

Packet 6.2 - DNA & Proteins Unit

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: How does DNA affect protein assembly?</p>	
<p>Anchoring Phenomenon: DNA has four bases (A, C, G, and T). The order of bases in a gene determines the sequence of amino acids in a protein, resulting in a trait. But how does a cell interpret this information? We'll investigate using the DNA of whales to determine how their genes enable their huge size.</p>	
<p>Deeper Questions</p> <ol style="list-style-type: none"> 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? 	
<p style="text-align: center;">Schedule</p> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Part 1: Introduction</p> <ul style="list-style-type: none"> - Initial Ideas & Data Dive - Big ol’ Whales - 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: The Armstrong Siblings - B: Transcription/Translation Demo <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"> - DNA, mRNA, & Medicine </div> <div style="width: 45%; text-align: center;"> <p>RNA Ribonucleic acid</p> <p>DNA Deoxyribonucleic acid</p> </div> </div>	
<p>NGSS Standards (<i>PEs & CCCs are summarized below. SEPs are noted throughout the packet.</i>)</p> <p>HS-LS1-1 - How the structure of DNA determines the structure of proteins and function.</p> <p>HS-LS1-2 - How inheritable variations result from 1) changes via meiosis; 2) errors during replication; 3) mutations via environmental factors</p> <p>HS-LS1-4: How mitosis and differentiation enable complex organisms.</p> <div style="display: flex; justify-content: space-around; text-align: center;"> <div> Patterns</div> <div> Cause and Effect</div> <div> Scale, Proportion, and Quantity</div> <div> Systems and System Models</div> <div> Energy and Matter</div> <div> Structure and Function</div> <div> Stability and Change</div> </div>	
<p>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; Review Game</p>	

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*)

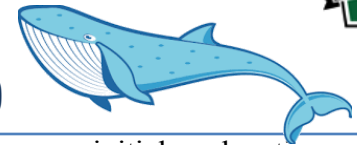
7. Mutations & Change

- [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.



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

- 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*
- 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 animal ever! It is about 100 feet long and weighs 190 metric tons (209 US tons). In a span of 5-10 million years, whales changed 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 are found in polar regions with limited amounts of photosynthesis.
 - 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. Instead, they use baleen to filter food from the water. *Toothed whales* generally have a smaller body size but still have their teeth.

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

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. This protein also regulates cell death (apoptosis), blood vessel formation, wound healing, and tooth formation.

A mutation in the *EGF* gene causes cells to make an incomplete protein that doesn't function properly. This prevents the whale's cells from controlling and limiting mitosis, increasing their body size. This dysfunctional protein also interferes with teeth formation, resulting in toothless whales.

- 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?
- Based on this data, what are two conclusions that would be supported by this data?** Provide evidence and reasoning to support your claims.
- Does this data support or refute any of the initial claims on the previous page?** If so, explain.
- How did the *EGF* gene relate to some of the traits that are common in large whales?**
- 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

- | | |
|---|---|
| <ol style="list-style-type: none">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: <i>mRNA, RNA polymerase</i>.6. Create the complementary mRNA sequence for this DNA sequence: 3' TAC-GCT-ATG 5'7. Summarize what occurs during translation. | <ol style="list-style-type: none">8. Summarize the purpose of each during translation: <i>ribosomes, tRNA, amino acids</i>.9. Explain transcription & translation using a simple analogy or a metaphor.10. What would happen if the following became dysfunctional? <i>RNA polymerase; ribosomes</i>.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: Review each Driving Question. Circle any questions that are still unclear to you.

Step 2: Identify and discuss any remaining confusion with your instructor.

Step 3: Complete the Formative Assessment (individually or small groups). Compare responses as a class.

Step 4: Individually complete a Mastery Check. If needed, your instructor will provide further support.



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.

- 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.

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

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

Mike: _____

Lucia: _____

Oscar: _____

Writer's Name:

- 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:

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: _____

Packet Performance Evaluation

Summary of Expectations for Packets: Students should fully and accurately answer all required questions with detailed and precise responses that reflect their best effort and show improvement over time. Specifically:

- **Completion:** Full written responses should be provided for all questions with a blank, box, or line.
- **Accuracy & Precision:** Responses should be accurate and use precise language whenever feasible.
- **Effort:** This should reflect proper effort for your age/skill. It shouldn't be rushed, unclear, or gibberish. Packet readings should be annotated, and extra notes & reminders should be written in the margins.
- **Growth & Progress:** You should show evidence of improvement in your reasoning and sensemaking. Your revised explanations should improve in quality, precision, & accuracy with each attempt.

Packet Completion Rubric

Category	Above & Beyond (5+ points)	Nice Work (5 points)	Acceptable (3-4 points)	Revise & Resubmit (1-2 points)	See the following for examples
Completion	All responses consistently exceed expectations for completion.	All questions are fully answered with clear and complete responses.	Nearly all questions have clear & complete responses.	More completion is needed to show you're ready to move forward.	
Accuracy & Precision	All responses consistently exceed expectations for accuracy & precision.	All responses are correct & detailed, showing a good understanding.	Acceptable amount of accuracy & precision to move forward.	Responses need improvement to show you're ready to move forward.	
Effort	Amount of effort consistently exceeds expectations.	Solid effort is evident throughout - it's clear you gave it your best.	Sufficient amount of effort to move forward.	More effort is needed to show you're ready to move forward.	
Growth & Progress	Final responses clearly improved, are outstanding, & are error-free.	Improvement is clearly evident, showing learning & growth.	Some evidence of improvement.	More evidence of progress is needed to show you're ready to move forward.	

Overall Score: _____/20

- **Above & Beyond (21):** The student consistently exceeds expectations with high-quality work in all areas.
- **Meets Expectations (20):** The student shows a good level of quality and effort; minor areas need improvement.
- **Near Expectations (16):** The student meets basic requirements but responses need significant improvement.
- **Below Expectations (0):** The student falls short of meeting the basic requirements in most areas.

Students need a score of 16/20 or higher to be eligible for retakes on summative assessments & projects.

Comments: