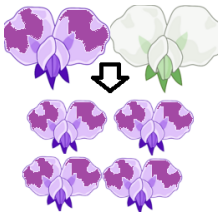
Driving Question:
1. How do offspring inherit the traits of their parents? *(Keep this in mind as your read & answer later)*

2. Summarize the claims, evidence, and reasoning for and against the idea of *preformism*.

Pangenesis Theory: By the 1800s, scientists were still unable to explain how offspring inherit traits from both parents. Some proposed that cells carried chemical signals to each generation that could be altered by experiences in life. For example, some reasoned that exercising more would result in more athletic children. Francis Galton tested this idea by swapping blood cells between black & gray rabbits. The traits of the rabbits and their offspring did not change after blood transfusions, disproving this idea.

3. Summarize the claims, evidence, and reasoning for and against the *Pangenesis Theory*.

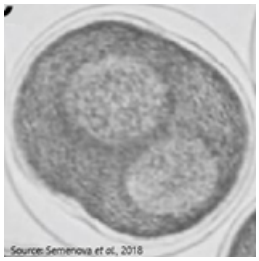
Mendel's Peas: In the mid-1800s, Gregor Mendel studied heredity using pea plants. He noticed that some traits were always passed to offspring; others appeared only in specific conditions. E.g., mating peas with purple flowers to white flowered peas usually resulted in all purple offspring. Conversely, sometimes two purple-flowered plants could have offspring with white flowers. This disproved the idea that offspring traits are just a blend of both parents's traits. *(Image Source)*



4. Summarize Mendel's claims, evidence, and reasoning.

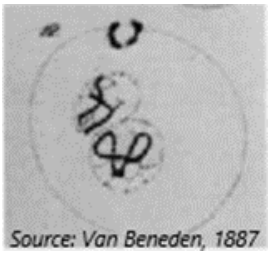
5. Summarize Hertwig's claims, evidence, and reasoning.

Hertwig's Eggs: Improvements to microscopes in the late 1800s helped scientists study cells more easily. Oscar Hertwig used a microscope to watch sperm cells fertilize the transparent egg cells in sea urchins. He saw the sperm's nucleus join with the egg's nucleus. Cell division (mitosis) began after this; all of the other cells originated from this fertilized egg cell. This suggested that the contents of the sperm and egg nuclei determined the traits of offspring. *(Image Source)*



6. Summarize Van Beneden's claims, evidence, and reasoning.

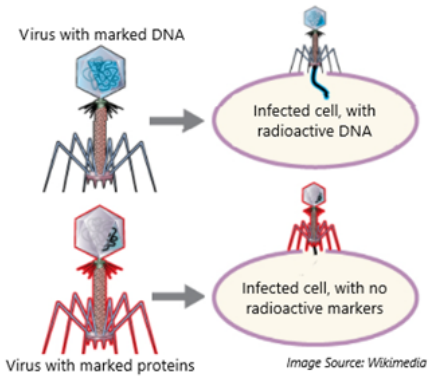
Van Beneden's Loops: A few years later, Edouard Van Beneden discovered that the nucleus of each cell contained "loops". When a sperm cell fused with an egg cell, the number of "loops" doubled as their nuclei combined. Van Beneden hypothesized that these loops (chromosomes) contained the genetic info that determines an organism's traits. *(Image Source)*



7. Summarize the claims, evidence, and reasoning of Hershey and Chase.

Hershey & Chase Go Viral: Chemical analysis showed that a cell's nucleus contains both proteins *and* DNA. Hershey and Chase wondered which of these carried the information that determines traits. To investigate, they used simple viruses with only two parts: protein and nucleic acid (such as DNA). Viruses inject their genetic information into infected cells to make them produce more viruses.

Knowing this, Hershey and Chase added radioactive dyes to either a) the proteins or b) the nucleic acid of these viruses. When the dye was on the viral proteins, it stayed within the virus. When the viral DNA was dyed, they could see it go in the cell, indicating it carries the genetic information.



8. Using all of the evidence and arguments in this reading, explain how offspring inherit the traits of their parents.

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*

How are traits inherited from parents? 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 (5.2.2)

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. You might also watch this video.

Driving Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Developing & Using Models

1. What is the difference between sexual and asexual reproduction? What are the advantages and disadvantages of each?
2. How did low genetic diversity from asexual reproduction cause the Irish Potato Famine?
3. What is a gamete? Why is it important for sexual reproduction?
4. What is meiosis? How does it relate to gametes?
5. What is the difference between a diploid and haploid cell?
6. Why are gametes haploid? What would happen if a gamete was diploid?
7. How are mitosis and meiosis similar, and how are they different?
8. Why does a second round of division occur in meiosis? How does this affect the production of haploid gametes (sperm and egg cells)?
9. What is crossing over? How does it increase the genetic diversity of offspring?
10. How does crossing over relate to the genetic diversity and species survival rates?
11. What are linked genes? What determines if genes are linked?
12. Summarize how gametes change during fertilization.

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

How are traits inherited from parents? Based on this new info, how would you now respond?

_____

_____

Part 3A: Meiosis Simulation (5.2.3a)

Pre-Investigation Questions - *Work as a group to prepare verbal responses for these questions. When you think you are <u>all</u> 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. What is the difference between sexual and asexual reproduction?
2. What is meiosis? What are gametes? How are these terms related?
3. How are mitosis and meiosis similar and how are they different?
4. What is crossing over? How does it increase the genetic diversity of offspring?

This activity was completed _____ (*instructor signature*)

Overview: You will be using a computer simulation to identify similarities and differences between mitosis and meiosis. You will then use this information to test your understanding of these concepts and why they occur.

Hypothesis - *Discuss your ideas and record your predictions in the spaces below.*
SEP: Planning and Carrying Out Investigations

1. In a moment you will observe mitosis and meiosis occur side-by-side in a simulation. Predict three ways in which the processes and outcomes of meiosis will differ from mitosis in this simulation:

   <u>1.</u> _____

   <u>2.</u> _____

   <u>3.</u> _____

Directions - *Carefully read the directions below <u>before</u> beginning.* *SEP: Developing & Using Models*

Methods: Check each box as you complete each step.

1. ☐ Using a school-approved device, visit this website: Meiosis Simulation
2. ☐ Adjust your settings so that you only have one pair of chromosomes, and so that crossing over is turned on. Leave the animation on, and only run one cycle.
3. ☐ Click "Run Simulation". Observe what occurs before recording any observations.
4. ☐ Click "Reset". Confirm you have the same settings as before. Be prepared to record your written observations based on the questions in the Results section. When ready, click "Run Simulation".
5. ☐ Record your observations and answer the questions in the Results section.

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

1. **Complete the table below.** (*Note: each chromosome is shown as a single blue or red line*).

	Chromosome Number at Start	Chromosome Number at End	Cell Number at Start	Cell Number at End	Was DNA duplicated?	Did Crossing Over Occur?
Mitosis					Y / N	Y / N
Meiosis					Y / N	Y / N

2. **What are three ways in which the outcomes of meiosis differ from mitosis?**

3. **How does the chromosome number per cell differ after mitosis vs. meiosis? Why?**

4. **What kinds of cells are created through meiosis? What kinds of cells are created through mitosis?**

5. **Why is it necessary to have two kinds of cell division? What results from meiosis that cannot occur as a result of mitosis?**

6. **Which resulted in more genetic diversity - mitosis or meiosis? Defend your claim with evidence and reasoning.**

Part 4: Review & Assessment (5.2.4)

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 – Sex-linked Traits (5.2.5)

Overview: For this activity, you will consider three claims about color blindness. You will then use a one-page reading to determine if your initial ideas are supported by evidence.

Initial Ideas - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Engaging in Argument from Evidence

1. Oscar has learned he is color blind, and that this condition is far more common among men. Oscar doesn't understand how he could have this trait as neither of his parents are color blind (although his grandfather is). **Do you agree or disagree with each claim**?

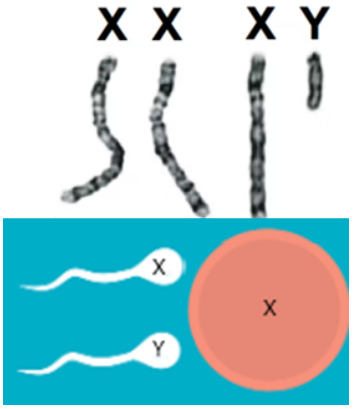
- Oscar: I think that the cells in the eyes of males work differently from females, which results in an increased risk of some problems like color blindness. *Agree / Disagree*
- Avery: I think that some genes are only inherited from the mother's side of the family and these sometimes skip a generation somehow; maybe this is one of those traits(?) *Agree / Disagree*
- Nina: I think it involves X and Y chromosomes. However, I thought that this determined a person's biological sex, so I don't know how that could also affect their eyes. *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: Human cells typically have 46 chromosomes. Each parent contributes half (23) of the chromosomes. The first 44 chromosomes are called *autosomes* and they are the same in males and females. The final pair of chromosomes are called *sex chromosomes*. Females usually have two X chromosomes; males typically have an X and a Y chromosome. The SRY gene is found only on the Y chromosome and is responsible for male traits.	**Driving Questions:** 1. **What determines biological sex?**

A person's biological sex is generally determined by whether a sperm cell carries an X or Y chromosome; the egg cell from the mother always contains an X chromosome.



Exceptions to XX & XY. It is possible for an individual to have a Y chromosome with a dysfunctional SRY gene. This would result in an individual who was chromosomally male (XY) but has female traits.

Alternatively, the SRY gene could be moved to the X chromosome during crossing over. This would result in an individual who was chromosomally female but genetically male (*XX male syndrome*). In either case, the individual wouldn't know their sex chromosomes didn't match their sexual traits unless they were specifically tested for this.

2. Can someone have sexual traits that differ from their sex chromosomes? How?

Additionally, a sperm cell sometimes carries multiple sex chromosomes. For example, *Klinefelter syndrome* occurs if an individual inherits two X chromosomes and a Y chromosome. This results in a mixture of male and female traits.

3. **What is XX male syndrome? How does it occur?**

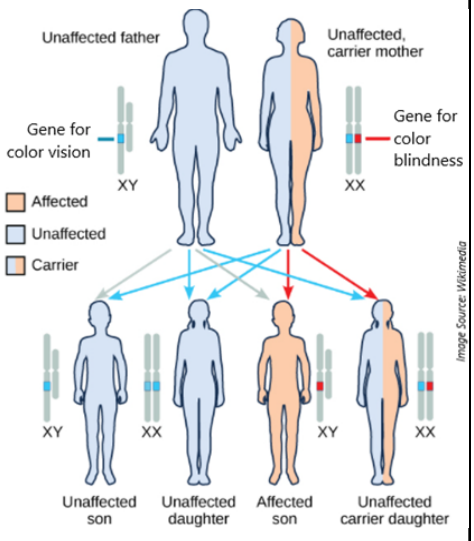
Other Factors. In addition to genes and chromosomes, hormonal changes during pregnancy can also alter biological sex. For example, sometimes cattle are born with a mix of female and male traits. Unlike humans, twins in cattle share a common blood supply. This lets hormones from the male twin alter the sexual development of the female twin. As a result, the female exhibits both male and female characteristics (known as a *freemartin*).

4. **What is Klinefelter syndrome? How does it occur?**

Sex Linked Traits. The X chromosome has over 1400 genes, but the Y chromosome only has 158. Individuals with XY chromosomes inherit some genes exclusively from the mother. These are known as sex-linked genes.

5. **What is a freemartin?**

This explains why color blindness is far more common among males than females. Women with XX chromosomes can carry the colorblindness gene without being colorblind (you only need one functional gene to see color). People with XY chromosomes get one color vision gene from their mother. If the mother passes a color-blind gene to her son, his only copy of the gene will be dysfunctional. It's unlikely for individuals with XX chromosomes to be colorblind unless they inherit a colorblind gene from both parents.



6. **Why are most color-blind individuals male?**

Traits & Genes Packet 2 Formative Assessment (5.2.4)

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. **What is the difference between sexual and asexual reproduction? What are the advantages and disadvantages of each?**

   _____

   _____

   _____

   _____

   Writer's Name:

2. **Do you agree or disagree with each student's claim?**
   Bristol: "I think that individuals mostly get either their mother's or father's genes." *Agree / Disagree*
   Nina: "I think that the traits of offspring are a mix of the traits of the parents." *Agree / Disagree*
   Darryl: "I think that offspring equally receive half of each of their parent's genes." *Agree / Disagree*

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

   _____

   _____

   _____

   Writer's Name::

3. **Explain what a gamete is and how it is formed during meiosis.** Include and underline the terms *diploid* and *haploid*.

   _____

   _____

   _____

   _____

4. **During meiosis, one regular cell will eventually form four haploid cells, each with a different set of DNA. Use the term crossing over to explain how one cell can form four genetically unique cells.**

Writer's Name:

5. **Domesticated animals with docile temperaments also tend to have floppy ears and short noses (see the images below) compared to similar undomesticated animals. Why does this occur?** Include and underline the term *linked genes*.

Writer's Name: