6.2 - DNA & Proteins 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 does DNA affect protein assembly?

Anchoring Phenomenon: DNA has four bases (A, C, G, and T), and their order in a gene decides the sequence of amino acids in a protein, which influences traits. But how does a cell interpret this information? Let's explore this using the DNA of whales to figure out how their genes enabled their size.

Deeper Questions

1. How is the information in DNA used to assemble amino acids?
2. How do cells "know" how to interpret the info stored within DNA?
3. What is RNA and how is it both similar and different from DNA?

Schedule

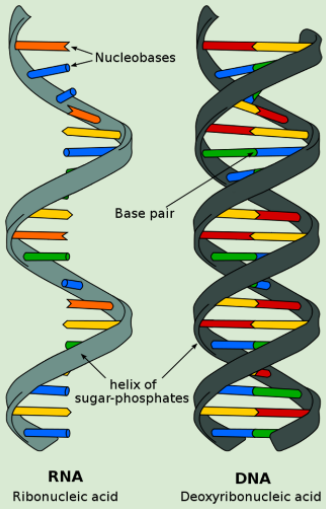
Part 1: Introduction
- Initial Ideas & Data Dive - Big ol' Whales
- Discussion & Developing Explanations

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

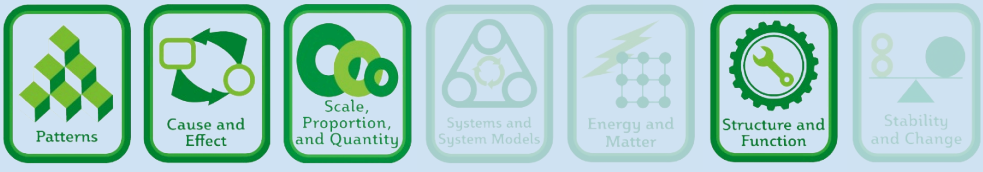
Part 3: Investigation
- A: The Armstrong Siblings
- B: Transcription/Translation Demo

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

Part 5: Life Connections
- DNA, mRNA, & Medicine



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)*

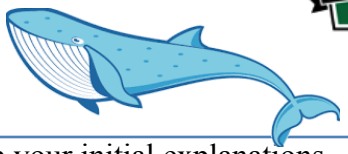
7. Mutations & Change
7.1: How does a protein get its shape & function?
7.2: How do mutations change genes & proteins?
7.3: How can mutations create new traits & species?
7.4: Unit Assessment
7.5: How Does Antibiotic Resistance Occur?

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 1 & Video Quiz 2; Videos of Transcription & Translation; DNA/mRNA Video; Part 5 Video; Firefly Proteins Video; Paula Murase Pic;

Part 1: Introduction – Big ol' Whales (6.2.1)



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*

1. Three friends argue how whales got to be so large. **Do you agree or disagree with each student's claim?**
- **Avery**: "Whales are large because they have genes for making large proteins." *Agree/ Disagree*
- **Nina**: "Most of the earth's photosynthesis happens in oceans, creating more access to food." *Agree / Disagree*
- **Daryll**: "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 1 - *Annotate the text below as you are reading by recording questions, evidence, key points, etc.*
SEP: Obtaining, Evaluating, and Communicating Information; Engaging in Argument from Evidence

Whales are often huge creatures. The blue whale is the largest ever at about 100 feet long and weighing 190 metric tons. In a span of 5-10 million years, they went from being as small as sea lions to their massive size today. The relatively fast pace of change is surprising and still not fully understood. Two hypotheses have been proposed to explain why and how whales got so big so quickly.

The **first hypothesis** is that genetic *mutations*, or changes to the whale's DNA, caused their increase in body size. Changing the DNA changes the way that proteins are assembled in cells. Usually mutations are harmful, but some can be beneficial. Mutations causing a larger body size would reduce the risk from predators and help whales regulate their body temperature more easily.

The **second hypothesis** is that easier access to food helped the whales grow larger. At least half of the world's photosynthesis occurs in the oceans. Because oceans have more photosynthesis, they can support greater numbers of living organisms. More photosynthesis also means that there is more food available to support larger body sizes. Larger bodies might also enable whales to store more energy in their fat. This could help them migrate across longer distances to find more food.

Driving Question:
1. What caused whales to become so large? *(Keep this in mind as your read & answer later)*

2. Summarize the claims, evidence, and reasoning for Hypothesis 1

3. Summarize the claims, evidence, and reasoning for Hypothesis 2.

4. Based on evidence and reasoning, which hypothesis seems most accurate? Why?

1. **Whales often live in polar regions with little photosynthesis. This ____ the second hypothesis.**
   a. Supports b. Refutes c. Does not relate to d. None of these apply

2. **Which of the following would be a possible rationale for the first hypothesis?**
   a. Oceans contain most of the world's photosynthesis.
   b. Marine habitats near the equator have the highest carrying capacities.
   c. If proteins that control cell division stop functioning, rates of mitosis could increase.
   d. Larger body sizes would enable whales to outcompete smaller organisms for access to food.

3. **If accurate, which of the following scenarios would *most* support the second hypothesis?**
   a. Ocean photosynthesis rates increased before the first fossil evidence of large whales.
   b. Large whales initially were only found in the warmest marine environments.
   c. Many large whales have a mutated gene for the protein that regulates mitosis.

Data Dive 2 - *Annotate the text below. Record your ideas separately (scratch paper, etc.).*
SEP: Obtaining, Evaluating, and Communicating Information; Engaging in Argument from Evidence (Photo credit: C. Kohn - Milw. Public Museum)

The table on the right shows the sizes of two types of whales: toothed and baleen. Whales listed in bold font are the "large whales" that are over 10 meters (33 feet) long. The biggest whales are usually *baleen whales*, which don't have teeth but use *baleen* to filter food from the water. *Toothed whales* generally have a smaller body size but still have their teeth.

A team of researchers (Silva *et al.*, 2023) analyzed the genes of whale species in each group. They determined that most of the large whales had a mutated *EGF* gene. Cells use the *EGF* gene to make a protein that regulates cell division, cell death (apoptosis), blood vessel formation, wound healing, and tooth formation.

The mutated *EGF* gene instructs the whale's cells to stop assembling this protein before it is fully assembled. This results in a protein that can't function because it isn't fully formed. This prevents the whale's cells from properly limiting mitosis. It also disrupts tooth formation, causing toothless whales.

Size (m)	Toothed Whales (Odontocetes)
5.0	Narwhal
5.7	Pilot Whale
8.0	Killer Whale
20.0	**Sperm Whale**
	Baleen Whales (Mysticetes)
17.0	**Bowhead Whale**
19.0	**Humpback Whale**
25.0	**Fin Whale**
30.0	**Blue Whale**

1. **Begin by summarizing the key points of this article**. What was the main takeaway message from this? How does this relate to any prior knowledge or experience that you have?
2. **Based on this data, what are two conclusions that would be supported by this data?** Provide evidence and reasoning to support your claims.
3. **Does this data support or refute any of the initial claims on the previous page?** If so, explain.
4. **How did the *EGF* gene relate to some of the traits that are common in large whales?**
5. **What caused some whales to become so large?** Defend your claim with evidence & reasoning.

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*

How does DNA affect protein assembly? 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 (6.2.2)

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.

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

1. What is RNA? What is the purpose of RNA?
2. How is RNA similar & different from DNA?
3. RNA and DNA are similar macromolecules Why does a cell need both RNA and DNA?
4. Summarize what occurs during transcription.
5. Summarize the purpose of each of these for transcription: *mRNA*, *RNA polymerase*.
6. Create the complementary mRNA sequence for this DNA sequence: 3' TAC-GCT-ATG 5'
7. Summarize what occurs during translation.
8. Summarize the purpose of each during translation: *ribosomes, tRNA, amino acids*.
9. Explain transcription & translation using a simple analogy or a metaphor.
10. What would happen if the following became dysfunctional? *RNA polymerase; ribosomes.*
11. How does tRNA deliver amino acids in the correct order to build a specific protein?
12. Some antibiotics deactivate RNA polymerase in bacteria. How does this prevent infections?

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

How does DNA affect protein assembly? Based on this new info, how would you now respond?

_____

_____

_____

Use this space for notes if needed.

Part 3A: Armstrong Siblings (6.2.3a)

Pre-Investigation Questions - *Prepare answers as a group. Raise your hand when you're ready. Your instructor will listen, give feedback, and decide if you can proceed.* *SEP: Developing & Using Models*

1. What is RNA? What is the purpose of RNA? Why is it needed?
2. Summarize what occurs during A) transcription and B) translation.
3. Summarize the function & purpose of each: *mRNA, ribosomes, tRNA, amino acids*.

This activity was completed _____ (*instructor signature*)

Overview: You'll make drawings for a metaphorical story explaining transcription and translation. Stick figures are fine if you're not artistic. Be ready to explain the metaphors to the rest of the class.

Donald N. Armstrong lives in the Nucleus Mansion. He decides what is made in the Ribosome Protein Factory.	**Donald N. Armstrong needs to stay inside the Nucleus Mansion at all times to stay safe. If he leaves, he could be in danger.**	**Myron Armstrong is the messenger. He delivers messages from the Nucleus Mansion to the Ribosome Protein Factory.**
Rhonda Armstrong is the CEO and runs the Ribosome Protein Factory.	**The Ribosome Protein Factory is where amino acids are assembled into proteins.**	**Tyrone Armstrong uses a truck to deliver amino acids to the Protein Factory.**
In summary, Donald N. Armstrong lives in the Nucleus Mansion. He decides what the Ribosome Protein Factory makes. Myron delivers his messages to the factory. Rhonda assembles amino acids into proteins based on these orders. The amino acids are delivered to the Protein Factory by Tyrone.		

Part 3B: Transcription/Translation Modeling

Overview: You will create 2D or 3D models to explain key aspects of transcription & translation.

Materials needed (per group of 4): resources for 2D and/or 3D modeling, such as: Playdoh, dry erase boards, scratch paper, a digital art program, etc. It could also involve a pre-existing kit.

Directions: *Carefully read the directions below before beginning.*

1. ☐ In your teams, go over the main ideas from this unit. Make sure everyone feels confident about their understanding of each key idea.

2. ☐ Develop a plan for how to portray transcription and translation using your available resources.
   a. Your models don't have to be exact – even if they just somewhat look like the things they represent, it's fine. Focus on using them to show how transcription & translation work.

3. ☐ Prepare to use your models to explain each of the following:
   a. How RNA differs from DNA.
   b. How an mRNA copy is made by RNA polymerase during transcription.
   c. How a ribosome assembles proteins from amino acids during translation.
   d. How tRNA 'knows' which amino acid to deliver each time.

4. ☐ Be prepared to critique your model. In what ways is it effective? What are its limitations?

5. ☐ When you think you are ready to explain your work, **raise your hand**. Your instructor will listen to your verbal responses and check your work.

This activity was completed _____ (*instructor signature*)

Part 4: Review & Assessment (6.2.4)

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 – Interview An Expert (6.2.5)

In this activity, you will have an opportunity to interview an individual with professional expertise in this week's content topics, or watch a pre-recorded video. This is similar to social science research, which involves analyzing and understanding human interactions. This often requires qualitative interviews for data collection.

Part 1 - Planning

1. This expert will discuss how transcription & translation relate to medical treatments like antibiotics and mRNA vaccines. Create a research question about this:

   We are unsure _____

   _____

2. Turn your research question into a hypothesis. Given what you currently know, what would you predict?

   We hypothesize that _____

   _____

3. Create three questions for an interview with this person that could help with your research. Focus your questions on the topic above. Use these to focus your attention during the interview.

   1. _____

   2. _____

   3. _____

4. Be prepared to discuss how your interview questions will give you the information needed to address your research question and hypothesis.

Part 2 – Interview Field Notes - Use the space below to record some field notes as the guest speaker presents to the class. Record anything that you hear or observe that might be relevant to your research question.

_____

_____

_____

Part 3 – Analysis & Debrief *(your instructor may choose to use verbal discussion instead of written responses)*

Does this interview support or refute your hypothesis? *Supports it / Refutes it / Not sure* *(circle one)*

Explain: _____

This page is intentionally blank.

DNA & Proteins Unit - Packet 6.2 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. **DNA and RNA are both macromolecules made from repeating chains of nucleotides. Why does a cell need both RNA and DNA?** Include and underline the following terms: *transcription & translation.*

_____

_____

_____

_____

Writer's Name:

Three students shared their ideas about the function of DNA and RNA.

a. Mike: "DNA is found in animal cells, and RNA is found in plant cells."
b. Lucia: "RNA is what turns DNA into a protein."
c. Oscar: "DNA is the instructions for a protein; RNA is the instructions for making fat."

2. **Provide a critique for each response. What was inaccurate about their statement?**

Mike: _____

Lucia: _____

Oscar: _____

Writer's Name:

3. **Some antibiotics fight bacteria by targeting and disabling RNA polymerase. How would this affect transcription and translation in bacterial cells? How would this slow or stop a bacterial infection?**

_____

_____

_____

_____

Writer's Name:

The mRNA vaccines do not contain any live virus. They work by 'teaching' our cells to make a harmless piece of a viral protein. After making the viral protein, cells display it on their surface. This trains our antibodies to recognize and destroy a virus before it can infect our cells. *(Source: CDC)*

4. This excerpt describes how mRNA vaccines work. Traditional vaccines inject part of a virus into the body to create an immune response. **How can an mRNA vaccine "teach" a cell how to produce a viral protein?** *In your response, explain the function of mRNA during transcription & translation.*

Writer's Name:

5. **Briefly summarize what occurs during translation. Then explain how tRNA "knows" which amino acid to deliver next as the protein is being assembled.**

Writer's Name:

6. The *EGF* protein regulates cell division. In some species of whales, a codon within the *EGF* gene changed into a stop codon. **A) Summarize how this would affect *EGF* protein translation. B) Then explain how these changes enabled the large size of some whales.**

Writer's Name: