DNA & Proteins Unit – Week 2

Score
□ Above & Beyond
□ Fully Complete
□ Mostly Complete
□ Incomplete – *fix the following pages*:

Name: _____ Hour_____Date: _____

Date Packet is due: *after Part 5* Why late? _____
If your work was late, describe why

Driving Question: How does DNA affect protein assembly?

Anchoring Phenomenon: DNA can be extracted from cells simply using alcohol and soap. However, extracted DNA often looks very different from the simplistic images of double helixes we normally see in popular culture. How can this molecule provide instructions for assembling complex macromolecules?

Deeper Questions

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

Weekly Schedule

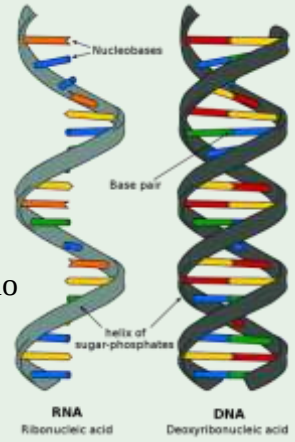
Part 1: Introduction
- Initial Ideas – How does DNA work?
- Data Dive – Extracting DNA
- Discussion & Developing Explanations

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

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

Part 4: Review & Assessment
- Ranking Your Readiness
- Assessment

Part 5: Life Connections
- Weekly Recap
- Life Connections – DNA, RNA, and Medicine



NGSS Standards:
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

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

Part 1: Introduction – DNA Extraction

Overview: In this activity, you will begin by discussing your initial ideas about how DNA works, and how it determines how proteins are assembled from amino acids.

Initial Ideas: Lucia recently attended a "Science Night" event at a local university with her family. At this event, a professor guided attendees as they extracted DNA from different cells. Lucia was excited to see actual DNA, but as she engaged in the activity, she realized she didn't understand how DNA works. She discussed this with her friends at lunch the next day.

1. Three students shared their ideas. **Do you agree or disagree with each student's claim**?
   a. Lucia: "I think that DNA is turned into proteins. Every gene has a different order of bases, which results in the formation of a different protein" Agree/ Disagree
   b. Bristol: "I disagree; I don't think proteins are made from DNA. I think that DNA has to be 'read' by something in the cell, and this affects how the protein is made." Agree / Disagree
   c. Daryll: "I remember that DNA has codons, and these code for the stuff that proteins are made from. So somehow the DNA is 'translated' into the protein's ingredients." 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: In this data dive, you will extract DNA and form hypotheses based on your observations.

Pre-Investigation Questions: Discuss the questions below in small groups. Be prepared to discuss as a class.

1. What is DNA? What is it made from?
2. How does DNA relate to the visible traits of organisms?
3. What is the relationship between DNA and proteins?
4. How does DNA relate to the genotype and phenotype of an organism?
5. In this activity, you will be extracting DNA from plant cells. What do you think you will see when you extract the DNA? Make a prediction below. Explain.

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

Directions:

1. Mix the salt, water, and dishwashing soap in a glass or small bowl. Set the mixture aside. This is your *extraction liquid*.
2. Line the funnel with the cheesecloth, and put the funnel's tube into the glass.
3. Put the berries/fruit in the plastic bag and push out all the extra air. Seal it tightly.
4. With your fingers, squeeze and smash the berry or fruit mixture for 2 minutes.
5. Add 9 teaspoons of the extraction liquid you made in Step 1 to the berries/fruit in the bag. Push out all the extra air and reseal the bag.
6. Squeeze the berries/fruit mixture with your fingers for 1 minute.

7. Put cheesecloth over the funnel and place the funnel in your test tube. Pour the berries/fruit mixture from the bag into the funnel. Let it drip into the test tube until there is no liquid left in the funnel.
8. Throw away the cheesecloth and the berries/fruit pulp inside. Pour out the contents of the test tube so it is 1/4 full.
9. Tilt the test tube or jar and very slowly pour the cold rubbing alcohol down the side. The alcohol should form a layer on top of the strawberry liquid. (Don't let the alcohol and fruit/berry liquid mix. The DNA collects between the two layers!). Slowly add enough alcohol so that you have equal parts of both liquids.
10. Dip the bamboo skewer into the test tube where the alcohol and berries/fruit layers meet. Pull up the skewer. The whitish, stringy stuff is DNA.

Post-Investigation Questions: Discuss the questions below in small groups. Be prepared to discuss as a class.

1. How did your experiences compare to your predictions? Were your predictions accurate? Explain.
2. Why do you think the 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 work the same as human DNA? Explain.

If time allows, extract DNA from your cheek cells using the instructions below.

1. Mix 500 ml of tap water with 1 tbsp. of salt in a cup. Stir until salt is dissolved.
2. Transfer 3 tbsp. of the salt water into a separate cup.
3. Gargle the salt water for 1 minute. Don't swallow it! Spit the water back into the cup.
4. Add one drop of dishwashing soap to the salt water. Stir gently. Try not to create any bubbles.
5. Gently pour 100 ml alcohol into the salt water cup. Tilt the salt water cup as you pour, so the alcohol mixture forms a layer on top of the salt water.
6. Wait for 2.5 minutes. You should see white clumps and strings forming.

Source: Planet Science

How does DNA determine protein assembly? 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.*

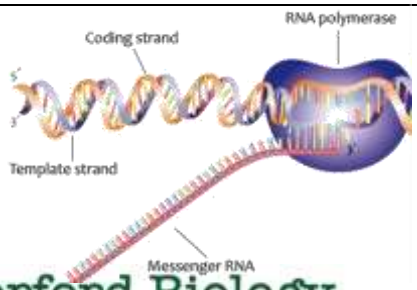
Intro Video – DNA Basics: https://dnalc.cshl.edu/resources/3d/12-transcription-basic.html

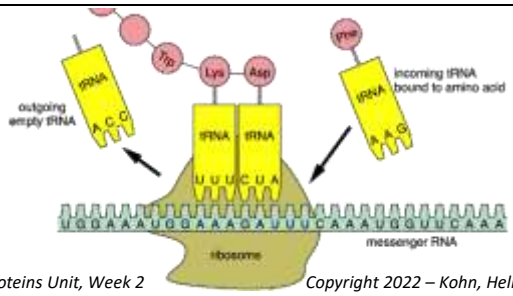
Core Ideas Presentation: https://bit.ly/WUHS-Bio-DNAProteinsW2

Driving Questions:

1. What is RNA? What is the purpose of RNA? How is it both similar and different from DNA?
2. RNA and DNA are both macromolecules made from chains of nucleotides. Why does a cell need both RNA and DNA?
3. RNA is involved in two key processes: transcription and translation. Briefly summarize what occurs in each of these processes.
4. Summarize the purpose of each of the following during transcription: mRNA, RNA polymerase, and transcription factors.
5. Create the complementary mRNA sequence if the start of a gene was: 3' TAC-GCT-ATG 5'
6. Summarize the purpose of each of the following during translation: ribosomes (rRNA), tRNA, and amino acids.
7. What would happen if the following became dysfunctional? *RNA polymerase; transcription factors; ribosomes.*
8. How does tRNA 'know' which amino acids to deliver to assemble a protein? How does tRNA deliver amino acids in the correct order for a given protein?
9. Transcription and translation are often targets for some prescription medicines. For example, some antibiotics target and disable RNA polymerase. Some vaccines use mRNA to help the body produce the viral proteins that antibodies need to recognize. Explain how each of these medications would work using your understanding of transcription and translation.
10. **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?

How does DNA determine protein assembly?





Part 3A Investigation: The Armstrong Siblings

Adapted from materials by Karen Mayes

Overview: In this investigation, you will create pictures for a metaphorical story to explain transcription and translation. Your job will be to draw pictures of what is described in each box. It is ok if you are not artistic - stick people are just fine! If you'd prefer not to draw, you may draw diagrams or flow charts or anything that will help you to remember what is in the box. Be prepared to explain the metaphors in this story as a group.

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

This activity was successfully completed _____ (*instructor signature*)

Donald Armstrong – Cellsburg's Smartest and Most Powerful Citizen	**Myron N. Armstrong** – Donald's memory-challenged brother and messenger.	**Rhonda Armstrong** – the CEO of the Ribosome Protein Factory.
Tyrone Armstrong – the truck driver who delivers products to the Protein Factory.	**The Nucleus Mansion** Where Donald Armstrong lives, and where Myron gets his instructions.	**The Ribosome Protein Factory** where proteins are made. Include Tyrone's trucks.

Donald Armstrong lives in the Nucleus Mansion. He is powerful but is reclusive and never leaves the mansion. He communicates through his brother, Myron.	Myron can only memorize what Donald says. If Donald says something wrong, so does Myron. However, usually Donald's messages are accurate.	Donald's messages are about the products made at the Ribosome Protein Factory. Donald is in charge of deciding what proteins will be made there.
Donald tells Myron what proteins should be made. Myron delivers those orders to the Ribosome Protein Factory, where Rhonda works.	Rhonda assembles proteins at the factory from amino acids. Amino acids are simple molecules that are linked together to make the bigger protein macromolecules.	Amino acids are delivered to Rhonda's factory by her brother, Tyrone. Tyrone uses trucks to deliver all the needed amino acids.
Rhonda, using the information from Myron, tells Tyrone what amino acids to deliver. Tyrone drives them to the Ribosome Protein Factory in his trucks.	Once amino acids arrive at the Ribosome Protein Factory, Rhonda assembles them into proteins based on the information delivered by Myron.	In summary, Donald uses Myron to communicate with Rhonda. Rhonda uses this info to assemble the amino acids delivered by Tyrone to make proteins.

Part 3B: Transcription/Translation Modeling

Overview: In this exercise, 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. These could involve any of the following: Playdoh, dry erase boards, scratch paper, a digital art program, etc. Resources should enable students to create models from scratch if possible to deepen their comprehension.

Methods:

1. In your assigned teams, review the key concepts from this unit. Check to ensure everyone in your group feels comfortable with their understanding of each key concept.
2. Develop a plan for how to portray transcription and translation using the resources that are available to you. Depending on your background and skills, you might choose different options (e.g., those with online artistry skills might prefer a digital art program to a dry erase board).
    a. Note that you shouldn't copy and paste images from the internet; rather, you should be working to personally create images to represent key aspects of transcription and translation.
    b. Your 2D or 3D models do not need to be scientifically accurate – if they only vaguely resemble the items they depict, that's ok.
3. Prepare to use your 2D/3D 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. 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 successfully completed _____ (*instructor signature*)

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.

How does DNA determine protein assembly?

_____

_____

Part 5: Life Connections – RNA & Medicine

Overview: For this activity, you will begin with a recap of the things that you learned in this packet. You will then take part in one of two activities. If possible, you will interview a local professional whose work involves the ideas we discussed this week. If this is not possible you will take part in a separate activity. If time is limited, your instructor may decide to postpone some of these options.

Weekly Recap (use a whiteboard, scratch paper, online document, etc.)

1. Summarize everything that you have learned through this packet within your group. Try to identify the common themes, major ideas, and most important concepts from the content you have learned.
2. Is there anything that anyone still doesn't completely understand? Is there anything that anyone maybe disputes or disagrees with? Did anything seem particularly surprising or noteworthy?
3. What you think are the most important ideas and concepts that you have learned so far. Aim to have at least 5 or 6 ideas written down. It is ok to have more than this.

Option A: Interview an Expert: In this activity, you will have an opportunity to interview an individual with professional expertise in this week's content topics. This activity will be reflective of *social science* research, or gathering, analyzing and interpreting information about human interactions. Often this work is conducted using *qualitative interviews*, which are interviews designed for research and data collection.

This activity will be divided into three parts:

1. **Part 1 – Planning**: After your instructor describes today's guest speaker, your group will identify your research question, which should pertain to the topics covered in class this week. Your instructor may ask your group to share your research question and interview questions prior to the interview and make sure that a variety of questions are ready.
2. **Part 2 – Interview**: Your instructor will facilitate the interview. Your group should record fields notes during this time that you will use at the end of the hour to address your research question.
3. **Part 3 – Analysis & Debrief**: You will be provided with some time to consider the responses that they receive and reach a tentative conclusion about their research question based on this data.

Part 1 - Planning:

1. Briefly summarize the topics that were covered in class this week in one sentence: *This week in class, we studied* _____

2. As a group, discuss what questions you still have about this week's topics. Ideally, use some of the following to start your questions: *Who, What, When, Where, Why, How*

   1. _____

   2. _____

   3. _____

   Once you have developed three questions, ask for your instructor to provide you with some feedback.

3. From this list, choose a research question for your group and complete the prompt below:

   Research Question: *We are unsure* _____

   _____

4. Turn your research question into a hypothesis. What do you think is the answer to your research question given what you currently know?

   We hypothesize that _____

   _____

5. Create three interview questions that you could ask this individual that may provide information related to your research question. Try to focus on their particular area of expertise as you craft your questions.

   1. _____

   2. _____

   3. _____

6. Be prepared to briefly describe your research question and hypothesis, and how your interview questions will provide you with information that will help to address your research question.

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. Note: you should also consider recording the guest speaker's responses to other group's questions if they are relevant to your own research question.

_____

_____

_____

_____

_____

_____

_____

Part 3 – Analysis & Debrief *(your instructor may choose to use oral responses as well as or instead of written)*

What are your conclusions based on the guest speaker's responses? Answer the questions below.

1. Does your data (your observations and field notes from this interview) support or refute your hypothesis? Circle one: *Supports it* / *Refutes it* / *Not sure*

   Explain: _____

   _____

   _____

2. If you were to continue this work, what kinds of investigations would you do next? Describe a potential research experiment that would be a suitable follow-up for today.

   _____

   _____

   _____

Option B: Life Connections: In this activity, students will break into teams based on their personal interests and/or career aspirations. They will then work in their assigned teams to address the questions below. After a sufficient amount of time, students will summarize their discussions for the class.

1. As a group, try to determine how these ideas relate decisions you will make in your future life. Specifically…
   a. How do these concepts relate to prior knowledge experiences from your life?
   b. How could your prior knowledge and experience help you to better understand these concepts?
   c. How might your daily activities in your life be affected by these concepts?
   d. How might the decisions you make as part of your career be influenced by these ideas?

2. As you listen to the ideas presented by other groups, listen for any ideas you might have missed that might be relevant to your life.

DNA & Proteins Unit - Week 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:

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 found in animal cells, and RNA is found in plant cells. Otherwise they are essentially the same thing and do the same job." Agree/ Disagree
   b. Lucia: "RNA is what turns DNA into a protein." Agree / Disagree
   c. Oscar: "There are multiple kinds of RNA; one makes a copy of DNA, and the others are needed to read that copy and assemble amino acids." Agree / Disagree

3. **Provide a critique for each response. What was accurate or inaccurate about their statement?**

   Mike: _____

   Lucia: _____

   Oscar: _____

   Writer's Name:

4. **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. Instead, they work by teaching our cells to make a harmless piece of a [viral protein] … After making the protein piece, cells display it on their surface. Our immune system then recognizes that it does not belong there and responds to get rid of it. When an immune response begins, antibodies are produced, creating the same response that happens in a natural infection."
Source: US Centers for Disease Control & Prevention

5. The excerpt above explains how an mRNA vaccine works. Instead of injecting a protein from a virus to create an immune response, the mRNA vaccine instructs the cell to produce the viral protein within the cell. **How can an mRNA vaccine "teach" a cell how to produce a protein? In your response, explain the function and purpose of mRNA during transcription & translation.**

Writer's Name:

6. **Briefly summarize what occurs during translation. Then explain how tRNA "knows" which amino acid to deliver next as the protein is being assembled.** Include and underline the following terms: *mRNA, ribosome, tRNA, codon.*

Writer's Name: