6.1 - DNA & Proteins Unit, Packet 1

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: What is DNA and how does it work?

Anchoring Phenomenon: DNA tests are common today, but what do they reveal? How does a molecule determine our traits? What is DNA made from? And how does a molecule direct the assembly of another molecule? We'll begin by assessing how DNA is depicted in movies and media.

Deeper Questions
1. What is DNA made from?
2. How does the structure of DNA determine its function?
3. How does a molecule determine the assembly of another molecule?

Schedule

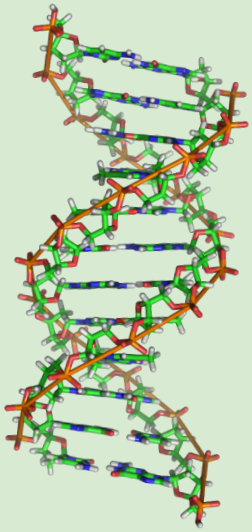
Part 1: Introduction
- Initial Ideas & Data Dive - What is DNA?
- Discussion & Developing Explanations

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

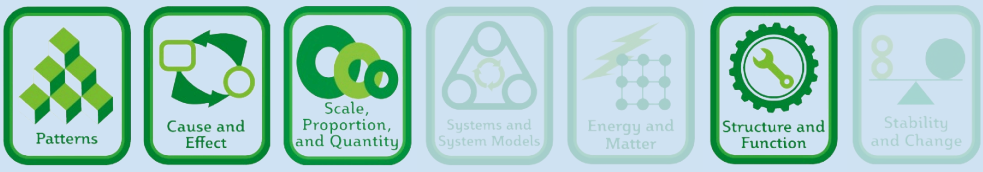
Part 3: Investigation
- A: DNA Models
- B: DNA Extractions
- C: Licorice DNA.

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

Part 5: Life Connections
- Life Connections - DNA Testing



NGSS Standards (*PEs* & *CCCs are summarized below. SEPs are noted throughout the packet*).
HS-LS1-1 - How the structure of DNA determines the structure of proteins and function.
HS-LS1-2 - How inheritable variations result from 1) changes via meiosis; 2) errors during replication; 3) mutations via environmental factors HS-LS1-4: How 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; Video Quiz; Spider Man; Spider Goats; Jurassic Park; Mammoths; Tale of DNA Video; What's Genetic Testing? CARDDS; DNA Extraction; Duplic. GIF;

Part 1: Introduction – What is DNA? (6.1.1)

Overview: Discuss your initial ideas about DNA. Then analyze data and develop your initial explanations.

Initial Ideas - *Record your ideas separately (scratch paper, etc).* *SEP: Engaging in Argument from Evidence*

Mike's parents decided to have their family's DNA tested through an option like *23andMe*. Mike realized his understanding of DNA mostly came from movies like *Spider-Man* and *Jurassic Park*. However, he wasn't sure if the way DNA was depicted in these movies was accurate. He shares this with his friends.

1. Three students shared their ideas about DNA. **Do you agree or disagree with each student's claim?**
- **Mike**: "DNA is like a brain for our cells; it gives our cells their instructions to function." *Agree/ Disagree*
- **Lucia**: "DNA is what proteins are made from. Proteins are what do the work of the cell." *Agree / Disagree*
- **Oscar**: "I know DNA is a molecule made from atoms. It is what a cell is made from." *Agree / Disagree*

2. Discuss your group's ideas. How are your ideas similar or different? Be prepared to present your ideas.

Data Dive - *Record ideas separately (scratch paper, etc).* *SEP: Obtaining, Evaluating, and Communicating Information*

You will compare how DNA is portrayed in popular culture using the questions below.

- What was accurate and what was about their portrayal of DNA?
- What scenarios seem possible, if any? What seems implausible? Why?
- What are you unsure about? What information do you still need?

Spider-Man - *A genetically-engineered spider bites Miles Morales, resulting in new spider-like traits. Compare this to a video about Spider Goats*
Jurassic Park – *Scientists use genetic engineering to bring back dinosaurs. Compare to a video about resurrecting mammoths*

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

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 is DNA made from and how does it work? 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 (6.1.2)

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

1. How are traits used to classify different species from each other? How do these traits relate to cells, DNA, and proteins?
2. What is the primary purpose of DNA? How does DNA enable a cell to function?
3. What three molecules are found in DNA? What is the purpose of each molecule?
4. What is a *nucleotide*? How does it relate to DNA and what DNA is made from?
5. How are the molecules in DNA similar to the components of a spiral notebook?
6. What are *complementary base pairs*? What are examples of complementary base pairs?
7. Explain two reasons why nucleotide bases always combine in specific ways.
8. What are *codons*? How do codons in DNA provide instructions for making a protein?
9. What determines the start and end of a gene?
10. What is the function and purpose of *helicase* and *DNA polymerase*?
11. How do complementary base pairs, helicase, and DNA polymerase each enable DNA to be duplicated?
12. What provides a sense of direction within DNA as it is being copied? Explain.

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

What is DNA made from and how does it work? Based on this new info, how would you now respond?

_____

_____

_____

Use this space for notes if needed.

Part 3A: DNA Models (6.1.3a)

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. What is the primary purpose of DNA? How does DNA enable a cell to function?
2. What three molecules are found in DNA? What is the purpose of each molecule?
3. What are complementary base pairs? Why do bases always form these two combinations? (2 reasons)
4. What are codons? How do they enable DNA to provide instructions for assembling a protein?

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.

Methods. *SEP: Constructing Explanations & Designing Solutions*

1. ☐ First, acquire a pre-prepared package of DNA components (such as in this option or this option, or 3D print nucleotides).
2. ☐ Assemble a nucleotide by matching each component to determine how each piece fits together.
    a. A *nucleotide* consists of a 1) base molecule, 2) a sugar molecule, & 3) a phosphate molecule.
3. ☐ Once you complete a nucleotide, assemble the remaining pieces to create an model of a strand of DNA. Be prepared to identify each of the following: *phosphate, sugar, base, nucleotide, codon*.
4. ☐ Create a **drawing** of your model of a DNA macromolecule in the space below. **Label** each part.
5. ☐ Check with your instructor when your group is finished to make sure your work is accurate.

Create your drawing here

This was successfully completed _____ (*instructor signature*)

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

Part 3B DNA Extraction (6.1.3b) *Source: Planet Science*

Overview: In this investigation, you will extract DNA from berries or fruits. Use this video if needed.

Materials Needed: measuring cup, measuring spoons, ice-cold rubbing alcohol, ½ tsp. (2.5 ml) of salt, 1/3 cup (80 ml) of water, 3 tsp. (15 ml) dishwashing soap, cheesecloth, sealable sandwich bags, test tubes/centrifuge tubes, berries and/or fruits, a cotton swab.

Trial 1: Berry DNA. *SEP: Carrying Out an Investigation*

1. ☐ Begin by predicting whether it's possible to see DNA. If so, what will it look like?

   _____

2. ☐ Mix salt, water, & dish soap to create extraction liquid (*your teacher might have done this earlier*).
3. ☐ Place berries or fruit in a plastic bag, remove excess air, and seal tightly.
4. ☐ Carefully squeeze and smash the berries or fruit mixture for 2 minutes until all lumps are gone.
5. ☐ Add 9 teaspoons (45 ml) of soapy extraction liquid to the bag. Push out the air and reseal tightly.
6. ☐ Agitate and mix the berry-soap solution for 1 minute.
7. ☐ Line the funnel with cheesecloth. Place it over a test tube or centrifuge tube. Pour the berry-soap solution into it. Fill the tube ¼ full. *Hint: Lift the cheesecloth slightly if it stops dripping in the tube.*
8. ☐ Place the cheesecloth and fruit in the sealable bag. Dispose of this properly as instructed.
9. ☐ **Slowly** pour cold rubbing alcohol down the side of the tube until the test tube is half full.
10. ☐ Collect DNA by dipping a cotton swab where the alcohol and berry/soap layers meet.

Post Investigation Questions. Be prepared to discuss these as a class. *SEP: Engaging in an Argument from Evidence.*

1. How did your observations compare to your expectations? Is this what you thought you would see?
2. Why do you think dishwashing soap was needed for this exercise? *Hint: what are cell membranes made from? How does soap interact with this substance?*
3. Did the DNA resemble how DNA is usually depicted in popular culture (e.g., a double helix)? What might explain this?
4. The DNA you extracted likely resembled a goopy glob; how could this substance provide instructions for how to assemble a protein?
5. You extracted DNA from fruit. Do you think plant DNA works the same as human DNA? Explain.

Trial 2: Human DNA (optional). *SEP: Carrying Out an Investigation*

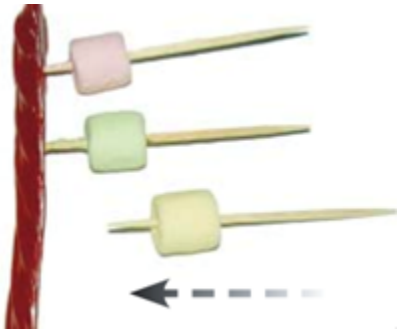
1. ☐ Mix 500 ml of tap water with 1 tbsp (15 ml) of salt in a small disposable cup until dissolved.
2. ☐ Transfer 3 tbsp (45 ml) of the salt water into a separate cup. *(Hint: adding some meat tenderizer can help too)*
3. ☐ Gargle the salt water for 1 minute, then spit it back into the cup.
4. ☐ Add one drop of dishwashing soap to the salt water and stir gently.
5. ☐ Gently pour 100 ml of alcohol into the salt water cup, tilting it as you pour to form a layer on top.
6. ☐ Wait for 2.5 minutes for white clumps and strings to form.

Part 3C Investigation: Licorice DNA (optional)

Adapted from the Genetic Science Learning Center

Overview: You will use licorice, toothpicks, and marshmallows to create an edible model of DNA. After explaining how the structure of DNA relates to its function, you will be able to consume your creation.

Directions: Licorice DNA - *Carefully read the directions below before beginning.*
Adapted from the Genetic Science Learning Center



1. ☐ Construct one side of the DNA molecule following the instructions below:
    a. The licorice and toothpicks represent the phosphates and deoxyribose sugars that hold the bases in DNA.
    b. The marshmallows represent the bases in DNA.
2. ☐ Assemble one side of the DNA molecule using this sequence: T A C G T A T G A A A C.
    a. Place the correct color of marshmallow (based on the key shown here) on the end of a toothpick. Ensure the point of the toothpick goes completely through the marshmallow.
    b. Anchor the toothpick into the licorice backbone.
    c. Continue this process until you have created the full sequence of 12 bases.
3. ☐ Attach the matching color marshmallow to the other end of each toothpick.
    a. Remember: A pairs with T; C pairs with G
4. ☐ Connect the other licorice backbone so it resembles a ladder.
5. ☐ Carefully twist the DNA molecule to create a double helix.
6. ☐ If available, compare and contrast your licorice model of DNA to a formal classroom model of DNA. How are they similar and how are they different?

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

1. **Did the DNA you extracted resemble the model of DNA you created? Explain:**

_____

_____

2. **Each marshmallow in your DNA model represents a base. What is a group of three bases called? How does this relate to how your cells assemble different proteins?**

_____

_____

Part 4: Review & Assessment (6.1.4)

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 – DNA Testing (6.1.5)

Overview: Obtain more information about genetic testing and critique your internet sources for credibility.

Investigation: Next, use the directions below to obtain more information about how DNA testing works using an internet search engine. *SEP: Obtaining, Evaluating, and Communicating Information*

1. Visit the following website: https://medlineplus.gov/genetics/understanding/testing/genetictesting/ (or type "*What is genetic testing?*" into an internet search engine to find the MedlinePlus article).
    - This reading is also available on the next page if the internet is not available.
2. Briefly read the content of this website and identify key points. If helpful, annotate the text from this website on the opposite page by highlighting or underlining key points and terms.
3. Work with your group to address *each* of the following items. Record your responses in this Google doc: https://forms.gle/HQchByVL5oEbR4qT8 (or record on a separate sheet if needed).

- **Credibility**: Who is the author? What are their credentials? Are they sufficiently qualified to provide this kind of information? Who is sponsoring or publishing this information?
- **Accuracy**: Does this information seem accurate based on what you already know about this topic? Do you have any reason to be concerned about accuracy in this source?
- **Reliability**: Does the website present a certain bias or viewpoint?
- **Relevance**: Does this website fully enable you to address your questions about this topic?
- **Date**: When was this information published? Is it still relevant, or is it potentially out of date?
- **Sources**: Does the author cite their sources? Are their sources credible?
- **Overall**: Based on your responses, do you think this is a good source to use for your research?

4. Use a search engine to find at least one more source on this topic. If needed, a second source has been provided on the following page. Repeat this process.
5. As a group, use this information to explain what kinds of information a DNA test can provide.
6. Be prepared to discuss your group's findings in a class discussion.

Reading 1. *SEP: Obtaining, Evaluating, and Communicating Information*

What is genetic testing?

Genetic testing is a type of medical test that identifies changes in genes, chromosomes, or proteins. The results of a genetic test can confirm or rule out a suspected genetic condition or help determine a person's chance of developing or passing on a genetic disorder. More than 77,000 genetic tests are currently in use, and others are being developed.

Genetic testing involves looking for changes in:

- **Genes**: Gene tests study DNA sequences to identify variations (mutations) in genes that can cause or increase the risk of a genetic disorder. Gene tests can be narrow or large in scope, analyzing an individual DNA building block (nucleotide), one or more genes, or all of a person's DNA (which is known as their genome).
- **Chromosomes**: Chromosomal genetic tests analyze whole chromosomes or long lengths of DNA to see if there are large genetic changes, such as an extra copy of a chromosome, that cause a genetic condition.
- **Proteins**: Biochemical genetic tests study the amount or activity level of proteins or enzymes; abnormalities in either can indicate changes to the DNA that result in a genetic disorder.

Genetic testing is voluntary. Because testing has benefits as well as limitations and risks, the decision about whether to be tested is a personal and complex one. A geneticist or genetic counselor can help by providing information about the pros and cons of the test and discussing the social and emotional aspects of testing.

Source: National Library of Medicine 8600 Rockville Pike, Bethesda, MD 20894 U.S. Department of Health and Human Services National Institutes of Health. Last updated July 28, 2021. https://medlineplus.gov/genetics/understanding/testing/genetictesting/

Reading 2. *SEP: Obtaining, Evaluating, and Communicating Information*

How your DNA becomes a report.

Human DNA is about 99.5% identical from person to person. However, there are small differences that make each person unique. These differences are called variants. Your DNA was passed down from your parents—and their parents and so on. Variants can be linked to certain health conditions, traits and ancestry groups. Your saliva contains DNA from cells in your mouth. We send you a saliva collection kit and instructions for providing your sample.

As part of our methodology, our CLIA-certified lab extracts DNA from cells in your saliva sample. Then the lab processes the DNA on a genotyping chip that reads hundreds of thousands of variants in your genome. Your genetic data is analyzed, and we generate your personalized reports based on well-established scientific and medical research.

The analysis we perform is called *genotyping*. Genotyping looks at specific locations in your DNA and identifies variations. These variations make you unique. In choosing these specific locations, we focus on the variations that are known to be associated with important health conditions, ancestry and traits. Genotyping is a great way to start understanding how your genetics can impact your life.

Source: 2024 23andMe, Inc.349 Oyster Point Blvd. South San Francisco, CA 94080. Phone Number: (800) 239-5230. All rights reserved. https://www.23andme.com/about/

DNA & Proteins Unit - Packet 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. **A) What is the primary function of DNA? B) Predict what would happen to a cell if it did not have its own copy of DNA.** Include and underline the following terms: *traits, proteins, genes.*

   _____

   _____

   _____

   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: "DNA is like the brain of a cell. It tells a cell how to function." Agree / Disagree
   b. Lucia: "DNA is what determines an organism's traits, like size or hair color." Agree / Disagree
   c. Oscar: "DNA provides the instructions for how to assemble proteins." Agree / Disagree

   Which claim(s) is/are most accurate? _____ **Why**? _____

   _____

   _____

   _____

   Writer's Name:

3. **What is the role of helicase and DNA polymerase during replication of DNA? How do these proteins ensure that DNA can be accurately duplicated?**

   _____

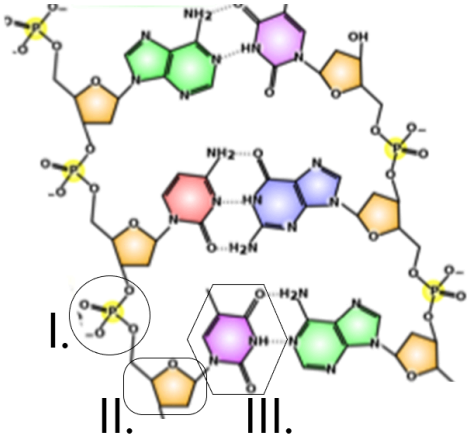
   _____

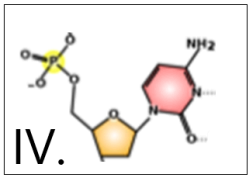
   _____

   _____

   Writer's Name:

4. Using the image at the right, **A) explain what each numbered item (I-IV) represents. Then B) describe the function of each of these components in a DNA macromolecule.**





Writer's Name:

	A	C	G	T
DNA Sample	31%	19%	19%	31%

5. An analysis of a sample of human DNA found that it was composed of 31% A's, 19% C's, 19% G's, and 31% T's. **A) What pattern(s) do you notice in the percentage of each base? B) What might explain these patterns? C) How does this pattern relate to how DNA is duplicated?**

Writer's Name:

