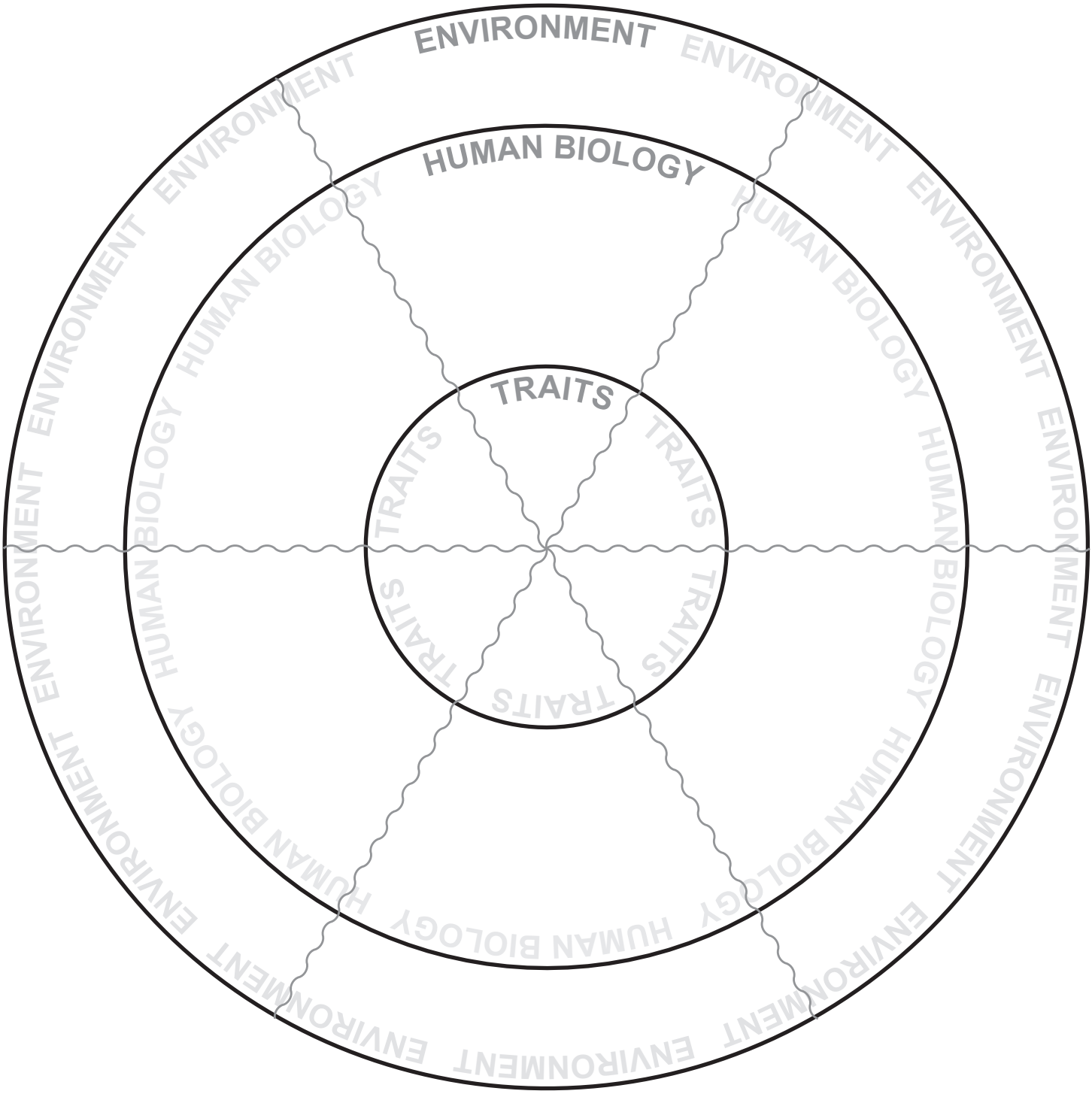
How SIMILAR or DIFFERENT Are We From Each Other?

Name_____

Date_____

Hour_____

Teacher_____


ENVIRONMENT
HUMAN BIOLOGY
TRAITS

Writing Scientific Explanations
(Stuff Unit IQWST II 2007)

Scientists often investigate something and then share their findings with other people. Imagine a scientist telling you that "Shampoo X" is better for you hair than "Shampoo Y". What are some things that you would want to know about the scientist's investigation before you made your decision about whether to buy shampoo X or Shampoo Y? Explain below.

Just saying one is better than another is not useful in helping you choose which shampoo to buy. You might ask questions like: How did you figure out that Shampoo X is better? What evidence do you have? Did you test it on hair that is different colors and different textures? In what way is Shampoo X better? Does it matter how often you use it? You might ask these questions because the answers would help you to decide if you agree or disagree with the scientist. The answers would also help you decide if Shampoo X is better that Shampoo Y or not. This reading is about scientific explanations- one way to communicate your ideas so that people can determine if they agree with your claims, and so they can make informed choices based on the explanation.

What are the parts of a scientific explanation?
Remember, a useful scientific explanation is not just a simple answer. A useful explanation includes a **claim**, **evidence** to support the claim, and **reasoning** that uses scientific principles to describe how the evidence supports the claim. The following paragraphs will further explain scientific explanations.

Claim: A claim is a statement that answers the original question. In the shampoo example, the question might have been: "Which shampoo is better for protecting hair from the sun, Shampoo X or Shampoo Y? The scientist's claim in this example may be: "Shampoo X is better for you than Shampoo Y." The claim would be better if it also included HOW Shampoo X is better. For example, writing: "Shampoo X is better than Shampoo Y at protecting hair from the sun damage.

Evidence: Evidence makes use of scientific data to support the claim. The scientist in the shampoo example probably has evidence, but if good data

is not provided in the explanation, then there's no reason to believe that the claim is a good one. You need to know what tests the scientists did and what he or she learned from those tests. For example, if tests show that Shampoo X contains a particular ingredient that is also found in sunscreen, but Shampoo Y does not contain that ingredient, that could be one piece of evidence for the scientist's claim. Data from an experiment become evidence when you use it to support a claim you have made.

Reasoning: In an explanation, reasoning shows why the data count as evidence to support the claim. Reasoning includes the important scientific principles. You might ask, "What do people know in science that can help to explain findings?" The scientist in the shampoo case should tell what is already known about the importance of sunscreen, for example.

Anyone can make a claim, but a good scientific explanation includes the evidence and reasoning that show the claim to be true. In this unit, when you write an explanation, remember to always include a claim, 2 pieces of evidence and reasoning in your paragraph.

Now, practice writing an explanation below.
Write a scientific explanation answering the following question: Which meal will provide you with the most health benefits, potato chips or a vegetable salad?

What is your claim?

_____
_____
_____

What are 2 pieces of evidence?

_____
_____
_____
_____
_____

What scientific principles can you tie your evidence to?

_____
_____
_____
_____
_____

Lesson 1: How SIMILAR or DIFFERENT Are We From Each Other?

Lesson 1: How Similar and Different Are We From Each Other?

LEARNING GOALS: WHILE COMPLETING THIS LESSON, CHECK TO MAKE SURE THAT YOU CAN DO THE FOLLOWING THINGS:
1. Identify similarities and differences between and within different people based on physical evidence.
2. Generate an initial hypothesis about the degree of similarity between and within different people based on physical evidence.
3. Construct an initial explanation for why skin color could vary in different people and provide a reasoning that includes skin cells functioning differently.

Take a moment and look around at the people near you. Look at their physical appearance.

What are some of the similarities and differences that you observe? Why do you think we have these differences and similarities? Below, fill in the charts to document what you observe.

Similarities	**Predictions: Reason for Similarities**

Differences	Predictions: Reasons for Differences

1. How similar do you think you are to the person sitting next to you? Make a prediction between 0 – 100%.

2. In groups, or with the person sitting next to you, discuss whether you think your similarities are genetic, due to the environment, or both. Then write some of the main points of your discussion below.

3. Use evidence from your chart to explain why you think you have these differences and similarities. Use complete sentences.

What is your claim?

What are 2 pieces of evidence?

How can you tie your evidence to scientific principles?

Now, think about the driving question, “How SIMILAR and DIFFERENT Are We From Each Other?”, and answer the following questions.

1. In complete sentences, explain what you think you are going to learn in this unit.

2. Why do you think it is important to learn about this topic?

Making Biological Comparisons

Looking back at the chart that you made in class, you can see that humans share some *biological* similarities.

Definition of Biological: Any features relating to the natural characteristics of an organism. For example, a biological feature might be eye color. Other examples include the cells or organs that make up an organism, like skin cells or the liver, or molecules that are found in an organism. Some features, like clothing, are not included when thinking of something biological.




1. What are some biological features that people **all around the world** share?

2. Why do you think humans share some biological features?

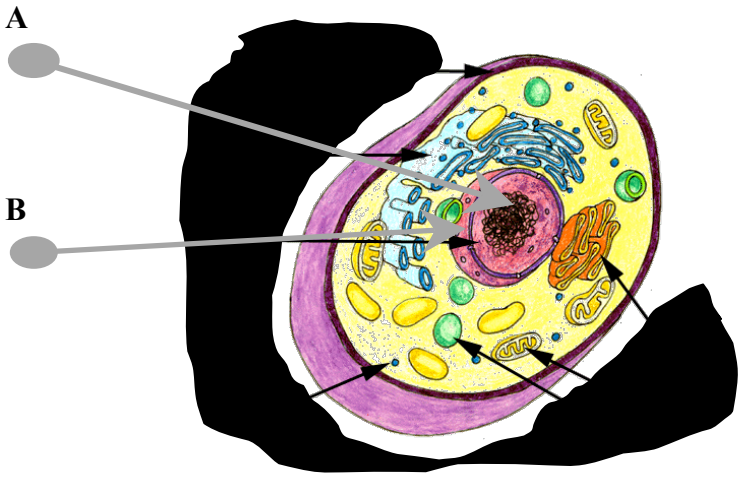
3. What are some biological features that some people share but others do not have?

While reading the following text, try using one of the follow reading strategies to organize your reading: Concept Cards, underlining unfamiliar words, or writing an outline of the text.

How Cells Work in Our Bodies

When you look in the mirror, what do you see? You see eyes, a nose, a mouth, some skin, hair and all types of body parts. While looking at yourself, do you ever wonder what these body parts look like at a microscopic level? If you looked at your body at the microscopic level, you would see about 10 trillion cells. In class you talked about how the body is made up of different organs that make the body function and that these organs are made up of cells. Recall, cells are the basic building blocks of all life, so in order to understand what makes people different and similar to one another, we have to understand the properties of cells and how they function. For example, our muscles are made of one unique type of cell, our livers are made up of a different unique type of cells, and there are even very specialized types of cells that make the enamel for our teeth and the clear lenses in our eyes. It is the difference between the types of cells that make each organ unique. In order to understand how the body works, you need to understand how cells work. All bodily functions and body developments, such as reproduction and fighting infections, work at the cellular level.

Look at the image below. Within the cell, there are many organelles. You might have heard of the mitochondria and the nucleus- these are some organelles of the cell. Every organelle has a specific job that helps the cells operate, and therefore the body function. The organelles in each cell are the same, however, there are certain components of the cell that make them different from each other. In later sections, you will learn about different components of the cell, such as proteins and different molecules, like pigment molecules, that cause the cell to function differently, depending on the organ it comes from.



http://web.jjay.cuny.edu/~acarpi/NSC/13-cells.htm

1. The body is made up of many different types of **cells**. Can you think of 2?

2. Identify the organelles in the picture to the left.

A.

B.

In the previous reading, you read that each organ in the body is made up of a unique type of cell. In this reading, you will learn about the types of cells that make up the skin. While reading the following text, try using one of the follow reading strategies to organize your reading: Concept Cards, underlining unfamiliar words, or writing an outline of the text.

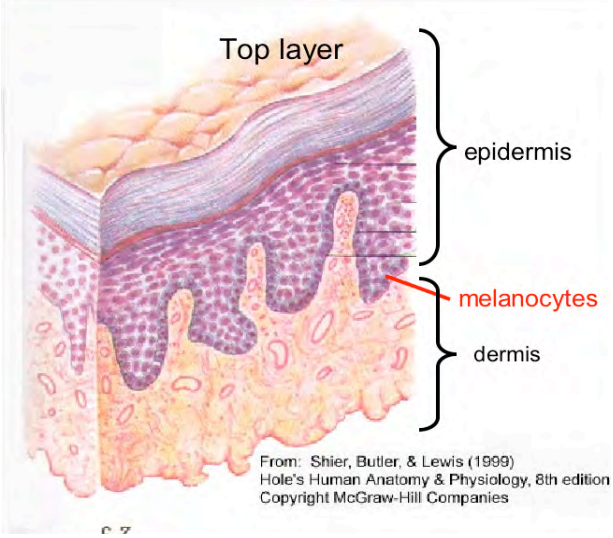
Components of the Skin

When you look around yourself in class, on the street, at the library or at the store, you might notice that people have different skin colors. There are several aspects of skin that give it the ability to have a certain color. The skin is made up of specific kinds of cells that are packed into layers. The top layer of cells is called the epidermis (these are also called epidermal cells). This layer of cells provides strength to our skin. The second layer of cells is called the dermis. In this layer, there are blood vessels that provide nutrients to the other cells of the skin.

Melanocytes are cells that produce melanin.

Melanin are molecules that give skin its color.

At the lower part of the epidermis, there are cells called melanocytes. **Melanocytes** produce molecules called melanin. **Melanin** is a type of pigment in skin, which gives the skin its color.



As you learned earlier, cells have different functions in the body. In the skin, melanocytes have the job of making melanin so that other cells can take up pigment molecules and have a certain skin color. Look at your skin. The color of your skin is determined by the amount of melanin that melanocytes produce.

If melanocytes produce melanin so far *below* the top layer of the skin, how do you suppose melanin reaches the *top* layer of the skin to give people their skin color?

Wrap Up

As of now, you have learned that humans are very similar to each other, but also have many differences. An example of one difference between humans is skin color. Some people have darker skin while some have lighter skin. You learned in the reading that different skin colors come from different amounts of melanin (a type of pigment) found in skin cells. Even though people have many differences, there are common biological features that all humans share, like lungs and a heart. All people need to use their lungs to breathe and use their hearts to transport oxygen throughout the body.

Now that you have read Lesson 1, use the following questions to help you organize what you learned.

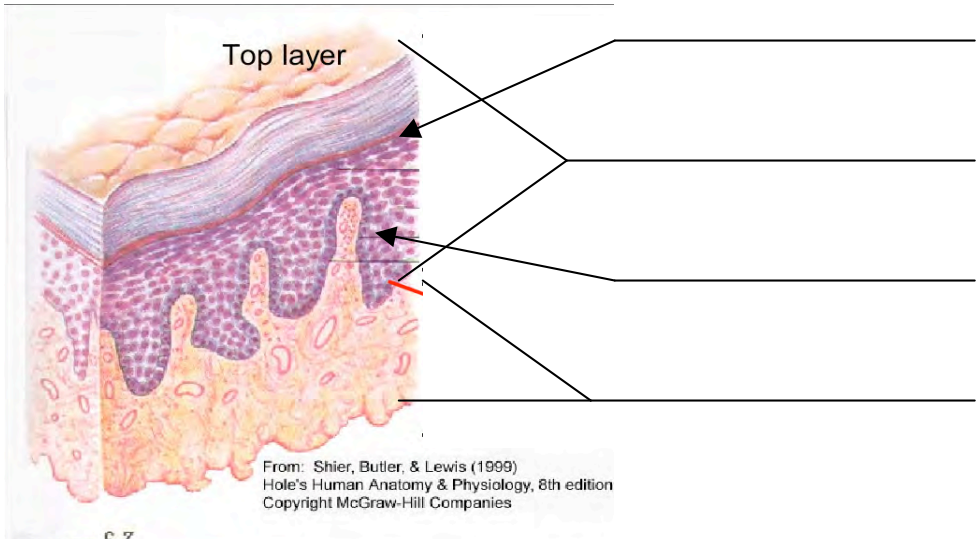
1. What is the driving question?

2. In what ways are people all around the world similar? Use complete sentences to explain your answer.

3. What would happen if the skin had no skin cells? Use complete sentences. What is your claim?

What are 2 pieces of evidence?

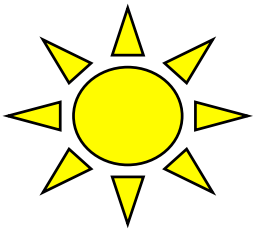
4. Below is a cross section of skin. Identify each component (melanocytes, dermis, epidermis and melanin) of skin to show how skin gets its color.

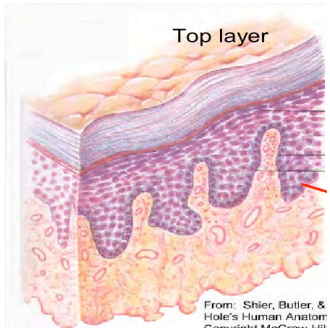


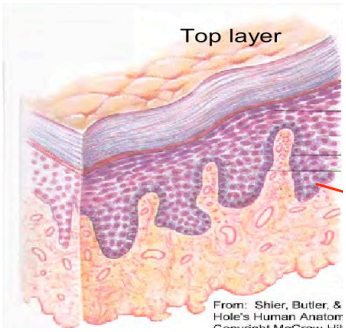
In 2 or 3 sentences, explain how you think skin gets its color.

5. Ronald was born and raised in Seattle, Washington, where the weather is usually dark and rainy. One day, Ronald moved to Miami, Florida, where the weather is usually bright and sunny. When Ronald moved to Florida, he noticed that his skin color started to get darker. Using the terms melanin, melanocytes, and pigments, write at least 3 sentences explaining why Ronald's skin got darker.

6. Use the diagram below to draw how Ronald's skin became darker.







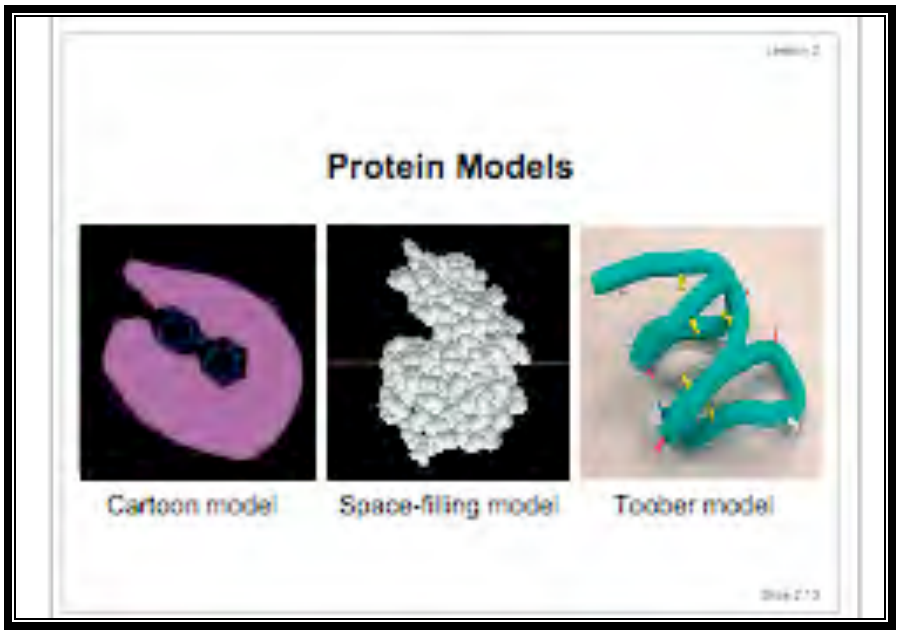
Seattle, Washington

Miami, Florida

7. How do you think the environment affected Ronald’s change in skin color?

8. List and define concepts and vocabulary from Lesson 1. Use the other side of the page if necessary.

Lesson 2: *What is going on inside us to generate our traits?*



Lesson 2: Exploring Proteins

LEARNING GOALS: WHILE COMPLETING THIS LESSON, CHECK TO MAKE SURE THAT YOU CAN DO THE FOLLOWING:
Assemble models of proteins using Toobers
Write a scientific explanation of how the order of amino acids in a protein determines its shape and consequently its function.
Write a scientific explanation of how properties of amino acids such as charge, hydrophobicity, and size can affect protein shape.
Write a scientific explanation of how a change in amino acid order can affect protein function.
Write a scientific explanation of how changes in proteins might affect a cell's ability to do its job.

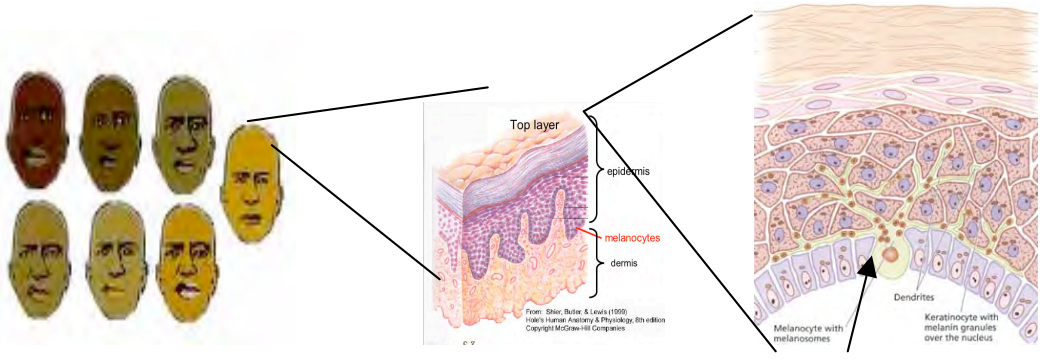
At the end of this lesson, be sure to complete the Wrap Up section. This section will help you prepare for your posttests.

Tyrosinase: How does this protein affect skin color?

In class, you learned that melanin in skin cells is responsible for the color of skin. **Tyrosinase** is an example of a type of protein called enzymes. Enzymes are proteins that increase the speed of chemical reactions in the body. In this reading, you will read about how tyrosinase is involved in skin color production. While reading the following text, try using one of the follow reading strategies to organize your reading: Concept Cards, Preview Guides, underlining unfamiliar words, or writing an outline of the text.

Review of Skin

Special Skin Cells Make Pigment



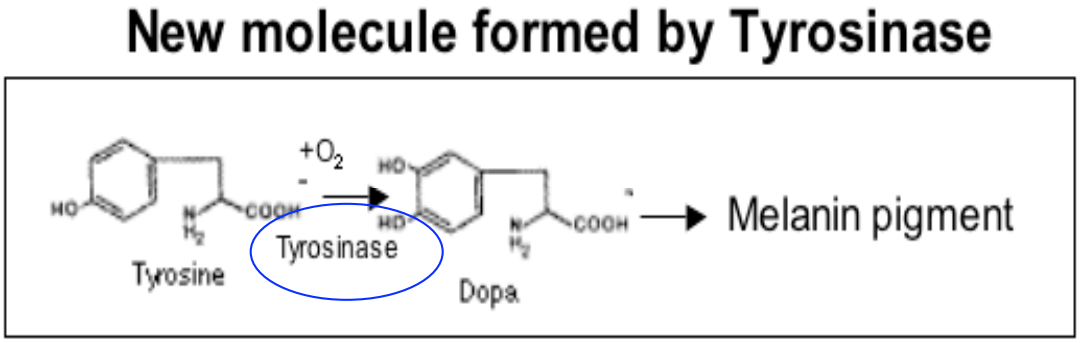
Skin Colors | Cross Section of Skin | Melanocyte

The image above shows a close-up look into the skin. The first figure shows the variation of skin colors that people can have. People can range from very

dark to very light skinned. The next image is a cross section of what a person's skin tissue might look like. This image shows the different layers of the skin (epidermis, dermis and subcutaneous layer). Within the skin tissue, there are melanocytes (See Lesson 1, pg 8). Look closely at the image on the far right. The small brown dots are **melanin** molecules that are produced by the melanocytes. Melanin is a type of pigment that gives skin its color.

Tyrosinase and Skin Color?

Now that you have examined the image, let us consider how melanin is produced. Have you ever seen an assembly line in a factory where cars are produced? In an assembly line, machines work, one by one, to put the car together. In the assembly line, each machine is doing something different and has a specific role in putting together the car. There is a similar process that takes place inside the body, more specifically, inside the cells. In order for melanin to be produced, there is an assembly line of enzymes that add and change parts of molecules to produce melanin. Each enzyme acts to modify (change) the molecule one spot at a time. **Tyrosinase** is the first enzyme to act in the process and is therefore very important. If tyrosinase does not act, then melanin cannot be made. Refer to the following chemical equation:



In the above diagram, tyrosinase acts on tyrosine (a molecule involved in the production of melanin) and at the end of the chemical equation, melanin is produced. Skin color depends on how much tyrosinase a person has. A person with darker skin produces more tyrosinase and more melanin than a person with lighter skin.

1. If tyrosinase is removed from the assembly line, what happens to melanin and skin color?

2. Jessica and Heather are close friends that both live in Ann Arbor, Michigan. Jessica was born with darker skin and Heather was born with lighter skin. Write a scientific explanation for why Jessica has darker skin than Heather. After reading about skin cells, melanin and tyrosinase, how would you explain their difference in skin color? Use complete sentences.

   What is your claim?

   What are 2 pieces of evidence?

   How can you tie your evidence to scientific principles?

The following case is about a teenager who discovered he was lactose intolerant. While reading the following text, try using one of the follow reading strategies to organize your reading: Preview Guides or underlining unfamiliar words.

Don't Pass the Milk, Please

It was a warm summer morning and Jason was late for his basketball game at the corner park. He quickly threw on some clothes and ran down the stairs from his bedroom.

As he zoomed past the dining room, his mom, Justine, called after him, "Jason, you can't leave this house without some breakfast! Come back here and have a seat with your sisters."

"But mom", Jason complained, "I have a basketball game and I'm really late."

Justine answered, "It doesn't matter. Have a quick breakfast then. You need to put something in your stomach."

"O.K, fine. I'll just have a bowl of cereal… is that O.K. with you, Mom?" Jason asked.

"Don't get smart with me. Chelsea, pass your brother the box of cereal and milk", said Justine.

Chelsea gave Jason the box of cereal. Jason quickly filled his bowl with cereal, added milk and sped through his meal. Before long, Jason was out of the door and on his way to the basketball game.

When Jason arrived at the game, his friends immediately gave him a hard time.

"Jason! Where have you been? We are down a man because of you! We have to make up two baskets in order to tie with the other team!" cried Marvin, one of his friends.

"Well… my mom made me stay and eat breakfast."

Instantly, all his friends began to laugh. Just as Jason started to join in, he suddenly grabbed his stomach and doubled over in pain.

"Hey man, are you ok?" asked Marvin.
The pain became worse and worse, until Jason finally asked to be taken home. Something was very wrong.

As Jason and his friends entered the house, Justine ran towards them. "What's wrong with him? Jason, are you alright?" she asked.

Jason replied, “I think I need a doctor, Mom. I don’t feel so good!”

At the doctor’s office, Jason went through several tests. Jason got the test results back and the tests showed that Jason’s body did not make the lactase protein. After all of the tests were analyzed, Dr. Sandoval sat Jason and his mom down and began to explain why Jason felt sick.

“You have what is called **lactose intolerance**” said Dr. Sandoval.

“Lactose intolerance? What is that? Is it serious?” replied Jason.

Dr. Sandoval tried to calm Jason down. “No, it is not serious. You are a completely normal young man. **Lactose** is a sugar found in milk and intolerance means extreme sensitivity or allergy. Therefore, lactose intolerance means that you cannot digest milk, but it doesn’t mean that you can’t do all of the normal things that other people do. Many people all over the world have this condition.”

Jason was confused. He remembered that his sister ate the same exact breakfast that he ate, but did not complain of pain. Jason asked the doctor, “Why didn’t my sister get sick? She drank the same milk that I drank.”

“Well” replied Dr. Sandoval, “although you and your sister are similar in many ways, you are different because *her* body can produce a particular protein. That protein is called **lactase**. Lactase breaks down lactose into more simple molecules that the stomach can digest, such as glucose and galactose.

Lactase breaks down the sugars in milk.

Jason chimed in, “So, I, on the other hand, cannot digest lactose because I do not have enough lactase?”

“That is correct” Replied Dr. Sandoval. “The small intestine needs lactase to break down lactose. If lactose is not digested, it can cause gas and stomach cramps.”

Justine asked Dr. Sandoval, “What can we do to prevent this from happening again?”

“Jason can stay away from food and drink products that contain milk and he can look for milk alternatives”, replied Dr. Sandoval. “While your sister is drinking milk with her cereal, next time, you will have to find something else to eat.”

Jason was relieved to find out that he was fine. He was even happier to know that he did not have to drink milk anymore.

In “Don’t Pass the Milk Please”, Jason was became ill when he had milk in his cereal.

1. What is the name of Jason’s condition? What are some of the symptoms of his condition?

2. Why can’t Jason’s body break down milk? Use complete sentences.
   What is your claim?

   What are 2 pieces of evidence?

   How can you tie your evidence to scientific principles?

3. Compare and contrast Jason's and his sister Chelsea's conditions and explain what makes them similar and different from each other. Make sure to talk about proteins, lactase, and lactose. Use complete sentences.

4. Dr. Sandoval told Jason that he could still do many things that other people can do. Provide Jason with a list of activities that he can do even though he is lactose intolerant.

Class Activity – How is lactose intolerance treated?

In this activity you will try to determine whether the medicine used to treat lactose intolerance has lactase in it.
You will use test strips that are able to detect the presence of glucose. When you put the strips in any liquid they will turn a certain color to indicate how much glucose is present. Using the chart you will be able to determine how much glucose is in milk before and after you have added lactose intolerance medicine to it.

How does the protein lactase work?

If the lactose intolerance medicine has lactase in it, what will happen to the amount of glucose in milk after you add lactose intolerance medicine? Explain why you think so?

Materials

- Crushed ½ lactose intolerance medicine
- 5-10 mLs milk
- 2 glucose test strips

Activity

Control: No medicine

1) Make sure that you have all of your materials.
2) Using the chart on the next page, predict what color you think the color the strip will be after dipping it in the milk.
3) Put one of the glucose test strips in the cup of milk for 1 second and then wait 30 seconds. (Have a friend time you for 30 seconds after taking the glucose strip out of the cup of milk.)
4) After 30 seconds, compare the color to the chart on the bottle.
5) What color is your strip? Record the results in the chart below.

Experiment: Lactose intolerance medicine in milk.

6) Add the crushed pill to the cup of milk. (It is important not to add the pill before this point.)
7) Swirl the pill gently into the milk.
8) Use the heat of your hand to help warm the milk by holding the cup in your hands. Do not put your hands or fingers in the milk.
9) Have a friend time you while holding the milk for 5 minutes.
10) Using the chart on the next page, predict what you think the color of the strip will be after dipping it in the milk.

11) After heating the milk with the pill in your hand for 5 minutes, use a fresh glucose test strip to test for the presence of glucose. Put one of the glucose test strips in milk for 1 second.
12) Wait 30 seconds before comparing the color to the chart on the bottle.
13) What color is the strip now? Record the results in the chart below.

Milk	Predict the Color of Strip	Glucose (mg/dl) Color of Strip?
Without pill.		
5 minutes after adding pill		

1. Why do you think the glucose test strip changed color after dipping it in the solution containing the pill?

2. Why are we testing milk for the presence of glucose before and after adding pill?

3. What evidence do you have that the medicine used to treat lactose intolerance is lactase?

4. What other evidence could you gather to be sure?

5. Think back to the story “Don’t Pass the Milk, Please”. Jason could not digest milk. After doing this activity, how do you think the results of your experiment might help Jason?

Ethics

Ethics provide a way for people to work through a problem that does not have a clear right or a wrong answer and determine what actions might be best for resolving that problem. When using ethics to determine the best actions, you should consider all the information available including:

- What facts you know about the problem.
- What you don't know about the problem.
- Who is concerned about the problem (stakeholders)?
- What are the concerns of the stakeholders?
- What possible solutions exist?

An example an ethical problem might address is "If killing is wrong, can one justify the death penalty or kill in self-defense?"

Can you think of other ethical problems?

Why do you think it is important to use ethics to help solve problems?

Often, people will disagree when they use ethics to try to find the best actions to solve a problem. The following rules will help you work together when disagreements happen:

1. Recognize and understand that there are multiple perspectives in the discussion. A discussion is not a competition with a winner and a loser.
2. Be civil, polite and courteous to other participants in the discussion.
3. Communicate your ideas using relevant supporting evidence from what you have learned in class.
4. Demonstrate appropriate use of vocabulary ad scientific content. Make your scientific statements factual and complete. Connect your ideas to other scientific concepts and experiences that you have had.
5. Show that you have an understanding of:
    a. The stakeholders
    b. The values and issues of the stakeholders
    c. Alternative decisions that may be made

Are there other rules that you or your class think should be on this list?

How should people with lactose intolerance be treated?

You have learned a lot about the protein lactase and how it works to break down lactose. You have also learned that people who do not make lactase are lactose intolerant. Currently, people who are lactose intolerant can buy special dairy products that already have lactase. However, dairy products with lactase are not available in all supermarkets and they are more expensive than milk, cheese, or ice cream without lactase. Some people who are lactose intolerant believe this is unfair.

One solution to this problem is to require that all dairy products have lactase added to them before they can be sold.

Consider the following information as you use ethics to determine if this is the best action to solve this problem:

- Milk without lactase costs $2.50 a gallon.
- Milk with lactase costs $5.00 a gallon.
- The cost of ice cream, cheese, yogurt, and many other products is dependent on the price of milk.
- 11% of the people in the United States are lactose intolerant.

Your class will now work together using ethics to try to solve the problem of how to treat people with lactose intolerance fairly.

What do you think is the ethical problem?

What are relevant facts? (Consider what you read above and what you have learned about lactose intolerance.)

What are questions that are still unknown?

Consider the following action:
To be fair to people who are lactose intolerant, all dairy products sold in the United States will have lactase added to them.

As your class uses ethics to decide if this is the best action, what stakeholders should you consider?

What stakeholder did your teacher assign you? _____

What do you think are the concerns of your stakeholder?

How does your stakeholder feel about adding lactase to all dairy products? My stakeholder (circle one):

completely agrees agrees disagrees completely disagrees

Explain why your stakeholder feels this way:

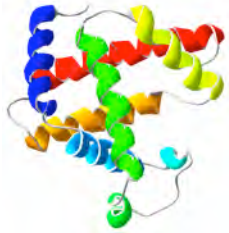
Who are the stakeholders?	What are the concerns of the stakeholders?

What are the possible solutions?

What solution do you think is the best solution? Why?

In *Don't Pass the Milk Please*, Jason's body could not produce a type of protein called lactase, which means he has lactose intolerance. The following reading gives a description of proteins, where we get them and how they are used inside the body. While reading the following text, try using one of the follow reading strategies to organize your reading: Underlining unfamiliar words, using concept cards, writing a summary of the text, or outlining the text.

Proteins- what exactly are they for?



When you think of **proteins**, what exactly goes through your mind? Many people think of proteins in regard to nutrition. On television, you might see commercials or infomercials that advertise protein shakes or pills. You may also see television shows that stress the importance of a balanced diet including protein in meat and beans. Since proteins are an important and essential part of your diet, it is important to understand why there is such an emphasis on including protein in your diet.

It is very important that we eat enough proteins. Proteins are useful for growth, and tissue repair and replacement inside the body. For example, bones and muscles need a steady supply of proteins in order keep healthy.

Think about the different foods that you eat on a daily basis. Do you eat meat or fish? If you do, these are excellent sources of protein. However, meat is not the only way to incorporate protein into your diet. If you drank milk this morning, or had some vegetables at lunchtime, then you had protein today.

Proteins are required for the structure, function, and regulation of the body's cells, tissues, and organs; and each protein has unique functions.

What do proteins do once they enter the body? When you eat food that contains proteins, your body breaks down the proteins in that food and rebuilds the protein so that it may be useful for *your* body. When the proteins are reassembled, different cells use them for different activities. It is important to note that your body does not take in the proteins and use them as they are. Your body always breaks them down and rebuilds them for the body to use. That way they can be used for specific jobs around the body, such as breaking down food and other molecules, building molecules that are used in the cell, transporting molecules around the body, and cellular division.

Think back to the reading "*Don't Pass the Milk, Please*." Jason's body needed special proteins called enzymes (lactase is a type of enzyme) to break down lactose in milk. These proteins are needed that have the job of breaking down food and other molecules. Without this particular protein, Jason was unable to

digest milk. When you are told to eat enough proteins, remember that proteins have very important and special duties throughout your body and that they are essential for your wellbeing.

1. What do proteins do and why are they important for bodily functions?

2. What are some functions of proteins inside the body?

3. What are some ways to make sure that you get protein in your body?

4. List 4 foods from your diet that provide protein.

5. Protein Activities: List 4 different activities that proteins are necessary for in the body. When you have listed 4, discuss your answers with the student sitting next to you. What activities did you both list? What activities were different?

Protein Activities	Classmate's Protein Activities

Similarities

Differences

Where are the proteins in the chicken?: Detecting the presence of proteins

Class activity: First answer the pre-lab questions; then read the directions carefully before beginning the lab.

Pre-lab Questions:
Where are proteins in the human body?

Where are proteins in a chicken's body?

In this activity you will perform a test on four different parts of the chicken to determine if the parts have protein or not. You will use a solution called Biuret solution. If there are no proteins present the solution will stay blue. If there are proteins, it will turn purple or violet.

Materials
Set of five bags with each type of chicken piece

- White meat
- Dark meat
- Liver
- Skin

15 mLs Biuret solution for detecting the presence of protein
15 mLs mixing solution
5 small cups for reaction
7 plastic pipets (1 for mixing solution, 1 for Biuret solution, 1 for each type of chicken)

Activity
Part 1: Biuret Only (Control)

1) Make sure you have all of your materials.
2) Predict which chicken parts will have protein in the table below.
3) Add one pipet full of mixing solution to each of the five bags of chicken.
4) Add Biuret solution to the bag with just mixing solution and record the results in the table below – if it stays blue it has no protein, if it turns purple it has protein. Do not add any Biuret solution to the bags of chicken yet.

Part 2: Chicken test (Experiment)

5) With the chicken still in the bag use your fingertips to gently mash the pieces of chicken. (Make sure the bag of chicken has the mixing solution in it.)
6) Add one pipet full of Biuret solution to each of the bags from step 7. Record the results in the table below – if it is blue it has no protein, if it is purple it has protein.

Part being tested	**Prediction – Is protein in this part? Yes or no.**	**Results – Is protein in this part? Yes or no.**
Mixing solution without any chicken		
White meat		
Dark meat		
Liver		
Skin		

1. Which parts of the chicken have protein?

2. How does this relate to the reading *"Proteins- what exactly are they for?"*

3. Write a scientific explanation for how this activity relates to you. (Refer to the reading “Proteins- what exactly are they for?” on page 24 and 25. Also refer to page 3 and 4.)

   Use complete sentences.

   What is your claim?

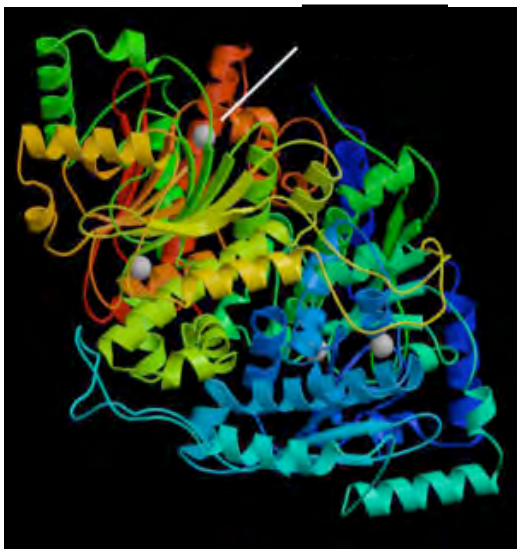
   What are 2 pieces of evidence?

   What is your scientific reasoning?

Proteins' Shape is Dependent on Amino Acids

While reading the following text, try using one of the follow reading strategies to organize your reading: Underlining unfamiliar words, concept cards, writing a summary of the text, or outlining the text.

Every **protein** has a specific job to do in the body. But, what makes each protein capable of fulfilling its duties? Each protein has a specific 3-dimensional shape because each protein has a specific job. In fact, the structure of the protein determines its function. Since proteins have a unique 3-dimensional shape, it would be difficult to switch two proteins and expect them to work the same way. For example, you cannot use tyrosinase to break down milk, nor can you use lactase to produce melanin because each enzyme is shaped uniquely for its job. In this next section, you will read about how proteins get their unique shapes.



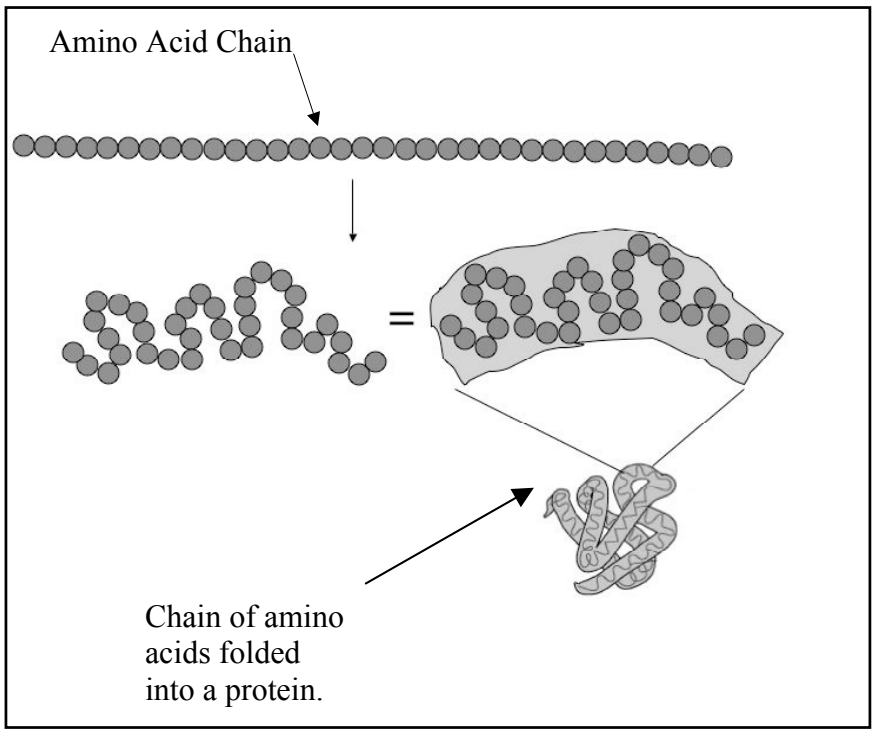
http://en.wikipedia.org/wiki/Enzyme#Enzyme_structure_and_mechanism

Take a look at the figure above. This is a 3 dimensional model of a protein. Notice how the protein bends, folds and twists around itself. The shape of a protein comes from amino acids.

Amino acids are the parts that make up a protein. Each amino acid is a molecule with a specific structure. There are 20 different amino acids, and without amino acids, proteins cannot be formed. Each amino acid has certain unique properties. For example, some amino acids are negatively charged, while some are positively charged. Later, you will read about the different properties of amino acids and how they determine the shape of proteins.

Proteins are made up of amino acids.

Amino acids can be written in a variety of ways. Amino acids are written with a single letter or as an abbreviation of the word. For example, the amino acid Alanine can be written as A or Ala. Similarly, the amino acid Valine can be written as V or Val.



When amino acids form a long chain, the chain folds and makes a protein. The amino acids cause the protein to twist and bend, as shown on the left.

1. What are proteins made of?

2. Explain how proteins get their shape.

3. If you were to describe to a friend what proteins are made up of, how would you describe it?

Thinking about size

The items listed below are all things you have seen in your reading or heard about in class. Use what you have learned to rank the following items in order from largest to smallest. Some of the items are about the same size and can be grouped together.

> protein, amino acid, melanocyte, nucleus, cell, tyrosinase, lactase, melanosome, mitochondria, melanin, lactose, human intestine, human, fruit fly

(The number of lines will help you figure out how many groups of items there are.)

Basic rules of protein folding

a. Charge
   - Positively and negatively charged amino acids attract each other.
   - Amino acids with the same kind of charge repel each other.

b. Hydrophobicity
   - Hydrophilic amino acids attract water.
   - Hydrophobic (water-hating) amino acids repel both water and hydrophilic (water-loving) amino acids.
   - Hydrophobic amino acids attract other hydrophobic amino acids.

c. Cysteines
   - Cysteines are a type of amino acid. When cysteines are near to each other, they attract and form a strong bond. These strong bonds contribute to protein shape formation.

Key to Toobers

Amino Acid Properties

Blue = positive charge (+)
K, R, H

Red = negative charge (-)
D, E

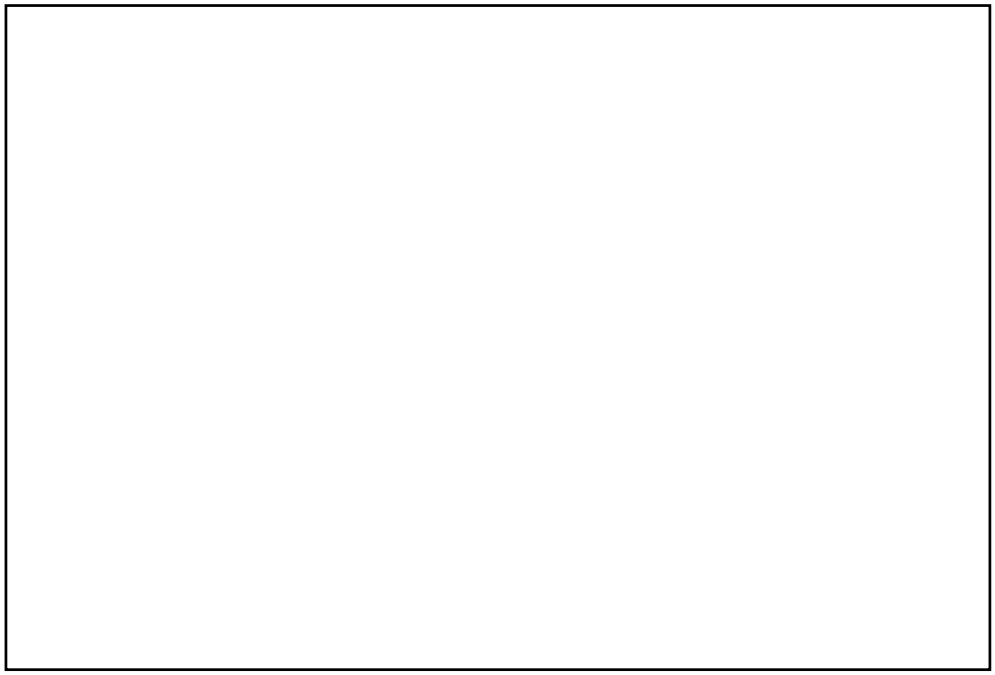
Yellow = hydrophobic
A, V, L, I, P, M, F, W

Green = hydrophilic
G, S, T, N, Q, Y

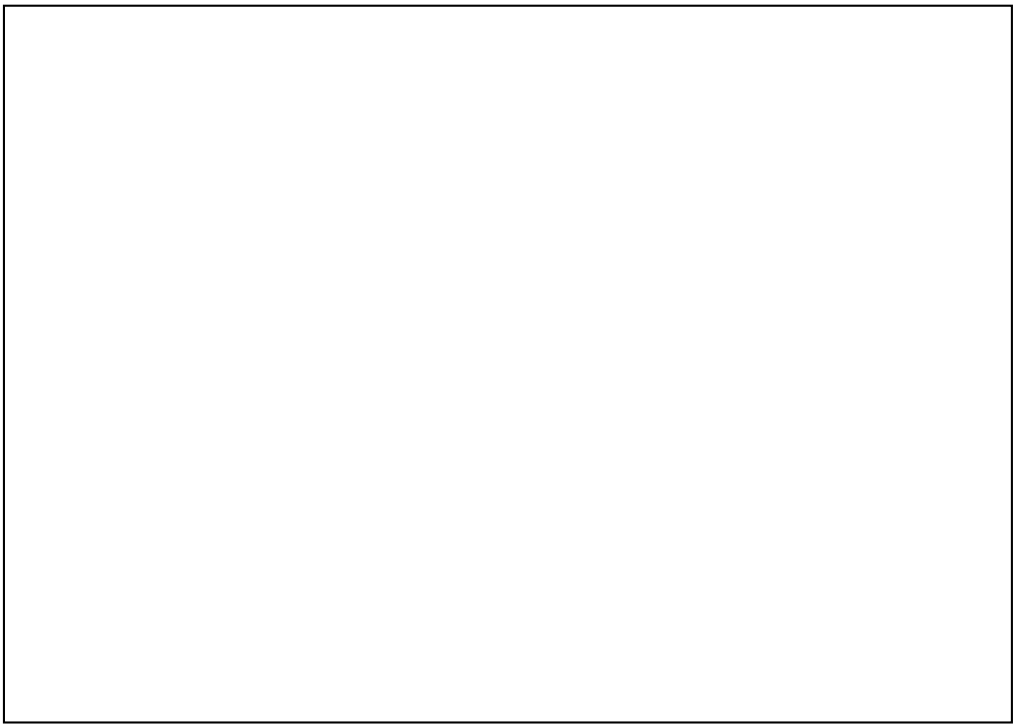
White = cysteines
C

Now that you have completed the toober activity, answer these questions.

1. Draw what your folded protein looks like.
   Amino acid sequence: DIPIYITENGVGLTN (amino acids 1266-1280)



2. After replacing the tacks (amino acids) in your protein chain, draw your new protein below.



3. How many protein shapes were created in your class?

4. After swapping differently charged amino acids, why do you think the shape changed?

5. The toobers that you just constructed are only models of proteins. They are not the real thing. Describe some of the ways your toober model may be similar to real proteins. How might they be different?

6. Look back at the Key to Toobers legend. Some amino acids have the same properties. Would it be possible to swap one amino acid for another and get the same shape? Use complete sentences.
   What is your claim?

   What are 2 pieces of evidence?

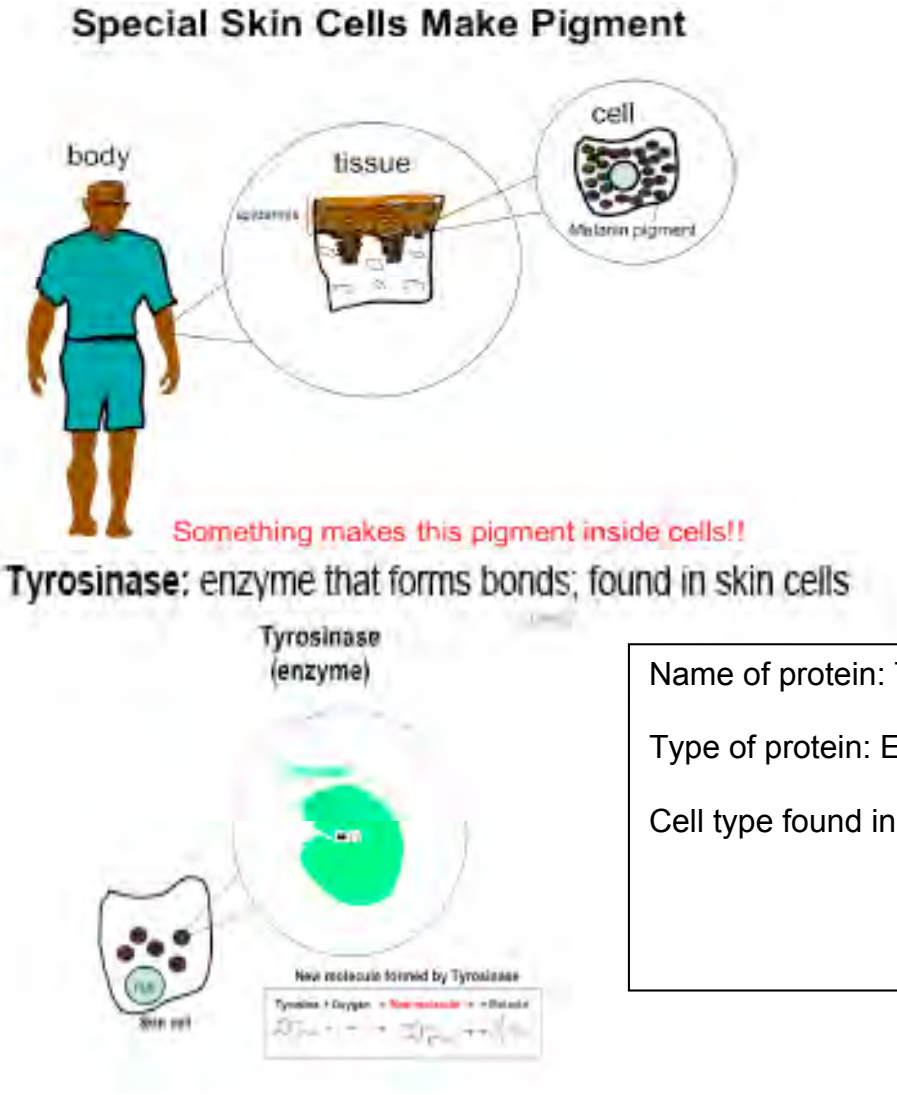
   How can you tie your evidence to scientific principles?

7. How does this activity show the relationship between the properties of amino acids and protein shape?

A Closer Look

For each protein below, read the description of the protein, then, identify what the protein does, how its shape is important for its function, and what might happen if the protein could not work.

TYROSINASE



Name of protein: Tyrosinase

Type of protein: Enzyme

Cell type found in: Skin cell (melanocytes)

Tyrosinase is an enzyme found in melonocytes of the skin (special cells that produce the melanin pigment). Remember from the last lesson that tyrosinase is the first enzyme to act in the production of melanin.

Tyrosinase helps to form bonds when new molecules are being formed. There is a precise fit between tyrosinase and the molecule it interacts with. The shape of the active site, or the pocket, of tyrosinase allows the interacting molecule to fit in the active site. At the end of the process, melanin is produced. If Tyrosinase could not function, melanin would not be produced.

How is the shape of the protein important for its function?

The shape of this protein is important because the pocket (active site) allows the interacting molecule (substrate) to enter so that melanin can be produced.

Predict:
What would happen to the cells if tyrosinase did not work?

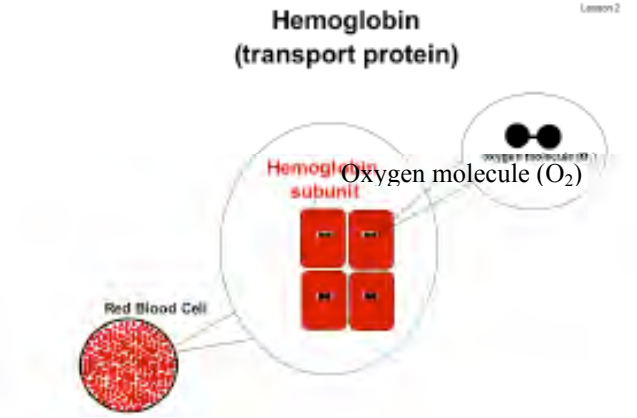
What would happen to the whole organism if tyrosinase did not work?

How does the function of tyrosinase make people more similar or more different?

HEMOGLOBIN

Transport proteins: transports other molecules in or between cells

- **Hemoglobin:** binds oxygen and carries oxygen to other parts of the body (between cells transporter); found mainly in blood cells



Name of protein: Hemoglobin

Type of protein: Transport protein

Cell type found in: Red blood cells

Hemoglobin is the protein in our blood that binds oxygen and helps move oxygen from one cell to another. Hemoglobin has a spot that oxygen attaches to. When hemoglobin binds oxygen, the oxygen is taken from the lungs to other parts of the body. If hemoglobin did not function, oxygen would not be transported to other parts of the body.

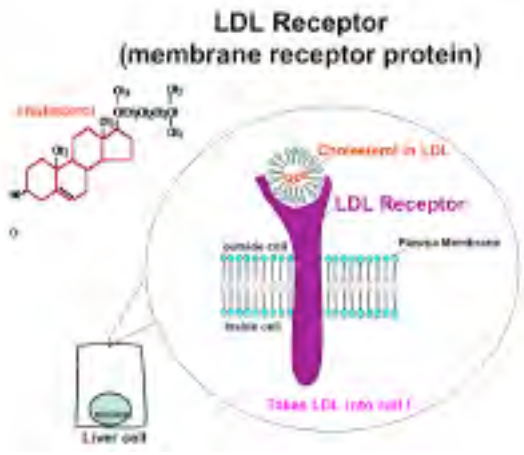
How is the shape of this protein important for its function?

Predict:
What would happen to the cells if hemoglobin did not work?

What would happen to the whole organism if hemoglobin did not work?

How does the function of hemoglobin make people similar or different?

LDL receptor: Binds to LDL (which contains cholesterol) into cell so cholesterol can be used in the cell; found in several types of cells; abundant in liver



Name of protein: LDL receptor

Type of protein: Membrane receptor protein

Cell type found in: Abundant in liver cells

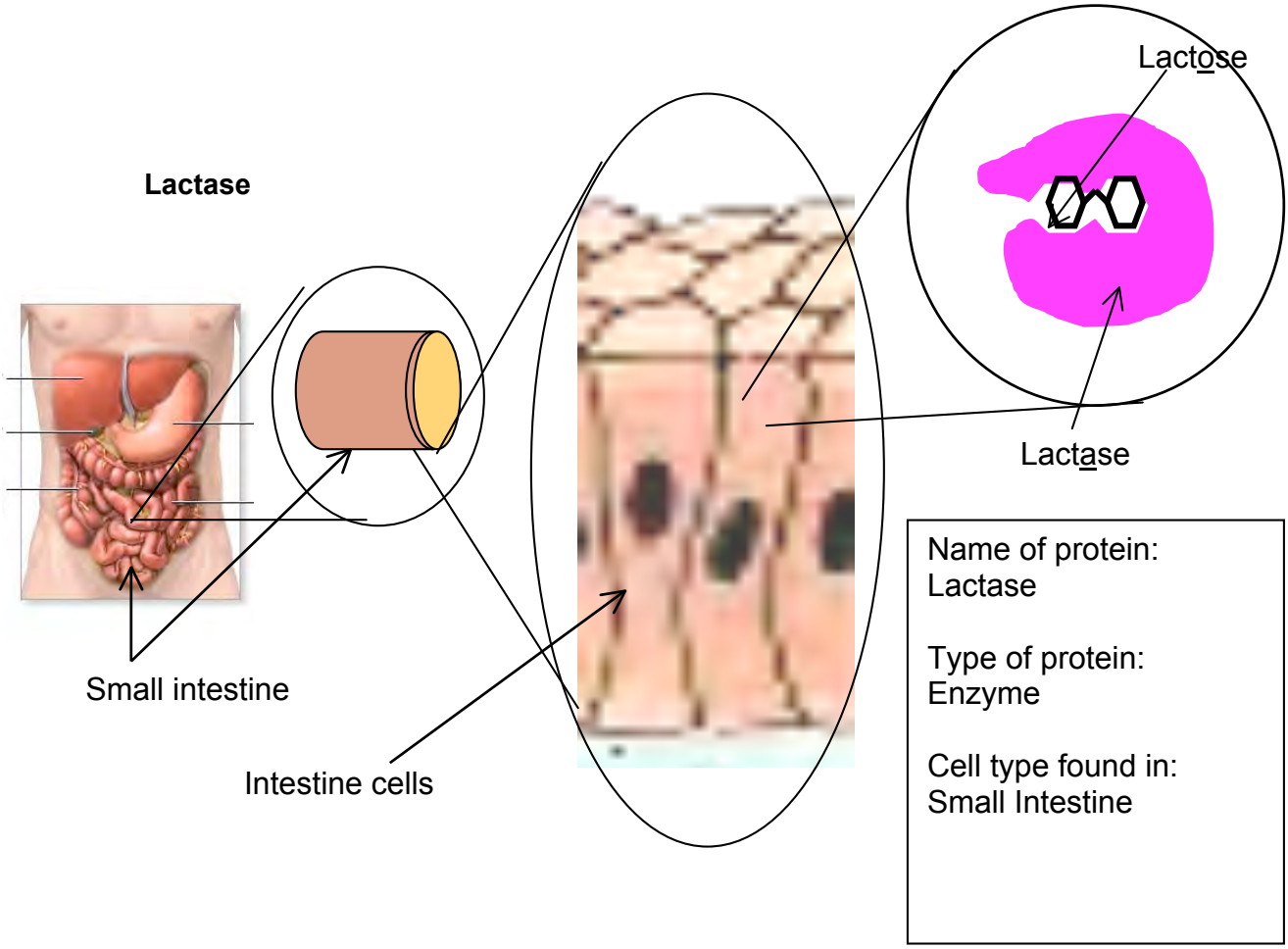
The LDL Receptor is an example of a membrane receptor protein.
When molecules bind to receptor proteins, a response is triggered on the inside of the cell. The LDL Receptor binds to a special particle called LDL, which contains cholesterol (the cholesterol is bound by the LDL particles) and brings cholesterol into the cell. The LDL Receptor is found in many cell types, but is abundant in the liver where cholesterol is taken up to be used for other things in the body such as making cell membranes and hormones. If the LDL Receptor could not function, then LDL and its associated cholesterol would not get into cells so that the cholesterol could be used.

How is the shape of this protein important for its function?

Predict:
What would happen to the cells if the LDL Receptor did not work?

What would happen to the whole organism if LDL Receptor did not work?

How would this make people similar and different?



Lactase is an example of an enzyme. When lactase binds to lactose, lactose gets broken down into glucose and galacatose. Lactse can be found in the small intestine and acts on lactose when lactose enters the small intestines (after consuming a food or beverage containing lactose, such as milk). If lactase did not function, a person could not digest lactose, commonly known as a condition called lactose intolerance.

How is the shape of this protein important for its function?

Predict:
What would happen to the cells if lactase did not work?

What would happen to the whole organism if lactase did not work?

How would this make people similar and different?

Protein Overview Questions

1. What were some similarities that you saw in each protein?

2. Did you find that all the proteins had a specific shape that was important for its function? Give examples that explain different functions.

3. Red blood cells and a cell from your stomach do very different things. Stomach cells release digestive enzymes to break down food while red blood cells transport oxygen to different parts of the body. Based on the last activity where you examined the functions and shape of different proteins, explain how it is that these cell types can do very different things, but also do some of the same things.

Wrap Up

In this lesson, you learned that proteins carry out the work of cells. Proteins, such as lactase, have important jobs. Our bodies can digest milk because lactase breaks down lactose. The driving question asks, “How Similar and Different Are We From Each Other?” You read that proteins have different jobs in the body and that different people have different kinds of proteins- recall, Jason was lactose intolerant because he *did not have* the protein lactase, and his sister was not lactose intolerant because she *had* the protein lactase. Similarly, some people have lighter skin because they make less tyrosinase, while people with darker skin make more tyrosinase.

Now that you have read Lesson 2, use the following questions to help you organize what you learned.

1. What is the driving question of this unit?

2. Think about the readings Proteins- what exactly are they for?, and Don’t Pass the Milk, Please. What are some important activities that proteins do? Why do we need proteins in our diet?

3. Is tyrosinase necessary for skin color production?

4. Lactase is a protein that breaks down lactose (found in dairy products) in the body. In some people, lactase may function differently, making it difficult to break down lactose that enters the body. Explain why some people have different functioning lactase proteins.

5. Refer to the list of amino acid properties on page 38. The sequence of your amino acid was D I P I Y I T E N G V G L T N. In the chart below, identify the properties of each amino acid. Use the notations below to represent each property. Some of them have been filled in for you.

- : Negative Charge

+ : Positive Charge

X : Hydrophobic

△: Hydrophilic

D	**I**	**P**	**I**	**Y**	**I**	**T**	**E**	**N**	**G**	**V**	**G**	**L**	**T**	**N**
-								△				X		

5a. If amino acid E was changed to D, how might this affect the proteins shape and function? Use complete sentences.

5b. Which change is MOST likely to affect the ability of the protein to do its job?

a) Change amino acid L to F

b) Change amino acid D to Q

c) Delete amino acid G

5c. Explain your answer.

6. List and define concepts and vocabulary from Lesson 2. Use the other side of the page if necessary.

Lesson 3: *How do genes cause diseases?*

Lesson 3: How do genes cause disease?

LEARNING GOALS: WHILE COMPLETING THIS LESSON, CHECK TO MAKE SURE THAT YOU CAN DO THE FOLLOWING:
Determine the amino acid sequence of a protein given a DNA sequence.
Assemble models of protein molecules based on a DNA sequence.
Predict the affect of changing the DNA sequence on protein structure and function.
Use models of proteins to show the effect of deletions, insertions, or substitutions on protein structure and function.
Draw pictures of how a specific gene is transcribed into RNA and translated into protein in the context of a cell

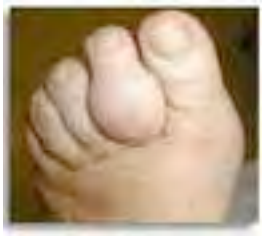
The following case will provide an introduction to some of the concepts you will be learning in this lesson. Try to use the case to understand what the Key Words mean and how they are used in the body. While reading the following text, try using one of the follow reading strategies to organize your reading: Concept Cards, Preview Guides, underlining unfamiliar words, or writing an outline of the text.

The Medical Case: Familial Hypercholesterolemia

Rachel was excited to start her first pre-med hospital program at her undergraduate university. She always dreamt of becoming a doctor, but since she was only 18 and inexperienced in medicine, she knew that she had a challenge ahead of her.

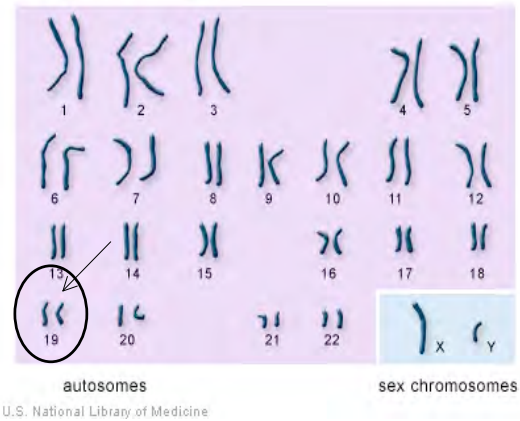
Doctor Lewis was going to be Rachel's advising doctor. Dr. Lewis invited Rachel into his office the day of his training. He handed Rachel a folder. Inside the folder were descriptions and pictures of several patients. There was one description that particularly stood out to Rachel. Before she read the description, she looked at pictures of different sections of the patient's body. These pictures showed fatty deposits that looked like bulges on the arms, knees, elbows and toes of the patient. She tried to think about what this patient was suffering from. As she continued to read, she noticed a picture that showed the patient's **chromosomes**. One of his chromosomes -- chromosome 19 -- had an arrow pointing at one spot on the

Fatty deposits in feet



www.hoslink.com

PICTURE OF PATIENT'S CHROMOSOMES



U.S. National Library of Medicine

chromosome. This arrow indicated something was different at this spot on chromosome 19. Rachel remembered that chromosomes are made up of **DNA**. Rachel concluded that the patient was having a problem with his DNA. But Rachel still could not understand how having problems with DNA could lead to such a severe illness. She continued to read and look at the pictures in the folder. She shuffled through the papers. Then, she found a paper that talked about the **low-density lipoprotein (LDL) receptor**. Rachel stopped to think.

Rachel asked Dr. Lewis, “Doctor, LDL receptors are proteins right?”

Dr. Lewis replied, “Yes they are Rachel. Who’s case are you looking at?”

Rachel answered, “This patient, George, has bulges on his toes, and problems with his DNA, and it looks like there is something wrong with the LDL receptors in his body.”

Dr. Lewis took the file from Rachel and began to look at it.

He said, “Oh yes. George is very young. He had a heart attack when he was only 25. We have been treating him for familial hypercholesterolemia ever since. I wish we knew about it earlier. We might have been able to treat him sooner. Let’s go talk to the patient himself. I think it will make more sense to you then.”

Dr. Lewis and Rachel walked into George’s hospital room. Rachel stopped at the door when she saw the patient.

Rachel exclaimed to Dr. Lewis, “George is obese. This is a good indication that he cannot remove **cholesterol** from his blood. Since the LDL receptors are unable to remove cholesterol from the blood, George’s body has more fat deposits than usual. But what does that say about his DNA?”

Dr. Lewis and Rachel returned to the office.

Dr. Lewis asked Rachel, “What did you think of George? Did you notice that his obesity is a result of his illness?”

Rachel paused for a moment, and then answered, “Yes. Genes are made up of DNA and DNA holds instructions for proteins. And since the LDL receptor is a protein, a gene must exist that codes for it.”

Doctor Lewis helped Rachel by asking, “And if the gene that is responsible for making LDL receptors is defective, how does that affect his health condition?

Rachel thought hard, and then replied, “That means that George cannot make LDL receptors in his body. So he will have more fat deposits, and that’s why he is obese. This must be what causes **familial hypercholesterolemia**.”

“Very good”, replied Doctor Lewis, “When we look at patients, it is important to remember that some of their medical conditions are due to DNA disorders. In this case, George has a problem with his genes, which caused a problem with his proteins, and that is why he is ill.”

At the end of the day, Rachel went home. She could not stop thinking about the patient with familial hypercholesterolemia.

In “The Medical Case: Familial Hypercholesterolemia”, Rachel struggled to understand her patient’s medical condition. Answer these questions to help Rachel diagnose her patient.

1. What led Rachel to realize that the patient George had a problem with his DNA? Use complete sentences.

2. From the reading, what do you *think* are some of the physical signs of familial hypercholesterolemia?

3. Using, the case you just read, explain how you *think* DNA and proteins are related?

4. What were some things you did not understand in this reading?

How SIMILAR or DIFFERENT Are We From Each Other?

Genes and Gregor Mendel

In the past, learning about genes meant learning about Gregor Mendel and the Punnett Square. Gregor Mendel might have been surprised to learn that most genes contain nothing more than instructions for assembling proteins. He might have asked what proteins could possibly have to do with the color of a flower, the shape of a leaf, a human blood type, or the sex of a newborn baby. The answer is that proteins have everything to do with these things. Many proteins are enzymes, which catalyze and regulate chemical reactions. For example, a gene that codes for an enzyme that produce melanin can control skin color. Another gene produces an enzyme specialized for the production of white blood cells to fight off diseases.

The gene combinations that might result from breeding any two individuals can be determined by drawing a diagram known as a Punnett Square. Punnett Squares can be used to predict and compare the genetic variations that will result from a genetic cross. In the Punnett Square, you explore different gene combinations and the kinds of biological characteristics that come from them. Those gene combinations determine the kinds of proteins that are produced, and those proteins determine the characteristics that make people similar and different from each other.

In this unit, instead of using Punnett Squares, you will learn how genes code for proteins in cells, and how those proteins contribute to the similarities and differences you may encounter in people. In the next activity, you will build a model of DNA. This model is a representation of what DNA looks like in your cells. Pay close attention to the different bases, how they pair with each other and the shape of the DNA molecule.

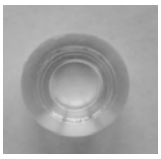
How SIMILAR or DIFFERENT Are We From Each Other?

Assembling a DNA model

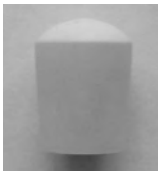
Make sure you have the following materials:

6 T (orange)
6 A (blue)
6 G (green)
6 C (yellow)

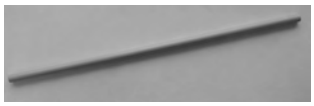
1 base
(light brown)



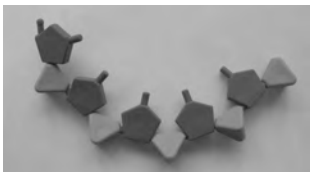
12 spacers
(transparent)



1 cap (white)



1 rod (grey)



2 side chains composed
of alternating deoxyribose (red)
and phosphate (purple)

1. Assemble the model **stand** by pushing the **rod** firmly into the hole in the **base**.
2. Join the DNA bases (the pieces labeled A, T, C, and G). Not all of the pieces will fit together.
3. Put the rod through the hole in the paired DNA bases with a spacer in between each pair.
4. Attach the side chain to the paired DNA bases, by inserting the deoxyriboses into the holes on the outside of the DNA bases.
5. The model is finished when the second chain has been attached and the double-helix completed. Put the white cap on the top to keep the DNA bases from falling off.

How many different types of DNA bases are there?

Do you notice any patterns about how the DNA bases attach to each other?

What is the sequence of the DNA bases in your model?

How SIMILAR or DIFFERENT Are We From Each Other?

Read the text below, then answer the questions that follow.

DNA Molecule

Backbone: sugar and phosphate groups

Bases: Adenine, Guanine, Cytosine and Thymine

Structure of DNA

While reading the following text, try using one of the follow reading strategies to organize your reading: Concept Cards, Preview Guides, underlining unfamiliar words, or writing an outline of the text.

In the last section you talked about genes. In order to understand how genes work, it is important to understand where genes come from. Genes are made up of **DNA (deoxyribose nucleic acid)**. While reading, refer to the DNA model that you built in class.

DNA is a long molecule made up of units called nucleotides. Nucleotides are made up of 3 parts: a sugar called deoxyribose, a phosphate group and a base. There are 4 kinds of bases in DNA. These bases are **adenine, guanine, cytosine and thymine**. The backbone of the DNA molecule is made of the sugars and the phosphate groups. The interior of the DNA molecule is made of the bases. The bases pair in a very specific way. Adenine pairs with Thymine and Cytosine pairs with Guanine; for every Adenine base, there is one Thymine base and for every Cytosine base, there is one Guanine base. The four different bases could be strung together in many different ways, making it possible to have many combinations of bases.

Eventually, scientists found that DNA was shaped into something called a “double helix”. Two strands of DNA lined up next to each other, then twisted into what looks like a spiral staircase or a twisted ladder. In this model, the backbone is on the outside, and the bases are in the middle.

Think back to what you learned about genes. You read and discussed that genes were instructions for making proteins. DNA is the important part of genes. DNA is the letter code for which amino acids are to be made. When the DNA bases are in a certain order, they have a specific meaning as an amino acid sequence. Amino acid sequences come from the genes, and the genes are made up of DNA bases that give specific instructions.

DNA is made up of 4 bases that pair in specific ways.

1. What bases make up DNA? Write their full names.

2. What combinations do DNA bases make? (How do they pair?)

How SIMILAR or DIFFERENT Are We From Each Other?

3. How are genes and DNA related?

4. How are genes responsible for protein shape?

A History Lesson on DNA
(The Double Helix)
http://www.pbs.org/wnet/dna/episode1/index.html

Key Words: Double helix, DNA

The Secret of Life

The discovery of the double helix structure of DNA is to science what the Mona Lisa is to painting. It's been called the single biggest discovery of all time. But it wasn't just stumbled upon- it was a race.

Jim Watson and Francis Crick

Specifically, it was a race between two teams of young scientists working in Britain and California. Rosalind Franklin and Maurice Wilkins were trying to identify the structure by studying X-ray diffractions of the DNA molecule. But Jim Watson and Francis Crick studied a little bit of everything. A few have gone so far as to accuse Watson of stealing Franklin's X-ray work.

Rosalind Franklin

In any case, Waston and Crick's inquisitive working style ultimately allowed them to determine the DNA structure first, in 1953 -- an achievement that led to their Nobel Prize in 1962. Meanwhile, Franklin passed away in 1958 from cancer.

How SIMILAR or DIFFERENT Are We From Each Other?

Read the text and article about different ways DNA is used.

What is crime scene investigation?

Information taken from http://www.crime-scene-investigator.net/respon1.html

You may be familiar with a television program called CSI. While watching this program, you probably see a criminal committing a crime. However, the show does not reveal the criminal until near the end of the show. As you watch the show, you have to follow the detectives in their search for the person who committed the crime. The crime scene investigation process is not as simple as it seems on television. The purpose of a crime scene investigation is to help establish what happened and to identify the person responsible. This is done by carefully documenting the conditions at a crime scene and recognizing important physical evidence pertaining to the incident. The ability to recognize and properly collect physical evidence is oftentimes critical to both solving and prosecuting violent crimes.

Despite Hollywood's portrayal, crime scene investigation is a difficult and time-consuming job. There is no substitute for a careful and thoughtful approach. An investigator must not leap to an immediate conclusion as to what happened based upon limited information but must generate several different theories of the crime. Reasonable inferences about what happened are produced from the scene appearance and information from witnesses. These theories will help guide the investigator to document specific conditions and recognize valuable evidence.

One of the kinds of evidence used in a crime scene investigation is DNA. **DNA** is a good way to identify a person since it is found throughout the body because everyone has unique segments of DNA. Each cell contains all of the individual's genetic instructions stored as DNA. Sometimes, in a crime scene, things such as hair or blood from the victim or criminal are left behind. Since blood and hair contain DNA, they can be used to identify people. Read the following article- this gives a true-life example of how DNA is used in crime scene investigations.

How SIMILAR or DIFFERENT Are We From Each Other?

While reading the following text, try using one of the follow reading strategies to organize your reading: Concept Cards, Preview Guides, underlining unfamiliar words, or writing an outline of the text.

Feline Forensics

By Judy Holmes
http://sumagazine.syr.edu/summer01/features/brightideas/brightpg4.html
(Edited)

The elusive cat—both revered and demonized throughout the course of human history—has become one of the animals most important to helping scientists understand human genetics. Marilyn Menotti-Raymond is among a group of scientists studying and developing a map of the cat genome at the National Cancer Institute's internationally renowned Laboratory of Genomic Diversity (LGD) in Frederick, Maryland. Part of the National Institutes of Health, it is the only research laboratory in the world attempting this work.

It turns out that cats and humans have much in common in terms of how their **genes** are ordered and organized, Menotti-Raymond says. "If you align human and cat **chromosomes**, the gene order and organization are more alike than with any other mammalian species whose genomes have been examined, except for some of the primate species," she says.

Menotti-Raymond's career took an unusual turn when a cat became a key part of a murder case on Prince Edward Island, Canada. In 1994, Shirley Duguay, a 32-year-old mother of five, disappeared. Her body was found in a shallow grave a few months later. Among the chief suspects in the murder was the woman's estranged common-law husband, Douglas Beamish, who was living nearby in his parents' home. The police had no evidence linking Beamish to the crime. During the search for the victim's body, however, the police discovered a plastic bag containing a leather jacket with blood stains that matched the victim's blood. The jacket also contained 27 strands of white hair, which forensic investigators determined were from a cat. The police remembered a white cat named Snowball living in Beamish's parents' home. The trick was to prove the cat hair found in the jacket was Snowball's.

An investigator used the Internet to search for an expert in cat **genomes**, which led him to Menotti-Raymond and LGD director Stephen J. O'Brien. "They wanted to know if we could do a **DNA fingerprint** (using DNA patterns as a way to determine whether two DNA samples are from the same person, related people, or non-related people) of the cat hair," Menotti-Raymond says. "We decided to proceed and determined there was a match between the cat and the hair found in the jacket."

Menotti-Raymond and O'Brien became expert witnesses during the murder trial, and their evidence helped convict Beamish. The case set a legal precedent as the first to allow animal DNA-typing data as evidence

in a court proceeding. Afterwards, the lab received numerous requests from across the United States for similar DNA typing.

Answer and discuss the following question:

If you were one of the scientists working on this murder case, describe a scientific experiment for how the cat hair would be used to convict or free Douglas Beamish? Answer the following questions then write a summary paragraph about your experiment.

a. What is the question you would like to answer?

b. What kind of background information do you need in order to carry out your investigation?

c. What is your hypothesis?

d. What type of evidence would you need to answer your questions?

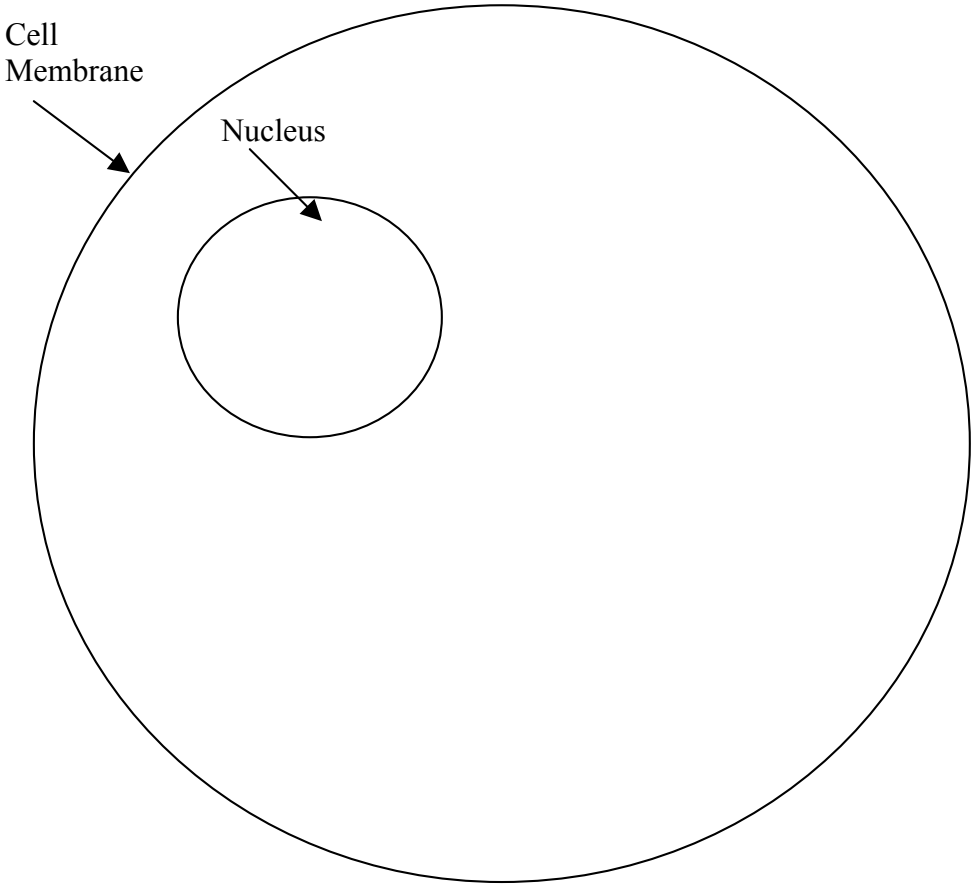
e. What kind of conclusions do you think you will find?

DNA to RNA and RNA to Proteins

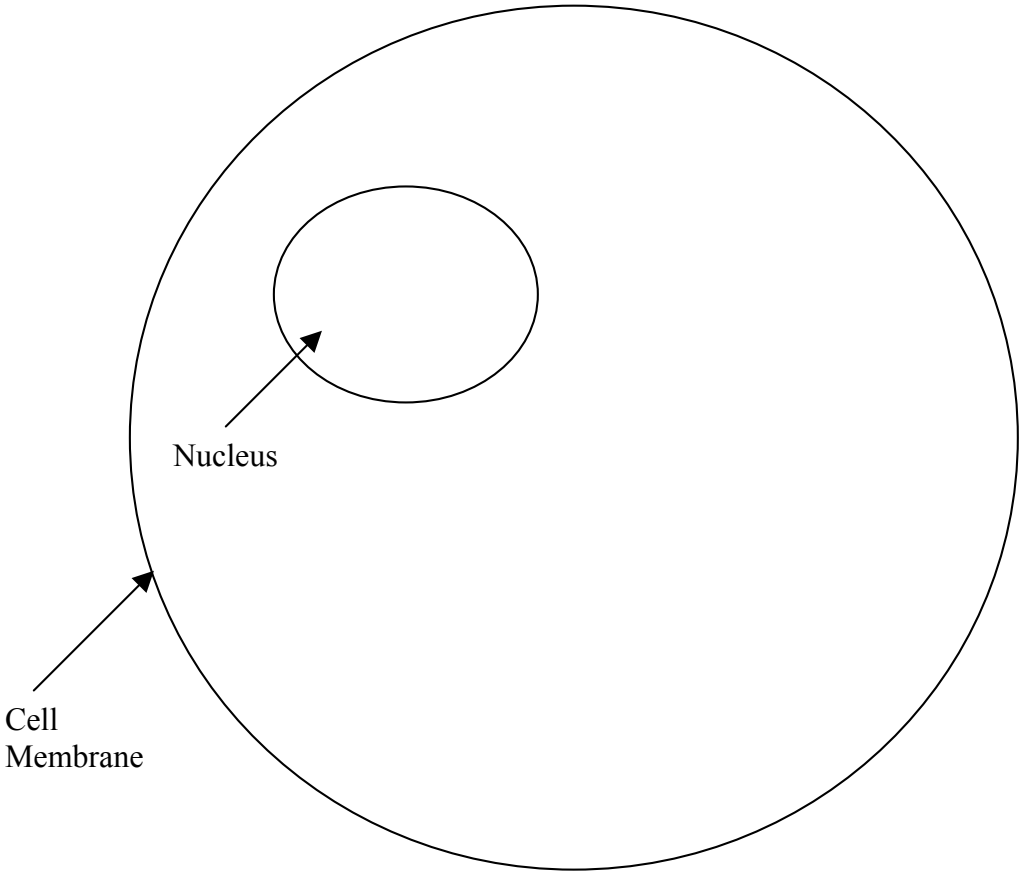
You learned that a gene is a segment of DNA, and that DNA is used to make proteins. There are several steps that are involved in the making of proteins. These steps are referred to as the Central Dogma. The Central Dogma is the process of making RNA from DNA, then making proteins from RNA.

In the space below, draw diagrams for questions 1 and 2. Make sure to label your drawings. The cell membrane and nucleus have been drawn for you.

1. In the process of transcription, DNA makes RNA. In the space below draw a diagram showing the process of transcription.



2. In the process of translation, proteins are made from RNA. In the space below, draw a diagram of translation.

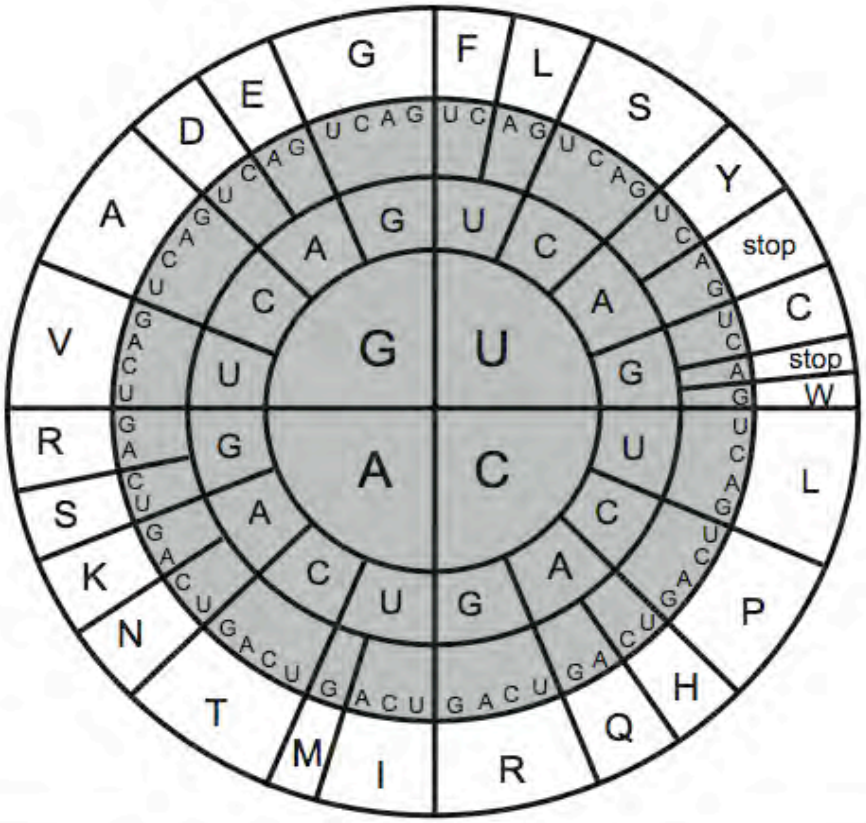


3. What does “a gene is a set of instructions for a protein” mean?

How SIMILAR or DIFFERENT Are We From Each Other?

Transcription and Translation

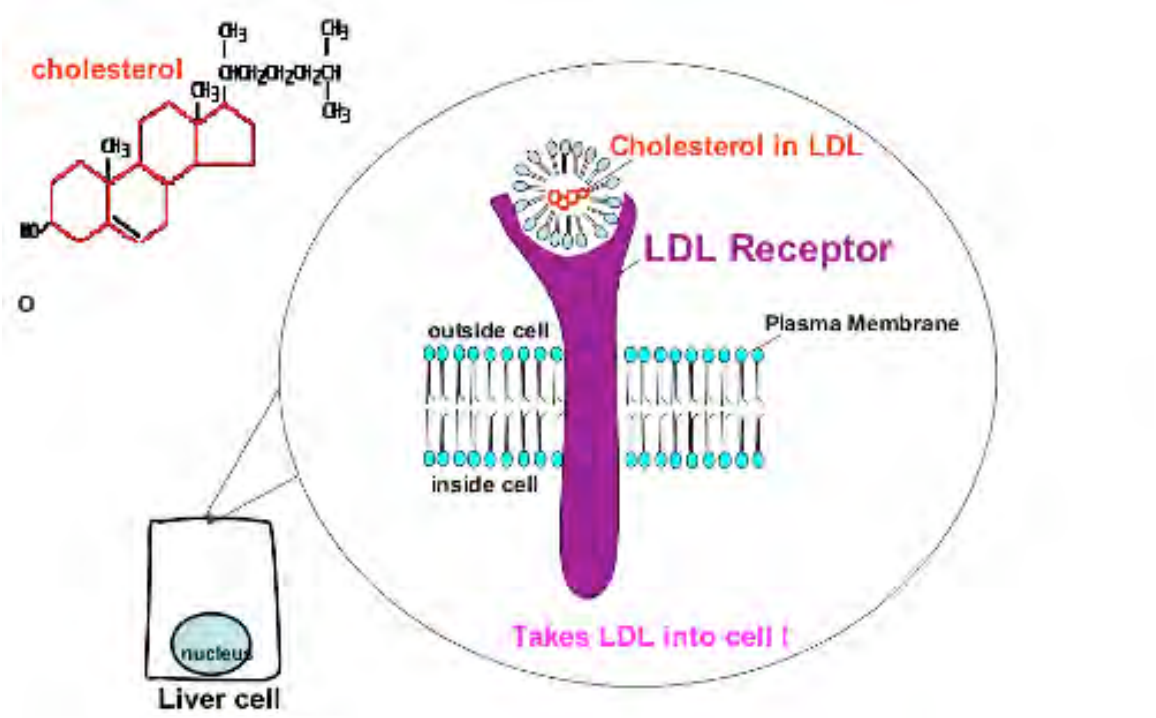
Below is a chart of amino acids. Use the chart to construct your protein.



RNA		
A = adenine	C = cytosine	G = guanine
U = uracil		

AMINO ACIDS		
A = alanine	C = cysteine	D = aspartic acid
E = glutamic acid	F = phenylalanine	G = glycine
H = histidine	I = isoleucine	K = lysine
L = leucine	M = methionine	N = asparagine
P = protline	Q = glutamine	R - arginine
S = serine	T = threonine	V = valine
W = tryptophan	Y = tyrosine	

LDL receptor revisited: Use the DNA sequence to build part of the LDL receptor.



Two stranded DNA sequence of part of LDL Receptor Gene	TGG	CGC	TGT	GAT	GGT	GGC	CCC	GAC	TGC	AAG	GAC	AAA	TCT	GAC	GAG
	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |	| | |
	ACC	GCG	ACA	CTA	CCA	CCG	GGG	CTG	ACG	TTC	CTG	TTT	AGA	CTG	CTC
Bottom strand of DNA															
RNA made from bottom strand of DNA															
Sequence of amino acids															

Mutations: Are they good or bad?

Changing the DNA bases may have created a change in your toober structure. This is similar to what happens at the molecular level. When there are changes in the DNA sequence, it can lead to a change in protein structure. When there is a change in protein shape, the function of the protein also changes.

When there is a DNA change from the normal sequence variations, this is called a mutation. **DNA mutations** or **variations** can occur for several reasons. There can be environmental reasons, such as UV light and nuclear radiation, and there can be mistakes that are made in the cell when DNA replicates. These kinds of changes cause errors in the DNA sequence. Since genes are made up of DNA, genes will also be affected by mutations. Many of these gene changes account for slight differences between people such as hair color and eye color. Some genetic mutations can actually have positive effects on traits. For example, some people that carry a gene for sickle cell also have an immunity to malaria. On the other hand, some changes in DNA might not have any effect on protein activity, and therefore never show as a different trait. But, some gene variations may result in disease or an increased risk for disease. Therefore, some mutations may have positive effects, some have no effects, while others may have negative effects. Although all differences in DNA are the result of a mutation, the scientists *only* refer to a change as a mutation when it is not part of the normal variations between people.

1. What are some positive effects that genetic variations can have? Provide examples that you know about.

2. What are some negative effects that genetic mutations can have? Provide examples that you know about.

3. Are there genetics mutations that can have NO effect? Provide examples that you know about.

Types of Mutations

http://www.genetichealth.com/G101_Changes_in_DNA.shtml (Edited)

Point Mutation

A point mutation is a simple change in one base (A, T, C, or G) of the gene sequence. This is equivalent to changing one letter in a sentence, such as this example, where we change the 'c' in cat to an 'h':

Original

The fat cat ate the rat.

Point Mutation

The fat **h**at ate the rat.

As you can see, a simple letter change in a sentence changes the entire meaning of the sentence. Imagine what it can do to DNA and proteins.

Frame-shift mutation

In a frame-shift mutation, one or more bases are inserted or deleted, the equivalent of adding or removing letters in a sentence. This type of mutation can make the DNA meaningless and often results in a shortened protein. An example of a frame-shift mutation using our sample sentence is when the 't' from cat is removed and all the letters shift to the left:

Original

The fat cat ate the rat.

Frame Shift

The fat caa tet her at.

Deletion

Mutations that result in missing DNA are called deletions. These can be small, such as the removal of just one DNA base or longer deletions that affect a large number of genes on the chromosome. Deletions can also cause frame-shift mutations. In this example, the deletion eliminated the word cat.

Original

The fat cat ate the rat.

Deletion

The fat ate the rat.

Insertion

Mutations that result in the addition of extra DNA are called insertions. Insertions can also cause frame-shift mutations, and generally result in a nonfunctional protein.

Original

The fat cat ate the rat.

Insertion

The fat cat **xlw** ate the rat.

Notice that the insertion of letters made the sentence difficult to read. Imagine what could happen to genes if random DNA bases were inserted into a gene. Would the gene still have the same function?

A CLOSER LOOK

1. Five different patients with high cholesterol want to know whether they have Familial Hypercholesterolemia or another disease. After they saw the doctor, their DNA sequences for the LDL receptor gene was sent to you. It is your job as a laboratory technician to determine whether these patients have FH (familial hypercholesterolemia) or another disease.

	Columns															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Normal sequence	TGG	CGC	TGT	GAT	GGT	GGC	CCC	GAC	TGC	AAG	GAC	AAA	TCT	GAC	GAG	
	ACC	GCG	ACA	CTA	CCA	CCG	GGG	CTG	ACG	TTC	CTG	TTT	AGA	CTG	CTC	
Patient 1	TGG	CGC	TGT	GAT	GGT	GGC	CCC	CAC	TGC	AAG	GAC	AAA	TCT	GAC	GAG	
	ACC	GCG	ACA	CTA	CCA	CCG	GGG	GTG	ACG	TTC	CTG	TTT	AGA	CTG	CTC	
Patient 2	TGG	CGC	TGT	GAT	GGT	GGC	CCC	GAT	TGC	AAG	GAC	AAA	TCT	GAC	GAG	
	ACC	GCG	ACA	CTA	CCA	CCG	GGG	CTA	ACG	TTC	CTG	TTT	AGA	CTG	CTC	
Patient 3	TGG	CGC	TGT	GAT	GGT	GGC	CCC	GGA	CTG	CAA	GGA	CAA	ATC	TGA	CGA	G
	ACC	GCG	ACA	CTA	CCA	CCG	GGG	CCT	GAC	GTT	CCT	GTT	TAG	ACT	GCT	C
Patient 4	TGG	CGC	TGT	GAT	GGT	GGC	CCC	ACT	GCA	AGG	ACA	AAT	CTG	ACG	AG	
	ACC	GCG	ACA	CTA	CCA	CCG	GGG	TGA	CGT	TCC	TGT	TTA	GAC	TGC	TC	
Patient 5	TGG	CGC	TGT	GAT	GGT	GGC	CCC	GAC	TGA	AAG	GAC	AAA	TCT	GAC	GAG	
	ACC	GCG	ACA	CTA	CCA	CCG	GGG	CTG	ACT	TTC	CTG	TTT	AGA	CTG	CTC	

Answer the following question about the mutations above.
What kind of mutation is found in each mutant sequence? Also indicate which column you found the mutation in.

Mutation 1.
Mutation 2.
Mutation 3.
Mutation 4.
Mutation 5.

1. What effect does each mutation have on the amino acid sequence encoded? Convert one of the DNA sequences (pick one mutation sequence) to RNA sequences (Transcription), then determine the amino acid sequences (Translation).

   Mutation #_____:
   Mutation DNA sequence:

   Mutation RNA sequence:

   Mutation Amino Acid sequence:

   Compare your mutation sequences with the Normal DNA sequence on page 68.

   Normal DNA sequence:

   Normal RNA sequence

   Normal Amino Acid sequence:

2. What effect did the mutation have on the amino acid sequence? Write a scientific explanation explaining how the amino acids sequence changed. If the amino acid sequence did not change, write an explanation for why not.

   What is your claim?

   What are 2 pieces of evidence?

   What is the scientific principle?

3. Do you think that the changed protein could carry out its function of binding LDL and taking it into the cell? Why or why not? Use complete sentences.

4. Based on your analysis of the DNA samples and the resulting amino acid sequence, do you think that the person is likely to have FH? Use complete sentences.

Wrap Up

In this lesson, you learned that DNA are the instructions for proteins. In this lesson, you learned the different bases used to make up the DNA molecule and you used DNA to carry out transcription and translation for Familial Hypercholesterolemia. You also read about the effects of mutations on proteins and a person. The driving question asks, “How Similar and Different Are We From Each Other?” Now, think about how DNA plays a role in making people similar and different from each other.

Now that you have read Lesson 2, use the following questions to help you organize what you learned.

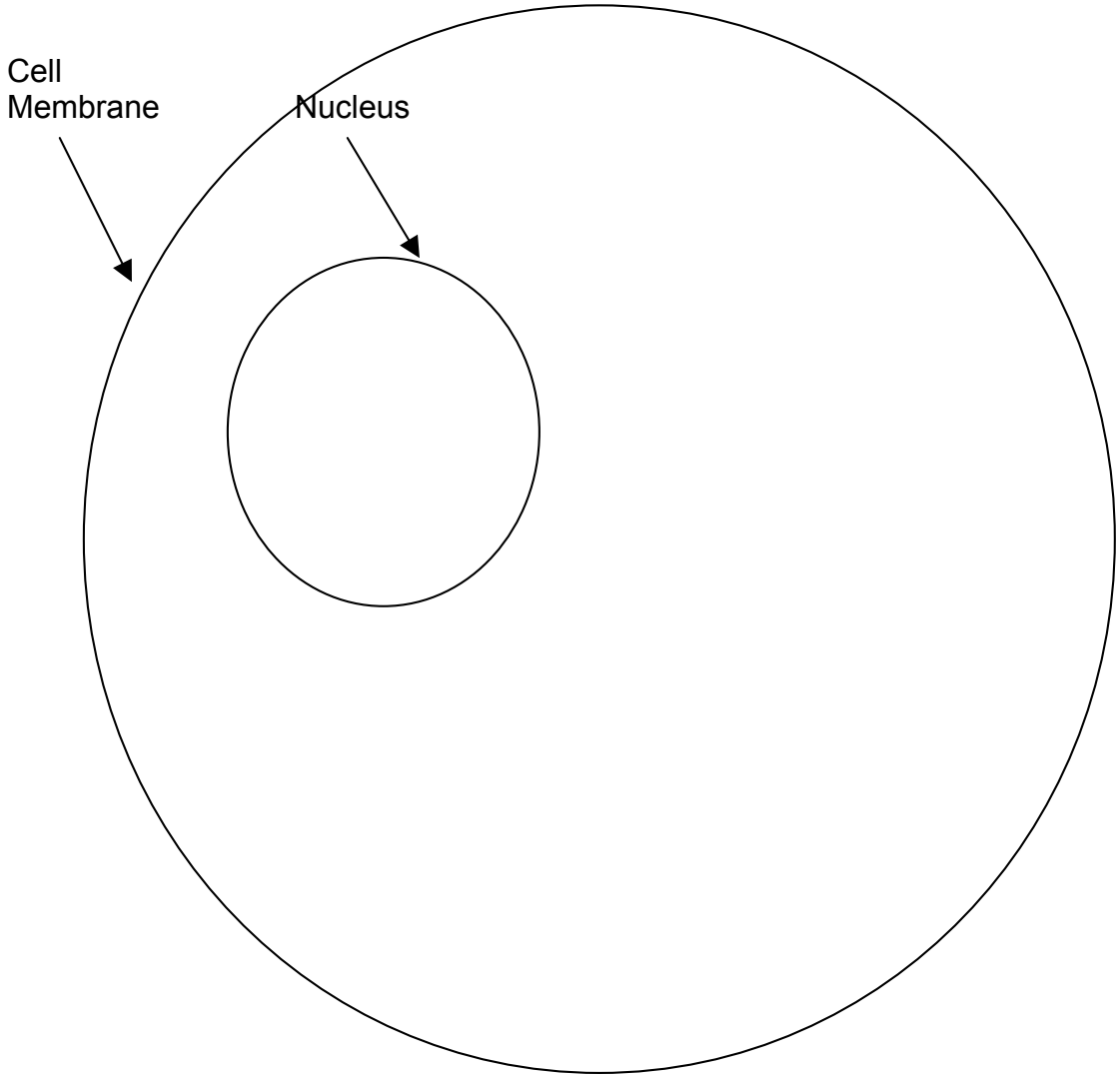
1. What is the driving question?

2. Think about the readings *A Medical Case: Familial Hypercholesterolemia* and *Mutations: Are they good or bad?*. How can DNA be involved in the health of a person?

3. What is the relationship between DNA and genes?

How SIMILAR or DIFFERENT Are We From Each Other?

4. In the space below, draw where the chromosome, gene and proteins are found in the cell. The drawing does not have to look accurate, but try your best. The cell membrane and nucleus have been drawn for you.



5. Why is DNA important for the functioning of proteins?

What is your claim?

What are 2 pieces of evidence?

How can you tie your evidence to scientific principles?

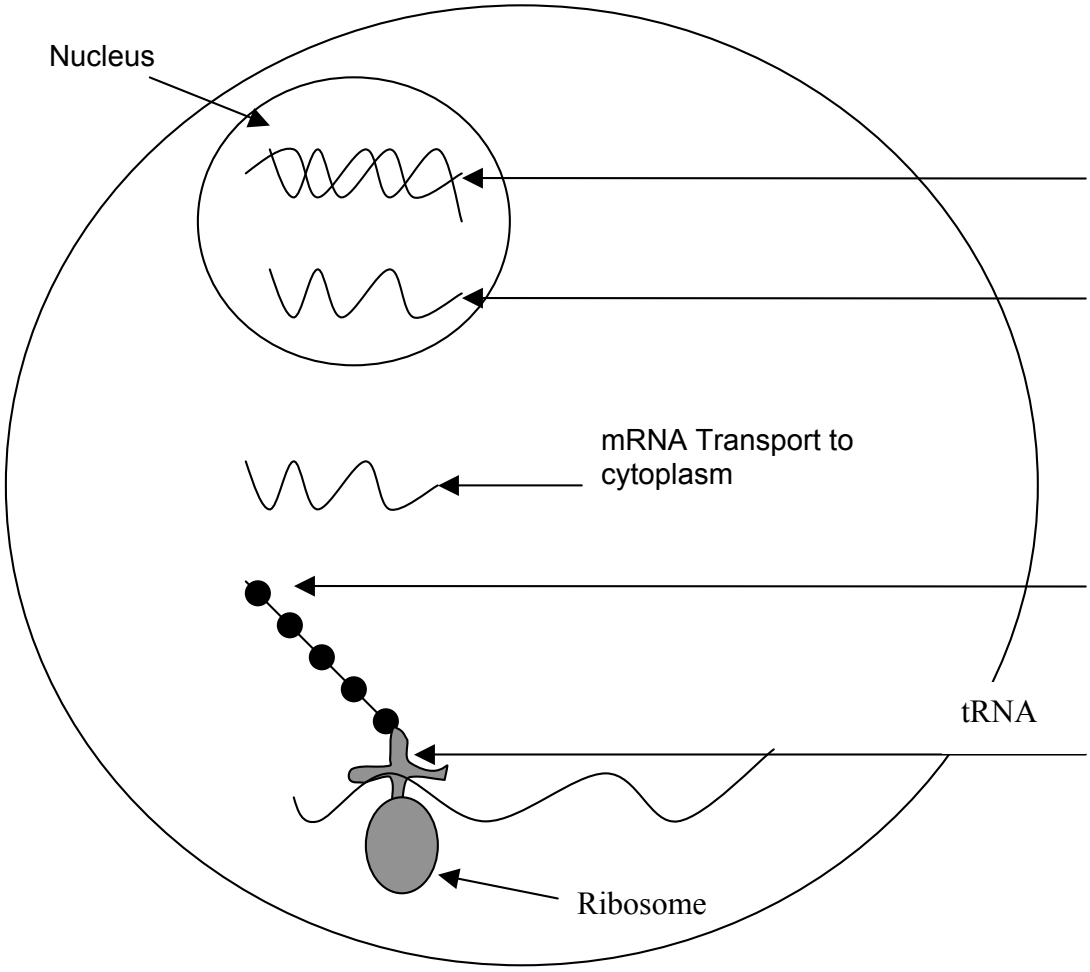
6. The Low Density Lipoprotein (LDL) Receptor is a protein that is needed to bring cholesterol into the cell. When a person has a mutation in the gene that codes for the LDL receptor protein, it is likely that the person can develop Familial Hypercholesterolemia (FH). Scientists are working on a medical treatment to help patients with Familial Hypercholesterolemia (FH).

    a. If you were a scientist and could replace the mutated gene with a properly functioning gene, how would this affect the LDL receptor protein? Discuss shape and function of proteins.

    b. Identify the steps of transcription and translation. Then explain how a mutated gene sequence can lead to an altered protein.

7. There is a protein called hemoglobin that carries oxygen throughout the body. Some people have different amino acid sequences for hemoglobin. Explain why some people have proteins with different amino acid sequences.

8. In order to get a complete view of the process of transcription and translation, label the structures on the diagram below.

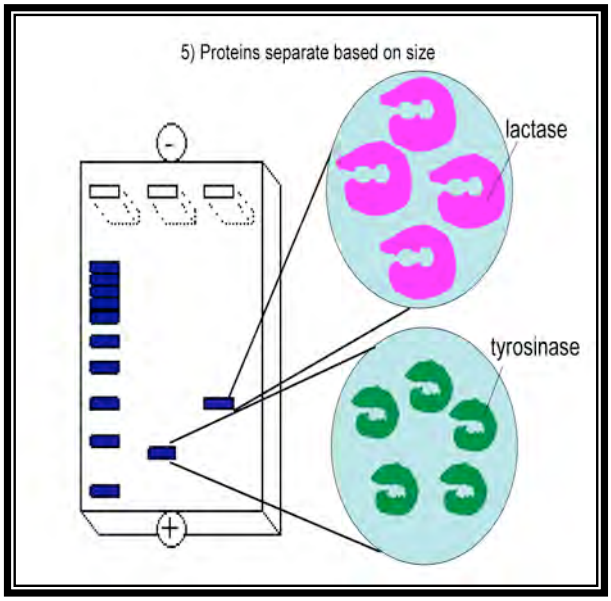


9. To complete the chart below, give the name and a brief description of each step in protein synthesis that occurs in the indicated part of the cell.

Part of Cell	Name of Protein Synthesis Process	Description
Nucleus		
Ribosome		
Cytoplasm		

10. List and define concepts and vocabulary from Lesson 3.

Lesson 4: Gene Expression



Lesson 4: Gene Expression

LEARNING GOALS: WHILE COMPLETING THIS LESSON, CHECK TO MAKE SURE THAT YOU CAN DO THE FOLLOWING THINGS:
Explain how turning genes on and off can make a specific type of cell, like a red blood cell or a melanocyte.
Understand that the environment and their genes both affect traits.
Use a decision making framework to make an ethical decision.
Draw and explain the process of transcription and translation.

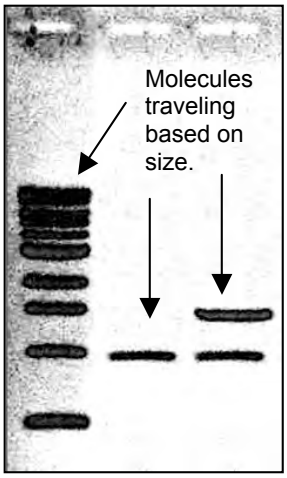
The following readings explain how to tell whether a gene is on or off. While reading, try using one of the following reading strategies: Underlining unfamiliar words, outlining the text, or using concept cards.

Gene Expression: Genes Can Be Turned On and Off

In lessons 3 and 4 you learned that certain DNA mutations can lead to certain diseases like Sickle Cell Disease. You also learned that mutations can cause conditions such as lactose intolerance. Think back to Jason and his family. Jason had lactose intolerance, but the rest of his family did not. There is an explanations for this. Although Jason and his family members share the same genes, it is possible for genes to be turned on or off.

How do you know that a gene is turned on or off? Remember, the cells contain genes in their nucleus. When a gene is turned on, the DNA in the gene makes RNA and the RNA makes the proteins. When a gene is off, no RNA is made and proteins cannot be made. In order for a gene to be turned on, a segment of DNA near the gene (called an on or off sequence) must be activated. When this sequence is activated, it starts the transcription process of the gene. We can tell whether a gene is on or off by looking closely at the cell. One way to look closely at a cell is by using a technique called gel electrophoresis.

Picture of Gel Electrophoresis

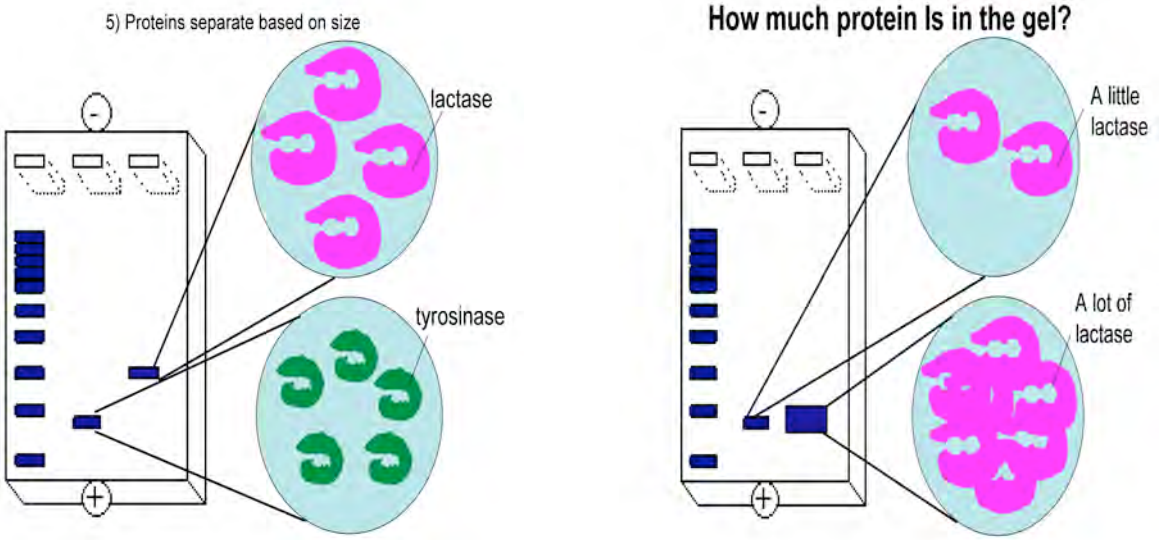


Gel electrophoresis is a method that separates molecules, like DNA or proteins, by their size, electrical charge and other properties. Look at the image on the right. This is what gel electrophoresis may look like. The *gel* looks and feels like gelatin. Under a microscope, the gel looks like a maze that the molecules must pass through. The term *electrophoresis* describes the movement of charged molecules under the influence of an electric field. Electro refers to the energy of electricity. Phoresis, from the Greek verb *phoros*, means "to carry

across." Thus, gel electrophoresis refers to the technique in which molecules are pushed across the gel by an electrical current. Activated electrodes at both ends of the gel provide the driving force. A molecule's size determines how rapidly an electric field can move the molecule through a gelatinous medium.

A Closer Look into Gels

Let us examine the image below.



In the first image, the lactase molecules are large molecules and the tyrosinase molecules are small molecules. Notice how the tyrosinase traveled farther down the gel. This is due to the fact that the small molecules can move faster through the small spaces in the gel than large molecules. In the second image, all of the molecules are lactase. The difference is in the amount of molecules in the gel. When there are a lot of molecules in the gel, it will look darker than if there were fewer molecules in the gel. But the group of large molecules will travel at the same speed as the group of molecules of the same substance. For an animation of how gels work, visit the website http://learn.genetics.utah.edu/content/labs/gel/.

Genes in a Gel

Earlier you read that genes can be turned on and off and that looking closely in the cell will reveal whether a gene is on or off. If a gene is on, it will be transcribed and proteins will be made. Scientists use gel electrophoresis techniques to identify proteins that are made. When the scientists see the proteins in the gel, they know that the gene is on. If they cannot see the proteins in the gel, then they know that the gene is off.

In the case of lactose intolerance, some people may have a mutation in the instructions for the protein (gene) that prevents lactase from being produced. However, some people may not have a mutation, but instead, cannot turn on the gene that produces lactase. This inability can also cause a person to have lactose intolerance.

Let us take a closer look at Jason and his family. You will look at data that have been gathered from Jason, his mom, his sister Chelsea and his sister Maya.

Make a prediction about why you think Jason is lactose intolerant and his sisters are not. Make sure to include a prediction about Jason's genes, his RNA and his proteins.

The first piece of evidence is about the order of DNA base pairs in each of the family member's genes.

DNA sequence of area NEAR the lactase gene

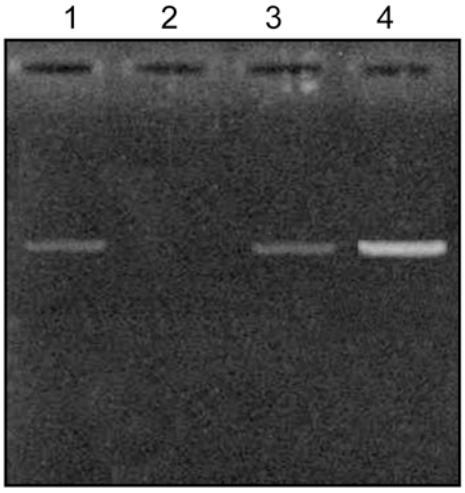
Results: DNA sequence analysis of lactase gene:

Mom:	no mutations in lactase genes
Jason:	no mutations in lactase genes
Chelsea:	no mutations in lactase genes
Maya:	no mutations in lactase genes

Do these results help explain why Jason is different from his sisters? Explain why or why not.

To help explain the results, RNA from each family member was analyzed:

Results: RNA analysis of lactase gene



Lactose intolerance:

1) No (Mom)
2) Yes (Jason)
3) No (Chelsea)
4) No (Maya)

The image above is an electrophoresis gel that shows the RNA results of Jason and his family. What do you notice about the gel?

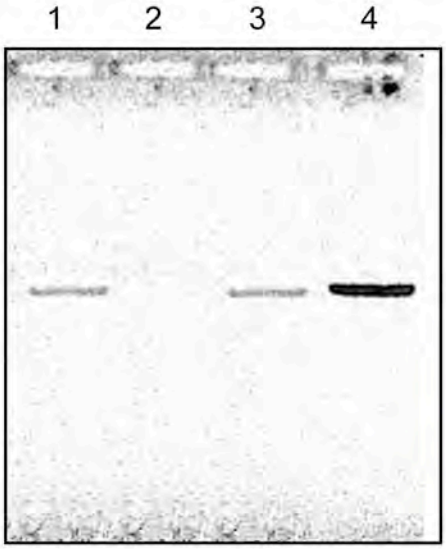
Why are some of the lines brighter than the other lines?

Why do you think there are no lines for Jason?

Is transcription of the lactase gene happening in Jason's small intenstine cells? Explain why or why not.

Here are the results of the analysis of protein in the family members:

Gel electrophoresis:
Lactase samples from 4 people



Lactose intolerance:

1) No (Mom)
2) Yes (Jason)
3) No (Chelsea)
4) No (Maya)

The image above shows the protein results of Jason and his family.

Do all of the family members have the same amount of lactase protein? Explain.

Do you think that you need a lot of protein to break down lactose? Explain why or why not. (Hint: How much protein do Mom and Chelsea have? Can they break down lactose?)

Based on the results from the RNA analysis, why doesn't Jason have the protein?

To help understand why Jason is lactose intolerant, the DNA lab looked at the DNA near the lactase gene. It is possible that this part of the DNA has an on/off switch for the lactase gene. Here is the DNA sequence for each family member. There are two sets because the lab sequenced the area near both copies of the lactase gene on each chromosome (remember, each cell has 2 copies of each chromosome; one from each parent).

Circle the base pair that you think might be the on/off switch in each set. The on/off switch for Mom has been **BOLDED** for you.

DNA sequence of area NEAR the lactase gene

Mom:

```
ATTTGC
||||||
TAAACG

ATCTGC
||||||
TAGACG
```

Jason:

```
ATCTGC
||||||
TAGACG

ATCTGC
||||||
TAGACG
```

Chelsea:

```
ATCTGC
||||||
TAGACG

ATTTGC
||||||
TAAACG
```

Maya:

```
ATTTGC
||||||
TAAACG

ATTTGC
||||||
TAAACG
```

What do you notice about this gene sequence NEAR the gene?

How is the DNA sequence near the lactase genes in Jason different from the other members of his family?

Study the data above to understand which genes are being expressed in each person and then fill in the chart below.

	Lactose Intolerance (Yes or No)	**DNA Mutation (Yes or No)**	**RNA (Yes or No)**	**Protein (Yes or No)**	**The on/off DNA sequence**	**Genes On or Off?**
Jason						
Mom						
Chelsea						
Maya						

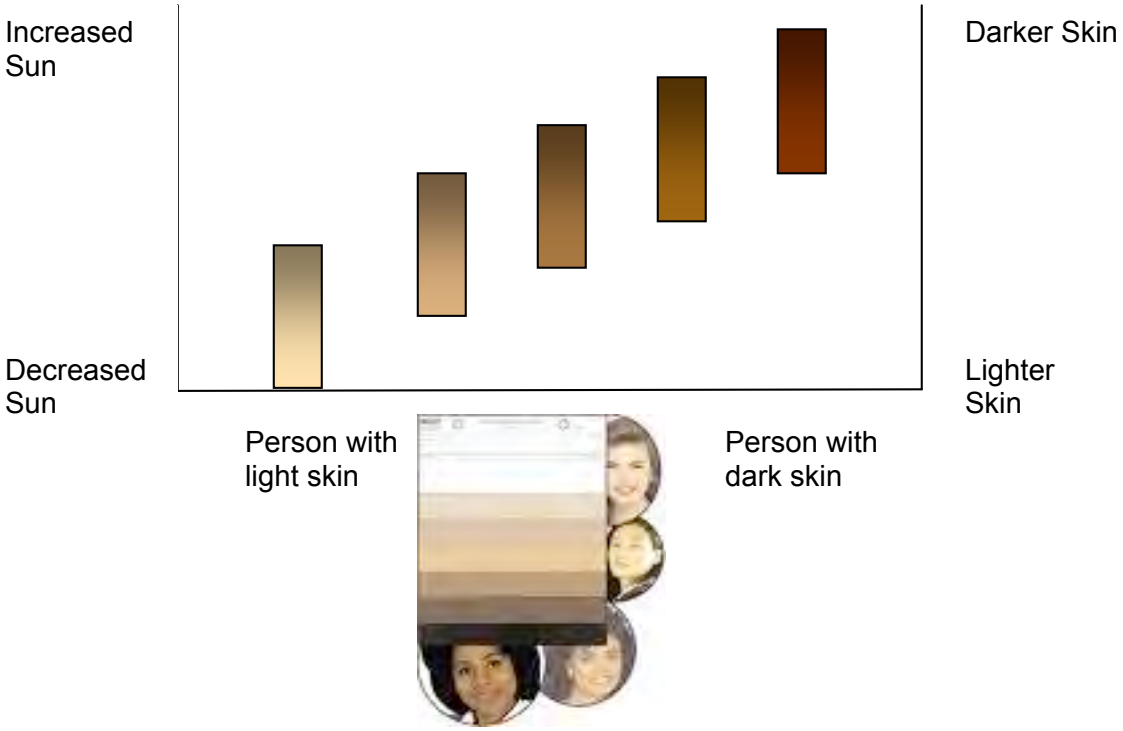
Write a scientific explanation answering the question: Why does Jason have lactose intolerance? (What is your claim, evidence and scientific reasoning?) Use the gels to help you form an explanation.

The Environment Can Turn Genes On and Off

In the previous section you read that genes can be turned on and off within the cell. There are other factors that can turn a gene on or off, such as the **environment**. For this reading, try using these reading strategies: Underlining unfamiliar words, outlining the text or using concept cards.

Think back to Lesson 1. You learned about skin color and that people around the world have different shades of skin due to differences in melanin production. Sometimes, the environment can have an effect on how light or dark the skin becomes. Have you ever seen a person lying out in the sun, getting a tan? These people use the sun to change how much melanin gets produced in the body. The longer they sit in the sun, the more melanin the body produces and the darker they become. Every person, regardless of skin color or ancestral origin can use the sun to get darker. Similarly, any person that stays out of the sun can lose melanin, making them lighter.

Look at the figure below.



This figure shows that although people have genes that make them start out lighter or darker, the possibility of becoming temporarily darker is due to the amount of sun the person is exposed to. The sun is an example of how the environment affects our genes. When a person is exposed to a lot of sun, the genes responsible for the proteins that build melanin get turned

on more often. And when a person is exposed to less sun, then the genes for instructions for proteins that build melanin get turned on less often.

The following reading will give an explanation of why people's genes cause them to have different skin colors.

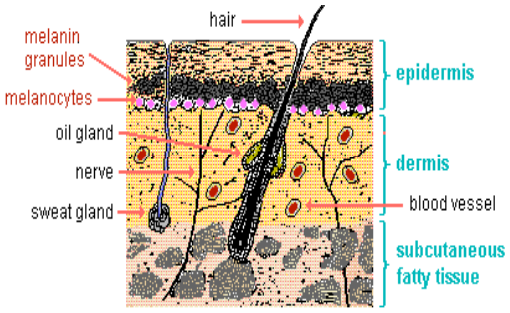
Skin Color Adaptation

http://anthro.palomar.edu/adapt/adapt_4.htm
(Text modified)

Human skin color is quite variable around the world. It ranges from a very dark brown among some Africans, Australians, and Melanesians, to a near yellowish pink among some Northern Europeans. There are no people who actually have true black, white, red, or yellow skin. These are commonly used color terms that do not reflect biological reality.

Some of the variation in human skin coloration (Sub-Saharan African, Indian, Southern European, and Northern European)

Skin color is due primarily to the presence of a pigment called melanin. Both light and dark complexioned people have this pigment.



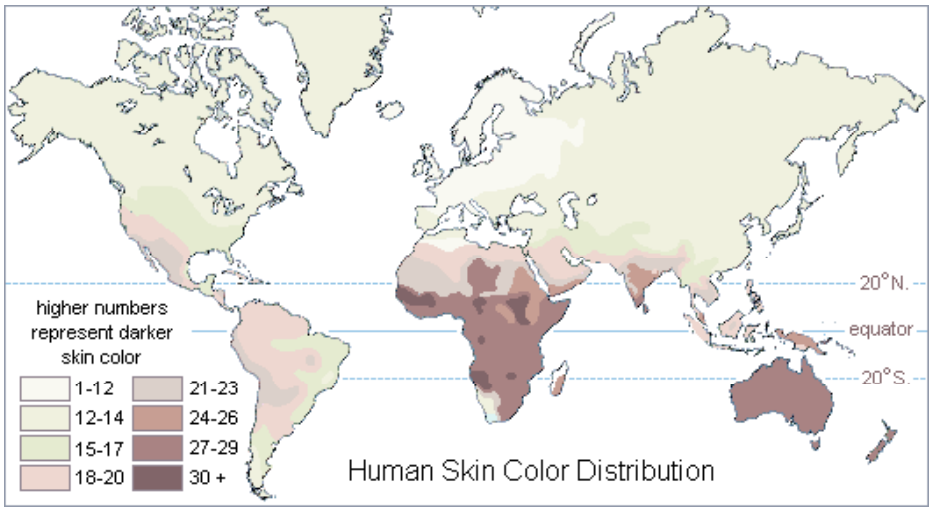
Cross section of human skin showing melanin and melanocytes

Nature has selected for people with darker skin in tropical latitudes, especially in non-forested regions, where the sun is usually the most intense. Melanin acts as a protective biological shield against harmful rays from the sun called ultraviolet radiation. By doing this, it helps to

prevent sunburn damage that could result in DNA changes that can cause melanoma --a cancer of the skin. Melanoma is a serious threat to life. In the United States, approximately 54,000 people get this aggressive type of cancer every year and nearly 8,000 of them die from it. Those at highest risk are European Americans. They have a 10 times higher risk than African Americans because they have less melanin in their skin to protect them from the sun.

It would be harmful if melanin acted as a complete shield. A certain amount of sunlight must penetrate the outer skin layer in order for the body to produce vitamin D. However, too much sun penetrating the skin may cause the break down of folic acid (or folate--one of the B vitamins) in the body, which can cause anemia. Anemia is a deficiency of red blood cells.

People who live in far northern latitudes, where the sun is not as bright and strong most of the year, have an advantage if their skin has little shielding pigmentation. In such an environment, very dark skin is a disadvantage because it can prevent people from producing enough vitamin D, potentially resulting in rickets disease in children. Rickets is an abnormal bone formation in children resulting from inadequate calcium in their bones. This lack of calcium can result from inadequate exposure to sunshine (needed to make vitamin D).

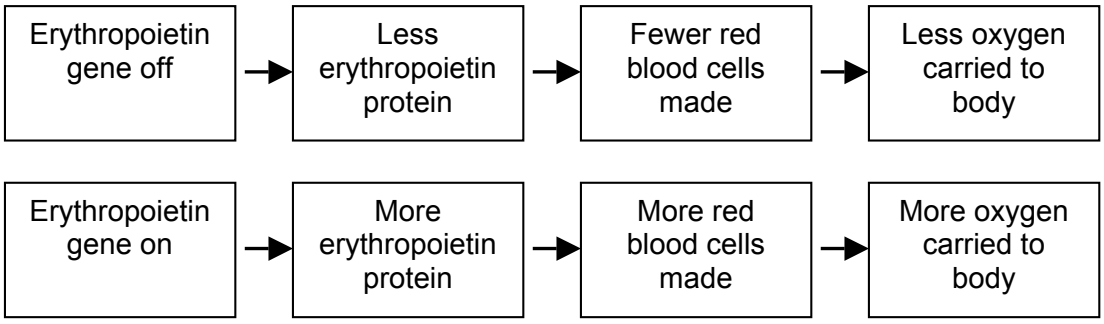


The distribution of human skin color in about 1500 A.D.--darker skin colors are found mostly between 20 degrees north and south of the equator

Ethical Dilemma

Should Athletes Alter Their Oxygen Levels in the Olympics?

The protein erythropoietin or EPO controls red blood cell production in the body. Red blood cells are responsible for carrying oxygen to all parts of the body. If the gene with instructions for making the protein EPO is not turned on as often the body does not make a lot of EPO, it will not be able to make a lot of red blood cells and less oxygen will be carried to all the parts of the body. If the gene for erythropoietin is turned on often, lots of EPO will be made causing more red blood cells to be made and more oxygen to be carried to the parts of the body.



All of us naturally make EPO, but depending on our environments we might make different amounts. People who live in environments with lots of oxygen, such as people who live at sea level, do not make as much EPO. People who live in the mountains live in an environment with less oxygen and their bodies make more EPO.

Athletes are very interested in EPO. They know that if their bodies have more EPO, they will have more red blood cells and more oxygen can be carried to their muscles. If more oxygen is being carried to their muscles, their muscles will be able to endure the athletic activity better. So the more EPO the athletes have the better their athletic performance will be. Currently, athletes are trying several methods to try to increase their EPO levels.

The International Olympic Committee has asked you to look into this matter and to make a recommendation about how athletes will be permitted to affect their EPO levels. They would like you to consider the following possibilities:

A. Permitting athletes to live in environments that naturally have less oxygen, such as the mountains.
B. Permitting athletes to alter their environments so that they contain less oxygen, such as training or sleeping in special rooms with less oxygen.
C. Permitting athletes to inject EPO protein that has been made in a lab, as long as they are under a doctor's supervision.
D. Permitting athletes to use a new drug that helps to turn on their own erythropoietin gene.

For each possibility, explain how allowing that possibility will affect the athlete at the gene, protein, cell and whole body level. Additionally, use ethical decision

framework that follows to make a decision about which if any of the possibilities should be permitted for athletes competing in the Olympics. Make sure to consider the reasons you came to this decision.

In the last paragraph of the reading, the Olympic Committee asked you to look into the matter. Explain how each possibility listed (A-D) will affect the athlete at the gene, protein, cell and whole body levels.

	Decision A	**Decision B**	**Decision C**	**Decision D**
Gene				
Protein				
Cell				
Whole Body				

Ethical Decision-Making Framework

What is the ethical question?

What are relevant facts?

What are questions that are still unknown?

Who are the stakeholders?	What are the concerns of the stakeholders?

What do you recommend to the Olympic Committee about each decision? Why?

A.

B.

C.

D.

Imagine you are a member of the United States Olympic Committee. You have been appointed the head of a committee that will draft a bill proposing rules for governing protein alterations in the body before athlete competitions. Below, list rules for why or why not athletes should be allowed to alter their protein levels. With each rule, provide a reason for why this rule should be passed. Share your rules with your classmates.

Rule 1:

Reason 1:

Rule 2:

Reason 2:

Rules 3:

Reason 3:

As a member of The United States Olympic Committee, you have been given the responsibility to write a draft of a bill proposing rules for governing protein alteration in the body before athletic competitions. Below, list rules for why or why not athletes should be allowed to alter their protein levels. With each rule, provide a reason for why this rule should be passed. Share your rules with your classmates.

Rule 1:

Reason 1:

Rule 2:

Reason 2:

Rule 3:

Reason 3:

Wrap Up

In this lesson, you learned that genes can be turned on and off. You studied electrophoresis gels to determine whether Jason had a mutation in his DNA or the inability to turn on the genes for lactase. You also learned that the environment can turn genes on and off. For example, skin color can be affected by the environment. The driving question asks, “How Similar and Different Are We From Each Other?” Now, think about how turning genes on and off plays a role in making people similar and different from each other.

Now that you have read Lesson 5, use the following questions to help you organize what you learned.

1. What is the driving question?

2. Think about the readings *Gene Expression: Genes Can Be Turned On and Off* and *Skin Color Adaptation*. How do you think skin color adaptation is affected by gene expression?

3. What is the difference between a DNA mutation and a gene that is turned off?

4. Scientists are working on a drug, called Pigmentol, that will stick to the DNA near the genes that are responsible for producing tyrosinase, and cause tyrosinase *genes to turn* on when they are in the sun. Normally, tyrosinase protein acts to produce melanin in the skin.

    a. Explain what will happen to the amount of tyrosinase protein if a person stands in the sun for a long period of time.

    b. Farmers spend many hours in the sun planting and managing their crops and animals. Many times, farmers get sun burned from long days under the sun. Do you think this new drug could benefit farmers? Explain why or why not?

    c. In this case, the hot sun is the environment for the farmer. How will the farmer's genes respond to the environment?

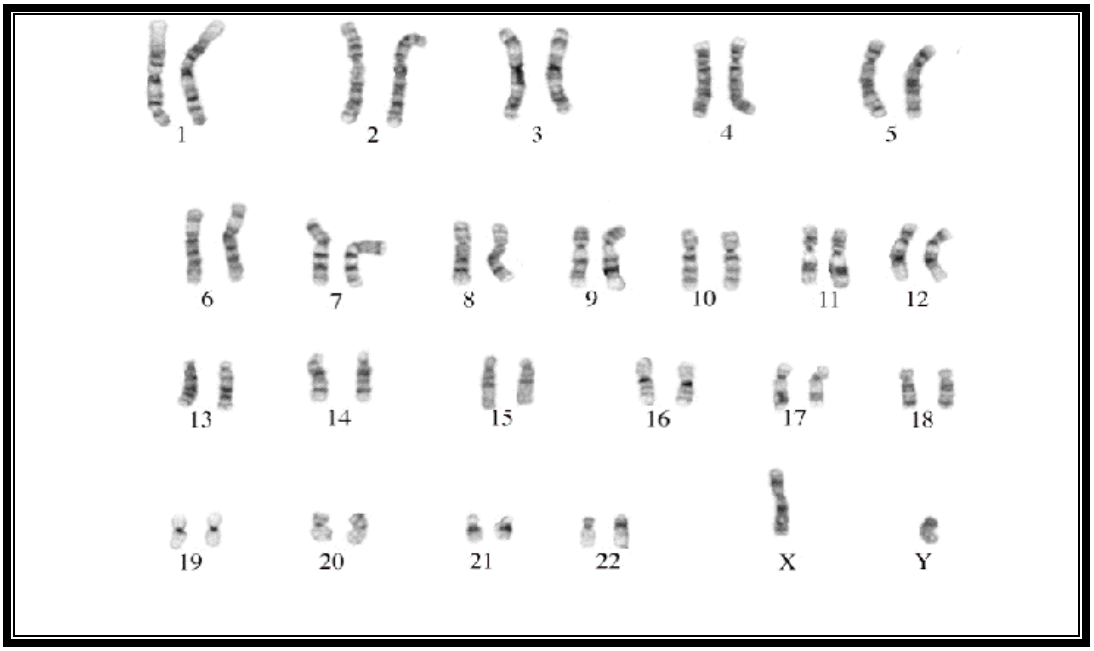
5. Faizon is a farmer in a town called Shadowston. In Shadowston, there is no sun for 9 months of the year. Since Faizon's crops were dying, he moved to Sunnydale, where the sun shines for 10 months of the year. While Faizon's crops were growing successfully, Faizon noticed that his skin was getting darker.

    a. Explain why Faizon's skin got darker when he moved to Sunnydale. Make sure your explanation includes the relationship between genes and environment.

    b. Could Pigmentol (from Question 4) help Faizon while he lives in Sunnydale? Explain why or why not.

6. List and define concepts and vocabulary from Lesson 2. Use the other side of the page if necessary.

Lesson 5: Genomes: What allows me to look like my parents?



Lesson 5: Genomes: What allows me to look like my parents?

LEARNING GOALS: WHILE COMPLETING THIS LESSON, CHECK TO MAKE SURE THAT YOU CAN DO THE FOLLOWING THINGS:
To define genome.
To identify how many genes and base pairs are in the human genome.
To identify genes that have been linked to diseases.

Read the following story and answer the questions that follow.

Priya Should Find Out If She Inherited a Fatal Disease
(or should she?)
http://www.ornl.gov/sci/techresources/Human_Genome/publicat/genechoice/2_priya.html

Priya has just lost her mother to an illness called Huntington's disease. It was hard for Priya to watch her mother die. First her mother had strange changes of mood. Then her arms and legs began twitching. Soon she couldn't talk or control her movements. In the end, she was totally bedridden and could barely get food down without choking.

Priya knows that Huntington's disease usually strikes people in middle age. It is always fatal, and there is no treatment. She also knows that since the disease is inherited, she has a strong chance of getting it herself.

Priya just learned about a test she can take. The test will tell if she carries the gene for Huntington's disease.

She is tempted to take the test. She thinks that if she could find out once and for all whether she will get the disease, she could plan for her future. On the other hand, she wonders if it is better not knowing. At least then Priya would still have some hope.

1. If you were Priya, what would you do? Would you want to find out whether you have the disease or not? Why?

2. Make a prediction about how Priya could test whether she carries the gene for Huntington's disease. (Hint: Use the karyotype provided.)

Karyotype

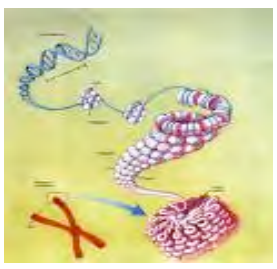
Chromosome 4 contains the gene for Huntington's disease.

The Human Genome

In Lesson 3, you learned that genes contain the instructions for making proteins. Another way to think about genes is to consider them to be a recipe for proteins. The set of all the genes that make a human being is called the **human genome**. It may help to think of the human genome as a book of instructions, with each gene as a set of instructions.

Scientists from around the world have set out to understand what genes do. This international effort is called the Human Genome Project. The United States is spending 3 billion dollars over 15 years on this project. Other countries also are investing large amounts of money on this research. A lot of effort is coming from researchers in biology, physics, engineering, computer science, and many other fields.

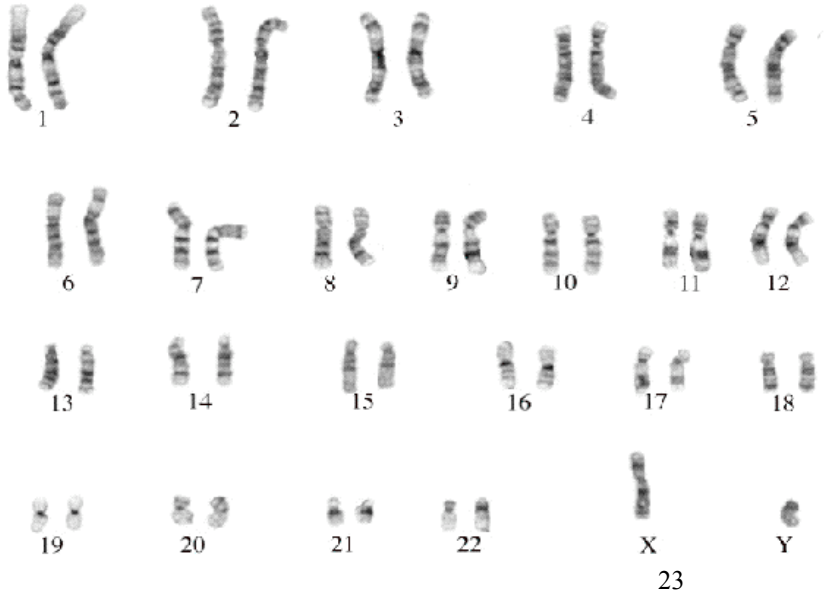
Recall from lesson 3 that genes are made up of DNA, which itself contains bases. There are only four bases, but they repeat one after the other in an ever-changing order throughout the genes. Think of the four bases as letters of the alphabet, combining together in some strange language to spell out each gene's instruction. Although there are only four bases, they can combine in numerous ways. A single gene can have thousands of bases. Some genes have millions of bases. As a whole, the entire genome has 3 million bases and there are 25,000 genes in the genome.



The immediate goal of the Human Genome Project is to put together a copy of all of the instructions, letter by letter. Understanding what makes up the genome will make it possible to understand how genes work. But this is a very difficult task. First, scientists have to get inside a cell. Then they have to get inside the

nucleus of the cell to the DNA. The DNA is curled into tight coils, so they have to straighten it out. Then they have to look at the DNA to see which of the four bases comes first, which second, which third, and so on. Then they have to write this down.

Below is a **karyotype**. Recall from the Lesson 3 story A Medical case: Familial Hypercholesterolemia, that a karyotype shows all 46 chromosomes in a human. In this particular figure, the chromosomes belong to a male. We can tell that this is a male because the 23rd chromosome is an XY chromosome rather than XX (female chromosome). Scientists have found that every cell in the body carries the same genetic information. If you look at the cells in your arm muscles and the cells in the skin on your face, you will find that the all of the genes are represented and are the same.



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1. What is the human genome? Use complete sentences.

2. If there are 25,000 genes and 23 chromosomes, how many genes are on a chromosome? Use complete sentences.

1. Identify chromosomes and regions on each chromosome where each of the following diseases have been linked. To identify the chromosome, write the chromosome number. To identify the regions, write whether the gene is at the top or bottom of the chromosome. Example: Bottom of Chromosome 4.

   Deafness (find 5)

   Dyslexia (find 1)

   Schizophrenia (find 1)

   Alzheimer's disease (find 1).

   Breast Cancer (find 2)

   Facial anomalies Syndrome (find 1)

   Duchenne Muscular Dystrophy (MS) (find 1)

2. Answer the following questions individually, share ideas then revise your answers. Use complete sentences.
   a. A region at the bottom of chromosome 12 is linked to Diabetes. What does this mean and what is being linked to the disease?

   b. Often in the news reports on breakthroughs in medicine, for example, you might hear a report that states "scientists have found a gene for Dyslexia." What do you think this means?

3. What might be the difference in the genomes of a person with Dyslexia and a person without Dyslexia? Use complete sentences. (Hint: Think back to the scavenger hunt activity you just did. Remember that every person has a complete set of unique chromosomes as shown in the chromosome map.)

4. Why do you think several genes, like Deafness, would be linked to a single trait? In other words, why are there 5 genes linked to deafness? Use complete sentences.

Group Activity: Comparing humans to chimps

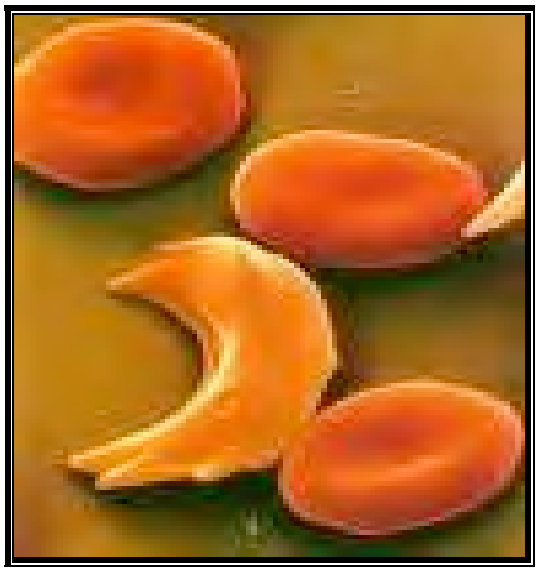
1. If you were to compare 2 humans, predict the percentage (%) that the DNA bases would be identical.

2. If you were to compare a human and a chimp, what percentage (%) of their DNA would be identical?

Total # of identical bases = Total # of bases – Total # of different bases

Percent (%) of identical bases = $\frac{\text{Total \# of identical bases}}{\text{Total \# of bases}} \times 100\%$

Lesson 6: How do gene mutations cause disease? Lessons from hemoglobin



Lesson 6: How do gene mutations cause disease? Lessons from hemoglobin.

LEARNING GOALS: WHILE COMPLETING THIS LESSON, CHECK TO MAKE SURE THAT YOU CAN DO THE FOLLOWING THINGS:
Determine the amino acid sequences of proteins given a DNA sequence.
Predict the effect of changing the DNA sequence on protein structure and function.
Explain that the effect of genes on health is mediated by the proteins they encode.

Here is a picture of a one eyed cat! Read the story about the cat and answer the following questions.

One-eyed cat no hoax

http://www.theage.com.au/news/world/oneeyed-cat-no-hoax/2006/01/13/1136956335177.html

January 13, 2006 - 12:18PM

Cy, short for Cyclops, a kitten born with only one eye and no nose, is shown in this photo provided by its owner in Redmond, Oregon

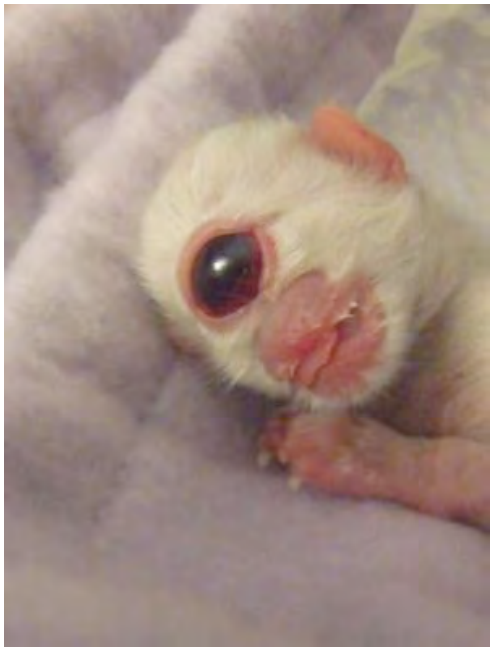


Photo: *Traci Allen*

AdvertisementAdvertisement

A photo of a one-eyed kitten named Cy drew more than a little skepticism when it turned up on various websites, but medical authorities have a name for the bizarre condition.

"Holoprosencephaly" causes facial deformities, according to the US National Institute for Neurological Disorders and Stroke.

In the worst cases, a single eye is located where the nose should be, according to the institute's Web site.

Traci Allen says the kitten she named Cy, short for Cyclops, was born the night of December 28 with the single eye and no nose.

"You don't expect to see something like that," the 35-year-old Allen said by telephone from her home in Redmond in central Oregon.

Allen said she stayed up all night with the deformed kitten on her recliner, feeding Cy a liquid formula through a syringe.

She says she cared for the kitten the next day as well, until it died that evening.

Allen had taken digital pictures that she provided to The Associated Press. Some bloggers have questioned the authenticity of the photo distributed on January 6.

AP regional photo editor Tom Stathis said he took extensive steps to confirm the one-eyed cat was not a hoax.

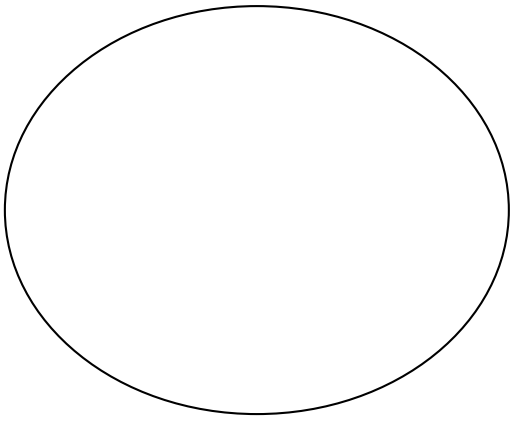
1. How would you describe this cat's deformities?

2. How would you **test** your description?
   Hint: Think about DNA, mutations, and proteins.
   Think about the different levels of cellular organization.

Viewing Cells Under a Microscope

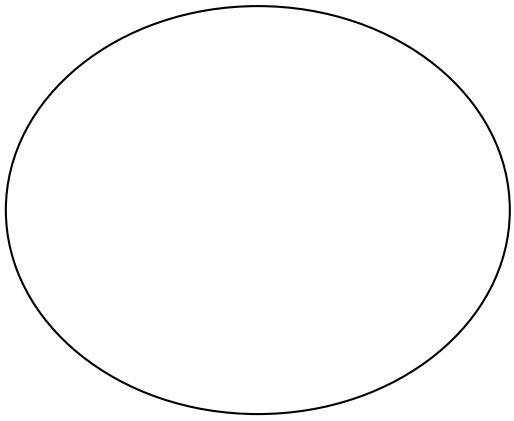
In class, you looked at red blood cells under a microscope. While looking at these blood cells, what were the differences that you saw? Write a brief description about what you observed regarding the shape of the red blood cells.

Red blood cells
Slide 1



Description

Red blood cells
Slide 2



Description

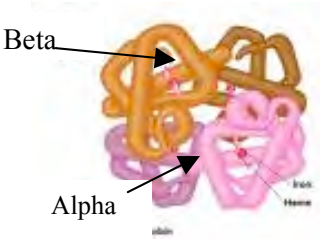
Apply: Sickle Cell Disease: The crooked red blood cells
Red Blood Cells Supply Oxygen
Here are some reading strategies you can try: Concept mapping, vocabulary cards or underlining unfamiliar words.

What comes to mind when you read the words "**red blood cells**"? Do you think of arteries and veins? Do you think of blood flowing through your body? Do you think of oxygen? If you do, that is good because these are all related to red blood cells. In a healthy person, blood can flow through the veins because that person's red blood cells are soft and can squeeze through small veins in the body, making the movement of oxygen possible. However, if something were to happen to the shape of the red blood cells that made it more difficult for them to pass through the veins, people would have a hard time delivering oxygen throughout the body.

Can I Run a Marathon With Sickle Cell Disease?
The affect of Sickle Cell Disease on Oxygen Intake

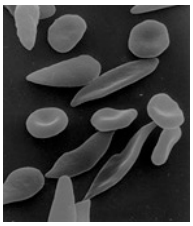
Imagine trying to run a race while someone plugged your nose. You might imagine feeling suffocated or pain in your chest. That is because oxygen would not be transported around your body. In order for our bodies to do even the simplest activities, oxygen is required.

Oxygen can be transported through the body by a protein in the blood called hemoglobin. Hemoglobin is the main protein of the red blood cell. It helps red blood cells carry oxygen from the air in our lungs to all parts of the body. As you can imagine, hemoglobin is very important for breathing.



Hemoglobin is made from two similar types of proteins that "stick together". Both proteins must be present for the hemoglobin to pick up and release oxygen normally. One type of protein is called alpha, and the other is called beta. People with sickle cell conditions make a different form of hemoglobin; the beta component is mutated. As a result, red blood cells with this disease do not live as long as normal red blood cells. They become stiff, distorted in shape and have difficulty passing through the body's small blood vessels. When sickle-shaped cells block small blood vessels, less blood can reach different parts of the body. Tissues that do not receive a normal blood flow eventually become damaged. This is what causes the complications of **sickle cell disease**. Sickle cell disease would prevent someone from being able to run a marathon because they would not be able to transport enough oxygen throughout their body. What are some other activities that you think someone with sickle cell disease could not do? What are some activities that they could still do? (Make a chart or write a brief paragraph.)

Why is it called Sickle Cell Disease?



Hemoglobin is the protein responsible for carrying oxygen in red blood cells. The composition of hemoglobin is the same in all people. The genes that code for hemoglobin are identical throughout the world. Occasionally, however, one of the genes is altered or mutated by any of a variety of "accidents" that can occur in nature. These alterations in the genes (called "**mutations**") are very rare. Some mutations in hemoglobin produce no problem. Occasionally, however, the alteration in the protein changes aspects of its shape and function. The red blood cells change from their original round shape to a shape called "sickled." This shape looks like a crescent moon or a banana. Since the red blood cells are no longer round, their ability to move through veins becomes stifled. This leads to organ failure, severe pain and/or bone problems.

Crescent moon

Below is a DNA sequence for part of a normal hemoglobin protein: write the corresponding RNA and protein sequences for the lower DNA strand.

DNA

Site X

AAGGTGCACCTG**ACTCCTGAG**GAGAAGTCTGCCGTTACTGCCCTG

TTCCACGTGGAC**TGAGGACTC**CTCTTCAGACGGCAATGACGGGAC

Write the RNA sequence below.

_____

Write the amino acid sequence below.

_____

1. Locate the **BOLDED** base pairs in the DNA strand. Suppose a deletion mutation occurred at the spot. Can the hemoglobin protein still perform its function? Explain why or why not.

2. If a child has inherited the sickle cell anemia gene from both parents, will the child definitely develop sickle cell anemia?

3. Using what you learned about genes, proteins and mutations, provide an explanation for your answer in Question 2.

4. If you were a genetics scientist, what kinds of treatment would you provide a person with sickle cell anemia?

A History Lesson

How Can Sickle Cell Disease Be Passed To Me?
Connecting the Punnett Square and Genetics


Gregor Mendel

Gregor Mendel was called the "father of genetics" because he was the first to study genes by studying how pea plants passed their genes to their offspring (descendents). Mendel looked at how plants obtained different characteristics.

One day as Mendel was walking through a monastery, he noticed an interesting looking plant. He picked the plant and replanted it next to a similar plant. He wanted to see what their offspring would look like. He was curious about whether the parent plants would pass their genes to the offspring. In the future generation, he found that the offspring plants had retained some of the parental traits. Each offspring carried one gene from each parent. This test encouraged work to be done on heredity. **Heredity** refers to the idea that genes can be passed from parents to offspring. It was Mendel's work that allowed the study of genetics to emerge. In the 1900's, people began to realize that there was an important part missing in Mendel's work- genes and DNA are related. From this point, scientists began to learn that genes are made of DNA and that through genes, proteins are built. Further research revealed that mutations in genes could also be passed to offspring, and could cause a change in the offspring's protein shape. These changes in protein shape can lead to diseases, such as Sickle Cell disease.

In the previous reading, you learned about Sickle Cell disease. Sickle Cell disease is called a **genetic disease**. When scientists say that something is genetic, it means that it can be passed from one generation to the next. A genetic trait is something that a mother or father can pass to their children through their genes.

How Do Children Receive Their Parent's Genes?
The following activity will provide a basic example of how parents can pass their genes to their offspring.

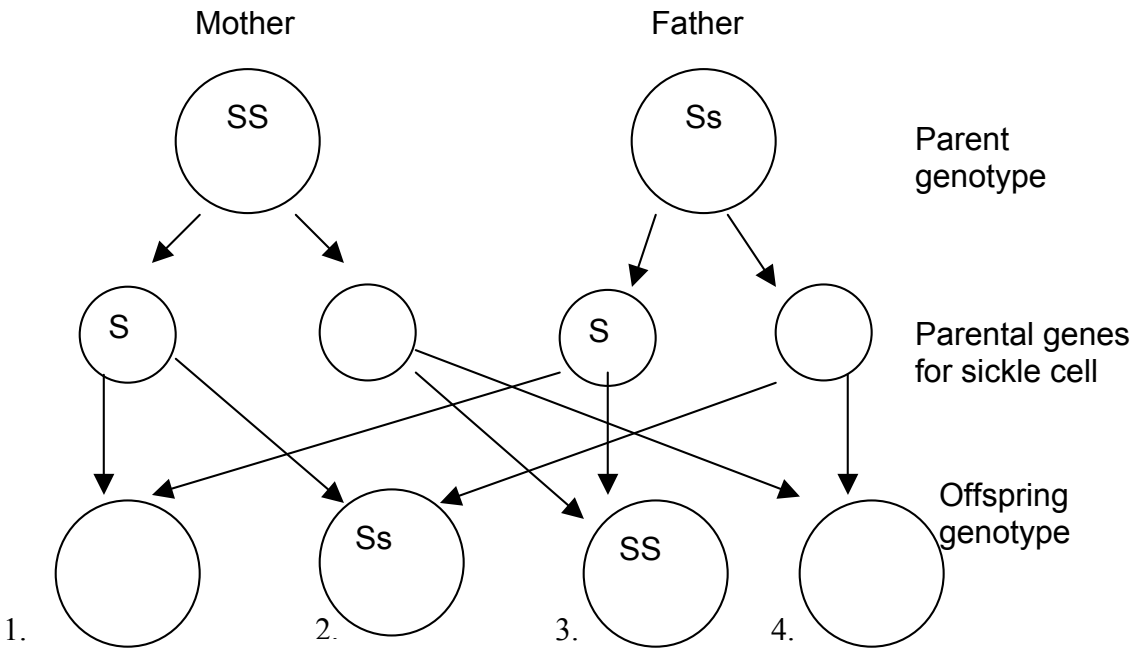
Fill in the circles with the appropriate genes. Use the Punnette Square to help determine the gene combinations. Some of the circles have been filled in for you. Remember that the offspring will have 2 of each type of gene because each offspring receives one gene from each parent.

Scenario: Suppose a father has a gene for Sickle Cell and a mother does not. If ss means that a person has sickle cell disease, determine which children will have the disease.

S = Normal hemoglobin gene
s = Mutated hemoglobin gene

SS = No- Sickle Cell Disease
Ss = No- Sickle Cell Disease
ss = Yes- Sickle Cell Disease

Mother's genes – SS
Father's genes - Ss



Punnette Square

Father \ Mother		S	S
	S	1.	3.
	s	2.	4.

S = Normal hemoglobin gene
s = Mutated hemoglobin gene

SS = No- Sickle Cell Disease
Ss = No- Sickle Cell Disease
ss = Yes- Sickle Cell Disease

After filling in the circles and the Punnette Square, answer the following questions.

1. What fraction of the offspring will have Sickle Cell disease? Remember, a person will have Sickle Cell disease if they carry BOTH mutated hemoglobin genes (ss). (Circle one)

   a. 3/4 b. 1/2 c. 1/4 d. 0

2. How can a child get Sickle Cell disease from his parents?

3. Why is Sickle Cell disease called a genetic disease? In other words, explain what happens at the genetic level when someone has sickle cell.

4. How is a person with Sickle Cell disease different from a person without Sickle Cell disease? (Discuss DNA, genes, mutations and proteins.)

Are All Mutations Bad?

A Mutation Story:

A gene known as HbS (the gene for sickle cell) was the center of a medical and evolutionary detective story that began in the middle 1940s in Africa. Doctors noticed that patients who had sickle cell anemia, a serious hereditary blood disease, were more likely to survive malaria, a disease that kills about 1.2 million people every year. What was puzzling was why sickle cell anemia was so prevalent in some African populations.

How could a "bad" gene -- the mutation that causes the sometimes lethal sickle cell disease -- also be beneficial? On the other hand, if it didn't provide some survival advantage, why had the sickle gene persisted in such a high frequency in the populations that had it?

The sickle cell mutation is an error in the DNA code of the gene that tells the body how to make a form of hemoglobin, the oxygen-carrying molecule in our blood. Every person has two copies of the hemoglobin gene. Usually, both genes make a normal hemoglobin protein. When someone inherits two mutant copies of the hemoglobin gene, the abnormal form of the hemoglobin protein causes the red blood cells to lose oxygen and warp into a sickle shape during periods of high activity. These sickled cells become stuck in small blood vessels, causing a "crisis" of pain, fever, swelling, and tissue damage that can lead to death. This is sickle cell anemia.

Researchers found that the sickle cell gene is especially prevalent in areas of Africa hard-hit by malaria. In some regions, as much as 40 percent of the population carries at least one hemoglobin gene for malaria.

It turns out that, in these areas, the sickle cell gene carriers have been naturally selected, because the trait confers some resistance to malaria. Their red blood cells, containing some abnormal hemoglobin, tend to sickle when they are infected by the malaria parasite. Those infected cells flow through the spleen, which picks them out because of their sickle shape -- and the parasite is eliminated along with them.

Scientists believe the sickle cell gene appeared and disappeared in the population several times, but became permanently established after a particularly vicious form of malaria jumped from animals to humans in Asia, the Middle East, and Africa.

In areas where the sickle cell gene is common, the immunity [associated with the Sickle Cell gene] has become a selective advantage. Unfortunately, it is also a disadvantage because the chances of being born with sickle cell anemia are relatively high.

1. The article above talks about some of the advantages and disadvantages of having the sickle cell gene. What is an advantage to having the sickle cell gene?

2. The article also shows that not all mutations are bad. Explain why you agree or disagree with the statement:

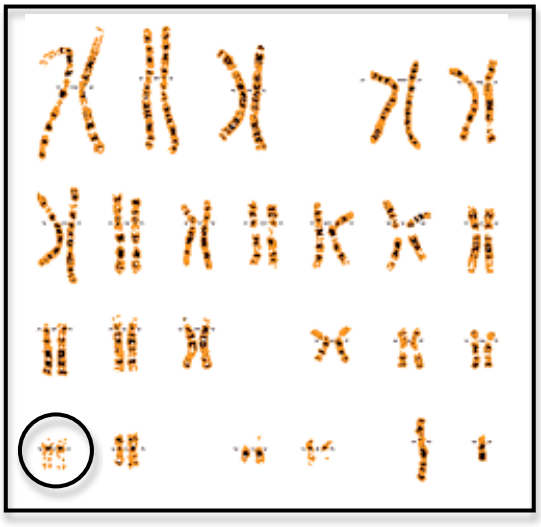
   "All mutations are a disadvantage to a person."

Wrap up

1. What is the driving question?

2. In the Karyotype below, a mutation was located on Chromosome 19. Scientists were trying to figure out what kind of mutation occurred at this spot. Provide a description of the kinds of mutations that the scientists should investigate.

Karyotype



3. Scientists found that the mutation was linked to the disease Familial Hypercholesterolemia (FH). As mentioned in Lessons 3, FH is a genetic disorder that causes high levels of low density lipoproteins to accumulate in the blood. This accumulation is due to malfunctioning low density lipoprotein (LDL) receptor proteins. From your description in Question 2, predict the kind of mutation you think might cause FH. Explain why you chose your mutation.

4. Sickle Cell Anemia is a disorder that is caused from a homozygous recessive mutation in a gene that codes for hemoglobin. In some areas of the world, the heterozygous mutation can be considered an advantage, because it is a biological defense for malaria.
    a. Explain why mutations are not always bad.

    b. A mutation can be something that we don't normally think about, like variations in hair textures or resistance to bacteria. What are some examples of good mutations, or variations, between people around the world?

Ethical Discussion

Should Individuals Who Have "Drug Addiction Genes" Be Treated Differently?

From the Scholastic website article, The Role of Genes and Drug Addiction
http://teacher.scholastic.com/scholasticnews/indepth/headsup/intro/index.asp?article=genes

A major finding about the genetics of drug addiction was reported in 2004 by investigators at Duke University Medical Center. The researchers were able to identify a specific protein—PSD-95—that had a relationship to drug addiction. Mice that had low amounts of PSD-95 were much more sensitive to cocaine (than mice with normal amounts of PSD-95).

The researchers concluded that mice with normal amounts of PSD-95 were less likely to become addicted to cocaine (than mice with low amounts of PSD-95). According to Marc G. Caron, Ph.D., an investigator who was part of the research team, PSD-95 "likely plays a role in addiction to other drugs—including nicotine, alcohol, morphine, and heroin."

Consider the following scenario:

The case of Jacob puts the dangers of drugs in focus. Jacob began using OxyContin (a prescription drug for pain) at 18. Eventually Jacob moved from OxyContin to heroin. "If I'd never touched OxyContin, I wouldn't have done heroin," he claims. Before long, Jacob was selling OxyContin pills to help support his habit. (Selling prescription drugs makes you a drug dealer and subject to criminal prosecution.) One day Jacob didn't have money to buy heroin. Desperate, Jacob robbed the local liquor store. Fortunately, no one was hurt but Jacob was arrested. Now he faces criminal charges from robbery to drug dealing. The judge has ordered Jacob to go to rehab to help him with his addiction. Jacob's lawyer read about a "Drug Gene" and has asked Jacob to get tested to see if he is genetically sensitive to drug addiction, meaning if he has the "Drug Gene" his body would produce low levels of the PSD-95 protein.

You are asked by the judge in Jacob's case to act as an adviser. Your job is to discuss the topic of individuals that have these "Drug Genes" and to make recommendations about how Jacob's case should be handled once his genetic test comes back. Consider the following:

A) It is estimated that genes contribute about 60% of a persons' vulnerability to drugs, an individual's environment contributes the other 40%. That means drug gene sensitive people are not "doomed" if they have this "drug gene" but they might want to be aware of the gene and its potential dangers.
B) Testing every drug addict for the "Drug Gene" will cost millions of dollars
C) Addiction adds to crime rates and violence.
D) If an individual tests positive for the "Drug Gene", what is their responsibility as an individual? Should they go to jail? Should they be forced to get help? Should they be let go because it's a "genetic"problem?

Use the ethical decision framework that follows to make a decision about what course of action the judge should take with Jacob if he is found to have the "Drug Gene." Should the results of Jacob's "Drug Gene" test affect what happens to Jacob? Should Jacob go to jail? Rehab? Counseling? Other?

Your class will now work together using ethics to try to make a recommendation to the judge about what action(s) he/she should take.

Ethical Decision-Making Framework

What do you think is the ethical problem?

What are relevant facts? (Consider what you read above and what you have learned about the "Drug Gene".)

What are questions that are still unknown?

Here are some potential actions the judge could take.

- Send Jacob to jail
- Send Jacob to rehab

List three more actions the judge could take:

What stakeholders should you consider?

What stakeholder did your teacher assign you? _____

What do you think are the concerns of your stakeholder?

What action does your stakeholder think the judge should take?

Explain why your stakeholder has chosen that action:

Now as a whole class, fill out this chart with all the stakeholders and their actions.

Who are the stakeholders?	**What action is this stakeholder recommending?**

What action(s) do you recommend the judge should take? Why?

Ethical Discussion

Should Employees Undergo Genetic Testing to See if They Are Sensitive to Certain Chemicals They Might be Exposed to on the Job?

Beryllium (**Be**) is found naturally in food and water, but high **Be** exposure is mostly caused by working with **Be** in factories where **Be** dust can be easily inhaled. Beryllium is used in such products as cell phones, aircraft engine parts and nuclear workers use them to make triggers for nuclear bombs.

Some people who are exposed to **Be** develop a disease called Chronic Beryllium Disease (CBD). CBD is a disease that is characterized by an accumulation of T cells in the lungs. T cells help the body fight infection. When there are too many T cells in the lungs they damage the lungs and cause shortness of breath and dry coughing.

Changes in a gene called, HLA DP (**h**uman **l**eukocyte **a**ntigen) causes people to be sensitive to exposure to **Be**. HLA DP has the instructions to make a protein that helps T cells do their job. When scientists looked at how the change in the HLA DP gene would affect the protein made, they discovered that people who are sensitive to **Be** have a different sequence of amino acids. Only a small portion (1-15%) of the population is **Be** sensitive.

What do you think is happening to the protein to cause some people to be sensitive to Be?

Read the following article about contract workers in the California based Livermore Lab.

Beryllium Exposure Warning Arrives Too Late for Contract Workers at Livermore Lab
http://www.chronicberylliumdisease.com/news/nw_020808_contract_workers_livermore_lab_ptr.htm (edited)

February 8, 2008 — At Lawrence Livermore Labs in California, as many as 178 GSE Construction workers may have been exposed to the known carcinogen (cancer causing) beryllium, a toxic metal that can cause lung cancer and chronic beryllium disease. Results from a routine beryllium test revealed dangerously high levels of beryllium as early as July 2007. GSE contract workers may have been unknowingly exposed to beryllium and placed at risk of developing beryllium related diseases (CBD).

Normally, when exposures to **Be** becomes known, the policy is to test workers for beryllium sensitivity, to make sure the workers are not at risk of developing beryllium related diseases and to prevent further beryllium exposure.

Since the Livermore lab does not plan to get rid of the beryllium because it will cost millions of dollars, they have chosen to test all of the exposed workers to see if they have the gene for **Be** sensitivity. If the test comes back positive, how should the workers be treated?

They have asked you to advise them on how to treat all their workers fairly. Should the **Be** sensitive workers be fired? Should the **Be** sensitive workers get extra health insurance? Should **Be** sensitive workers be forced to wear protective gear? Should the company they work for help them find a different job?

Use the ethical decision framework that follows to make a decision about what course of action the Livermore lab should take.

Ethical Decision-Making Framework

What do you think is the ethical problem?

What are relevant facts? (Consider what you read above and what you have learned about beryllium sensitivity.)

What are questions that are still unknown?

Here are some potential actions the Livermore lab could take.

- Offer extra health care to the people who are sensitive
- Fire the workers who are sensitive
- Treat all workers the same (no one is fired and all workers get the same amount of health care and the same protective gear)

List three more actions the Livermore lab could take:

What stakeholders should you consider?

What stakeholder did your teacher assign you? _____

What do you think are the concerns of your stakeholder?

What action does your stakeholder think the Livermore lab should take?

Explain why your stakeholder has chosen that action:

Now as a whole class, fill out this chart with all the stakeholders and their actions.

Who are the stakeholders?	**What action is this stakeholder recommending?**

What action(s) do you recommend the Livermore labs take? Why?

Research Project

Contents

Description of Project

One of the main activities you will do in this unit is create of a poster or brochure that explains a specific disease, trait, or career in genetics that you find interesting. On the next pages, you will find a collection of traits, diseases and career choices. Choose one of them to research. Each trait has a little bit of information about it and a website with some information about the trait. You will also find some questions that will help guide you in your search. You will also find a grading rubric at the end to help you understand what is expected of your project.

When your brochure or poster is completed, you will share it with your classmates. Try to make your project interesting to others around you. If you are a good artist, use your art abilities to make a colorful poster or brochure. In addition, make sure that you include enough information so that other people reading your poster or brochure will be able to understand more about the disease, trait, or career. Rather than cutting and pasting information you find on the Internet directly to your poster or brochure, restate the information in your own words. Finally, have fun with it!

Trait Descriptions and Websites

Androgen Insensitivity Syndrome

AIS, also known as Androgen Resistance Syndrome, results from mutations in the gene that codes for a protein that detects the presence of the hormone androgen. When the protein is missing, it causes sexual differentiation disorders. In some cases a person with AIS might have a female body, but be missing a uterus, fallopian tubes or ovaries. In another type, the person may have a male body but reduced sperm production and fertility.

http://en.wikipedia.org/wiki/Androgen_insensitivity_syndrome
http://www.rch.org.au/publications/CAIS.pdf
http://www.aissg.org/21_OVERVIEW.HTM
http://www.geneclinics.org/profiles/androgen/details.html

Breast Cancer (BRCA1)

Breast cancer occurs when there is an uncontrolled growth of cells within the breast. These cells form a tumor, and can break through the breast tissue and spread to other important parts of the body. BRCA 1 is one of the tumor-suppressing genes that when defected, may allow the growth of tumors that can cause cancer in the breast.

http://www.breastcancer.org
http://cms.komen.org/komen/AboutBreastCancer/TheABCsofBreastCancerGuide/index.htm
http://www.nationalbreastcancer.org/about-breast-cancer/beyond-the-shock
http://body.aol.com/conditions/breast-cancer-major-1

Colon Cancer (HNPCC)

Colon cancer is a one of the leading cause of deaths due to cancer in the United States. However, it is highly preventable and treatable. Colon cancer can be due to polyps, which are growths of tissue in the colon or rectum. Cancerous polyps are known as adenomacan. HNPCC (hereditary nonpolyposis colorectal cancer) is an inherited syndrome that puts people at a higher risk for developing the cancer before the age of 60.

- www.cancer.org (search for colon cancer)
- http://www.ccalliance.org/about/
- http://www.webmd.com/colorectal-cancer/guide/colorectal-cancer-overview-facts
- http://www.ccac-accc.ca/what-is-colorectal-cancer.html

Color-blindness

Color-blindness is a condition that mainly affects males. It is the inability to distinguish between some or many colors. It is generally a genetic disease, but is sometimes also caused by damage to certain brain areas, the optic nerve, or the retina. There are many classifications of color-blindness.

http://en.wikipedia.org/wiki/Color_blindness
http://webexhibits.org/causesofcolor/2C.html
http://www.nlm.nih.gov/medlineplus/colorblindness.html
http://www.tsbvi.edu/Education/color.html

Cri-du-Chat

Infants with Cri-du-Chat ('cry of the cat' in French) make a high-pitched mewing sound. This eventually lessens over time when the larynx develops correctly. Other characteristics include small head size, low-set ears, round faces, and folds of skin over the upper eyelids. Some of the characteristics become less prominent as the child ages.

- http://en.wikipedia.org/wiki/Cri_du_chat
- http://www.criduchat.asn.au/criduchat/what.htm
- http://www.nlm.nih.gov/medlineplus/colorblindness.html
- http://ghr.nlm.nih.gov/condition=criduchatsyndrome
- http://learn.genetics.utah.edu/units/disorders/whataregd/cdc/

Cystic fibrosis

Cystic Fibrosis (CF) is a condition in which there is an overproduction of mucus in the lungs, often leading to lung infections, scarring, and eventually death. CF is one of the most common inherited diseases.

- http://en.wikipedia.org/wiki/Cystic_fibrosis
- http://www.marchofdimes.com/pnhec/4439_1213.asp
- http://www3.nbnet.nb.ca/normap/CF.htm
- http://www.cftrust.org.uk/aboutcf/publications/booklets/

Deafness

Deafness, or a hearing impairment, is the decreased ability to hear. Hearing loss may be caused by injury or illness, long-term exposure to noise, or also by genetic reasons. There are dominant genes and recessive genes that can lead to hearing impairments. The three major types of hearing loss include conductive hearing loss, neuro/sensoneural hearing loss, and some combination of the two.

- http://en.wikipedia.org/wiki/Hearing_impairment
- http://www.nlm.nih.gov/medlineplus/hearingdisordersanddeafness.html
- http://www.medicinenet.com/deafness/article.htm
- http://www.who.int/mediacentre/factsheets/fs300/en/index.html

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Diabetes

Diabetes is a disorder that is characterized by hyperglycemia (high blood sugar). There are three types: type 1, which is due to the autoimmune destruction of insulin producing cells; type 2, which is due to insulin-resistance; and gestational diabetes, which is like type 2 but occurs during pregnancy. Although genes play a role in diabetes, scientists have found that the environment has a role in causing diabetes as well.

- http://en.wikipedia.org/wiki/Diabetes
- http://www.diabetes.org/about-diabetes.jsp
- http://darwin.nmsu.edu/~molbio/diabetes/disease.html
- http://diabetes.webmd.com/default.htm

Down Syndrome

Down Syndrome, also known as trisomy 21, is due to the presence of an extra (or part of an extra) chromosome 21. It results in physical abnormalities and mental retardation. Those with Down Syndrome are more at risk for health problems such as congenital heart defects and muscle hypotonia.

- http://en.wikipedia.org/wiki/Down%27s_syndrome
- http://www.ndss.org/
- http://www.nads.org/pages_new/facts.html
- http://www.ygyh.org/ds

Duchenne's Muscular Dystrophy

Duchenne's Muscular Dystrophy is generally an inherited X-linked recessive disorder, although 1/3 of the cases are due to spontaneous mutations in the DNA. It is characterized by muscle weakness in the legs that increases and eventually spreads to the rest of the body. The most common reason for death for people with Duchenne's Muscular Dystrophy is respiratory failure.

- http://en.wikipedia.org/wiki/Duchenne%27s_Muscular_Dystrophy
- http://www.ygyh.org/dmd
- http://www.parentprojectmd.org/site/PageServer?pagename=und_index
- http://www.genome.gov/19518854

Dwarfism - Achondroplasia

Achondroplasia is a common form of dwarfism. It is cause by a genetic change. People with achondroplasia are usually about 4 feet tall and have shortened arms, legs, fingers and toes.

- http://en.wikipedia.org/wiki/Achondroplasia
- http://www.medicineonline.com/encyclopedia/A/Achondroplastic-Dwarfism-Achondroplasia
- http://www.marchofdimes.com/professionals/14332_1204.asp
- http://www.nlm.nih.gov/medlineplus/ency/article/001577.htm

Fatal familial insomnia

Fatal familial insomnia is a genetic disease that results in the disturbance of normal brain function. Patients with the disease suffer from an inability to sleep. As the disease continues, the patient suffers from dementia and eventually dies.

- http://en.wikipedia.org/wiki/Fatal_familial_insomnia
- http://www.msnbc.msn.com/id/6822468/
- http://www-personal.umd.umich.edu/~jcthomas/JCTHOMAS/1997%20Case%20Studies/AAkroush.html
- http://www.rense.com/general63/fatal.htm

Klinefelter's Syndrome

Klinefelter's Syndrome is a genetic condition in which a male has an extra X chromosome, making a total of 2 X chromosomes and 1 Y chromosome. The extra chromosome almost always leads to sterility.

http://en.wikipedia.org/wiki/Klinefelter%27s_Syndrome
http://ghr.nlm.nih.gov/condition=klinefeltersyndrome
http://klinefeltersyndrome.org/
http://www.ksa-uk.co.uk/

Lesch-Nyhan

Lesch-Nyhan Syndrome (LNS) is a rare, X-linked recessive disease. It is carried by the mother and passed down to her son. Uric acid overproduction, behavioral disturbances and neurological dysfunction characterize LNS. Affected individuals also often develop certain self-destructive behaviors, such as head banging, finger biting and biting of the lips and tongue.

- http://en.wikipedia.org/wiki/Lesch-Nyhan
- http://healthlink.mcw.edu/article/921774523.html
- http://children.webmd.com/Lesch-Nyhan-Syndrome
- http://healthlink.mcw.edu/article/921774523.html

Marfan syndrome

Marfan syndrome is a genetic disorder of the connective tissue characterized by unusually long limbs, great stature or long toes or fingers in proportion to height. The disease may also affect numerous other structures and organs — including the lungs, eyes, heart, and blood vessels. Abraham Lincoln was believed to have had Marfan Syndrome.

- http://en.wikipedia.org/wiki/Marfan%27s_syndrome
- http://www.marfan.org
- http://www.hughston.com/hha/a_12_2_4.htm
- http://www.niams.nih.gov/hi/topics/marfan/marfan.htm

Parkinson's Disease

Parkinson's Disease is a brain disorder that can cause tremors, stiffness, difficulty with balance, and slowness of movement. It occurs when 80% of the cells that produce dopamine (which is vital in keeping body/muscle movements coordinated and smooth) are damaged. Second to Alzheimer's, it is the most common neurodegenerative disease.

- http://www.parkinson.org
- http://en.wikipedia.org/wiki/Parkinson%27s#Genetic
- http://www.pdf.org/AboutPD/
- http://www.nlm.nih.gov/medlineplus/tutorials/parkinsonsdisease/htm/index.htm
- http://www.apdaparkinson.org/user/AboutParkinson.asp

PKU

Phenylketonuria is a genetic condition resulting from a defective gene that normally codes for the protein that converts the amino acid phenylalanine to tyrosine. This often results in severe mental retardation, seizures, and hyperactivity, among other symptoms.

- http://en.wikipedia.org/wiki/Phenylketonuria
- http://www.ygyh.org/pku/whatisit.htm
- http://www.medschool.lsuhsc.edu/genetics_center/louisiana/article_PKU.htm
- http://www.peds.umn.edu/pku/Basics.html

Polycystic kidney disease

Polycystic kidney disease is a genetic disease in which the kidneys develop multiple cysts. It can also damage other organs such as the liver, pancreas, heart and brain. The disease often leads to the complete failure of the kidneys.

- http://en.wikipedia.org/wiki/Polycystic_kidney_disease
- http://www.ygyh.org/pkd/whatisit.htm
- http://www.kidney.org/atoz/pdf/polycystic.pdf
- http://www.pkdcure.org

Retinoblastoma cancer

Retinoblastoma develops in some children and is a cancer of the retina. Parents that are unfamiliar with the disease will normally first start to see white blotches in one or both eyes in photographs of the children's faces, as opposed to the red-eye effect that is normal.

- http://en.wikipedia.org/wiki/Retinoblastoma
- http://www.cancerhelp.org.uk/help/default.asp?page=6157
- http://www.cancer.org/docroot/CRI/CRI_2_3x.asp?dt=37
- http://www.eyecancer.com/Patient/Condition.aspx?nID=53&Category=Retinal+Tumors&Condition=Retinoblastoma

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Severe combined immunodeficiency disease

Severe combined immunodeficiency disease, or SCID is a genetic disorder in which the immune system does not develop. It is also known as the "bubble boy" disease because its victims are extremely vulnerable to infectious diseases.

- http://en.wikipedia.org/wiki/Severe_Combined_Immunodeficiency_Disease
- http://www.kidshealth.org/parent/medical/allergies/severe_immunodeficiency.html
- http://www.scid.net/
- http://www.primaryimmune.org/pubs/book_pats/e_ch05.pdf

Thalassemia

Thalassemia is a genetic disorder in which the patient has red blood cells that are easily damaged and therefore die quickly. The disease can be treated by regular blood infusions.

- http://en.wikipedia.org/wiki/Thalassemia
- http://www.thalassemia.com
- http://sickle.bwh.harvard.edu/menu_thal.html
- http://www.noah-health.org/en/blood/thalassemia/

Turner Syndrome

Turner Syndrome is a genetic condition present in some females. It is primarily due to monosomy-X, meaning that only one of the X chromosomes is present and fully functional. Some common symptoms include reproductive sterility, short stature, thyroid problems, and kidney abnormalities. There is no cure but often those with Turner Syndrome undergo estrogen replacement therapy and take growth hormone injections.

- http://en.wikipedia.org/wiki/Turner_syndrome
- http://www.umm.edu/ency/article/000379.htm
- http://www.tss.org.uk
- http://learn.genetics.utah.edu/units/disorders/karyotype/turnersyndrome.cfm

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Werner syndrome

Werner Syndrome is a genetic disorder in which the patient starts aging during puberty. Following puberty, they age rapidly, so that by the time they reach age 40, they often appear as though they are several decades older.

- http://en.wikipedia.org/wiki/Werner_syndrome
- http://children.webmd.com/Werner-Syndrome
- http://www.madisonsfoundation.org/content/3/1/display.asp?did=426
- http://ghr.nlm.nih.gov/condition=wernersyndrome

Xeroderma pigmentosum

Xeroderma pigmentosum, or XP, is a genetic disorder is which the patient is particularly sensitive to UV light. The sensitivity to light leads to skin cancer at a young age. Patients with XP often find it necessary to avoid sunlight.

- http://en.wikipedia.org/wiki/Xeroderma_pigmentosum
- http://www.xps.org/student_tips.htm
- http://www.rare-disorders.com/xeroderma-pigmentosum.html
- http://www.webmd.com/skin-problems-and-treatments/Xeroderma-Pigmentosum-10968

CAREERS

Agricultural Geneticist

Agricultural geneticists study genetics and biotechnological methods in plants and animals in order to improve agriculture. Agricultural geneticists use their knowledge to improve crop efficiency, prevent diseases for plants and animals, and genetically modify food for better health.

- http://www.agric.usyd.edu.au/disciplines/science/genetics/index.htm
- http://www.bls.gov/oco/ocos046.htm
- http://www.bookrags.com/research/agricultural-genetics-wog/
- http://www.collegeboard.com/csearch/majors_careers/profiles/majors/14.0301.html

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Biomedical Engineer

Biomedical Engineers use engineering principles to solve medical and health problems. Many of the develop treatments for genetic diseases.

- http://www.collegeboard.com/csearch/majors_careers/profiles/majors/14.0501.html
- http://en.wikipedia.org/wiki/Biomedical_engineer
- http://www.bmes.org/default.asp
- http://www.healthline.com/galecontent/biomedical-engineering

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Biological Anthropologist

Biological anthropologists study the evolution of humans through their evolutionary history, genetics, morphology, and fossil record.

- http://en.wikipedia.org/wiki/Physical_anthropology
- http://weber.ucsd.edu/~jmoore/bioanthro/brochure1.html
- http://physanth.org/
- http://www.ispub.com/ostia/index.php?xmlFilePath=journals/ijba/vol1n1/integrated.xml

Lawyer

Lawyers can specialize in patents for new biomedical products as well as in ethical, legal, and social issues surrounding genetic research.

- http://www.genelaw.info/
- http://www.genome.gov/11510209
- http://geneticsandsociety.org/index.php

Computational Biology/Bioinformatics

Bioinformaticians acquire and analyze data about genetics from a variety of sources. Computational biologists solve complex genomic problems using statistics and mathematical approaches.

- http://www.biohealthmatics.com/careers/biocareerpaths.aspx
- http://jobsearchtech.about.com/od/jobs/l/aa032398.htm
- http://www.explorehealthcareers.org/en/Career.90.aspx

Military

Scientists can work within the military as consultants or basic researchers. Scientists may assist in soldier identification, pathogen identification, and biological and chemical warfare research. What do you think this has to do with genetics?

- http://www.afip.org/
- http://www.bio.com/store/product.jhtml?id=prod640005#top
- http://www.usamriid.army.mil/

Genetic Researcher- Basic Research

Geneticists conduct research on hereditary diseases and evolutionary patterns within genetics. They may conduct research in a laboratory or clinic, and perform research in medicine, sequencing, or environmental studies.

- http://www.collegeboard.com/csearch/majors_careers/profiles/careers/106690.html
- http://en.wikipedia.org/wiki/Genetics#Genetic_research_and_technology
- http://genetics.faseb.org/genetics/gsa/careers/bro-01.htm
- www.kumc.edu/gec/prof/ashg.html

Forensic Science

Forensic scientists use a variety of science techniques to solve criminal cases and serve the public through public safety and health services. Many of them work with DNA evidence found at crime scenes.

- http://www.collegeboard.com/csearch/majors_careers/profiles/careers/106918.html
- http://en.wikipedia.org/wiki/Forensic_science
- http://aafs.org/default.asp?section_id=resources&page_id=choosing_a_career#Bookmark1
- http://www.bls.gov/opub/ooq/1999/Fall/art01.pdf

Genetic Counselors

Genetic counselors help families understand genetic disorders and provide them with information and support.

- www.kumc.edu/gec/prof/abgc.html
- www.kumc.edu/gec/prof/nsgc.html
- http://www.ornl.gov/sci/techresources/Human_Genome/medicine/genecounseling.shtml
- http://en.wikipedia.org/wiki/Genetic_counseling

Teacher/Professor

Teachers may specialize in science and serve as school district consultants to other teachers in the surrounding area. Professors work at colleges or universities and not only teach students but perform their own research as well. Many professors teach genetics classes and do genetics research.

- http://careercenter.tamu.edu/guides/resources/careers/genetics.html
- www.teachforamerica.org
- http://careercenter.tamu.edu/guides/resources/careers/genetics.html
- http://www.nap.edu/openbook.php?record_id=5129&page=R1

Spend some time looking at websites about the topic you have chosen.

I have chosen the following topic:_____

Why do you think this topic is interesting?

Why do you think others will find this topic interesting?

Name 2 things that you would like to learn about this topic:

Guidance Questions – TRAIT OR DISEASE

Using the provided websites or other websites you have found answer the following questions:

- What effect does this trait have on the whole body?

- What effect does this trait have on the cells?

- What effect does this trait have on the proteins?

- Is there a specific gene involved? Does it have a name that is different from the name of the trait? (If there are several genes that could be involved, pick 1 and use it to answer the next two questions)

    - What chromosome is the gene located on?

    - What type of protein does the gene have the instructions to make?

- How common is the trait?

- Is there a medical treatment for the disease?

- In your own words, explain how genes are involved in the trait you have chosen. Write your answer in the form of a scientific explanation using the information you gathered above. Be sure to include a claim, evidence and reasoning.

Guidance Questions – CAREER

Using the provided websites or other websites you have found answer the following questions:

- What does a person who has this career do when they are working?

- What kind of training or degree do people with this career have?

- How could this career be used help other people?

- How many people have this career?

- How much money does someone with this career earn?

- In your own words, explain how something you have learned in biology class relates to the career you have chosen?

Project Layout and Template

Here are some examples of layouts for the information on your poster or brochure:

Poster sample

TITLE

Researcher's Name

Background of the problem
What's happening at the cellular level?
What's happening at the protein level?
What work is the protein doing?

General Information
What is the trait?
How common is the trait?
Is there a medical treatment?

Explanation
How are genes involved in the trait? (claim, evidence, reasoning)

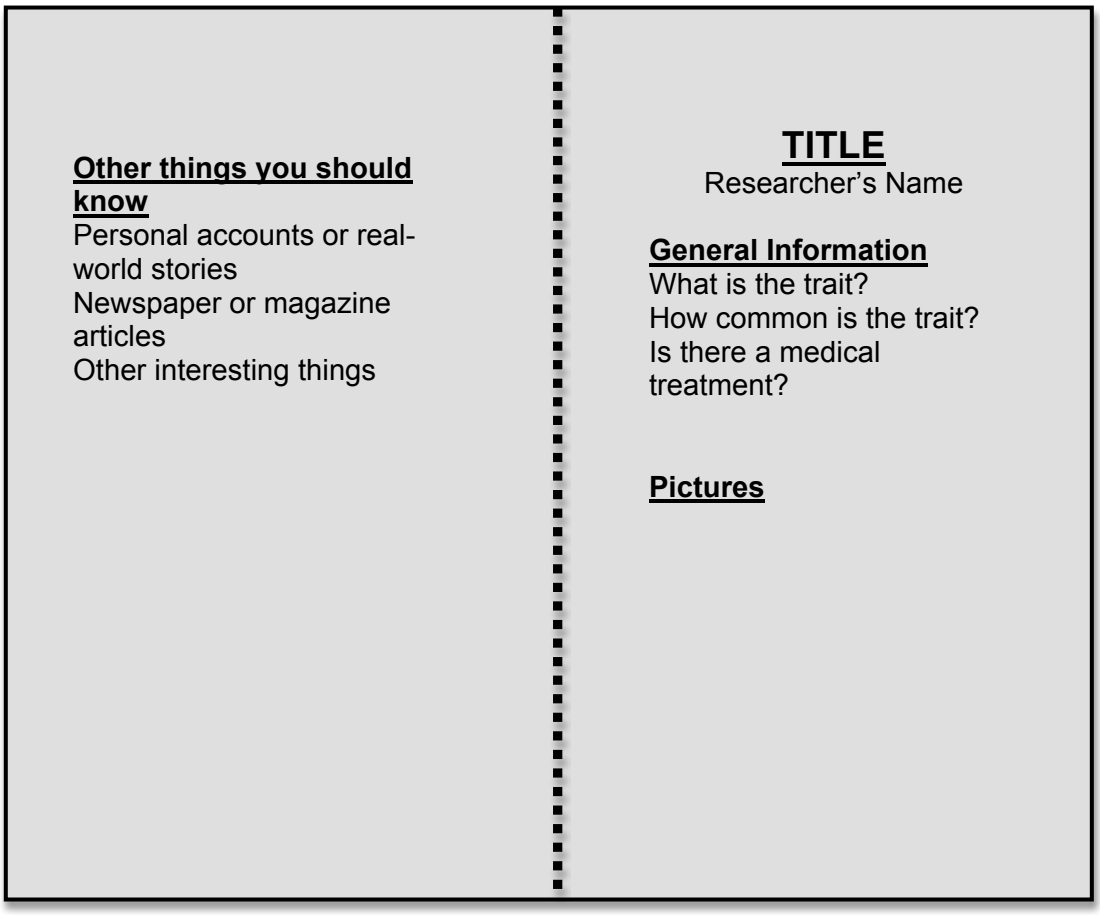
Pictures

Genetics issues to consider
What gene is involved?
What is the name of the gene?
What chromosome is the gene located on? (Is there a picture?)

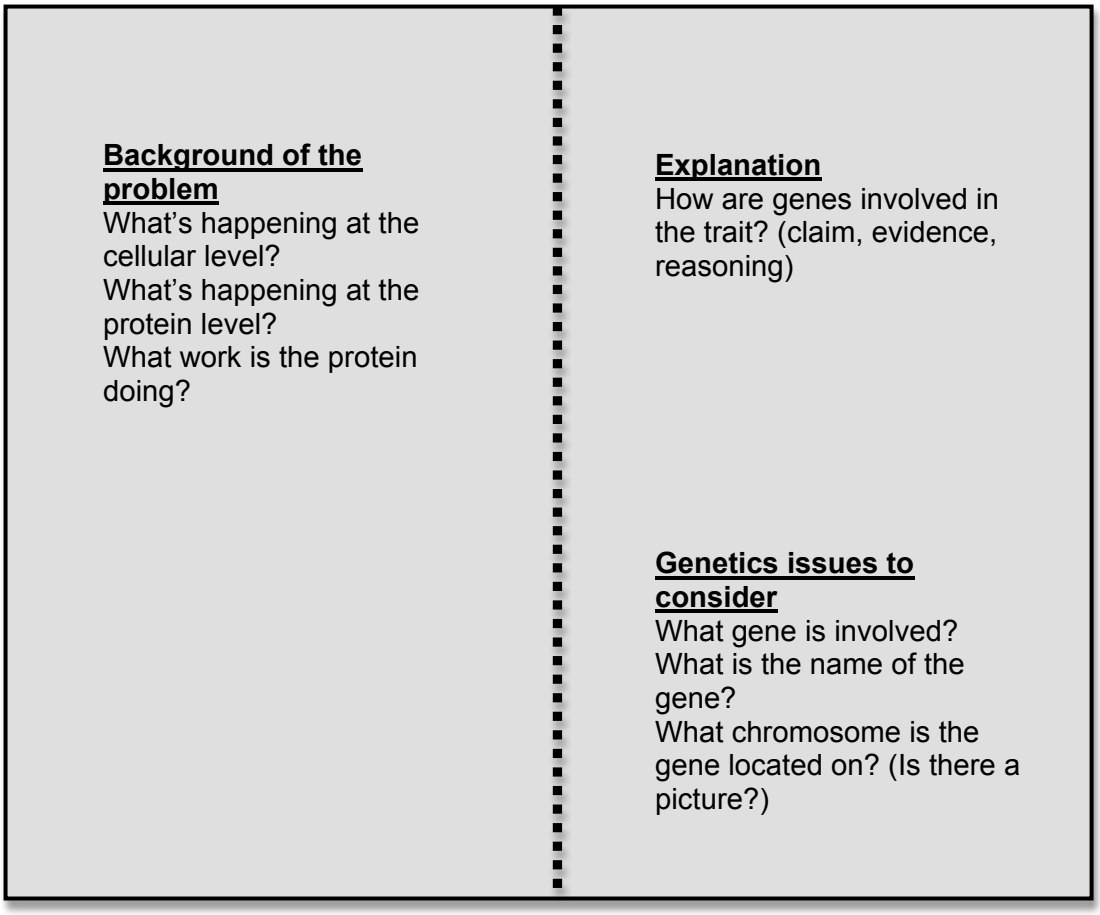
Other things you should know
Personal accounts or real-world stories
Newspaper or magazine articles
Other interesting things

Brochure sample

Outside



Inside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