Evolution of Sick Humans - Student Materials

Unit 3	Biology

Student Materials Table of Contents

Unit Opening

Unit 3 Evolution of Sick Humans	Biology

Student Name:

Tell the Story

Directions:

1. Silently read the text provided to you.
2. Circle or highlight three details that are most important to the phenomenon being described.
3. Share with your group. Each person should identify the details that they circled or highlighted.
4. Discuss as a group, and determine the overall story. What is the phenomenon?

A New Student at Lunch

Kanna is a high school student who recently moved to New York City from Tokyo, Japan. During the first few weeks in her new home, she noticed a lot of similarities and differences between her life in Tokyo and her life in the new city. Kanna felt instantly comfortable with riding the subway to school and living in a small apartment with her family, as these parts of her life did not change. She did discover some new and unusual things, especially when she experienced her first day at school.

At lunch, she was very surprised to see that milk and dairy products were at the forefront of what was included in the school lunch. Not only was every student given the option of regular and chocolate milk, but the main entree that was offered was cheese pizza with mozzarella sticks on the side!

At her previous school in Japan, milk was rarely offered to students at lunch, and she had never seen such big cheesy slices of pizza in the school cafeteria. She was hesitant to eat the school lunch, but she noticed that many of her classmates were eating the lunch that was offered to them. Kanna didn't want to stand out as different or strange on her first day of school, so she drank her milk and ate a large slice of cheese pizza.

A couple of hours later, Kanna noticed that she didn't feel very well. Her stomach was cramping, and she was uncomfortable. She looked around at her classmates who had also drunk the milk and eaten the cheese at lunch. No one else seemed to be having any difficulty or feeling unwell. Kanna was very confused. Why was she sick from consuming the dairy-heavy lunch, while many of her classmates were not?

What is the overall story?

Important details our group surfaced (provide at least 5):

1. _____
2. _____
3. _____
4. _____
5. _____

Overall Story (based on group discussion):

At first,

_____

_____

_____

Then,

_____

_____

_____

Finally,

_____

_____

_____

Performance Task Organizer

Unit 3 Evolution of Sick Humans	Biology
Student Name:	

Lactase Persistence Engineering Journal

Learning Sequence 1: Introduction to the Task & Define the Problem

Engineering Component	Defining a problem
	The first step engineers take is to clearly define the problem. Part of defining the problem is understanding what the underlying issues (or parts of the problem) are. Things to consider are: • Who is impacted by the problem • Identify the needs of the people impacted by the problem • Why we should address the problem

1. Describe how our body does not match the environment that we live in today, based on the biology learned in this 5E sequence.

2. Why is this a problem that we need to address?

What are some possible solutions to the problem?
WHOLE CLASS BRAINSTORM:

3. Choose one of the possible solutions you brainstormed as a class. Describe it or use the space below to sketch out your solution.

4. How is your solution addressing the biology of this problem?

Your Solutions	How it addresses the problem (or sub-problem) and connects to the science content or research you have done

4. In this 5E, you learned how structure and functions are connected. In the space below, describe how investigating the properties and structures of DNA, enzymes, lactase, or lactose helped you design your solution.

Notes, drawings, ideas, or questions I still have…

Leptin Resistance Engineering Journal

Learning Sequence #2: Identifying Criteria and Constraints

Engineering Component	Identifying Criteria and Constraints/limitations
	Although it is fun to brainstorm lots of solutions to a problem, engineers have to consider criteria and constraints when identifying solutions to a problem. **Criteria** are things the design needs to do in order to be successful--its requirements. **Constraints** are limitations on the design. These may be materials available, the cost of the materials, the amount of time they have to develop the solution, etc. When thinking about solutions, we can break them down into design elements. A **Design element i**s the components or parts of the solution. The solution is your design that addresses the problem(s) that we identified. A design element is something you would change, add, or take away from the system in order to address the problem.

1. Describe how our body does not match the environment that we live in today, based on the biology learned in this 5E sequence.

2. Why is this a problem that we need to address?

What are some possible solutions (design elements) to the problem?
WHOLE CLASS BRAINSTORM:

3. Now that we have investigated two related problems involving two different proteins (lactase and leptin), revise or add on to your initial solution (design elements) to address the new problem. Describe or use the space below to sketch out your solution.

4. Based on what you know about **constraints and limitations** in the engineering process, describe what specific constraints and limitations are associated with your solution.

5. How is your solution (design element) addressing the biology of this problem?

Design element in the system	How it addresses the problem (or sub-problem) and connects to the science content or research you have done

6. In this 5E, you learned about how the concept of cause and effect helps with understanding leptin resistance. In the space below, describe how thinking about causality helped you design your solution or better understand the phenomenon/problem. The sentence prompts below may be helpful.

    a. Is [claim that states a causal relationship or a claim that states a correlational relationship] a causal claim? If so, what makes it a causal claim? If not, why not?
    b. Is the evidence discussed sufficient to conclude that ____ caused ___ ? If not, what additional evidence is needed?

Notes, drawings, ideas, or questions I still have…

Circadian Rhythms Engineering Journal

Learning Sequence #3: Developing a prototype

How can we develop a prototype that achieves our goal while taking the constraints and limitations into account?

Engineering Component	Developing a prototype A **prototype** is a simple experimental model of a proposed solution intended to quickly and economically test or validate ideas and design elements so that the designer(s) involved can make necessary revisions or changes in their design solution.

1. Describe how our body does not match the environment that we live in today, based on the biology learned in this 5E sequence.

2. Why is this a problem that we need to address?

What are some possible solutions (design elements) to the problem?
WHOLE CLASS BRAINSTORM:

Designing a School System Prototype

Task:

1. Use the space below to identify all the components (parts) of a school. This includes: physical spaces, objects like desks, parts of the building structure like the roof and windows, and parts that are not 'seen' such as bell schedules and the amount of sunlight entering the building.

2. Use your labeled diagram to develop your prototype.

3. Your prototype design should have the following **CRITERIA**:

    - Achieve your goal (solve the problem)
    - Take into consideration all of the constraints and criteria that have been identified
    - Be high-leverage (address many parts of the problem at once)
    - Align with the science concepts you have learned with any research you may have done
    - Demonstrate how different components in the system (school) interact
    - Include **at least** three design elements. A design element is something you would change, add, or take away from the system in order to address the problem.

Prototype

3. How is your solution (design elements) addressing the biology of this problem? Choose at least one design element to discuss below

Design element in the system	How it addresses the problem (or sub-problem) and connects to the science content or research you have done

4. When thinking about the problems (and subproblems) and the associated science concepts, discuss how you used the lens of **cause and effect** to design solutions or to better understand the phenomenon/problem? The following prompts maybe helpful:
    a. Is [claim that states a causal relationship or a claim that states a correlational relationship] a causal claim? If so, what makes it a causal claim? If not, why not?

b. Is the evidence discussed sufficient to conclude that ____ caused ___ ? If not, what additional evidence is needed?

Notes, drawings, ideas, or questions I still have…

Common Ancestry Engineering Journal

Learning Sequence #4: Evaluating, Testing, and Iterating on a Prototype

How can we iterate on a prototype that achieves our goal while taking the constraints and limitations into account?

Engineering Component	**Evaluating, Testing, and Iterating on a Prototype.** Engineers perform tests and collect data on how well the design solution meets the criteria and constraints. These data are analyzed and used to develop new ideas to help improve the design.

1. Describe how our body does not match the environment that we live in today, based on the biology learned in the Elaborate Phase of this 5E sequence.

2. Why is this a problem that we need to address?

What are some possible solutions (design elements) to the problem?
WHOLE CLASS BRAINSTORM:

3. Choose one design element to discuss further. How is your solution (design element) addressing the biology of this problem?

Design element in the system	How it addresses the problem (or sub-problem) and connects to the science content or research you have done

Revise the Prototype

Designing a school system

Task:

1. Use the space below to identify all the components (parts) of a school. This includes: physical spaces, objects like desks, parts of the building structure like the roof and windows, and parts that are not 'seen' such as bell schedules and the amount of sunlight entering the building.

2. Use your labeled diagram to develop your revised prototype.

3. Your prototype design should have the following **CRITERIA**:
    - Achieve your goal (solve the problem)
    - Take into consideration all of the constraints and criteria that have been identified
    - Be high-leverage (address many parts of the problem at once)
    - Align the science concepts you have learned with any research you may have done
    - Demonstrate how different components in the system (school) interact
    - Include **at least five** key design elements. A design element is something you would change, add, or take away from the system in order to address the problem.

4. In the space provided below, identify each design element you are including in your prototype and explain how each addresses the problem or a specific sub-problem.

Revised Prototype

Testing the Prototype

Task:

1. Identify at least one design element to test.
2. Choose an appropriate way to test the effectiveness of that element (develop a model, design a survey, etc.).
3. Describe your results and observations below, including what you learned that will help you improve your design.

Evaluate the Prototype

How can we ensure that we have the best design to address the problem so far?

Task: Evaluate

1. Categorize each design element in your prototype into one of the four quadrants below. Each quadrant can have more than one design element.

Easy to implement; does not address a lot of the problem	**Easy to implement; does address a lot of the problem**
Hard to implement; does not address a lot of the problem	**Hard to implement; does address a lot of the problem**

1. What did you learn from the testing and evaluation process about how to improve your design? Describe or sketch out any changes you would make to the prototype based on your evaluation.

Final Design Task

Creating the Final Design

Your design should:

- Achieve your goal (solve the problem)
- Take into consideration all of the constraints and criteria that have been identified
- Be high-leverage (address many parts of the problem at once)
- Align the science concepts you have learned with any research you may have done
- Demonstrate how different components in the system (school) interact
- Include **at least five** key design elements. A design element is something you would change, add, or take away from the system in order to address the problem.

Final Design

Design Rationale

Provide a written rationale for your design that explains your thinking on how at least three of your design elements address the problem and subproblems identified throughout the unit. The rationale should include:

1. A description of the overall mismatch problem, including relevant scientific concepts
2. A description of at least one of the subproblems, including relevant scientific concepts
3. A description of how the design elements address the subproblems, including how the cross-cutting concept of form and function and/or cause and effect contributed to the design or to your understanding of the phenomena/problem. The following prompts might be helpful:
    - Describe the structures (or sub-structures) in your solution. Describe the function in your solution. What is important about the relationship between structure (or sub-structures) and function in your solution that makes it a successful design?

OR

    - What evidence are you using to support a claim of causality? What additional evidence might you need to support your claim?
4. A description of how at least one of your design elements address the identified criteria and constraints

Design Process Evaluation

Design Process Evaluation

Use all of your resources from the unit (Performance Task Organizer, class notes, handouts) to respond to the following reflection prompts:

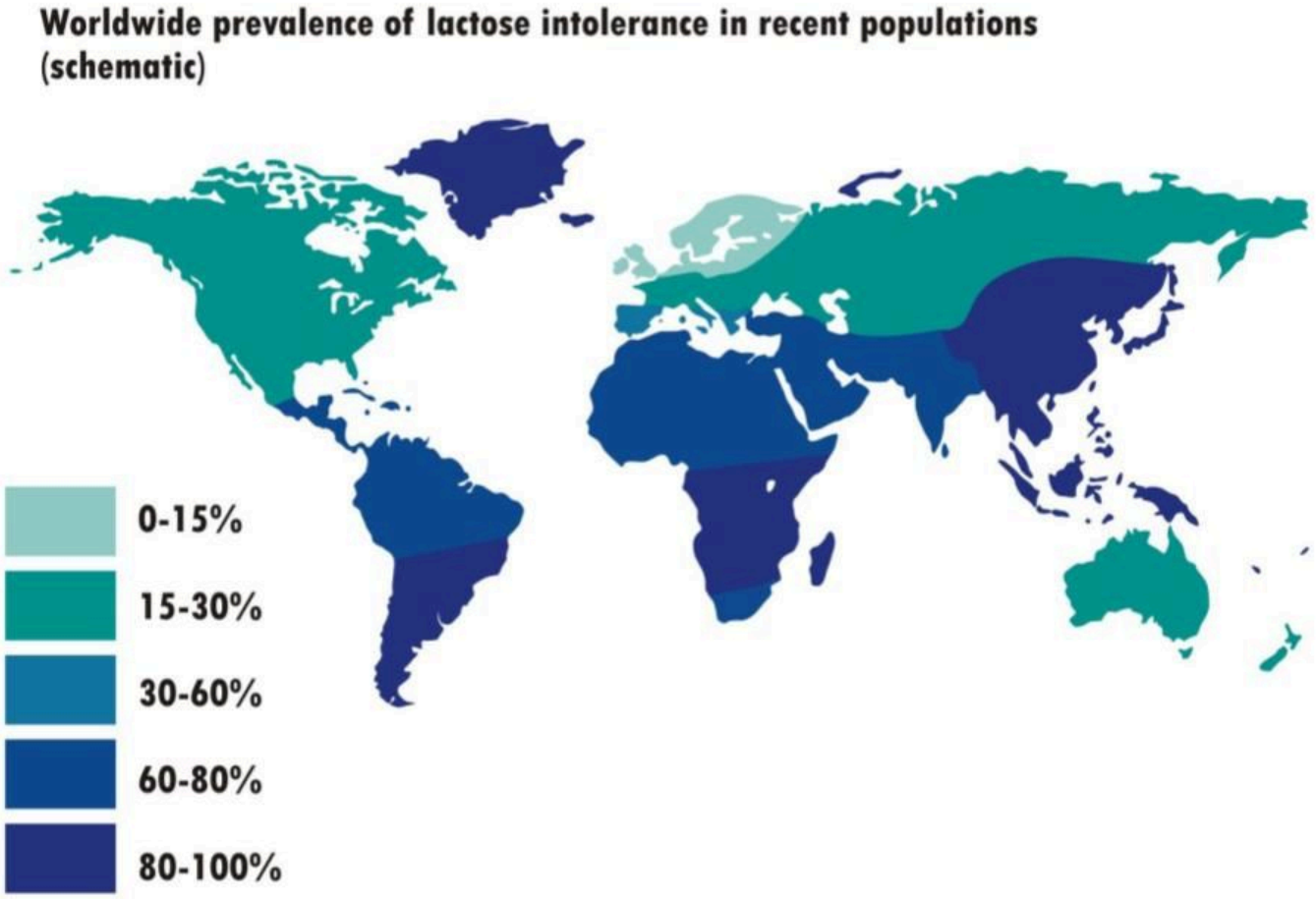
- Describe how engineers use the design process. How has your thinking about engineers changed since the beginning of the unit?
- How did your earlier prototypes change to become this final design? Why did you make these changes?
- What are the limitations of your design?
- How would you improve upon your design?

Lactase Persistence 5E

Unit 3 Evolution of Sick Humans	Biology

Student Name:

Lactose Intolerance Frequency Map



See-Think-Wonder

Lactose intolerance - unable to digest dairy products
Lactase persistence - able to digest dairy products

See	Think	Wonder
• *Which regions have the highest lactose intolerance?* • *Which regions have the highest lactase persistence?* • *Are there more lactose intolerant or lactase persistent regions?* • *Which regions have a mix of lactose intolerance and lactase persistent populations?*	• *What do the patterns in the data make you think about? What connections can you make?*	

Blank World Map

Dairy Investigation

Research Question: What happens to milk once it is consumed? How is it different for babies and adults?

Introduction: In this investigation, we will explore what happens to milk in the digestive system of different groups of people. We will use an indicator strip to identify what differences may be apparent in intestinal fluid samples after people have consumed milk.

People:

- Kanna
- Kanna's baby brother
- Kanna's mother
- Alissa (a student in Kanna's class that is from NYC)

Materials:

- Intestinal fluid sample from each of the above people
- Beakers (4 per group)
- 4 Test strips
- Markers to label beakers
- Timer

Procedure:

1. From your teacher, obtain the intestinal fluid sample from each person
2. Pour 50 ml of each sample into an appropriately labeled beaker
3. Using a new test strip for each sample, immerse the strip into the sample for 5 seconds
4. Make sure the test strip is fully submerged in the sample and wait 5 seconds (submerging the strip in the sample for longer will make the test invalid.)
5. Pull out each strip and carefully place each one on a paper towel in front of its labeled beaker
6. Wait 2 minutes
7. Compare the results to identify which components were found or missing in each person's intestinal fluid contents.
8. Use the data table to record your results

Data Table: Components of intestine contents after consuming milk

Intestine contents sample	Galactose	Proteins	Fats	Glucose	Calcium	Lactase
Kanna						
Kanna's baby brother						
Kanna's mother						
Alissa						

Analysis:

1. What do you notice in the data you collected?

2. What questions do you have about the data?

Making Sense of Dairy Investigation

Research Question: What happens to milk once it is consumed? How is it different for babies and adults?

Introduction: In this investigation, we explored what happens to milk in the digestive system of different groups of people. In the investigation, you surfaced some interesting ideas around the presence or absence of glucose in the intestinal fluid of each person. You will now zoom in closer to examine a model of a biological process that is occurring in the digestive system.

Procedure: Use the See-Think-Wonder graphic organizer to document your ideas about the process modeled in *Simple Lock-and-Key Diagram*.

See-Think-Wonder

See	Think	Wonder
• *Describe the parts or components you see in the process* • *Describe what you notice about the structure and relationships of the components shown for this process*	• *In describing the structure of the components, how do you think they are related to their function (or job?)* • *What do you think is happening in this process, based on the structure and function of the components or parts and how they connect to each other?* • *How do you think the digestive process represented in the model is related to our research question?*	• *What questions do you have about the model or the process that the model represents?* • *How is the substrate being broken down when connected to the enzyme?*

Dairy Investigation Model

Looking at the results in *Dairy Investigation* and what you are figuring out about how components work together in this process, model what is happening in Kanna vs. Alissa.

Kanna	Alissa

Dairy Investigation Rubric

Student Rubric - Dairy Investigation

How did you do in the investigation?

	Student Self-Score Select one		
I know how this investigation connects to our current unit.	No - I need help.	Almost	Yes
I was able to contribute to the See-Think-Wonder and respond to the evaluation questions.	No- I need help.	Almost	Yes
I used my time well in this investigation.	No	Mostly	Yes
I plan to come in for extra help to complete parts of the investigation or ask questions.	No		Yes

What other resources could you have used to get more out of this investigation?

- More time
- More resources
- More information
- More help from my partners
- More help from my teacher
- Other:

Partner Rubric - Dairy Investigation

How did your partners do in the investigation?

Directions: Think back to how your partners participated in the lab. For each of the four categories, write the name(s) of your partner(s) in the appropriate box.

	Unsatisfactory	Pretty Good	Excellent
Contributions	Did not participate.	Did the minimum of what was required.	Provided useful ideas when participating in discussion.
Working with Others	Rarely listened to others. Disrupted or discouraged others' attempts to participate.	Usually listened to, shared with, and supported the efforts of others.	Listened to, shared with, and supported the efforts of others.
Time Management	Procrastinated, did not use school time or schedule provided to get work completed.	Mostly used time well and completed investigation on time.	Used time well to ensure things get done on time.

Digesting Dairy Text

Guiding question(s):

Directions: Annotate the text

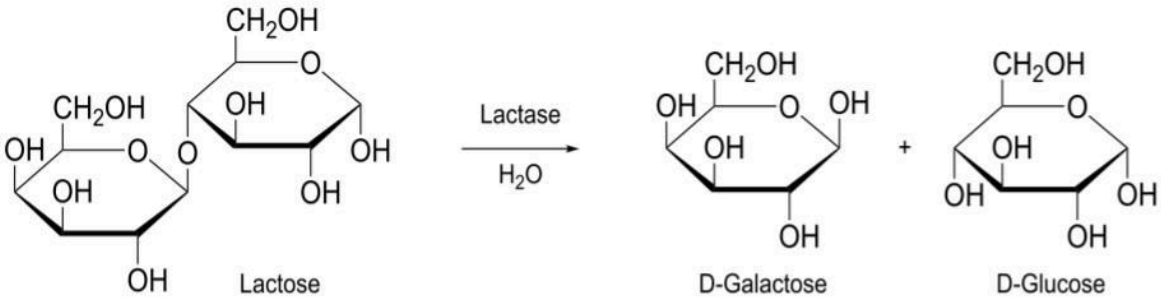
- **<u>Underline</u>** information that helps us answer the guiding questions
- Place **!** next to something interesting
- Place a **?** next to something you have a question about

Cows, humans, cats, and pigs are all examples of mammals. One defining characteristic of all **mammals** is that females have mammary glands that produce milk for the young. As infants, virtually all humans have the ability to digest the breast milk produced by human mothers. Humans are the only organism that continues to drink milk into adulthood, and the only organism to drink the milk of another species. Humans generally drink cow milk, but in some cultures it is common to drink goat, sheep, and camel milk.

Table 1. A comparison of the milk of humans and cows

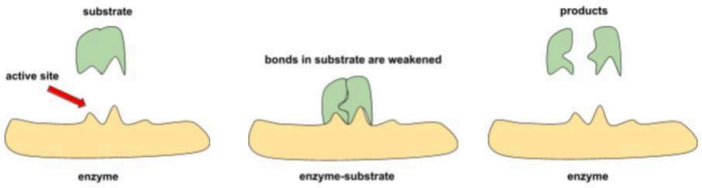
	Human breast milk	**Cow milk**
Proteins	11 g/L	33 g/L
Lipids (fats)	35 g/L	35 g/L
Lactose	70 g/L	50 g/L
Calcium	0.33 g/L	1 g/L
Vitamin C	60 mg	20 mg
Calories	640-720 kcal/L	650 kcal/L

Lactose is a sugar found in milk, and that is why scientists call it a primary carbohydrate. Lactose is a complex and large carbohydrate that has to be broken down in the digestive system so that it can enter the bloodstream. Almost every human infant produces an enzyme, called **lactase**, in cells that line the walls of their small intestine. **Enzymes** are proteins that help make reactions occur in the human body. Lactase helps break down the lactose found in breast milk into two different, smaller carbohydrates (sugars): glucose and galactose.



The enzyme lactase breaks down the large carbohydrate lactose into two smaller carbohydrates (the sugars galactose and glucose).

The enzyme lactase helps 'break' the bond between glucose and galactose, separating them. All enzymes, including lactase, are specific to the molecule that they interact with. The lactase enzyme has a special shape that fits with the sugar lactose.



After lactase helps convert lactose into two smaller sugars (galactose and glucose) they are small enough to pass into the bloodstream from the small intestine and enter cells. Without lactase, lactose cannot be absorbed into the bloodstream. Undigested lactose can make a person feel ill and have diarrhea and other digestive problems.

DNA / Protein Synthesis Model

1. Generate an initial model: Demonstrate the relationship between chromosomes, DNA, genes, and proteins
2. Annotate your model as needed to clarify the relationships between chromosomes, DNA, genes, and proteins

DNA Comparison Investigation

Research Question:

Introduction: The gene for lactase is found on chromosome number 2. Chromosome 2 is the second largest chromosome, with more than 242 million base pairs! In this investigation we will compare chromosome 2 at different scales for each individual in order to make comparisons between each person.

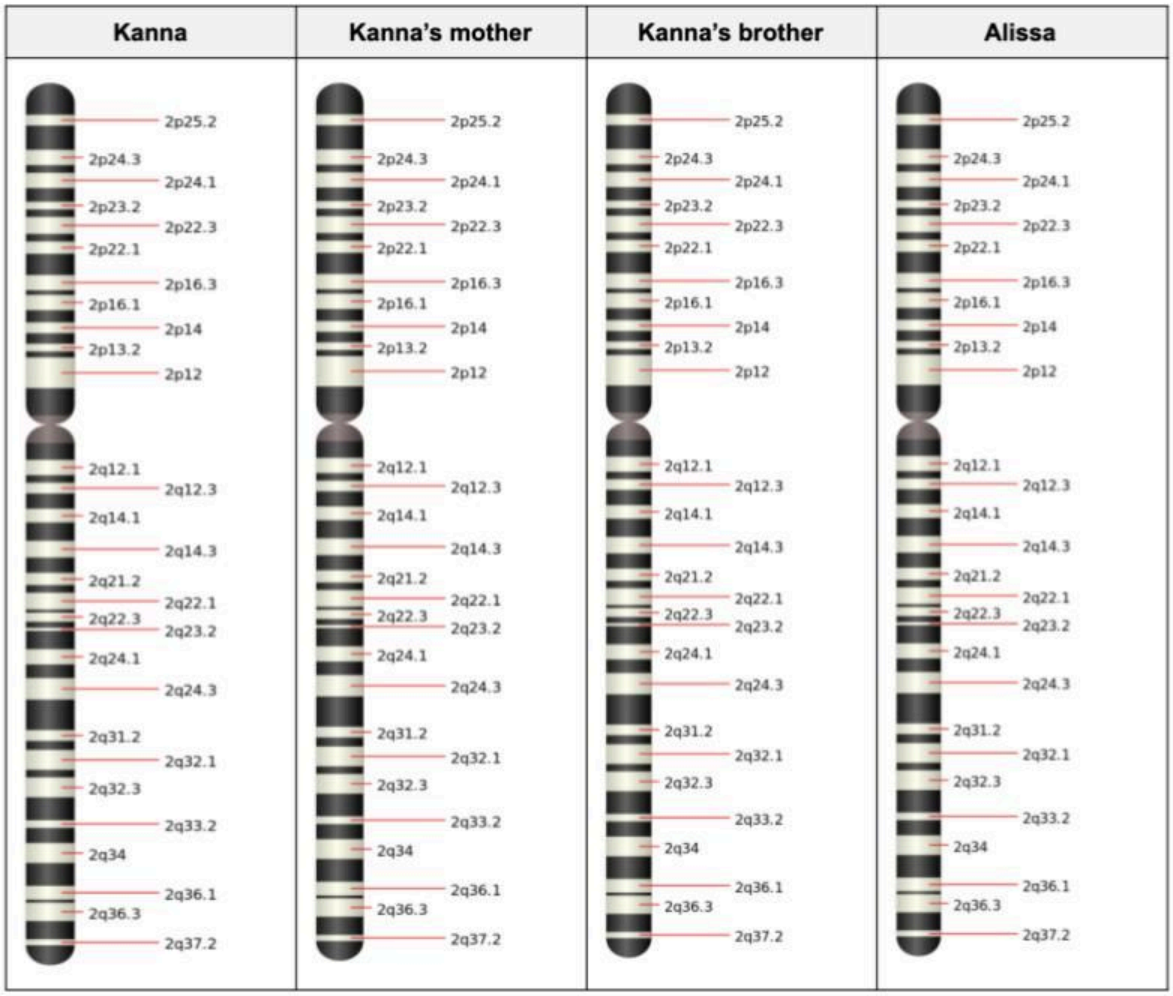
Directions: Use the information below to make comparisons about the genetic information between individuals. Note all of your observations in the data table below.

Data Table: Comparing the DNA of each individual

Individual	Figure 1	Table 1	Table 2
Kanna			
Kanna's mother			
Kanna's brother			
Alissa			

Figure 1: Chromosome 2 structure for each individual

Note: All chromosomes demonstrate a banding pattern (the light and dark regions). The bands help us locate specific genes on the chromosome.The numbers and letters represent different locations on the chromosome. For example 2p25.2 means: 2 = 2nd chromosome, p = shorter part of the chromosome (top), 25.2 = position



Chromosome with lactase gene

Table 1: Sequence of DNA from the lactase gene for each individual

Note: Remember that we receive 2 copies (alleles) of each gene, one from each parent

Individual	DNA Sequence
Kanna	*Allele 1: ATA-AAG-GAC-ACT-CTT-GAC-AA* *Allele 2: ATA-AAG-GAC-ACT-CTT-GAC-AA*
Kanna's mother	*Allele 1: ATA-AAG-GAC-ACT-CTT-GAC-AA* *Allele 2: ATA-AAG-GAC-ACT-CTT-GAC-AA*
Kanna's brother	*Allele 1: ATA-AAG-GAC-ACT-CTT-GAC-AA* *Allele 2: ATA-AAG-GAC-ACT-CTT-GAC-AA*
Alissa	*Allele 1: ATA-AAG-GAC-ACT-CTT-GAC-AA* *Allele 2: ATA-AAG-GAC-ACT-CTT-GAC-AA*

Table 2: Sequence of DNA upstream (before) the lactase gene for each individual

Individual	DNA Sequence
Kanna	*Copy 1: TTA-CGG-TAA-ATT-AAT-GCC-AA* *Copy 2: TTA-CGG-TAA-ATT-AAT-GCC-AA*
Kanna's mother	*Copy 1: TTA-CGG-TAA-ATT-AAT-GCC-AA* *Copy 2: TTA-CGG-TAA-ATT-AAT-GCC-AA*
Kanna's brother	*Copy 1: TTA-CGG-TAA-ATT-AAT-GCC-AA* *Copy 2: TTA-CGG-TAA-ATT-AAT-GCC-AA*
Alissa	*Copy 1: TTA-CGG-TAA-ATT-AAT-GCC-AA* *Copy 2: TTA-CGG-TAA-ACT-AAT-GCC-AA*

Making Sense of DNA Comparison

Analysis Questions

Use the data you collected in Data Table 1. Comparing the DNA of Individuals and your understanding of biology to respond to the following prompts.

1. Describe the differences and similarities between the structure of chromosome 2 across the four people (Figure 1).

2. Explain the relationship between the chromosome depicted in Figure 1 and the data found in Table 1 and Table 2. You can describe the relationship in words, or by generating a visual representation/ model.

Description:

3. Compare the DNA sequences found in Table 1 and Table 2 across the four people. What are the similarities and differences?

4. Based on your understanding of lactase intolerance and the data from this investigation, why do you think that some people have the ability to easily digest dairy in adulthood, while others cannot?

DNA Comparison Investigation Rubric

Student Rubric - DNA Comparison Investigation
How did you do in the investigation?

	Student Self-Score Select one		
I know how this investigation connects to our current unit.	No - I need help.	Almost	Yes
I was able to contribute to the See-Think-Wonder and respond to the evaluation questions.	No- I need help.	Almost	Yes
I used my time well in this investigation.	No	Mostly	Yes
I plan to come in for extra help to complete parts of the investigation or ask questions.	No		Yes

What other resources could you have used to get more out of this investigation?

- More time
- More resources
- More information
- More help from my partners
- More help from my teacher
- Other:

Partner Rubric - DNA Comparison Investigation
How did your partners do in the investigation?

Directions: Think back to how your partners participated in the lab. For each of the four categories, write the name(s) of your partner(s) in the appropriate box.

	Unsatisfactory	**Pretty Good**	**Excellent**
Contributions	Did not participate.	Did the minimum of what was required.	Provided useful ideas when participating in discussion.
Working with Others	Rarely listened to others. Disrupted or discouraged others' attempts to participate.	Usually listened to, shared with, and supported the efforts of others.	Listened to, shared with, and supported the efforts of others.

Time Management	Procrastinated, did not use school time or schedule provided to get work completed.	Mostly used time well and completed investigation on time.	Used time well to ensure things get done on time.

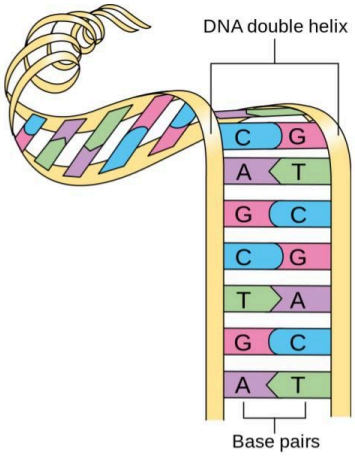
Non-coding DNA Text

Guiding Question: ***Why are some people able to digest milk into adulthood, but others cannot?***

Directions:

1. Reference your DNA/Proteins model as a starting point in responding to the guiding prompt.
2. Read the text, highlight or underline information that may be useful:
    a. In refining or revising the DNA/Protein model
    b. In responding to the guiding question

Proteins, like lactase, do the 'work' of the cell. The instructions our cells need to make these important proteins are found in our DNA. Remember that DNA is composed of long stretches of nucleotides that contain nitrogenous bases, represented by the letters, A,T, G, and C. DNA can be organized into sections. The sections of DNA that have those instructions for the creation of proteins are called **genes.** We also refer to these sections of DNA as coded regions, because they contain the code or the instructions for a protein.

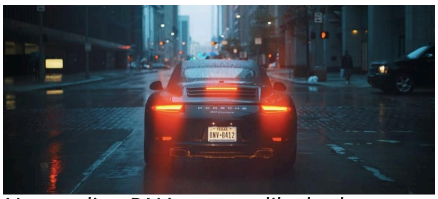


When we unwind DNA, we can see that it is made up of long stretches of nucleotides (A,T,C,G)

Only about 1% of DNA is considered coding DNA. In other words, 1% of all of the DNA in a cell is composed of genes or holds the information needed to create proteins. The other 99% of DNA is not composed of genes, called **non-coding DNA**. These long stretches of DNA were once considered to be 'junk' because scientists did not know the function or use of this DNA.

However, subsequent research demonstrated that some non-coding DNA plays a variety of important functions in an organism. Some non-coding DNA plays a protective role. It is located on the edges of chromosomes, thus protecting coding DNA from damage. Another example is that some non-coding DNA located near a gene can play a **regulatory function** by turning that gene on or off or even speeding up or slowing down the creation of a protein.

Lactase is an example of a gene that is regulated by a section of non-coding DNA. Stretches of DNA that surround the lactase gene can essentially stop the production of lactase, without changing the gene itself. As babies, virtually all mammals produce lactase in order to digest breast milk from their mothers. As adults, mammals consume a variety of foods and are no longer dependent on their mothers. Most humans produce lactase as babies, but the gene for lactase is slowed down or silenced as they age, and they are no longer able to effectively digest lactose, the sugar found in milk.


Non-coding DNA can act like brakes on a car. It can stop or even slow down the production of a gene.

Some humans have a mutation in the non-coding DNA that can regulate the lactase gene. This mutation stops the silencing (keep active) of the lactase gene, and these individuals continue to produce lactase into adulthood. This phenomenon is called **lactase persistence** because it is unusual that an adult mammal would produce lactase for their entire lives (or persist in making lactase into adulthood). The remaining people, the majority of the population on Earth, are considered **lactose intolerant** because their lactase gene has been silenced or slowed down.

Non-coding DNA is also partially responsible for making cells different from each other. In multicellular organisms, body systems are made of specialized cells that each perform their specific functions. Every cell in a person's body has the same DNA, but only certain parts of that DNA are used by each cell, so that each cell only makes the proteins it needs. In this case, non-coding DNA turns on the lactase gene in specialized cells that line the small intestine and are responsible for digestion, but silences that same gene in other cell types, like muscle cells.

There is a solution designed for people who are lactose intolerant but want to consume dairy products called lactase pills, which contain the lactase enzyme. These pills are made by isolating lactase from certain types of yeast or bacteria, which have a lactase gene very similar to the human gene and produce a similar enzyme. However, slight differences in structure between the yeast and human lactase enzymes mean that they function a little bit differently in the digestive system, and some people may not find the pills to allow them to consume as much dairy as a lactose tolerant person can.

References:
https://ghr.nlm.nih.gov/primer/basics/noncodingdna
https://www.genome.gov/genetics-glossary/Non-Coding-DNA

CER Rubric

Component	Not Evident	Level 1: Beginning	Level 2: Developing	Level 3: Advancing	Level 4: Proficient
Claim	Does not make a claim	Claim does not answer the question (i.e., describe the relationship between the 2 variables)	Claim does answer the question but it is inaccurate	Claim answers the question, and is accurate, but is incomplete	Claim answers the question, is accurate, and is complete. Completely describes the trend in the relationship between the IV and DV where appropriate
Evidence	Does not provide evidence	Only provides inappropriate evidence (evidence does not support the claim)	Provides appropriate, but insufficient evidence to support the claim. May include some inappropriate evidence	Provides appropriate and sufficient evidence to support the claim. May include some inappropriate evidence	Provides appropriate and sufficient evidence to support the claim
Reasoning: Science Concepts	Does not include reasoning	Restates evidence and does not include explanation of science concepts	Includes explanation of science concepts but all are inappropriate concepts that do not link evidence to claim	Includes explanation of some science concepts that link evidence to the claim, but are insufficient (one or more concepts that should have been included are not included) or some are inappropriate	Includes explanation of science concepts that link evidence to the claim (concepts are appropriate), and they are sufficient (no omission of key science concepts) and are clearly stated and accurate

Reasoning: Logic	Does not include reasoning	Restates evidence or claim and does not include a logic statement that links the evidence to the claim	Attempts to include a logic statement that links the evidence to the claim but does not adequately link the evidence to the claim	Includes a logic statement that attempts to link the evidence with the claim but needs to be more clearly stated to demonstrate logical reasoning	Includes a logic statement that links the evidence to the claim (including words such as *because* and *therefore*) that clearly demonstrates logical reasoning

Summary Task

Today we completed a class consensus discussion. How did it go?

1. One thing that went well in the discussion:

2. One thing we can improve the next time we have a discussion:

3. One person who helped me learn today:

4. What did you learn from this person?

5. One idea that I contributed to my group or my class:

Explain what you know about the following questions based on what we discussed today.

1. Using lactase as an example, describe the relationship between chromosomes, genes, DNA, and proteins. (This could also be a drawing)

2. Explain why some adults have the ability to digest dairy, while others do not.

3. Describe one example from class in which you investigated a new system or structure to reveal how it works or to solve a problem.

Read-Generate-Sort-Solve Organizer

Guiding prompts:
Why do some populations have the ability to digest dairy into adulthood but not others? Why would it be advantageous to be able to digest the milk of other animals?

1. **Watch** the video.
2. **Generate** ideas on which claim is better supported by the scientific ideas presented in the texts, video, or evidence from your investigation.

Name: _____	**Name: _____**	**Name: _____**

3. **Sort -** Discuss each solution or idea and ☆star☆ or highlight the ideas that seem the most useful.
4. **Solve -** Individually write a response to the prompt incorporating the most useful ideas from the sorting process. Use evidence from the investigation and reasoning from the texts to support your claim.

5. Reflect: How do you think the fact that the mutation exists in certain populations could help us understand evolution and relationships between people and populations?

6. Reflect: What additional questions do you have about how genes can tell us about evolution and relationships? What information would you need in order to better understand the relationship between genetic information and evolution?

Lactase Persistence Engineering Mini-Rubric

Explanation of a mismatch	Identifying a problem:
	• The mismatch problem of lactase persistence or lactase intolerance is described
	• An accurate explanation of the following science concepts are included:
	  • How a system of specialized cells create lactase, which is needed to break down lactose into smaller components (to avoid illness)
	  • The relationship between DNA, genes, and traits
	  • How regulatory genes can influence the expression of a trait
		Circle or Highlight One:
		
		Proficient - Includes **all** of the components
		
		Developing - Includes **some** of the components

The Design Cycle	Engaging with the design cycle:
	• An initial description of the design cycle includes:
	  • Identifying the problem
	  • Brainstorming solutions
	  • Using science concepts and/or research to inform the initial solution
	  • The CCC of **Structure & Function** is used to connect the science concepts and the possible solution(s)
		Circle or Highlight One:
		
		Proficient - Includes **all** of the components
		
		Developing - Includes **some** of the components

Notes, Ideas, and Questions	The open sketch portion of the engineering journal is used to: • Note down additional ideas • Initial design sketches • Additional research • Additional questions	Circle or Highlight One: Proficient - Includes **all** of the components Developing - Includes **some** of the components
Self-Evaluation	Grow: Glow:	
Teacher / Peer Evaluation	Grow: Glow:	

Leptin Resistance 5E

Unit 3 Evolution of Sick Humans	Biology

Student Name:

The Role of Leptin Investigation

Research Question:

Introduction: The ability to store fat is an advantageous trait that benefits our survival. However, some people's bodies store excess fat, a condition called obesity. One protein that plays an important role in fat storage is called leptin. Leptin is secreted by fat cells and regulates hunger. In this investigation, you will examine data from two different research studies on fat storage, obesity, and the role of leptin.

Procedure:

Using a jigsaw process, as a group you will engage with two different research excerpts (data sets and brief summaries of scientific articles that include graphs).

1. Starting from a home group you will be assigned to look at one of the article summaries in pairs
2. Using a See-Think-Wonder organizer, work with your partner to generate observations and questions about your assigned study and data set
3. Collaborate with your partner to develop a summary of your assigned study and independently write your summary using the sentence frames given below.
4. Return to your home groups; each pair shares out about their study using the written summary as a guide
5. Each group member takes notes in the space provided below as they listen to each summary
6. Collaboratively decide on high-level observations and questions about the two studies and then independently write your high level observations and questions on them

Written Summary:

The following sentence frames may be helpful:

- The title of study is…
- The researchers in this study wanted to know…
- The researchers found that…
- These findings are interesting and/or connected to… because…
- The study design did/did not provide evidence that as to whether ____ causes ____ because __

Notes on Shared Summaries

Collaborative High-Level Observations and Questions on the Two Studies

See-Think-Wonder Organizer

See *What do you see in the data*	**Think** *What does the data make you think about?*	**Wonder** *What does the data make you wonder about?*
• I see a relationship between ___ and blank ___ • I see that ___ • As ___ increases/decreases ___ increases/ decreases / stays the same	• The data provided is/ is not sufficient to conclude that ____ causes ___ • I would want to collect ____ data before claiming ___ causes _____	

The Role of Leptin Research Excerpts

Study #1: Blood Leptin Levels and Weight in Japanese Women

Researchers were interested in finding out more about factors that might contribute to osteoarthritis. Osteoarthritis is the most common form of arthritis, affecting millions of people worldwide. It occurs when the protective cartilage that cushions the ends of your bones wears down over time. Although osteoarthritis can damage any joint, the disorder most commonly affects joints in your hands, knees, hips and spine. Fifty Japanese women with knee osteoarthritis (age: 50-88 years) were recruited for a study. Radiographs (x-rays) of the knee were taken, leptin levels in the blood were measured, the women were weighed, and their total fat mass was calculated. Some of the results are presented below:

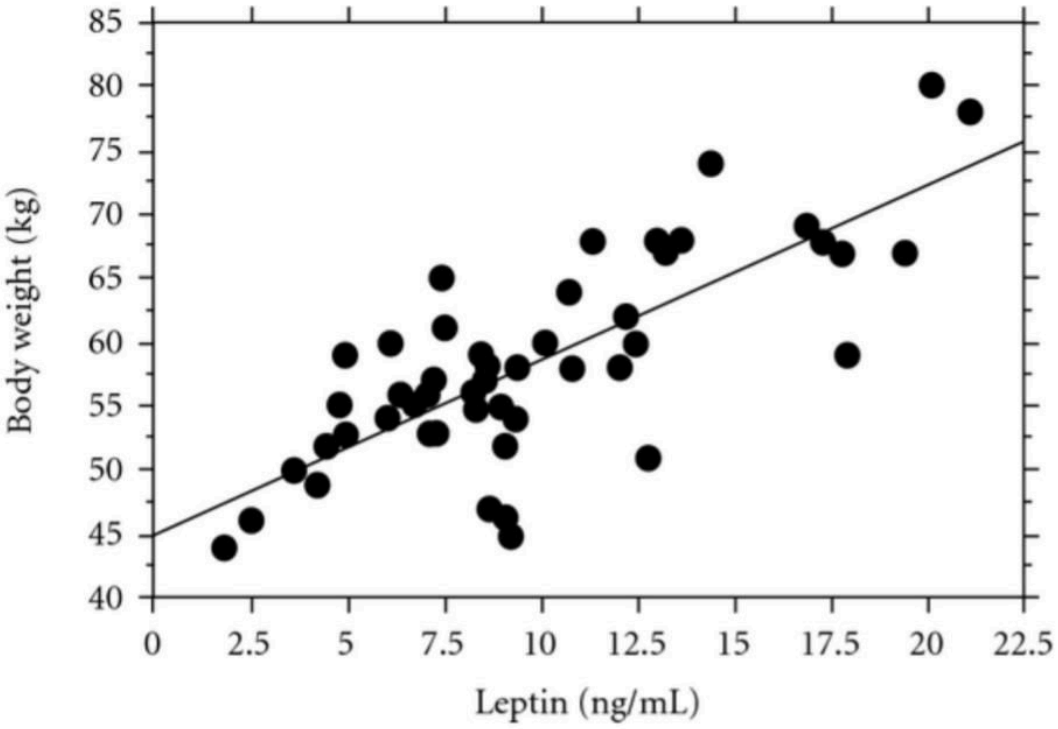


Figure (a) Correlation between serum leptin level and body weight

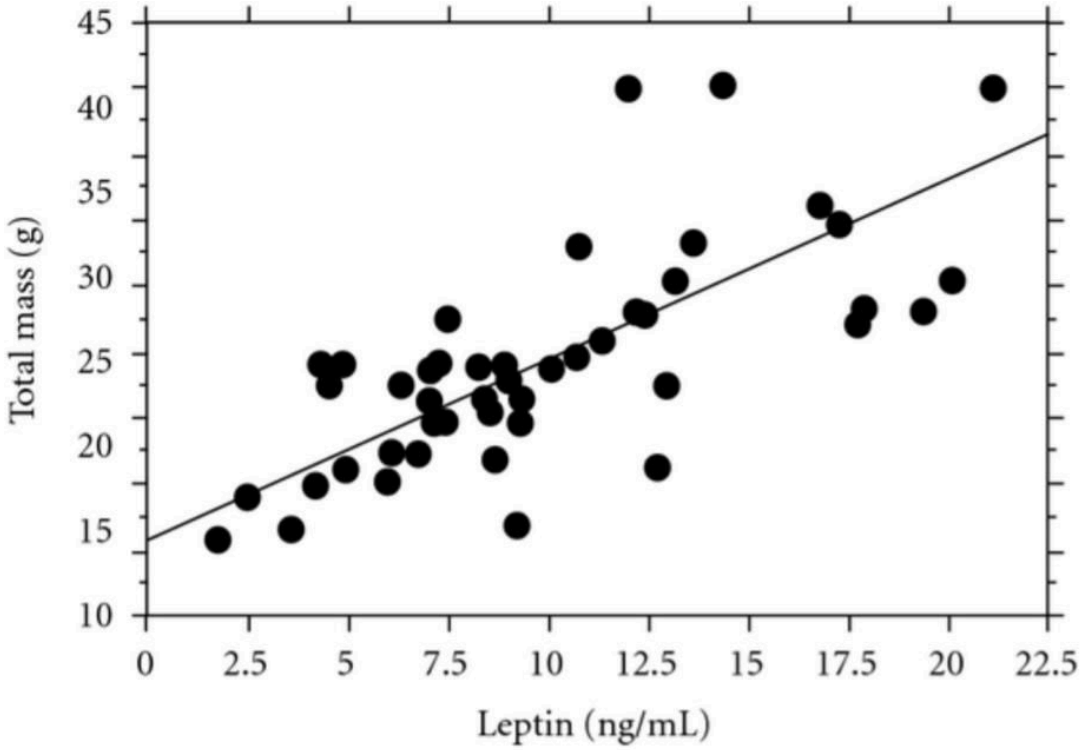


Figure (b) Correlation between serum leptin level and total fat mass

Study #2: The Impact of Dietary Fructose on Obesity

Researchers were interested in finding out if a high-fructose diet (fructose is a sugar) has an impact on how leptin works in the body and on obesity. The researchers designed an experiment with two groups of rats. One group was given a control diet (not high in fructose), and the second group was fed a high-fructose diet for six months. They then tested how well leptin was doing its job in all of the rats. In order to test if leptin was working in their bodies, the rats were given either an injection of saline or of leptin and then recorded how much food each group of rats ate. Food intake was then tracked for 24 hours. Finally, in each group, 50% of those rats were given a diet either high in fat, or they continued on with the respective diet they had been on (either high-fructose or the control diet) for two weeks. Finally, all of the rats were evaluated for weight gain, adiposity (how much fat they stored), and their blood leptin levels. Some of the results are presented below:

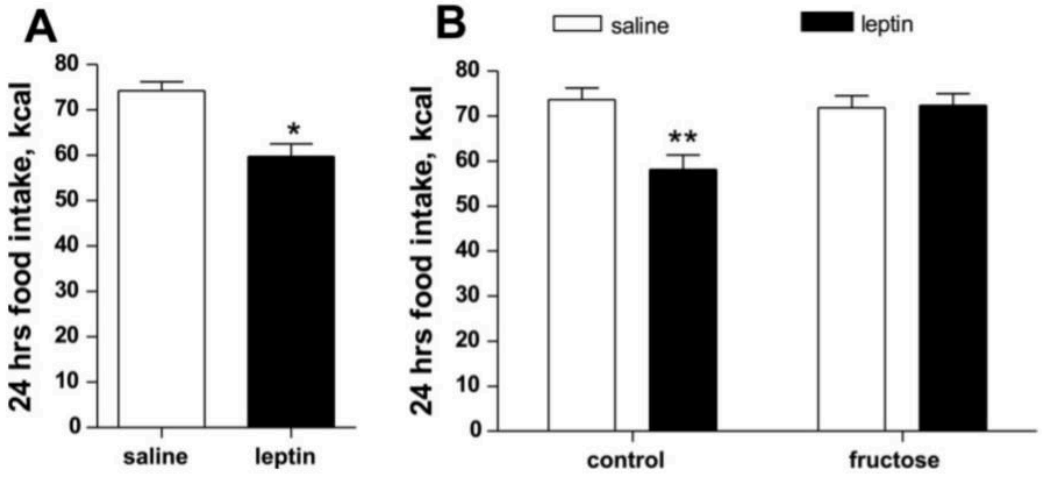


Figure (a) Leptin responsiveness as measured by cumulative food intake 24 h after an injection of either saline or leptin prior to initiating the experimental diets (A) and after 6 months on either the fructose-free control or the high-fructose diet (B). The values used are the mean of each group of rats, and the error bars represent the variation around that mean value.

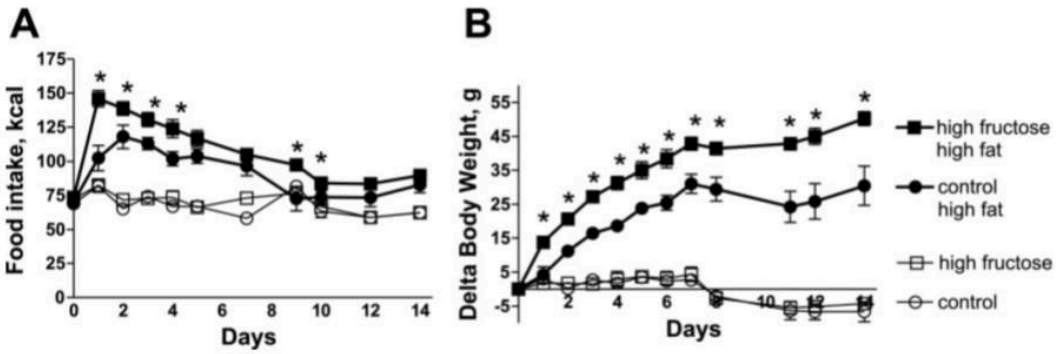


Figure (b) Food intake (A) and change in body weight (B) in rats either maintained on the fructose-free or high-fructose diets or switched from the control to high-fat diet or from high-fructose to high-fat diets. The values used are the mean of each group of rat, and the error bars represent the variation around that mean value.

Table 1. Blood Leptin Levels and Adiposity at the End of the Experiment

	Control Diet	High Fructose Diet	Control + High Fat Diet	High-Fructose + High-Fat Diet
Adiposity (in grams)	129.8	129.1	138.9	143.3
Blood Leptin Levels (ng/dl)	5.4	5.0	10.1	10.4

The Role of Leptin Investigation Rubric

Student Rubric - The Role of Leptin Investigation

How did you do in the investigation?

	Student Self-Score Select one		
I know how this investigation connects to our current unit.	No - I need help.	Almost	Yes
I was able to contribute to the See-Think-Wonder and / or respond to the analysis questions.	No- I need help.	Almost	Yes
I used my time well in this investigation.	No	Mostly	Yes
I plan to come in for extra help to complete parts of the investigation or ask questions.	No		Yes

What other resources could you have used to get more out of this investigation?

- More time
- More resources
- More information
- More help from my partners
- More help from my teacher
- Other:

Partner Rubric - The Role of Leptin Investigation

How did your partners do in the investigation?

Directions: Think back to how your partners participated in the lab. For each of the four categories, write the name(s) of your partner(s) in the appropriate box.

	Unsatisfactory	Pretty Good	Excellent
Contributions	Did not participate.	Did the minimum of what was required.	Provided useful ideas when participating in discussion.
Working with Others	Rarely listened to others. Disrupted or discouraged others' attempts to participate.	Usually listened to, shared with, and supported the efforts of others.	Listened to, shared with, and supported the efforts of others.
Time Management	Procrastinated, did not use school time or schedule provided to get work completed.	Mostly used time well and completed investigation on time.	Used time well to ensure things get done on time.

Protein Synthesis Handout

Guiding Question: How is leptin made in the body?

Introduction
Proteins do all of the work in an organism. Scientists have identified several proteins that impact how we regulate fat storage and may play a role in obesity. One protein we will explore is a hunger regulating protein called leptin. Leptin is a protein-based hormone. Leptin is produced in our fat cells and helps to regulate hunger, thus how much energy we consume. It may be helpful to understand how leptin is created in fat cells so we can investigate the role it may play in obesity.

Directions:

1. **Watch** each of the following animations on silent. Animations: Transcription and Translation (protein synthesis).
2. **Describe** what you see in your own words (don't worry about specific vocabulary at this stage). Write your observations in the left-hand column.
3. **Read** the *Protein Synthesis Text*, and **summarize** the key ideas in the right-hand column.
4. **Draw** an arrow connecting your description from the left to the summary on the right-hand side.
5. Write a final **summary** of the entire process using the terms: DNA, chromosome, gene, protein, codes, instructions, form, function

Description from animation	Summary from text
Transcription: Translation:	

Summary:

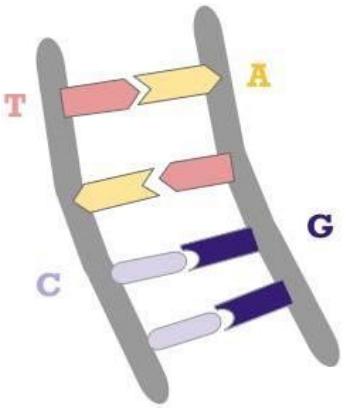
Protein Synthesis Text

How are proteins created?

Protein synthesis is the process by which cells make proteins. These proteins are used in a variety of biochemical processes and play a role in the presence or absence of the traits of an organism. For example, through protein synthesis, skin cells produce a protein called melanin that is responsible for determining skin color. The information detailing the production of a specific protein is usually contained in one section of DNA, called a **gene**. However, sometimes multiple genes provide the information to produce a single protein or trait, or one gene can influence multiple proteins and traits. Some stretches of DNA do not code for proteins at all but instead serve regulatory functions. Additionally, there are some stretches of DNA that as of yet, have no known function.

In **eukaryotes**, the first step of protein synthesis (called **transcription**) begins in the **nucleus** of the cell. An enzyme unwinds the needed section of DNA and using complementary **base-pairing**, creates a complementary single strand of RNA. In base-pairing, the original DNA strand is used as a template, and an enzyme matches up the corresponding RNA nucleotides (base). Base pairing works by matching up complementary bases in the DNA. For example, adenosine (A) always matches up with thymine (T).

This single RNA strand is called **messenger RNA** (mRNA) and since it is smaller than a DNA molecule, it can leave the nucleus through tiny openings called nuclear pores. The DNA itself does not leave the nucleus, therefore the mRNA serves as a copy of the original genetic information found in the DNA.



Complementary base pairing

Once the mRNA is in the cytoplasm, it can interact with an organelle called the **ribosome**. Once the mRNA has reached the ribosome, the second phase of protein synthesis, called **translation**, can begin. Within the ribosome, the information coded in the messenger RNA is translated into an amino acid sequence which will form a protein.

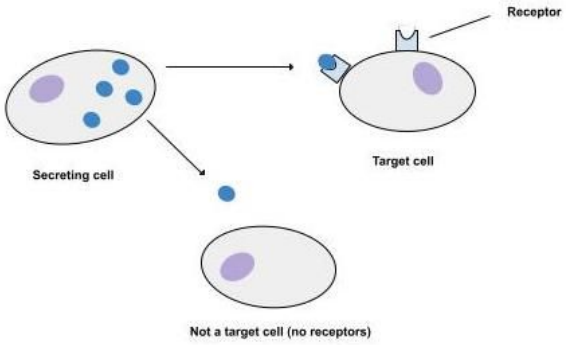
The first step in translation is when a transfer molecule approaches the messenger RNA. The transfer molecule is interesting because it is divided up into two parts. On the bottom, it possesses a specific sequence of 3 bases. On the top, it holds a specific **amino acid** that corresponds with those 3 bases.

Within the ribosome, the transfer molecule matches up with a complementary 3-base sequence on the messenger RNA strand. Once it has matched up, or bound, with the mRNA strand, it releases its amino acid. Then, the next transfer molecule that is complementary to the next 3 bases on the mRNA binds with the mRNA and leaves its amino acid. The amino acids bind together to form a specific sequence and eventually a protein. Therefore, the sequence of bases found in the mRNA is *translated* into a set of amino acids that bind to form a protein. Each protein is made up of a unique sequence of amino acids that is formed based on the information originally contained in DNA.

Leptin Resistance Text

Human bodies are designed to store fat. Fat plays many different roles in the body, including energy storage, vitamin storage, insulation, and is essential for reproduction and health. Throughout human history, it has been advantageous to store some body fat. However, we are currently experiencing the problem that too many people are storing too much fat. The storage of too much fat, called obesity, may cause health problems such as diabetes and arthritis.

Leptin resistance has been identified as one contributor to obesity. Leptin is a protein that is produced in fat cells during a meal. The gene for leptin is activated, and through protein synthesis, DNA is transcribed into RNA, and RNA is translated into a specific sequence of amino acids. The sequence of amino acids forms the protein, leptin. When leptin is secreted from fat cells, it travels through the bloodstream and reaches the hypothalamus in the brain. Because leptin is made up of a specific sequence of amino acids, it has a specific shape. The shape of leptin fits into the leptin receptor in the hypothalamus, telling the brain to reduce appetite. Generally, if an individual has more fat cells, they produce more leptin, thus lowering hunger. If a person does not have a lot of fat, less leptin is produced, thus increasing hunger and encouraging food consumption.



Leptin binding to hypothalamus cell receptor.

If the leptin receptor becomes over-stimulated (used too much) or damaged, the leptin no longer fits inside of the receptor and does not communicate to the hypothalamus to reduce appetite. This is called leptin resistance. Leptin resistance may be, in part, caused by the overconsumption of high-fat and high-sugar food. Other causes of leptin resistance are chronic inflammation, lack of exercise, and the over-consumption of processed foods. Some people have genetic variations that may also impact leptin resistance.

Leptin Resistance Sequence Chart Summary

Documenting the Leptin Resistance Sequence Chart

In the space below, draw, sketch, or insert a picture of the leptin resistance sequence chart.

Individually respond to the prompts below:

1. According to the text and sequence chart, describe one way in which fat cells are specialized to help the body perform an essential function of life

2. How did you use evidence from the texts and research studies to inform the order of causes and effects in your sequence chart?

3. Pretend that a friend of yours is out sick today. In your own words, and using diagrams or drawings to help you communicate clearly, explain how leptin resistance occurs.

Role of Genetics & Environment Investigation

Research Question:

Introduction: The ability to store fat is an advantageous trait that benefits our survival. However, some people store excess fat, called obesity. In the previous investigation, we looked at the role of leptin. However, fat storage and hunger regulation in an individual are complex. In this investigation, you will examine data from two different research studies on fat storage, obesity, and the roles of genetics and environmental factors.

Procedure:

Using a jigsaw process, as a group you will engage with another two different research excerpts (data sets and brief summaries of scientific articles that include graphs).

1. Starting from a home group you will be assigned to look at one of the article summaries in pairs
2. Using a See-Think-Wonder organizer, work with your partner to generate observations and questions about your assigned study or data set
3. Collaborate with your partner to develop a summary of your assigned study and independently write your summary using the sentence frames given below
4. Return to your home groups; each pair shares out about their study using the written summary as a guide
5. Each group member takes notes in the space provided below as they listen to each summary
6. Collaboratively decide on high-level observations and questions about all the four of the studies (the two from your last investigation and the two here) and then independently summarize them below

Written Summary:

The following sentence frames may be helpful:

- The title of study is…
- The researchers in this study wanted to know…
- The researchers found that…
- The study design did/did not provide evidence that as to whether ____ causes ____ because __
- These findings are interesting and/or connected to… because…

Notes on Shared Summaries

Collaborative High-Level Observations and Questions on the Four Studies

Study #3: Genetic Influences on Childhood Eating Behavior

Researchers wanted to understand how genetics influences eating behavior, such as food avoidance or overconsumption of food, and therefore the likelihood of a child storing too much fat (obesity). Questionnaires have been given to parents in order to collect large amounts of data on childhood eating behaviors. To examine this data, two different approaches have been taken:

1) Quantitative genetic studies estimate broadly the extent to which behavior is influenced by genes or environment. Twins are often used in these types of studies because identical twins share 100% of the same genes, while fraternal twins share between 38-61% (or on average 50%) of the same genes just like any two siblings do. Both types of twins share the same environment (same access to food, family culture, etc.) so if there is a greater similarity between identical twins compared to fraternal twins, it suggests that genes influence eating behavior. Heritability is the statistic that is derived from twin studies, and it indicates the extent to which individual differences in the sample are explained by genetic variation. The statistic ranges from 0% (genetic variation does not contribute to individual differences) to 100% (individual differences can be explained entirely by genetic variation).

2) Molecular genetic studies try to identify the specific genes that may influence both eating behaviors and the likelihood of someone storing excess fat. Recent advances in technology and the Human Genome Project have made it possible to explore the impact of millions of genetic variants (variations) on traits such as obesity across the wider population.

Some of the results of these analyses are below:

Table 1: Results from Quantitative Genetic Studies

Indicator	Heritability
General Body Weight	70%
Responsiveness to Food Cues (likely to consume more food)	75%
Satiety Responsiveness (likely to consume less food)	63%
Eating Speed	63%
Enjoyment of Food	53%
Food Responsiveness in Infants	59%

Table 2: Example Genetic Variants found in Molecular Genetics Studies

Gene Variation	Impact	Notes
A set of mutations in genes that regulate leptin production	• Causes severe early on-set obesity • Associated with voracious appetite	• Extremely rare • Does not explain variations in weight across a population
Variations in the FTO gene (fat mass and obesity-associated gene)	• Associated with observational measures of food responsiveness • Associated with satiety responsiveness • People with 2 or more variants in this gene are on average 6.6 pounds heavier than those with no variants	• Nearly half of the population have at least 1 variant in this gene

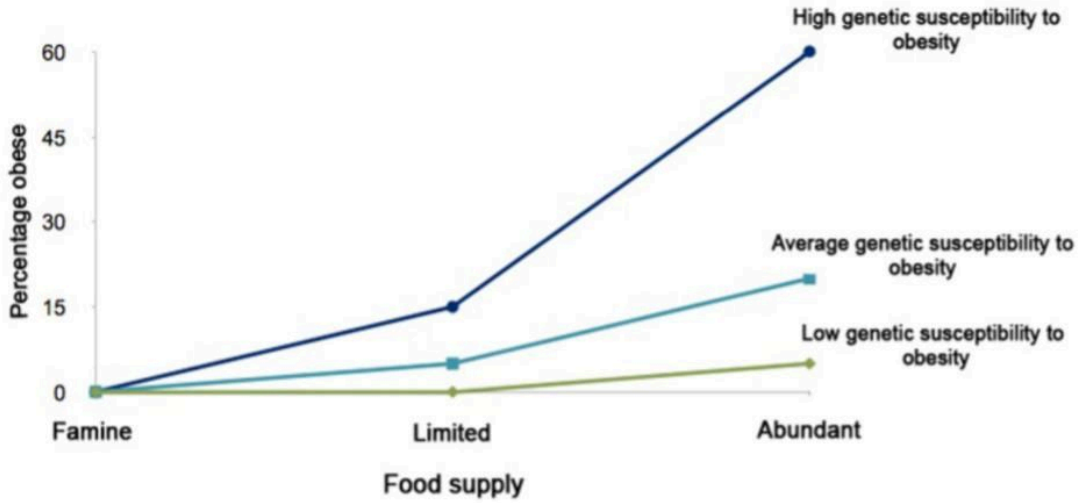


Figure (a) is a hypothetical demonstration of the percentage of children who are obese under three different environmental conditions, according to whether they have a low, average, or high genetic susceptibility to obesity.

Study #4: The global childhood obesity epidemic and the association between socio-economic status and childhood obesity.

Childhood obesity has become a global public health crisis. Researchers wanted to understand the extent of the problem and if there is an association between socioeconomic status and childhood obesity. One important indicator that is used to measure the prevalence of overweight or obsese children is BMI, or body mass index (BMI = weight/height (kg/m2)). The researchers used data from the World Health Organization (WHO) and other similar global organizations to better understand how many children are overweight or obsese across the globe and if there is an association between being overweight and socioeconomic status. Some of the results of these analyses are below:

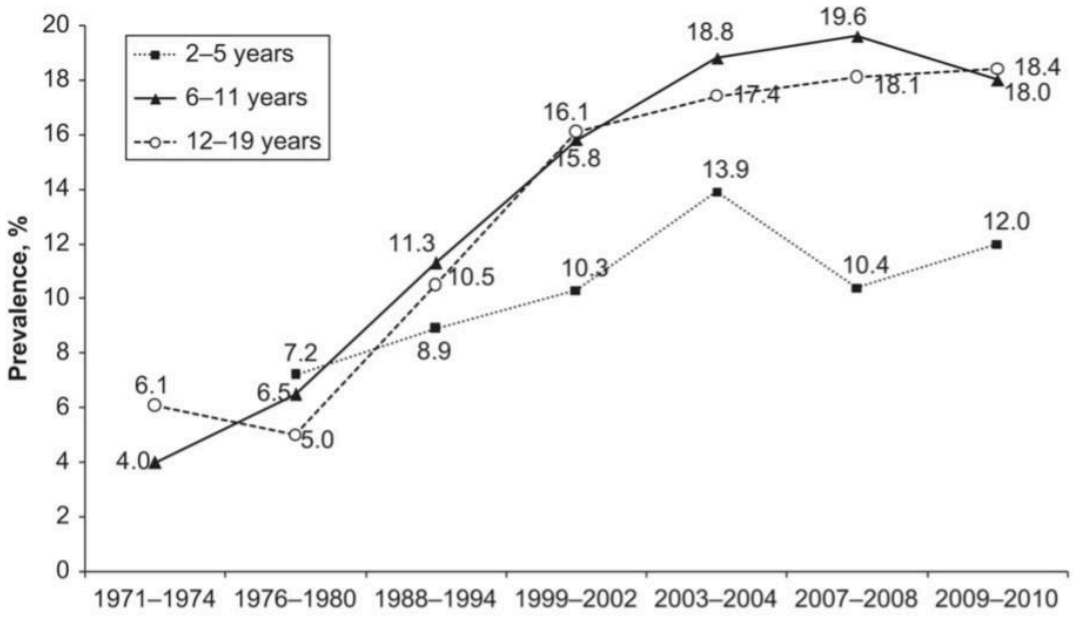


Figure 1. Trends in the prevalence (%) of obesity (BMI ≥ 95th percentile) in US children and adolescents by age: 1971–1974 to 2009–2010.

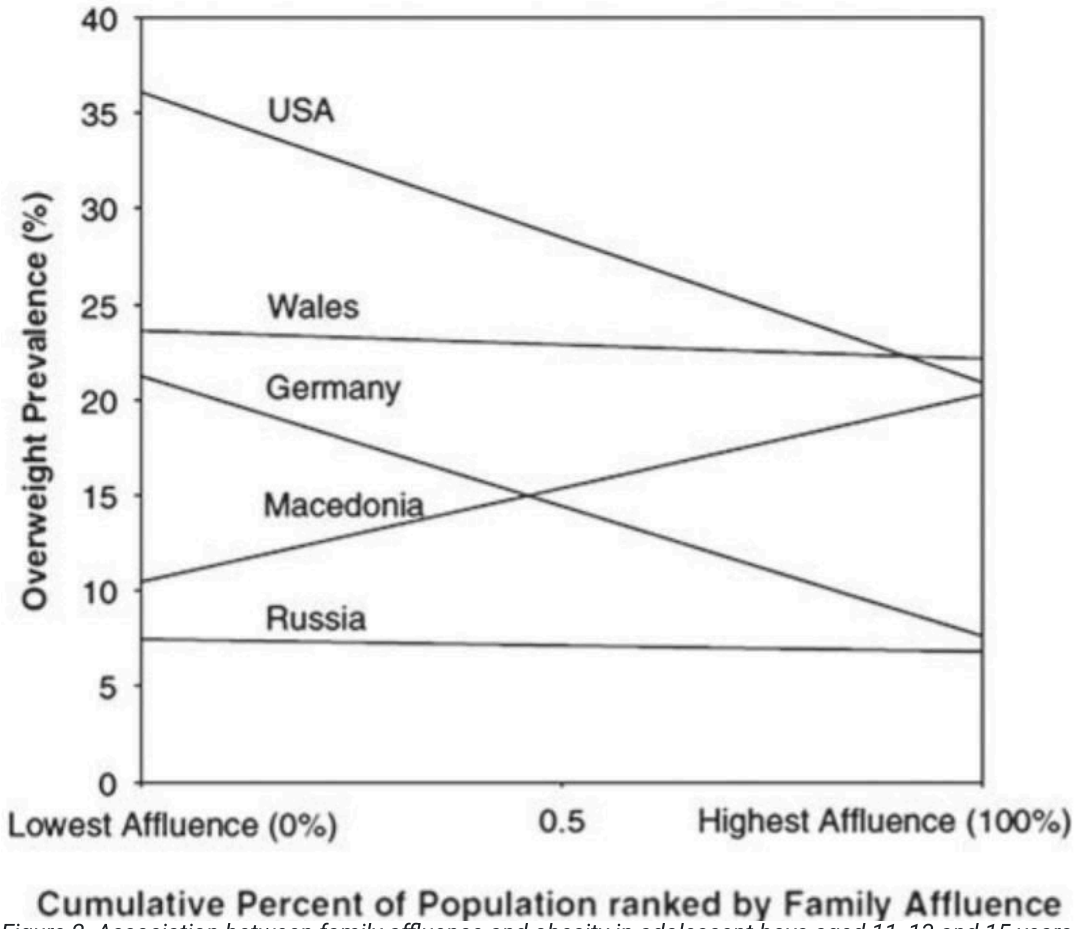


Figure 2. Association between family affluence and obesity in adolescent boys aged 11, 13 and 15 years from five countries. Family affluence was measured as a function of family possessions (e.g. car ownership, number of computers, child had own bedroom) and number of family travels over the past year.

Table 1: Time trends in the combined prevalence (%) of overweight and obesity in preschool-age children aged 0 – 5 years for the years from 1990 to 2010 and projections for 2015 and 2020, by United Nations (UN) region. *Note that the data is from 2012, so 2015 and 2020 are projections based on the data available at that time.

UN Region	1990	1995	2000	2005	2010	2015	2020
Global	4.2%	4.6%	5.1%	5.8%	6.7%	7.8%	9.1%
Africa	4.0%	4.7%	5.7%	6.9%	8.5%	10.4%	12.7%
Asia	3.2%	3.4%	3.7%	4.2%	4.9%	5.7%	6.8%
Latin America & the Caribbean	6.8%	6.8%	6.8%	6.9%	6.9%	7.0%	7.2%
Oceania	2.9%	3.1%	3.2%	3.3%	3.5%	3.6%	3.8%

See-Think-Wonder Organizer

See	Think	Wonder
• I see a relationship between ___ and blank ___ • I see that ___ • As ___ increases/decreases ___ increases/ decreases / stays the same	• The data provided is/ is not sufficient to conclude that ____ causes ___ • I would want to collect ____ data before claiming ___ causes _____	

The Role of Genetics & Environment Investigation Rubric

Student Rubric - The Role of Genetics & Environment Investigation

How did you do in the investigation?

	Student Self-Score Select one		
I know how this investigation connects to our current unit.	No - I need help.	Almost	Yes
I was able to contribute to the See-Think-Wonder and / or respond to the analysis questions.	No- I need help.	Almost	Yes
I used my time well in this investigation.	No	Mostly	Yes
I plan to come in for extra help to complete parts of the investigation or ask questions.	No		Yes

What other resources could you have used to get more out of this investigation?

- More time
- More resources
- More information
- More help from my partners
- More help from my teacher
- Other:

Partner Rubric - The Role of Genetics & Environment Investigation

How did your partners do in the investigation?

Directions: Think back to how your partners participated in the lab. For each of the four categories, write the name(s) of your partner(s) in the appropriate box.

	Unsatisfactory	Pretty Good	Excellent
Contributions	Did not participate.	Did the minimum of what was required.	Provided useful ideas when participating in discussion.
Working with Others	Rarely listened to others. Disrupted or discouraged others' attempts to participate.	Usually listened to, shared with, and supported the efforts of others.	Listened to, shared with, and supported the efforts of others.
Time Management	Procrastinated, did not use school time or schedule provided to get work completed.	Mostly used time well and completed investigation on time.	Used time well to ensure things get done on time.

Think-Talk-Open Exchange + Buzzwords Organizer

1. **Think -** Individually respond to the prompt in the space below.

From an evolutionary perspective, being able to store fat is an advantageous trait. However, the number of people (including children) that are storing excess fat is increasing. Using evidence and scientific reasoning from this learning sequence, construct an explanation for why some populations of people might be experiencing an increase in excess fat storage (obesity). Be sure to use the following words and ideas in your explanation.:

Buzzwords: leptin resistance, gene(s), DNA, protein, cause/causal, empirical evidence.

2. **Talk**: Share with your group one at a time. Record a tally mark (✔✔✔✔) each time you hear a specific buzzword during the share.

	Leptin Resistance	Gene	DNA	Protein	Cause/ Causal	Empirical evidence
Person 1						
Person 2						

3. **Open Exchange:** As a group, discuss the following questions- be sure to use the buzzwords!

- Describe patterns or commonalities between what each group member shared.
- Which buzzwords did you hear the most? Least?
- Are there buzzwords that your group doesn't understand?
- Are there other words you heard a lot? If so, which words?

4. **Reflection -** Individually respond to the prompt below.

What are some new ideas you heard during your discussion with your group?

Summary Task

Today we completed a class consensus discussion. How did it go?

1. One thing that went well in the discussion:

2. One thing we can improve the next time we have a discussion:

3. One person who helped me learn today:

4. What did you learn from this person?

5. One idea that I contributed to my group or my class:

Explain what you know about the following questions based on what we discussed today.

1. Describe where and how leptin is made in the body.

2. Discuss one example of a possible causal relationship discussed in this learning sequence. How did you determine causality and what evidence did you use to differentiate between cause/effect and a correlation relationship?

3. Fat storage is an evolutionarily advantageous trait. Explain how both genetic and environmental influences may lead to excessive fat storage (obesity).

Read-Generate-Sort-Solve Organizer

Insulin is another important protein that serves as a hormone in the body. Insulin is made by a set of specialized cells called the beta cells in the islets of Langerhans portion of the pancreas.

Insulin can also be produced using genetically engineered bacteria. In 1978, scientists successfully inserted the human insulin gene into *E. coli* bacteria. Because the As, Ts, Cs, and Gs of the genetic code are universal, bacterial cells are able to read human genes, and therefore transcribe and translate the gene into insulin protein. The insulin can then be extracted from the bacteria, creating an injectable source of human insulin.

Guiding prompt: Why is injectable insulin a good solution for people with type 1 diabetes, but not insulin resistance?

1. **Watch** the video.
2. **Generate** ideas using evidence from the blurb above, the video, and information from this learning sequence that help explain why injectable insulin is a good solution for people with type 1 diabetes but not insulin resistance.

Name: _____	**Name: _____**	**Name: _____**

3. **Sort -** Discuss each solution or idea and ☆star☆ or highlight the ideas that seem the most useful.
4. **Solve -** Independently respond to the prompt incorporating the most useful ideas from the sorting process! In your response, be sure to
    - Use evidence from the investigation, video, and text blurb and reasoning from the texts to support your claim
    - Describe the difference in causes between type 1 diabetes and type 2 diabetes/insulin resistance
    - Discuss how each condition alters specialized cells and impacts their ability to perform the essential processes of life

Leptin Resistance Engineering Mini-Rubric

Explanation of a mismatch	Identifying a problem:
	• The mismatch problem of leptin resistance is described
	• An accurate explanation of the following science concepts are included:
	  • How a system of specialized cells create leptin
	  • The relationship between DNA, genes, and traits
	  • How resistance is caused by the changing shape of the receptor (due to a combination of genetic and environmental factors) which no longer allows for leptin to bind
		Circle or Highlight One:
		
		Proficient - Includes **all** of the components
		
		Developing - Includes **some** of the components

Engaging with a Design Process	Engaging with the design cycle:
	• An initial description of the design cycle includes:
	  • Identifying the problem & subproblem(s)
	  • Brainstorming solutions
	  • Using science concepts and/or research to inform the initial solution
	  • Identifying appropriate criteria and constraints
	  • The lens of cause and effect is used to connect the science concepts and the possible solution(s)
	  • Includes discussion of evidence needed to make claims about causality
		Circle or Highlight One:
		
		Proficient - Includes **all** of the components
		
		Developing - Includes **some** of the components

Notes, Ideas, and Questions	The open sketch portion of the engineering journal is used to: • Note down additional ideas • Initial design sketches • Develop a representation of a design process • Additional research • Additional questions	Circle or Highlight One: Proficient - Includes **all** of the components Developing - Includes **some** of the components
Self-Evaluation	Grow: Glow:	
Teacher / Peer Evaluation	Grow: Glow:	

Circadian Rhythms 5E

Unit 3 Evolution of Sick Humans	Biology

Student Name:

Jeffrey's Story

Jeffrey's Story

When Jeffrey began high school, his grades took a hit. He was often late to first period classes, despite living closer to his new high school than he had to his middle school, and he felt like he could never focus properly

When Jeffrey spoke to his parents and teachers at parent-teacher conferences, he told them that he was too tired all the time, and it made it hard for him to pay attention. His parents left for work early in the morning and could not make sure that he woke up on time, and he was sleeping through his morning alarms.

His teacher asked what time he was going to bed at night. He told them he often didn't go to sleep until at least 11:30. His parents thought he was up too late scrolling on his phone, and began to take it away at 9:00 every night. But Jeffrey still couldn't sleep. He reported that he'd go to bed by 10 every night, but lie awake for hours. In the morning, he felt exhausted.

Day-Night Cycle Investigation: Part 1

Introduction: In this part of the investigation, we will look at a model organism, a plant called *Mimosa pudica,* the Fairy Sensitive Plant. We will use time-lapse photography to record the plant over the period of 24 hours in order to understand if it demonstrates a day-night cycle. Time-lapse photography is used to take a picture of something at a regular interval so you can observe differences over time.

Materials per group:

- 1 *Mimosa pudica* seedling
- 1 digital camera or phone with a digital camera and a time-lapse photography app such as O'Snap pro
- 1 camera tripod

Procedure:

1. Using the tripod, set up the camera or phone so that it can take a clear photograph of the seedling.
2. Open the time-lapse photography app and set it to take photos at regular intervals, such as every 30 minutes.
3. Start the time-lapse, recording the time below.
4. Run the time-lapse for 24 hours.
5. Observe the time-lapse video and record your observations below.

Data:

Start time and date: _____ End time and date: _____

Table 1. Observations of *Mimosa pudica* seedling over a 24-hour period.

Time period	Day	Night	Day
Observations			

Day-Night Cycle Investigation: Part 2

Introduction: Humans also have distinct activities that differ between night and day. Virtually all animals, including humans, have periods of sleep or sleep-like states. In this investigation, you will use a Google survey to gather information about day-night cycles in people, including variables that might influence their length or quality of sleep.

Procedure:

1. In your groups, brainstorm what you would like to know about human day-night cycles and what factors might influence how long they sleep or how long they are awake in a 24-hour period.
2. As a class, come to a consensus on what information you would like to collect in order to address your most important questions.
3. In groups, propose a survey design using Google Forms that can be given to your classmates and your community.
4. As a class, come to consensus on the survey design.
5. Provide the survey to as many people as possible.
6. Using a See-Think-Wonder organizer, generate observations based on the data collected.

Step 1: Brainstorm what you would like to know about human day-night cycles and what factors might influence how long they sleep or how long they are awake in a 24-hour period.

Step 2: Class consensus.

Points to consider:

- How can you narrow down your questions so that the most important data can be collected?
- How can you design questions that are respectful and can be answered by anyone in your community?

Step 3: In groups, propose a survey design using Google Forms that can be given to your classmates and your community.

Points to consider:

- Is the survey concise and can it be answered quickly and easily?
- Is the survey clear and easy to understand?
- Can the survey be used effectively with all members of the community?
- Does it collect appropriate data that addresses the important questions you surfaced as a class?
- How many people will you try to give the survey to?
- How many days will the survey be filled out by participants?

Notes on the design and link to initial draft of Google Form:

Step 4: Class consensus

Notes on the final design. Include a link to the final Google Form.

Step 5: Analyze your data from the survey using the See-Think-Wonder Organizer.

See	Think	Wonder

Making Sense of the Day-Night Cycle Investigation

Data Analysis:

1. What patterns did you notice in observing the time-lapse video of the plant over a 24-hour period?

2. What patterns did you notice in the survey data about day-night cycles of humans?

3. In the survey data, was there one variable that appeared to cause sleep disruption? What additional evidence would you need to collect to differentiate causality and correlation between sleep disruption and that specific variable?

4. Use the following data to make comparisons between the sleep patterns of your community, the sleep patterns of people across the United States, and the sleep patterns in pre-industrial societies.

Table: Average sleep patterns in the United States and in pre-industrial societies (Hadza, San, and Tsimane people).

Variable	**Average of People in the United States (2014-2016)** Sleep Foundation Data	**Average of People Living in Pre-Industrial Societies** Current Biology Report
Average number of hours of sleep per night	6 hours 36 minutes	6 hours 29 minutes
Reported trouble staying asleep (woke up more than 2x in a night)	70%	Less than 1%

Reported being unable to fall asleep on a regular basis (insomnia)	20%	2%
Time of sleep onset (fell asleep)	10:15pm	11:35pm
Reported that they had an very good or good night night of sleep (4 or 5 on a scale of 1-5)	65%	No data

Summary:

1. Based on the data you collected, how can you describe day-night cycles in plants and in humans?

2. Based on the comparison of sleep patterns in your community, on average across the United States, and in pre-industrial societies, how can you describe sleep patterns in humans?

3. What else do you need to figure out about day-night cycles to better understand our investigative phenomenon?

Evaluation:

1. Evaluate the limitations of the survey you designed. Describe how you could improve the survey to provide more accurate data.

Day-Night Cycle Investigation Rubric

Student Rubric - Day-Night Cycle Investigation

How did you do in the investigation?

	Student Self-Score Select one		
I know how this investigation connects to our current unit.	No - I need help.	Almost	Yes
I was able to contribute to the See-Think-Wonder and / or respond to the analysis questions.	No- I need help.	Almost	Yes
I used my time well in this investigation.	No	Mostly	Yes
I plan to come in for extra help to complete parts of the investigation or ask questions.	No		Yes

What other resources could you have used to get more out of this investigation?

- More time
- More resources
- More information
- More help from my partners
- More help from my teacher
- Other:

Partner Rubric - Day-Night Cycle Investigation

How did your partners do in the investigation?

Directions: Think back to how your partners participated in the lab. For each of the four categories, write the name(s) of your partner(s) in the appropriate box.

	Unsatisfactory	Pretty Good	Excellent
Contributions	Did not participate.	Did the minimum of what was required.	Provided useful ideas when participating in discussion.
Working with Others	Rarely listened to others. Disrupted or discouraged others' attempts to participate.	Usually listened to, shared with, and supported the efforts of others.	Listened to, shared with, and supported the efforts of others.
Time Management	Procrastinated, did not use school time or schedule provided to get work completed.	Mostly used time well and completed investigation on time.	Used time well to ensure things get done on time.

Day-Night Cycle Notetaker

1. What questions are you investigating?

2. As you listen, watch, or read your assigned resource, listen or look for information that addresses the questions you are investigating. Use the space below to record your notes.

3. Share out your most important ideas with your partners and listen to their ideas based on their assigned resource. Record important information from your peers below.

Melatonin Text

Melatonin is a hormone that helps to regulate sleep-wake cycles in animals. It is produced in cells of the pineal gland (a small gland located in the brain). Melatonin is produced in most organisms, including plants, but may play slightly different roles in different organisms. In humans, increasing melatonin encourages sleep. However, when light is received through the eyes, production of melatonin is inhibited (stopped), keeping the person awake. When less light is available, melatonin production ramps up, and the feeling of sleepiness increases.

Melatonin levels in babies become regular in the third month after birth with the highest levels measured between midnight and 8:00 am. Human melatonin production decreases as a person ages, which may explain why some older people have difficulty going to sleep. Also, as children become teenagers, the nightly schedule of melatonin release is delayed, leading to later sleeping and waking times.

Bright light during the day helps inhibit melatonin and contributes to feeling more awake and alert. This is because sunlight includes intense 'blue' light. Among the visible light spectrum, blue wavelengths have the most powerful effect on your sleep-wake internal body clock by stopping melatonin production. However, most of our electronic devices that we use in the evening, including cell phones, laptops, and televisions, also generate blue light. Using these devices at night may slow or interfere with melatonin production, making it more difficult to feel sleepy or fall asleep.

Melatonin receptors are found throughout the body and play an important role in maintaining circadian rhythms. A circadian rhythm refers to the natural, internal process that regulates an organism's day-night or sleep-wake cycle that repeats roughly every 24 hours. Circadian rhythms act like an internal clock, and people that live in dark caves for weeks at a time continue to follow an approximately 24-hour pattern. This is because the instructions to produce melatonin and other hormones and proteins associated with regulating the circadian rhythm are found in specific genes in each person's DNA. However, the production, and even the timing of these molecules, can be regulated through interactions with the environment, especially exposure to light and temperature.

Sleep is a crucial process for all complex organisms. Migrating birds even sleep while they are flying by resting half of their brain at a time. During sleep, almost every part of the body experiences important changes. While the full biological function of sleep is not totally understood, research shows that sleep reinforces the cardiovascular and immune systems and helps regulate metabolism. It has also been shown that sleep helps reinforce learning and memory. Without sufficient sleep, people are more likely to develop chronic diseases such as cardiovascular disease and neurological diseases such as Alzheimer's.

Summary Task

Today we completed a class consensus discussion. How did it go?

1. One thing that went well in the discussion:

2. One thing we can improve the next time we have a discussion:

3. One person who helped me learn today:

4. What did you learn from this person?

5. One idea that I contributed to my group or my class:

Explain what you know about the following questions based on what we discussed today.

1. Describe where and how melatonin is made and regulated in the body.

2. Discuss one example of cause and effect and how to differentiate between causality and correlation.

3. Maintaining circadian rhythms, particularly getting enough rest or sleep, is essential to health. Explain how both genetic and environmental influences may lead to disruptions in sleep-wake cycles.

Developing a Bedroom Prototype

Introduction: A prototype is an early sample, model, or release of a product or design built to test a concept or process. A prototype is often modified after testing to improve the design based on feedback from the testing and evaluation process. In this task, you will collaboratively develop a prototype design for a bedroom that addresses the problem (and subproblems) discussed in this learning cycle around sleep-wake cycles.

Step 1. Define the problem

1. What is the problem you are trying to solve in this learning sequence?

2. What are the related sub-problems?

3. What are the science concepts that you figured out in this learning sequence that may help you create a design to address the problem and sub-problems?

Step 2. Identify the criteria and constraints. Think about your own sleeping space. What constraints might you face in redesigning your space? What criteria are important in developing your prototype design?

1. Identify 1-2 constraints.

2. Identify 1-2 criteria.

Step 3. Defining the system. We can think of our bedrooms and everything associated with when we sleep and wake up as a part of this system. In your group, identify the common components of the system, and sketch them out below. In your diagram, include a way to represent how different parts of the system interact.

Step 4. Identify solutions. Brainstorm design elements that would be a part of your prototype design. As a group, identify 1-2 design elements that address the problem and subproblems, and satisfy the constraints and criteria. An optimal design element is high-leverage, meaning that it addresses more than one sub-problem at a time. For each design element, provide a rationale that includes:

- How the science concepts you figured out in this learning sequence inform the decision to include that element
- How examining the different components of the system and their function(s) informed your ideas on which design elements to include

Step 5. Create the prototype design.

Summary:

1. What additional information, research, or testing would you need to do to optimize the prototype?

Circadian Rhythms Engineering Mini-Rubric

Explanation of a mismatch	Explanation of a mismatch:
	• The mismatch problem of regulating circadian rhythms is described
	• An accurate explanation of the following science concepts are included:
	  • How a system of specialized cells create melatonin
	  • The relationship between DNA, genes, and traits
	  • How environmental cues can influence the expression of a trait
		Circle or Highlight One:
		
		Proficient - Includes **all** of the components
		
		Developing - Includes **some** of the components

Engaging with a Design Process	Engaging with the design cycle:
	• An initial description of the design cycle includes:
	  • Identifying the problem & subproblem(s)
	  • Brainstorming solutions
	  • Using science concepts and/or research to inform the initial solution
	  • Identifying appropriate criteria and constraints
	  • Developing prototype designs
	  • The CCC of **Cause & Effect** is used to connect the science concepts and the possible solution(s)
		Circle or Highlight One:
		
		Proficient - Includes **all** of the components
		
		Developing - Includes **some** of the components

Notes, Ideas, and Questions	The open sketch portion of the engineering journal is used to: • Note down additional ideas • Initial design sketches • Develop a representation of a design process • Additional research • Additional questions	Circle or Highlight One: Proficient - Includes **all** of the components Developing - Includes **some** of the components
Self-Evaluation	Grow: Glow:	
Teacher / Peer Evaluation	Grow: Glow:	

Common Ancestry 5E

Unit 3 Evolution of Sick Humans	Biology

Student Name:

A Shared Mismatch

A Shared Mismatch

“Most anthropogenic (human-caused) disturbances have natural analogs: the climate has warmed before, habitats have fragmented, species have invaded new ranges, and new pesticides (also known as plant defenses) have been developed. Yet for all of evolutionary time, the daily cycle of light and dark, the lunar cycle, and the annual cycle of the seasons have all remained constant. Until now…”

Humans are not the only organisms affected by blue light at night. Organisms that rely on moonlight to navigate, like birds and turtles, are getting lost when they follow artificial light into dangerous areas. Nocturnal predators and prey both have reduced darkness to hide in, resulting in both sets of organisms obtaining less food. Many amphibians, like frogs, rely on evening cues for mating rituals, which become disturbed when evening doesn’t appear to come.

Though the affected behaviors vary across species, a connecting thread exists: animals use melatonin to regulate their day and night cycles, and artificial light disrupts that natural rhythm. As we’ve learned, nighttime artificial light suppresses melatonin production in humans, disrupting sleep patterns. That impact stretches across the animal kingdom. Even in insects, reduced melatonin levels have been connected to reduced fitness, reproductive success, and immune functioning.

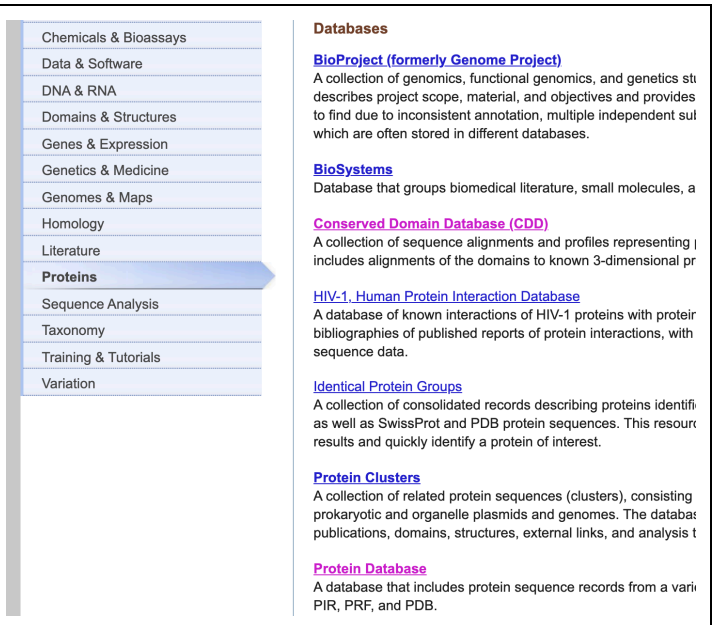
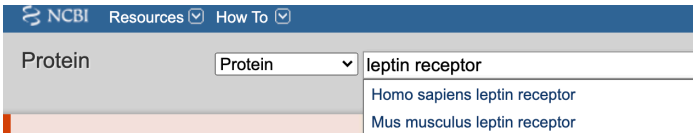
Comparing Amino Acid Sequences Investigation

Introduction: In this investigation, you will engage with the Basic Local Alignment Search Tool (BLAST) to compare nucleotide or protein sequences of different species. The tool calculates the statistical significance of matches. BLAST can be used to better understand functional and evolutionary relationships between sequences as well as help identify members of gene families. We will investigate the leptin receptor, insulin receptor, and lactase sequences. Receptors for hormones are always proteins, making the search more efficient.

Procedure Part 1:

1. Obtain the protein sequence in humans. First, go to the main page of the database using the NCBI Genetic Database . Follow the instructions below to obtain the protein sequence. Use the screenshots to help you navigate the database.

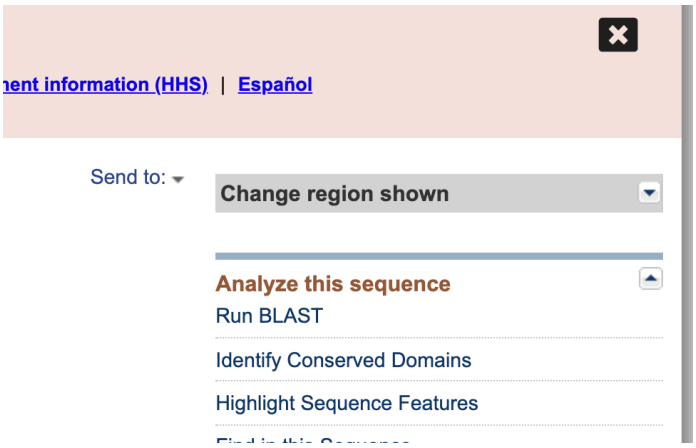
2. Compare the human sequence to other organisms. Use the screenshots to help you navigate the database.

1. • Select 'Proteins' from the left-hand menu • Chose 'Protein Databases' from the database menu	
2. • At the top of the page, type: "homo sapiens leptin receptor" • Click 'Search'	
3. • Look at the first result; click 'FASTA' FASTA is a representation of an amino acid sequence.	

4.

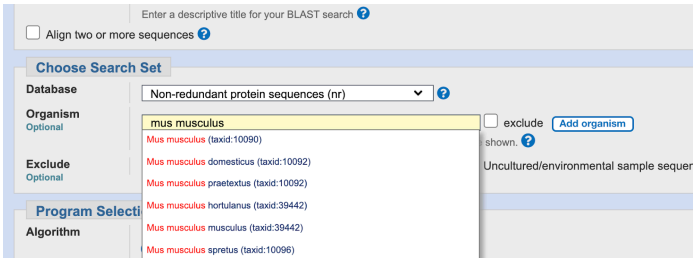
- From the FASTA page, click on the upper right-hand menu: Click ‘Run BLAST’

BLAST is a way to compare the amino acid sequences to find similarities and differences



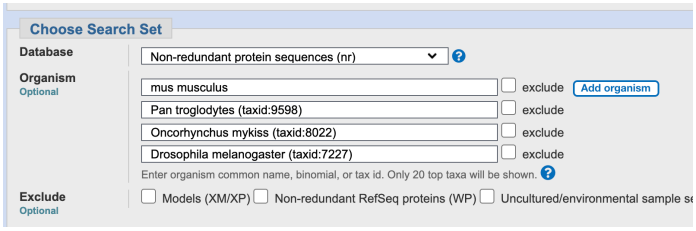
5.

- On the BLAST page, leave all of the pre-settings as they are
- In the organism box, type the first organism we will compare: “mus musculus” (a mouse)



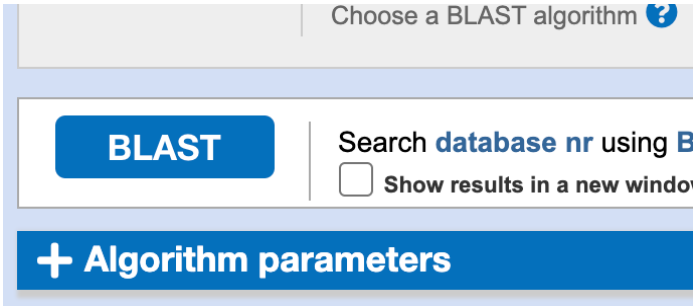
6

- Choose ‘Add organism’
- Type in the next species: “Pan troglodytes” (a chimpanzee)
- Choose ‘Add organism’ and type in the next several species:
  - “Oncorhynchus mykiss” (a rainbow trout fish)
  - “Drosophila melanogaster“ (a fruit fly)



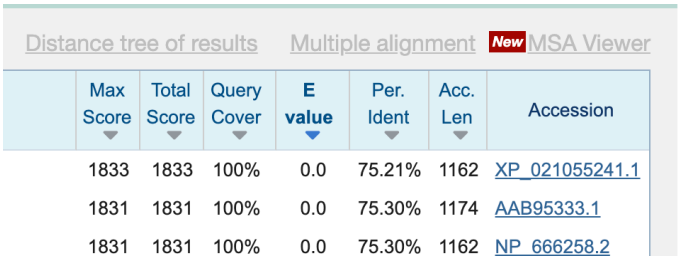
7

- Click the ‘BLAST’ button on the bottom of the page
- Be patient as the database runs the analysis

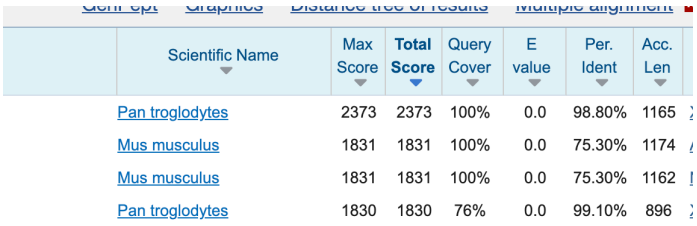


8.

- Once the results are in, click ‘Total Score.’ This will sort the results to give us the highest scores. The higher the score the more accurate the result.



Max Score	Total Score	Query Cover	E value	Per. Ident	Acc. Len	Accession
1833	1833	100%	0.0	75.21%	1162	XP_021055241.1
1831	1831	100%	0.0	75.30%	1174	AAB95333.1
1831	1831	100%	0.0	75.30%	1162	NP_666258.2

8. • For each of the species we are interested in, find the most accurate result (the highest score) • In the results table, indicate the 'Percent Identity.' This number demonstrates how similar the amino acid sequence for the same protein is to the human version. • Add the 'Percent Identity' to the data table below.	

9
• Now we will run the same analysis for each of the proteins that we are investigating.
• Go back to the main page (use the original link).
• Repeat steps 1-9 for each of the following proteins:
  • Homo sapiens insulin receptor
  • Homo sapiens lactase
  • Homo sapiens melatonin receptor
• Record your data in the table below.	

Table 1: Amino Acid Sequence comparison from NCBI Database

	Amino acid sequence for leptin receptor	**Amino acid sequence for insulin receptor**	**Amino acid sequence for lactase**	**Amino Acid sequence for melatonin receptor**
humans	100%	100%	100%	100%
mouse				
chimpanzee				
rainbow trout				
fruit fly				

Procedure Part 2:

For each of the same organisms, use the Timetree Database to calculate the evolutionary divergence time from humans. This means how long ago each species branched off from a common ancestor with humans.

1. In the first set of search boxes (GET DIVERGENCE TIME FOR A PAIR OF TAXA) enter 'humans' and each of the species in the data table.

2. Add the divergence time to the data table below.

Organism	**Divergence time from humans (estimated time in million years ago)**
humans	0 mya
mouse	

chimpanzee	
rainbow trout	
fruit fly	

Making Sense of the Comparing Amino Acid Sequences Investigation

Summary Questions:

1. When using the NCBI database, what pattern did you notice at the amino acid sequence level between the organisms?

2. When using the TimeTree database, what pattern did you notice at the level of time divergence between the organisms?

3. How do you think the amino acid sequence data and the evolutionary time divergence data are related to one another?

4. How do the patterns in these data sets help you figure out the phenomenon under investigation?

5. What questions do you have now about the phenomenon or about the data you collected?

Comparing Amino Acid Sequences Investigation Rubric

Student Rubric - Comparing Amino Acid Sequences Investigation

How did you do in the investigation?

	Student Self-Score Select one		
I know how this investigation connects to our current unit.	No - I need help.	Almost	Yes
I was able to contribute to the See-Think-Wonder and / or respond to the analysis questions.	No- I need help.	Almost	Yes
I used my time well in this investigation.	No	Mostly	Yes
I plan to come in for extra help to complete parts of the investigation or ask questions.	No		Yes

What other resources could you have used to get more out of this investigation?

- More time
- More resources
- More information
- More help from my partners
- More help from my teacher
- Other:

Partner Rubric - Comparing Amino Acid Sequences Investigation

How did your partners do in the investigation?

Directions: Think back to how your partners participated in the lab. For each of the four categories, write the name(s) of your partner(s) in the appropriate box.

	Unsatisfactory	Pretty Good	Excellent
Contributions	Did not participate.	Did the minimum of what was required.	Provided useful ideas when participating in discussion.
Working with Others	Rarely listened to others. Disrupted or discouraged others' attempts to participate.	Usually listened to, shared with, and supported the efforts of others.	Listened to, shared with, and supported the efforts of others.
Time Management	Procrastinated, did not use school time or schedule provided to get work completed.	Mostly used time well and completed investigation on time.	Used time well to ensure things get done on time.

Evidence for Common Ancestry

All living creatures originate from a common ancestor. Over long periods of geologic time, populations have branched off of a common line, forming new groups of organisms and new species. The evolution of life resembles the twisted branches of a bush or tree with new groups splitting off the original trunk. Some branches of life continue to twist and develop new shoots, while others have gone extinct. There are several lines of evidence that indicate that all life evolved from a common ancestor.

Fossil Record

Fossils are the preserved remains of previously living organisms or their traces (like a footprint), dating from the distant past. Not all organisms that once lived have become fossilized. However, many fossils have been found that can be used to tell the 'story' of evolution. Fossils are often contained in rocks that build up in layers. The layers provide a sort of timeline, with layers near the top being newer and layers near the bottom being older. In addition, scientists can date fossils, allowing them to know which ones are older or younger.

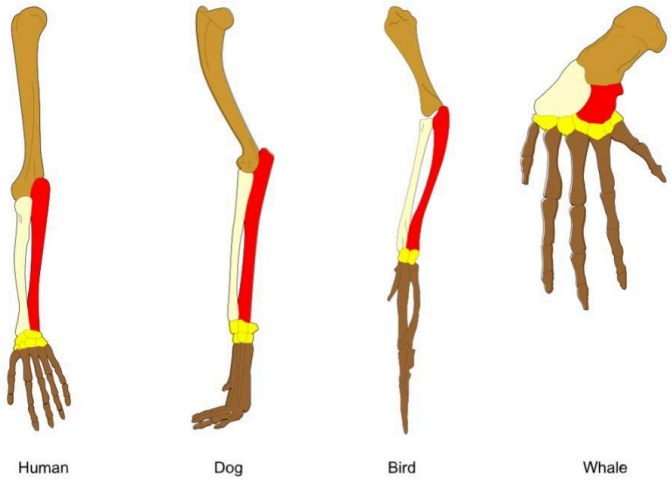
An ancient fish fossil

Some fossils found in early layers are no longer found today, while others are found only in later layers demonstrating how organisms have either gone extinct or adapted to new environments. Some fossils show that some organisms have gone relatively unchanged for millions of years. Scientists can look closely at the anatomical structures of fossilized organisms to understand how they have changed over time.

Comparative Anatomy

When two or more organisms share a unique set of anatomical features such as bone structure or a body plan, they may have had a common ancestor. For example, the forelimb bones of humans, dogs, birds, and whales all show a very similar pattern. The outside of these organisms looks different, because they have adapted to different environments. However the bone structure itself is very similar and it is unlikely that it evolved independently in all of these organisms. It is more likely that they inherited from a common ancestor.

Additionally, scientists often compare embryos (unborn developing babies) to understand evolutionary relationships. The more closely related two species are, the more similar the embryos' anatomy and physiology.



Physical features shared due to evolutionary history (a common ancestor) are said to be homologous.

Think Talk Open Exchange + Buzzwords Organizer

Think-Talk-Open Exchange + Buzzwords

1. **Think -** Individually respond to the prompt in the space below.

Construct a scientific explanation using evidence and scientific reasoning from the unit for the phenomenon under study: Why do we have mismatches between our genes (and traits) and our current environment? Be sure to use the following words and ideas in your explanation.

Buzzwords: patterns at different scales, common ancestry, evolution, timeframe

2. **Talk**: Share with your group one at a time. Record a tally mark (✔✔✔✔) each time you hear a specific buzzword during the share.

	patterns at different scales	common ancestry	evolution	timeframe
Person 1				
Person 2				

3. **Open Exchange:** As a group, discuss the following questions - be sure to use the buzzwords!

- Describe patterns or commonalities between what each group member shared
- Which buzzwords did you hear the most? Least?
- Are there buzzwords that your group doesn't understand?
- Are there other words you heard a lot? If so, which words?

4. **Reflection -** Individually respond to the prompt below.

What are some new ideas you heard during your discussion with your group?

Summary Task

Today we completed a class consensus discussion! How did it go?

1. One thing that went well in the discussion:

2. One thing we can improve the next time we have a discussion:

3. One person who helped me learn today:

4. What did you learn from this person?

5. One idea that I contributed to my group or my class:

6. Why do animals as different as fruit flies and humans share mismatch diseases?

7. In the *Comparing Amino Acid Sequences Investigation*, what patterns in the data did you observe? What were the time scales at which these patterns were observed?

8. How did observing patterns at different time scales help you understand why we and other organisms experience mismatch diseases, and why we can't evolve quickly to solve them?

Additional Mismatch List

Mismatch	Brief Description
Nomadic vs. Sedentary Lifestyle	Sedentary lifestyles may be connected to increased rates of osteoporosis (a bone disease that occurs when the body loses too much bone, makes too little bone, or both. As a result, bones become weak and may break from a fall or, in serious cases, from sneezing or minor bumps). Running and walking stimulates osteoclastogenesis, helping bone regeneration and reducing osteoporosis.
Crooked or crowded teeth	Reduced chewing due to highly-processed diets may lead to smaller jaws and more teeth crowding. Descendants of Australian aborigines who transitioned to Western diets have smaller jaws and serious tooth crowding.
Cavities	Since the advent of agriculture, we have eaten more processed food and sugary food, which may lead to increased cavities.
Overproduction of cortisol and adrenaline due to chronic stress	Chronic stress encountered in the modern environment may be leading to the overproduction of the hormones cortisol and adrenaline, which over the long term can lead to health problems. See Chronic stress response for more information.
Infectious diseases	Higher population densities and more contact with animals increase the number of infectious disease outbreaks.
High blood pressure	The vast majority of adults in the US have high blood pressure. This may be due to a number of mismatches with our current environment.
Reproductive Success	Couples are having less success getting pregnant, which might be due to stress and environmental factors (mismatches) impacting the creation of egg and sperm in one or both partners. Many things can change a couple's ability to conceive. These include factors for both partners such as: • Age • Smoking • Excess alcohol use • Stress • Poor diet • Athletic training • Being overweight or underweight • Sexually transmitted infections (STIs) • Health problems that cause hormonal changes to the female body, such as polycystic ovarian syndrome and primary ovarian insufficiency (see glossary, such as www.womenshealth.gov) • Health problems that cause hormonal changes to the male body, such as male hypogonadism or disorders of the hypothalamus, pituitary, thyroid, and adrenal glands (https://www.mayoclinic.org/diseases-conditions/male-infertility/symptoms-causes/syc-20374773) See Factors related to infertility for more information.
Immune system (allergies)	Hygiene hypothesis: people who fought off mild infections for much of history had immune systems that were always moderately busy. Now that we have widespread hygienic practices, more people are developing allergies and other autoimmune disorders.

Myopia (nearsightedness)	Reading and electronic devices may have increased myopia (difficulty seeing faraway objects).

Mismatch Analysis

Mismatch Analysis

State the mismatch disease you will investigate further _____

Using the internet, textbooks, and other resources, explain the genetic cause of the mismatch disease by answering the following questions:

1. What is one protein or other biological model with a genetic basis that is important in this disease?

2. Why is that molecule important? Where is it produced in the body, and what role does it play? What other molecules does it interact with?

3. How did this molecule function before our environment changed? How is its activity different now?

4. What evidence supports its role in this mismatch disease? Why do scientists believe this molecule is important?

How are scientists and researchers working to create solutions for this mismatch disease?

1. Describe one solution that either exists or is being developed/researched to address this disease.

2. What criteria would you use to evaluate if this solution is effective?

3. What constraints or trade-offs make this solution challenging to implement?

Common Ancestry Engineering Mini-Rubric

Explanation of a mismatch	Identifying a problem:
	• The mismatch problem of the rate of evolutions is described
	• An accurate explanation of the following science concepts are included:
	  • How the genes for important molecules (such as lactase) are found across many species and have changed little over time
	  • How common genes, DNA/amino acid sequences, the fossil record, and embryological anatomy provide evidence for common ancestry
		Circle or Highlight One:
		
		Proficient - Includes **all** of the components
		
		Developing - Includes **some** of the components

Engaging with a Design Process	Engaging with the design cycle:
	• An description of the design cycle includes:
	  • Identifying the problem & subproblem(s)
	  • Brainstorming solutions
	  • Using science concepts and/or research to inform the initial solution
	  • Identifying appropriate criteria and constraints
	  • Developing, testing, and evaluating prototype designs
	  • The CCC of patterns used to connect the science concepts and the possible solution(s)
		Circle or Highlight One:
		
		Proficient - Includes **all** of the components
		
		Developing - Includes **some** of the components

Notes, Ideas, and Questions	The open sketch portion of the engineering journal is used to: • Note down additional ideas • Initial design sketches • Develop a representation of a design process • Additional research • Additional questions	Circle or Highlight One: Proficient - Includes **all** of the components Developing - Includes **some** of the components
Self-Evaluation	Grow: Glow:	
Teacher / Peer Evaluation	Grow: Glow:	

Unit Closing

Unit 3 Evolution of Sick Humans	Biology
Student Name:	

Healthy Schools Design Challenge Final Rubric

Component	Not Evident	Level 1: Beginning	Level 2: Developing	Level 3: Advancing	Level 4: Proficient
Representing the System	Design is missing or not presented as a 3D or drawn model.	Design is presented as a 3D or drawn model. No annotations, labels, or components of the system are included.	Design is presented as a 3D or drawn model. Annotations and labels and/or components of the system are inaccurate or missing.	Design is presented as a 3D or drawn model. Annotations and labels are mostly clear and most components of the system are represented.	Design is presented as a 3D or drawn model. Annotations and labels are clear. All major components of the system are represented and it is clear how at least 2 components are interrelated.

Note: Components of the system may vary based on school context and the focus of the design but should include: the physical building, structures inside the building such as classrooms, windows, furniture, hallways, cafeteria; and components that are not structures such as the bell schedule or the cafeteria menu.

Design Elements	Does not include design elements and/or all design elements do not appropriately address any of the subproblems and/or do not take into consideration any of the identified criteria or constraints.	Design includes less than 5 elements. But at least 1 element does appropriately address at least 1 subproblem and/or some of the identified criteria or constraints.	Design includes at less than 5 design elements. At least 2 elements address 1 or more subproblems and some of the identified criteria or constraints	Design includes 5 design elements. Most of the identified elements address at least two subproblems and takes into consideration most of the identified criteria or constraints.	Design includes at least 5 design elements. All design elements appropriately address at least two subproblems and all 5 take into consideration all of the identified criteria and constraints.

Note: An example of a design element that appropriately addresses at least 2 subproblems is planning a rooftop garden that students would work in. Exposure to daylight is helpful for regulating day-night cycles; fresh unprocessed food for the cafeteria is helpful for leptin resistance. Additionally, if students chose lack of exercise as a subproblem, working in the garden provides opportunities for movement and exercise.

Design Rationale	Does not include a rationale	Restates evidence and does not include explanation of scientific concepts or the CCC of structure & function or cause & effect.	Includes explanation of science concepts but all are inappropriate concepts that do not link evidence to claim and/or the CCC of structure and function or cause & effect is not addressed.	Includes explanation of some science concepts that link evidence to the claim, but are insufficient (one or more concepts that should have been included are not included) or some are inappropriate and how the CCC of structure & function or cause & effect informed the design is addressed but insufficient.	Provides a clear rationale for at least 3 design elements that includes all of the appropriate scientific concepts, how all of the criteria and constraints informed the elements, and how the CCC of structure & function or cause & effect informed the design.

Note: The scientific concepts include evolution and common ancestry, the relationship between DNA, genes, and proteins in determining traits.

Evaluation	Does not include an evaluation	Includes an evaluation but all three components are missing or very incomplete: 1) an explanation of how a design cycle was used to develop the design. 2) The limitations of the design. 3) Suggestions on how to further improve the design.	Includes an evaluation, but at least two of the following components are missing or very incomplete: 1) an explanation of how a design cycle was used to develop the design. 2) The limitations of the design. 3) Suggestions on how to further improve the design.	The evaluation is clear and mostly complete. One of the following components is missing or very incomplete: 1) an explanation of how a design cycle was used to develop the design. 2) The limitations of the design. 3) Suggestions on how to further improve the design.	The evaluation is clear and complete. It fully addresses the following components: 1) an explanation of how a design cycle was used to develop the design. 2) The limitations of the design. 3) Suggestions on how to further improve the design.