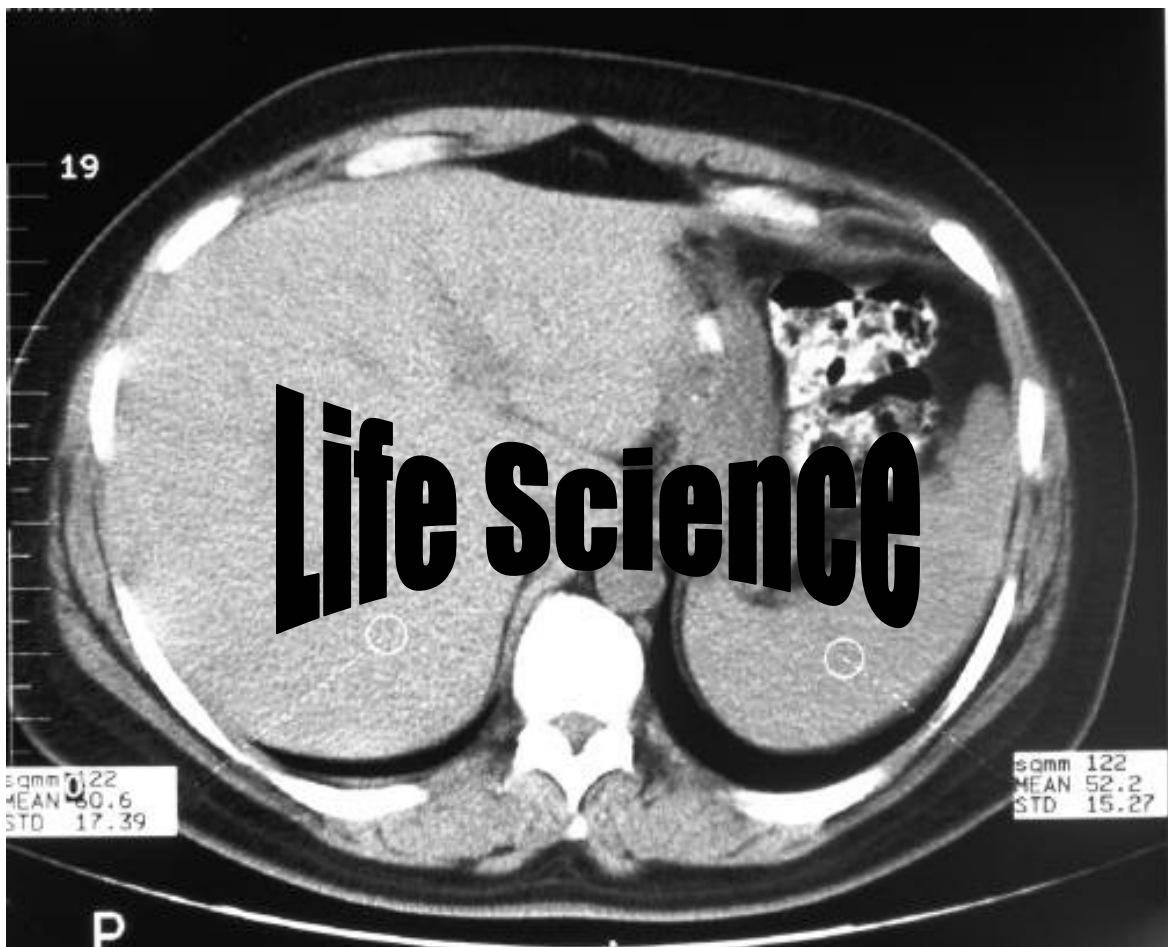




TAKS Objective 2 – The student will demonstrate an understanding of living systems and the environment.



TEKS 8.6 B

Look Mama, It's Alive!

TAKS Objective 2 – The student will demonstrate an understanding of living systems and the environment.

Learned Science Concepts:

- ➔ **Interdependence occurs among living systems.**
 - Traits of species can change through generations.
 - The instructions for traits are contained in the genetic material of the organisms.

TEKS Science Concepts 8.6

The student knows that interdependence occurs among living systems. The student is expected to:

- (B) identify feedback mechanisms that maintain equilibrium of systems such as body temperature, turgor pressure, and chemical reactions

Overview

Maintaining a body that is in balance is critical to life in all humans. Normal blood pressure must be maintained to keep from blowing out blood vessels. The level of blood sugar must be kept stable or the body goes into shock and dies. Elimination of excretory wastes, carbon dioxide, and extra body heat constantly occurs. What all these processes have in

common is that they are controlled by feedback systems and the proper function of these feedback systems is essential to survival.

Instructional Strategies

Students will investigate negative feedback systems as they explore anorexia nervosa and pancreatic enzymes. Some activities make use of video as a learning tool. Another techniques allow students to learn through kinesthetic motion as they role play the regulation of blood glucose in the body systems. The information processing technique utilizing rhyme as a learning tactic is used to aid in the storage and retrieval of information about the role of glucose and glucagon in blood glucose regulation.

Lesson Objectives

1. The learner will produce a graph or sketch to describe a negative feedback system, such as for serotonin production.
2. The learner will demonstrate understanding of how blood glucose is controlled in humans by creating labeled drawings and providing a summary of the process.
3. The learner will produce a labeled sketch that describes thermal regulation in humans.

For Teacher's Eyes Only

Teacher Background: **Maintaining homeostasis in the human body is critical to life.** Our body's ability to monitor and maintain homeostasis is dependent on a many complex interactions between the various body systems linked by the circulatory system. When these interactions do not function properly, a number of problems occur, some of which can be life threatening.

In this TEKS the student will explore a positive and negative feedback systems and their role in the maintenance of homeostasis. **A negative feedback system is one that tries to keep the body constant.** There are a number of negative feedback systems in the human body such as those involved in the control of blood glucose, blood calcium, blood pressure, reproduction, reaction, growth and metabolism. A very common example is how the body reacts to reverse the direction of change as the concentration of carbon dioxide in the blood increases. The diaphragm works in conjunction with the lungs to increase activity to decrease Carbon Dioxide levels in the body and increase oxygen levels. As water flows into a flaccid plant cell, the cell begins to swell and push against the cell wall creating turgor pressure. When the cell wall pressure is great enough, the cell wall pushes against the turgid cell and no net movement of water will occur across the cell membrane any longer. Another type of feedback system is a positive feedback system, which works in a different way.

In a positive feedback system the change will continue to increase in one direction until something happens in the body to stop it. For example, contractions of the uterus are triggered by pressure against the cervix during childbirth. This pressure causes the release of a hormone, oxytocin. The contractions will continue until the child exits the womb. Testosterone production is another example of a positive feedback system.

In addition to chemically regulated feedback systems, the body also uses thermal regulation to achieve homeostasis. In skin cells, there are sweat glands and receptors for heat and cold. When the body temperature goes up, the hypothalamus in the brain sends a nerve signal to cause sweat glands to release water. At the same time, blood vessels in the skin dilate which helps move heat away from the skin. Sweating cools the body through evaporation. On the other hand, in order for the body to keep warm, sweat glands and blood vessels constrict to conserve body heat. If the body temperature continues to fall, the skeletal muscles will shiver to produce heat. Finally, as a last resort, the decomposition of fat will rev up the metabolic rate and produce heat to maintain a constant body heat.

Misconceptions

Misconception

Each body system works in isolation.

Science Concept

Body systems are interrelated and work through a series of feedback systems.

Rebuild Concept

Provide experiences that demonstrate how feedback systems work together and what happens when these systems do not function properly.

Misconception

Feedback systems react quickly.

Science Concept

In feedback systems, the action of system components is typically slow in terms of time. That is, there is built up in one direction and slowly, the body returns to homeostasis.

Rebuild Concept

Provide experiences to familiarize students with various feedback systems and the rate at which they occur.

Student Prior Knowledge

Students should be familiar with the components associated with body systems TEKS 6.10 (C) identify how structure complements function at different levels of organization including organs, organ systems, organisms, and populations and the functions of these systems; TEKS 7.9 (A) identify the systems of the human organism and describe their functions; and TEKS 7.9 (B) describe how organisms maintain stable internal conditions while living in changing external environments.

5 E's

ENGAGE

View the video clip, “The Search for Answers” beginning at 2:50. This video clip introduces the student to feedback systems associated with anorexia nervosa.

<http://www.pbs.org/wgbh/nova/thin/program.html#>

You may want to purchase the video, *Dying to Be Thin*, in order to assure permanent access to these materials.

EXPLORE

Look carefully at the feedback system showing the level of serotonin and serotonin receptors. Stop the video clip at 3:50, 3:56, and 4:03. Record the numbers of serotonin units and serotonin receptors in your journal.

Time	# Serotonin units	# Receptors
3:50	10	3
3:56	3	3
4:03	2-3	7

EXPLAIN

Dr. Kaye describes his research into the brains of patients suffering from anorexia nervosa. These patients show high levels of a neurotransmitter, serotonin that controls mood, appetite, sleep, anxiety, and memory. High levels of serotonin reduce appetite. Perhaps dieting, even starvation is how afflicted individuals try to lower serotonin levels in an effort to reduce anxiety. However, the brain adapts quickly by adding more receptors onto nerve cells. This is how the brain attempts to regulate serotonin levels. Unfortunately, the anorexic patient eats less and less and this causes the body to add more receptors. Because of unnaturally high levels of serotonin in the brain, the anorexic is caught in a cycle that can spiral downward and lead to death if untreated.

ELABORATE

Elaboration 1

Role Play: The Rise and Fall of Glucose

Class Time: 20 minutes

Materials:

Script (see Black-Line Masters)

Laminated cards with drawings of pancreas, muscles, liver, small intestine, and adipose tissue

Preparation Students participate in a role-playing activity for the glucose/glycogen feedback system. Create 8" X 12" laminated cards for each wizard and glucose/glycogen molecule. The laminated card for glucose/glycogen should have the word, glucose on one side and glycogen on the opposite side. Attach yarn to form a necklace from which the card is suspended. Create poster-size drawings of the pancreas, muscles, liver, small intestine, and adipose tissue. The play script is available in printable version.

Factoid: You might know someone with an insulin problem whose pancreas is not working right. These folks have a disease we call diabetes, and if they don't get treatment, they could lose a finger, a toe, or other

body part that starved to death from lack of sugar in those particular cells. Diabetes can be a serious problem for some folks.

Elaboration 2

Questions and Discussion

Ask students the following question, “How does the body keep from overheating?” Include the following information in the discussion. In skin cells, there are sweat glands and receptors for heat and cold. When the body temperature goes up, the hypothalamus in the brain sends a nerve signal to cause sweat glands to release water. At the same time, blood vessels in the skin dilate (open larger) which helps move heat away from the skin. Sweating cools the body through evaporation.

Ask students this question, “On the other hand, how does the body keep warm?” Include the following information in the discussion. In order for the body to keep warm, first the sweat glands and blood vessels constrict (become smaller) to conserve body heat. If the body temperature continues to fall, the skeletal muscles will shiver to produce heat. Finally, the decomposition of fat will rev up the metabolic rate and produce heat.

Additional feedback systems that could be examined including the relationship between the kidneys and circulatory system, the digestive system and nervous system, the endocrine system and the reproductive system, and many interactions involving the nervous and endocrine systems.

EVALUATE

1. After viewing the video clip from “Dying to Be Thin” and participating in a class discussion, the learner will produce a graph or sketch in his/her journal to describe a negative feedback system for serotonin production. A grade of pass/fail will be given.
2. Using the text, and class notes, the learner will produce a labeled sketch in his/her journal that describes thermal regulation in humans. A grade of pass/fail will be given.
3. Using the text, and class notes, the learner will demonstrate understanding of how blood glucose is controlled in humans by creating labeled drawings and providing a 100 word summary of the process. A minimum score of 70% on the rubric is required.

Black History Months

ACTORS:

Pancreas
Muscles
Liver
Adipose tissue (fat)
Small intestine
9 Glucose/Glycogen molecules
Insulin Blue Wizard (Glucose converter)
Glucagon Red Wizard (Glycogen breakdown)

THE RISE AND FALL OF GLUCOSE

Act I

Pancreas: I am the pancreas, and I secrete some very important hormones to help keep your body in perfect balance. One of these hormones you may have heard of before; it's called insulin. When glucose, which is a sugar, is high in the blood, I release insulin to help bring the glucose level back to normal by helping glucose (sugar) from the food you eat to become stored in the body until you need it. Stored sugar is called glycogen. Let me show you how this works. Let's say you just ate lunch.

Glucose Molecules: Four Glucose Molecules are moving around in the bloodstream (Five glucose molecules move out from behind the small intestine. Wow! Are we glad to get out of the digestive system! (Glucose Molecules move around the middle of the room) Where are we? Where is our home?

Pancreas: (To the audience) Notice that they're too many Glucose Molecules in this blood right now. So, I will release some insulin to bring the blood glucose level back down. (Pancreas releases Insulin Blue Wizard).

Insulin Blue Wizard: Hey, let me show you your new home. Five Glucose molecules follow Insulin Blue Wizard to the liver, muscles, or adipose (fat) tissue. The Blue Wizard lightly taps each of the five Glucose Molecules on the shoulder with a wand and says, "Transform!" (Switch labels). This changes each Glucose Molecule into a Glycogen Molecule.

Pancreas, Glucose Molecules, and Insulin Blue Wizard perform the Insulin Rap.

Insulin Insulin
Storing sugar is so much fun
Muscles, liver, fat that's right
Get sugar each time you take a bite

Act II

Pancreas: But having only one job is boring and I am a born multitasker, so I also secrete a different hormone you may not have heard of before; it's called glucagon. Glucagon is a hormone that breaks down the glycogen I help store in the liver, muscles, or adipose tissue, so your cells can keep on eating even when you're not or when you are sleeping. Let me show you how this works. Let's say lunch is over now and it's time to catch a few Z's.

Glucose Molecules: Only two Glucose Molecules are moving around in the bloodstream.

Pancreas: What's Up? The blood glucose level is too low! We need more Glucose Molecules in the blood (releases two Glucagon Red Wizards into the blood).

Glucagon Red Wizard: The Glucagon Red Wizard goes over to the muscles and lightly taps glycogen on the shoulder with a wand and says, "Transform!" (Switch labels). This changes glycogen back to glucose.

Glucose: The two Glucose molecules move out of the muscles and back into the blood. Since there are four glucose molecules in the blood now, everything is in balance again.

Pancreas, Glucose, and Glucagon Red Wizard perform the Glucagon Rap.

Glucagon, glucagon

For in between meals and until dawn

Formative assessment: Assume the blood glucose level is high. Place the cards in order to show the sequence of events. Begin with the pancreas.

Pancreas secretes insulin.

Glucose is converted to glycogen. Glucose is also transported to cells.

Blood glucose level drops, which inhibits insulin secretion.

Blood glucose level rises inhibiting glucagons secretion.

Breakdown glycogen to glucose; glucose released from cells.

Pancreas secretes glucagon

CHECK SHEET FOR INDEPENDENT INVESTIGATION

I.	<p>Stating a problem to investigate</p> <p>Problem phrased as a research question</p> <p>If...then hypothesis statement</p>	5
II.	<p>Develop a procedure to compare baseline heart and respiration rates to an after exercise heart and respiration rates.</p> <p>All steps in sequential order and reproducible</p> <p>Multiple trials indicated</p> <p>Materials are appropriate and described</p>	15
III.	<p>Gathering respiration and heart rate data</p> <p>Data organized in table or chart</p> <p>Data has a title</p> <p>Labels for manipulated & responding variables</p> <p>Units are stated</p> <p>Multiple trials, totals and averages are included</p>	15
IV.	<p>Graphing data</p> <p>Appropriate graph type used</p> <p>Appropriate scale, range, and interval are used</p> <p>Graph has a title</p> <p>Descriptive label for variable on the x-axis and responding variable for the y-axis</p> <p>Graphed data matches data collected</p> <p>Units indicated for each axis</p>	20
V.	<p>Data analysis</p> <p>Results from graph clearly stated</p> <p>Inferences made about results</p>	20
VI.	<p>Conclusion</p> <p>Conclusions based on results and inferences</p> <p>Hypothesis is restated</p> <p>Hypothesis is accepted or rejected</p>	25

Blood Glucose Rubric				
	Revise and Resubmit	70-79 Points	80-89 Points	90-100 Points
Accuracy	Fewer than 70% of the assigned details are present OR most details are difficult to identify.	70%-79%) have been added. A few details are difficult to identify.	Almost all assigned details (at least 80%) have been added. The details are clear and easy to identify.	All assigned details have been added. The details are clear and easy to identify.
Label	Less than 70% of the items that need to be identified have labels OR it is not clear which label goes with item.	Most items (70-79%) that need to be identified have labels. It is clear which label goes with which structure.	Almost all items (80%) that need to be identified have labels. It is clear which label goes with which structure.	Every item that needs to be identified has a label. It is clear which label goes with which structure.
Drawing	Less than 70% of the assigned structures are drawn AND/OR labeled accurately.	70% -79% of the assigned structures are drawn accurately and are recognizable. 94-85% of the assigned structures are labeled accurately.	80% of the assigned structures are drawn accurately and are recognizable. All assigned structures are labeled accurately.	90% or more of the assigned structures are drawn accurately and are recognizable. All assigned structures are labeled accurately.

This rubric was created using information from the following website:

<http://rubistar.4teachers.org/index.php>

TEKS 8.6 A

You Can't Have One without the Other

TAKS Objective 2 – The student will demonstrate an understanding of living systems and the environment.

Learned Science Concepts:

- ➔ **Interdependence occurs among living systems.**
 - Traits of species can change through generations.
 - The instructions for traits are contained in the genetic material of the organisms.

TEKS Science Concepts 8.6

The student knows that interdependence occurs among living systems. The student is expected to: The student knows that interdependence occurs among living systems. The student is expected to:

- (A) describe interactions among systems in the human organism

Overview

One of the most remarkable features of the human body is the interdependence among systems within our body. Because of this interdependence, more than one system is generally affected when a person is exposed to a disease or sustains an injury. For example, tobacco smoke irritates the cells lining the bronchi of the lungs. Tobacco smoke also destroys the macrophages of the immune system whose job is to

patrol the cilia and engulf microorganisms and fine particles that do not belong in the lungs.

Another example of the interdependence among body systems is the influence of hormones such as epinephrine (fight-or-flight) on the heart. During times of stress, during exercise, or when we become excited, the nervous system increases the heart rate. In contrast, the heart rate is decreased when we are asleep or depressed.

One final example of interdependence among systems within our body involves HIV infection. A person can become infected with HIV through (1) sexual contact with an HIV-infected individual, (2) sharing needles contaminated with HIV, (3) blood transfusions, or (4) other contact with HIV infected blood or body fluids. When HIV develops into AIDS, the immune system is destroyed opening the body to opportunistic diseases that affect many systems in the body such as the respiratory system (Pneumocystis pneumonia), reproductive system (yeast infections), digestive system (Candida affecting the esophagus), integument (Kaposi's sarcoma) and the nervous system (Progressive multifocal leukoencephalopathy).

Understanding this interdependence among systems within our bodies will help to raise awareness about the importance of healthy habits so that we may act responsibly and engage in behaviors that maintain a healthy body throughout life.

Instructional Strategies

Students will examine the relationship among various systems in the human body using an inquiry model of teaching. This model is based on the assumption that an engaging question that is relevant to student interest will provide a context in which students grasp and retain information while engaging in scientific ways of thinking and doing.

Lesson Objectives

1. After participating in the “Natural Born Killers: The Ebola Plague” learning experience, the student will describe in their science journal, the connection between the circulatory system and the immune system.

2. Working in a group and given 40 minutes, the student will design and implement an experiment to demonstrate the relationship between heart and respiration rates. A minimum score of 70% on the “Check Sheet for Independent Investigations is required.
3. After participating in the Respiration and Muscle Rumble, the student will write a 100-150 word summary about oxygen debt and muscular contractions. A completion grade will be given.
4. Using the information from your notes and from the text, create two labeled drawings of the lungs and diaphragm during (1) inhalation and (2) exhalation. Record the information in the science journal.

For Teacher's Eyes Only

Teacher Background: **There are twelve major organ systems in the human body (i.e., circulatory, skeletal, respiratory, excretory, integumentary, nervous, digestive, endocrine, reproductive, immune, lymphatic, and muscular systems).** In this TEKS, we will introduce the most common interactions in the human body by relating them to the nervous and/or circulatory system. A brief description of these interactions follows.

Nervous System - The nervous system works together with the endocrine system to maintain homeostasis in the body. Growth, metabolism, blood sugar/calcium level, and gamete production are all examples of processes regulated by the nervous system. The nervous system also interacts with the muscular system to allow us to physically move thorough and respond to our external environment. In fact, **the nervous system interacts directly or indirectly with all systems in the body** (e.g., diaphragm movement/respiration, heart pumping/circulation, sweat glands/integument, oxytocin release/reproduction).

Circulatory System – **The circulatory system uses the blood to carry oxygen, nutrients, other cells, and substances throughout the body.** For example, white blood cells and antibodies are carried throughout the body using the circulatory and lymphatic systems. During respiration, the exchange of oxygen and carbon dioxide occurs through the walls of the capillaries that surround the alveoli in the lungs. The circulatory system also interacts with the excretory system as during filtration of body wastes in Bowman's capsule which is located in the nephron of the kidney. Many hormones associated with endocrine system and reproductive system (e.g., thyroid-stimulating hormone, Follicle-stimulating hormone, and insulin) are carried throughout the body via the circulatory system. These hormones act on specific target cells to coordinate body functions and bring about and maintain homeostasis. In the digestive system, nutrients are absorbed into the blood through capillaries surrounding the villi of the small intestine. Finally, lactic acid build up due to oxygen-debt is carried away from the muscles via capillaries. This is yet another way the circulatory system partners with other systems to carry on various functions associated with everyday life.

In this TEKS the student will explore interactions between and among systems in the human organism. Many of these interactions are further elaborated in TEKS 8.6 (B) that identifies feedback mechanisms used to maintain homeostasis in the human body.

Student Misconceptions

Misconception

Each body system works in isolation.

Science Concept

Body systems are interrelated and work through a series of feedback systems.

Rebuild Concept

Provide experiences that demonstrate how systems work together and what happens when these systems do not function properly.

Student Prior Knowledge

Students should be familiar with the components associated with body systems TEKS 6.10 (C) identify how structure complements function at different levels of organization including organs, organ systems, organisms, and populations and the functions of these systems;

TEKS 7.9 (A) identify the systems of the human organism and describe their functions; and

TEKS 7.9 (B) describe how organisms maintain stable internal conditions while living in changing external environments.

The teacher may review body systems by creating body systems brochures using Microsoft Publisher® or Microsoft Word® “newspaper columns.” It is also possible for students to create brochures without the use of computer technology by using paper and marking devices such as map pencils, markers, and/or crayons.

5 E's

ENGAGE

Show the movie or show movie clips from *Ebola: The Plague Fighters* video.

EXPLORE

Activity: Are you catching?

Class Time: 20 minutes

Objective: After participating in the “Natural Born Killers: The Ebola Plague” learning experience, the student will describe in their science journal, the connection between the circulatory system and the immune system.

Materials

- One test tube per student
- Test tube rack
- Water
- Sodium hydroxide solution 0.1 M
- Phenolphthalein solution
- Pipette or eyedropper

Preparation Fill all but one test tube 1/3 full with water. Fill the remaining test tube 1/3 full with sodium hydroxide solution. Place the test tubes in a test tube rack.

1. Demonstrate the technique for sharing contents of the test tube with another student; pour the full contents of one test tube into a second tube, then pour half of the contents back. Each test tube should have approximately the same amount of liquid after the sharing transaction.
2. Ask students to select a test tube and share the contents with other students in the class.
3. Tell the students they have just simulated virus transmission within a population that contained one Ebola infected individual. Test the contents of each student's test tube by adding a dropper full of phenolphthalein to each test tube. Each student who shared with the Ebola infected individual (test tube filled with sodium hydroxide) will test positive showing a bright pink response.

EXPLAIN

The Ebola virus is transmitted through blood and body fluids and even a corpse can transmit the virus although infection usually occurs among hospital workers or family members who care for an infected individual. Ebola replication takes about eight hours releasing hundreds of thousands of viruses into the human body. This fast acting virus targets liver cells and cells of the reticuloendothelial system quickly overrunning the immune system's ability to manage or eliminate the virus. Ebola attacks the lining of the blood capillaries causing the capillaries to leak fluids and plasma proteins leading to organ failure. Once clinical shock sets in, it is unlikely the patient will recover. The Zaire Ebola has a 90% fatality rate. Presently, there is no cure.

ELABORATE

Repeat the experiment, but this time the students have the option to abstain from sharing with other students. Compare the results of experiment 1 with experiment 2. It is possible to conduct the simulation changing the infectious agent from Ebola to HIV.

EVALUATE

After participating in the “Natural Born Killers: The Ebola Plague” learning experience, the student will describe in their science journal, the connection between the circulatory system and the immune system.

5 E's

ENGAGE

Play the introduction to the song, “Turn the Beat Around” by Gloria Estefan.

EXPLORE

Your heart rate increases when you exercise. Your cells need more oxygen and food when you do vigorous exercise. The oxygen and the food are delivered to your cells by your blood. Since your cells need more oxygen and food, more blood must go past the cells. Your heart must pump faster and harder to send more blood by the cells. While sitting still, use a heart rate probe and a computer to measure your heart rate in beats per minute. NOTE: The student may also take heart rate by placing their index and middle finger over the carotid artery in the neck. This is called your resting heart rate. Use this information to calculate the following:

1. How many times does your heart beat per hour? *Answers will vary.*
2. How many times does your heart beat per day? *Answers will vary.*
3. How many times does your heart beat per year? *Answers will vary.*
4. Now think about how many times your heart will beat in your life. *Answers will vary.*

Now jog in place for one minute. Use the probe and computer to determine your active heart rate in beats per minute. Create a data table to

collect information about heart rate before and after jogging. Be sure to include multiple trials.

EXPLAIN

The teacher will guide a discussion to answer the following questions:

1. How much faster is your pulse after you have jogged compared to your resting pulse? *Answers will vary.*
2. Explain why your heart rate increased. *The need for oxygen increases.*
3. You noticed that as your heart rate increased, so did your respiration rate. Explain how the circulatory system and the respiratory system interact. *You must increase your breathing rate to get more oxygen into your blood in your lungs.*
4. Do you think there is a difference in the resting pulse of athletes compared to non-athletes? *Answers vary but may include taking the pulses of many athletes and non-athletes and comparing them.*

ELABORATE

Elaboration 1

Students will work in a group and design an experiment using exercise to explore the relationship between the respiratory and circulation system. Each student will use the “Check Sheet for Independent Investigations” to guide the exploration. The explorations might include comparing the respiration rates of males to females, athletes to nonathletes, or comparing baseline heart and respiration rates to heart and respiration rates after exercise. The teacher will provide a clock or stopwatches for data collection.

Elaboration 2

1. Ask students to take a deep breath. What is happening to the size of the chest cavity? *It is larger.*
2. Now ask students to exhale after taking a deep breath. What is happening to the size of the chest cavity? *It is decreasing.* Ask students, “How is the air pressure changing during the process of inhaling and exhaling (respiration)? *The air pressure is greater during exhalation and less during inhalation. Breathing occurs because of changes in air pressure. At rest, the air pressure inside the lungs is equal to the atmospheric pressure outside of the lungs. However, during inhalation the size of the chest cavity increases. There is now less air pressure inside the chest cavity. In order to maintain equal air pressure, molecules will move from a high concentration outside the body to the lower concentration area inside the chest. During exhalation, the opposite occurs. Air pressure increases inside the chest as the size of the chest cavity decreases. The air molecules will move outside the body to a less concentrated area. Once again, air molecules are trying to reach a state of equilibrium.*
3. What causes this change in air pressure? *A large muscle called the diaphragm separates the chest cavity from the abdominal cavity. When carbon dioxide levels reach a certain level, the brain signals the diaphragm to contract. The diaphragm moves down toward the abdomen and increases the space in the chest cavity. The diaphragm is in a flat shape. This causes some air from outside the body to flow into the lungs (and to the alveoli) to fill the space. When the diaphragm relaxes, it moves up toward the chest cavity and decreases the space. The diaphragm is bowed up into the chest cavity. This action causes some of the air to exit from the lungs.*

Elaboration 3

Students work in pairs to complete the following experiment to investigate the relationship between oxygen and muscle fatigue. Use the following procedure to explore lactic acid buildup in muscles.

1. Each pair of students is given a tennis ball.
2. Partner A holds the ball in his or her hand. Either hand is OK.

3. Partner B monitors the time for two minutes.
4. When Partner A says begin, Partner B squeezes the tennis ball with his or her hand as many times as possible until time is called at the end of two minutes. Simultaneously, Partner A will count aloud the number of times the tennis ball is squeezed.
5. Create a data table and record Partner A's data.
6. Partners switch roles, and repeat steps 2-4.
7. Record Partner B's data.

Provide a debriefing for the activity using the following questions:

1. Describe how your hand felt at the end of the activity? *Answers will vary but should include responses related to discomfort or pain.*
2. What is happening to the muscles in your hand? *The muscles are requiring more oxygen than the blood can deliver (oxygen debt). As oxygen levels decrease, the muscle cells form lactate, which causes discomfort or pain.*
3. How do swimmers overcome lactate buildup as they near the end of a race? *Initially, creatine phosphate powers the muscles during the race. However, near the end of the race, the swimmer uses rapid breathing to restore the oxygen supply to the muscles. The lactate diffuses out of the muscles and into blood where it is carried to the liver for conversion to glucose. The glucose is transported back to the muscle cells for cellular respiration to synthesize ATP which is used to regenerate creatine phosphate.*
4. Which body systems are interacting together in this learning experience? *Answers will vary, but might include the following: circulatory, respiratory, nervous, muscular. Students should be able to describe how these systems interact directly or indirectly.*

EVALUATE

Evaluation 1

Working in a group and given 40 minutes, the student will design and implement an experiment to demonstrate the relationship between heart and respiration rates. A minimum score of 70% on the “Check Sheet for Independent Investigations” is required.

Check Sheet for Independent Investigations			
I.	Stating a problem to investigate Problem phrased as a research question If...then hypothesis statement		5
II.	Develop a procedure to compare baseline heart and respiration rates to an after exercise heart and respiration rates. All steps in sequential order and reproducible Multiple trials indicated Materials are appropriate and described		15
III.	Gathering respiration and heart rate data Data organized in table or chart Data has a title Labels for manipulated & responding variables Units are stated Multiple trials, totals and averages are included		15
IV.	Graphing data Appropriate graph type used Appropriate scale, range, and interval are used Graph has a title Descriptive label for variable on the x-axis and responding variable for the y-axis Graphed data matches data collected. Units indicated for each axis		20
V.	Data analysis Results from graph clearly stated Inferences made about results		20
VI.	Conclusion Conclusions based on results and inferences Hypothesis is restated Hypothesis is accepted or rejected		25

Evaluation 2

Using the information from your notes and from the text, create two labeled drawings of the lungs and diaphragm during (1) inhalation and (2) exhalation. Record the information in the science journal.

Revise and Resubmit	70-89	90-100
Less than 70% of the items that need to be identified have labels OR it is not clear which label goes with which item.	Most items (70-89%) that need to be identified have labels. It is clear which label goes with which structure.	90-100% of the items that need to be identified have a label. It is clear which label goes with which structure.
There are several erasures, smudged lines or stray marks on the paper, which detract from the drawing. Overall, the quality of the drawing is poor.	There are a few erasures, smudged lines or stray marks on the paper, which detract from the drawing OR color is not used carefully. Overall, the quality of the drawing is good.	Lines are clear and not smudged. There are almost no erasures or stray marks on the paper. Color is used carefully to enhance the drawing. Stippling is used instead of shading. Overall, the quality of the drawing is excellent.
This rubric was created from the following website: http://rubistar.4teachers.org/index.php		

Evaluation 3

After participating in the Respiration and Muscle Rumble, the student will write a 100-150-word summary about oxygen debt and muscular contractions. A completion grade will be given.

5 E's

ENGAGE

Prepare beakers of distilled water with bromothymol blue indicator. Without the students knowledge, bubble carbon dioxide into one beaker until the solution turns green or yellow. Tell the students that a solution of water with bromothymol blue added changes color in the presence of carbon dioxide

EXPLORE

Andrea knows that her breathing rate increases when she starts to run or exercise. She thinks it is because she needs to increase her oxygen intake. Does increased activity have an affect on the amount of carbon dioxide she exhales? Design an experiment that will answer her question.

Materials (per group)

- 5 drops Bromothymol blue indicator
- Eyedropper
- 50 ml tap water
- Graduated cylinder
- Drinking straw
- 100 ml Beakers
- 3 ml ammonia
- Timer with second hand
- Safety goggles
- Lab apron

Procedure:

1. Use a graduated cylinder to measure 50 ml of tap water and pour into a beaker.
2. Using the eye dropper, add 5 drops of Bromothymol blue indicator solution to 50 ml of tap water.
3. Gently blow into the solution using the drinking straw until the solution changes color.
4. Observe changes in the solution.
5. Add 3 ml of a base solution such as ammonia to the tap water solution.
6. Observe changes in the solution.

EXPLAIN

Typically the pH of water is between 6 and 8. A pH of 7 is considered to be a neutral pH. When carbon dioxide is blown into water, carbonic acid, a weak acid is formed. The chemical bromothymol blue (BTB) can be used to detect the presence of carbonic acid in water. When carbon dioxide is added to a solution of BTB, the solution will turn from blue to green, yellow, or pale yellow depending on the amount of carbon dioxide dissolved in the solution. It is possible to measure the amount of carbon dioxide by counting the drops of a basic (high pH) solution it takes to turn the solution back to its original color. This process is called titration.

1. Explain why the BTB solution turned yellow in the presence of carbon dioxide. *BTB is an indicator of the presence of acid in a solution and the carbon dioxide dissolved in the water making it acidic.*
2. Draw a diagram that illustrates the route air takes as it enters the nose and moves to the lungs. Then diagram the exchange of oxygen and carbon dioxide within the lungs. *Check students' illustrations for accuracy.*
3. Why does the need for oxygen increase during exercise? *Cells need more energy and oxygen due to oxygen debt.*

4. List some sources of error that could occur while conducting this investigation. *Answers vary but may include: you did not inhale or exhale exactly the same for the different trials, bubbling techniques could vary, etc.*
5. Explain how the muscular, skeletal, circulatory, and the respiratory systems work together during one inhalation and exhalation. *Explanations should include: Muscle and skeletal – muscles on ribs in the diaphragm contract and ribs move at joints. Circulatory and respiratory – oxygen and carbon dioxide exchange takes place at the capillaries surrounding alveoli in the lungs.*

ELABORATE

Ask students to suggest an experiment to change the solution back to blue. Write the proposed experiment in the science journal. Hint: The amount of oxygen and carbon dioxide in the solution must be changed.

EVALUATE

Monitor students as they design and perform the experiment. Guide class debriefing using the questions provided in the “Explain” section of this activity. Student will record information in the scientific journal. A completion grade will be given.

5 E's

ENGAGE

Share the following information with students. Every day of our life, as food travels through our intestines, the tips of villi are sloughed off. About 1/5 of the tip of each villus is lost each day and it takes about five days to reach their full size. Just imagine how much time is spent repairing the villi in the intestine. In fact, the tips of our villi represent about 1/3 of daily excrement.

EXPLORE

Ask students which type of cloth they think will absorb the most water. The student should record the prediction in the science journal.

Materials:

Piece of smooth cotton cloth	Graduated cylinder
Piece of terry cloth	Beakers
Water	Timer or watch with second hand

Procedure:

1. Place smooth cotton cloth and terry cloth of equal length and width into a bowl of water.
2. Let both cloths soak for 30 seconds.

3. Remove cloths and drain for 20 seconds.
4. Wring out each cloth into different containers.
5. Measure the amount of water in each using a graduated cylinder.
6. Record measurements in your data table.

Data Table	Trial 1	Trial 2	Trial 3	Average
Terry cloth (ml)				
Smooth cloth (ml)				

7. Using your data table make a bar graph to illustrate your results. Remember to label each axis, title your graph, and include a key.

EXPLAIN

Most of the process of digestion and practically all absorption occur in the small intestine. Many enzymes and hormones are added to the beginning of the intestine (the duodenum) to aid in digestion. The other regions of the small intestine (the jejunum and ileum) are involved in absorption.

The folds of intestinal lining contain fingerlike projections called villi. These help to greatly increase surface area for better absorption. In the middle of each villus are branching capillaries. Nutrients will diffuse into the blood in these capillaries and be taken to the liver. Here the blood is regulated before it is circulated to the rest of the body. Smooth cotton cloth and terry cloth are used to model how villi help increase absorption in the small intestine. Students complete the learning activity, “Absorption in the Small Intestine.”

Teacher Questions:

1. Which cloth is similar to the inside of the small intestine? *The terry cloth.* Explain why. *The terry cloth has small projections like the villi in the small intestine.*
2. How would this help the small intestine in its absorption of food? *The villi increase the surface area of the intestine to facilitate digestion.*
3. What similarities can you cite between the villi of the small intestine, the alveoli of the lungs, and the nephrons of the kidneys? *They are all sites where diffusion of materials takes place between the blood and other structures in the body.*
4. List one limitation of using this model as a comparison to the villi in the small intestine. *Answers will vary.*
5. Which systems are interacting together in this learning activity? *Digestive and circulatory system.*

ELABORATE

Demonstrate diffusion across a cell membrane (osmosis) using raw eggs with no shell.

Materials:

Raw egg	2 beakers (~200 mL)
100 mL distilled water	100 mL Karo syrup
100 mL vinegar	Triple beam balance

Procedure:

1. Place a raw egg in white household vinegar overnight. Gently rub any shell that remains on the egg. Mass the egg using a triple beam balance. Record the information in the data table.

- Place the egg with no shell into a beaker of distilled water overnight. The following day, mass the egg again using the triple beam balance. Record the information in the data table.
- Place the egg in a beaker of light Karo® syrup overnight. Mass the egg again using the triple beam balance. Record the information in the data table.

Description	Mass of Egg	Observations
Day 1 – Egg in vinegar		
Day 2 – Egg in Karo syrup		
Day 3 – Egg in distilled		

Discussion:

- Ask students to explain what is happening to the egg each day.
Water is moving in and out of the egg.
- Ask students why the size of the egg increases or decreases? *The size of the egg increases and decreases due to the process of diffusion of water across the cell membrane (osmosis).*
- What would happen if the egg were placed back into distilled water? *The egg would no longer appear flaccid, but would rather the cell membrane would be extended so the egg appears full of liquid.*
- How does this experiment relate to various systems in the body? Provide information about specific structures in each system.
Responses will vary, but might include exchange between the capillaries interacting with (1) alveoli in the lungs (2) nephrons in the kidney (3) villi in the small intestine and (4) oxygen deprived muscle cells.

EVALUATE

Monitor students as they design and perform the experiment. Guide class debriefing using the questions provided in the “Explain” section of this

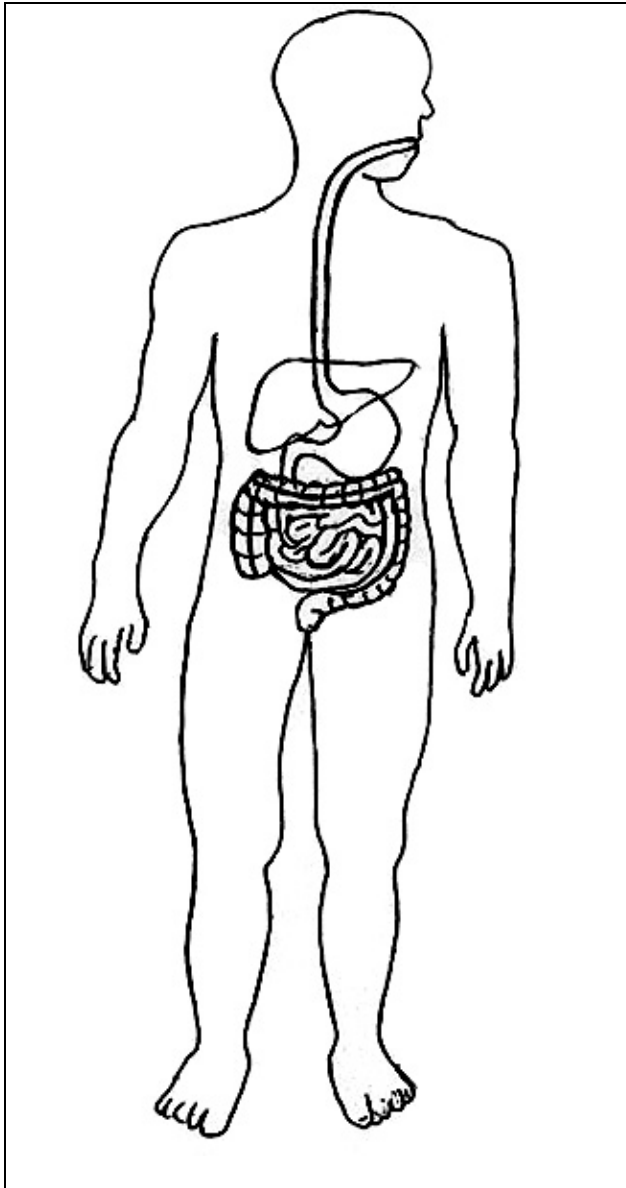
activity. Student will record information in the scientific journal. A completion grade will be given.

Summative Evaluation:

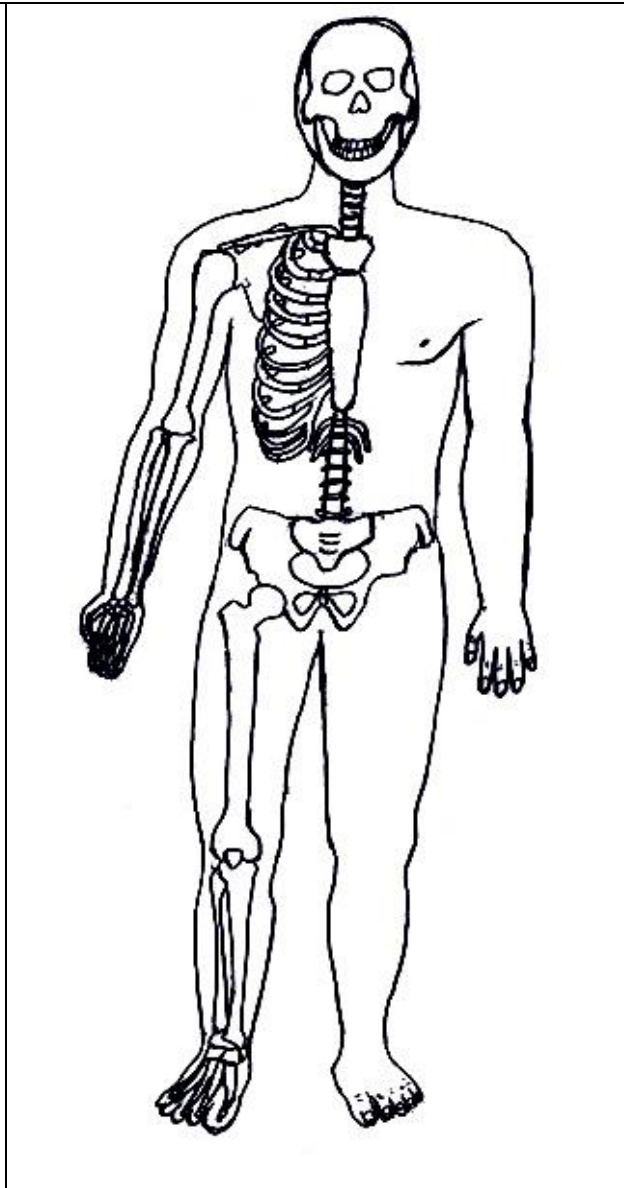
Distribute one Human Body Systems Figure to each student. Ask students to pair up with a partner and then describe to the class how the two systems shown on the Human Body Systems Figures interact.

Redistribute one Human Body Systems Figure to each student. Students form a group of at least three Human Body Systems Figures. A group spokesperson describes how the three Human Body Systems Figures interact.

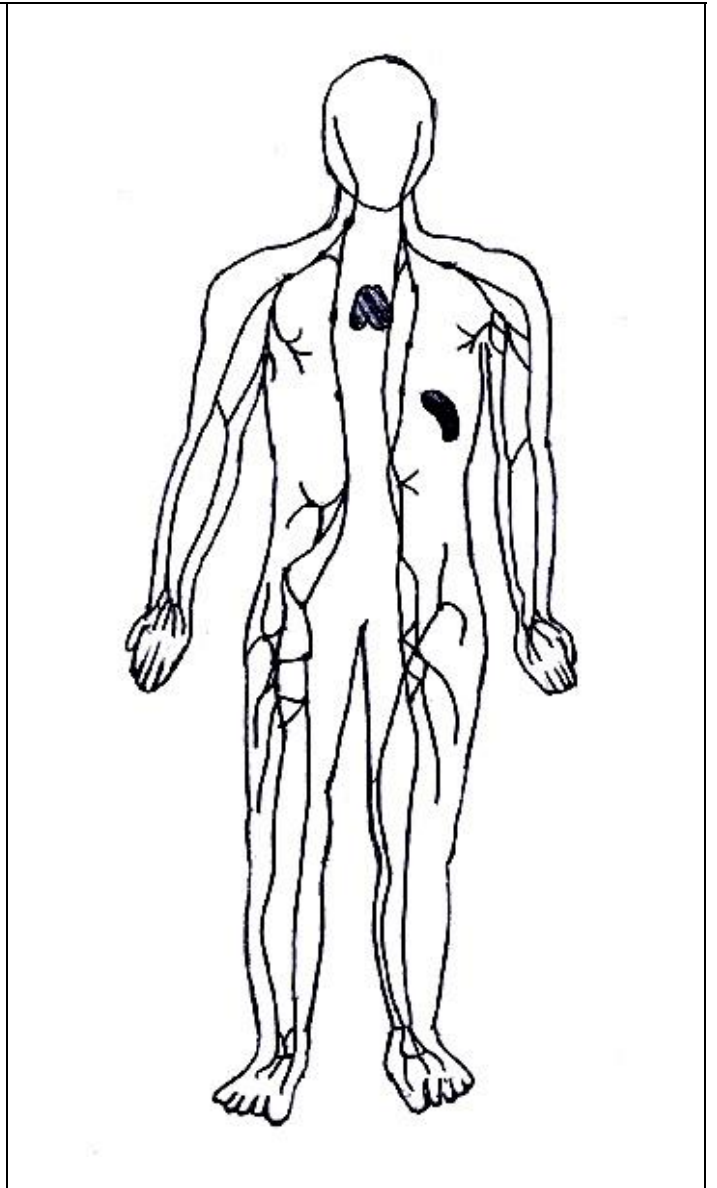
Black History Months



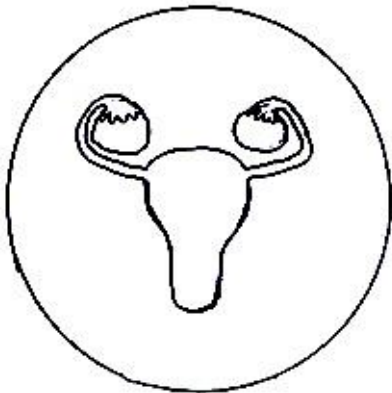
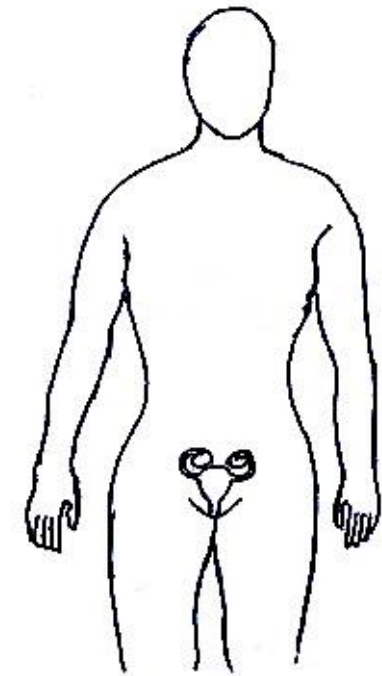
Digestive System



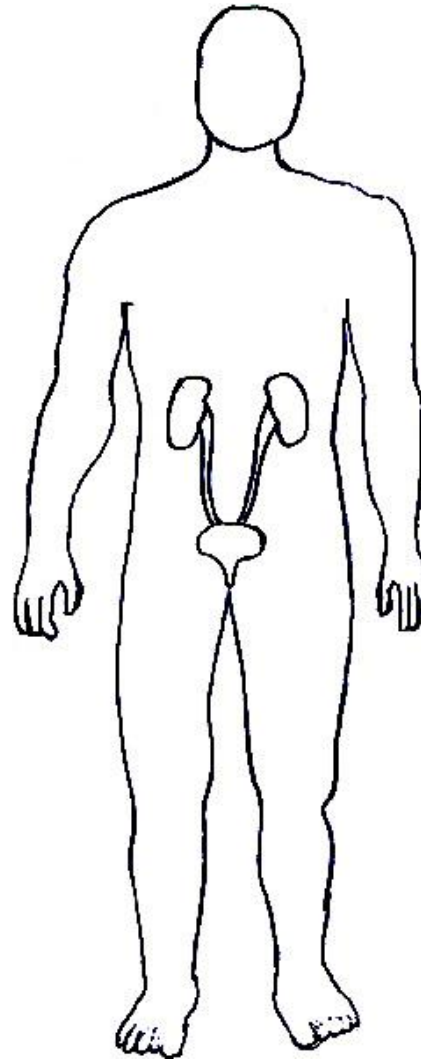
Skeletal / Integumentary System



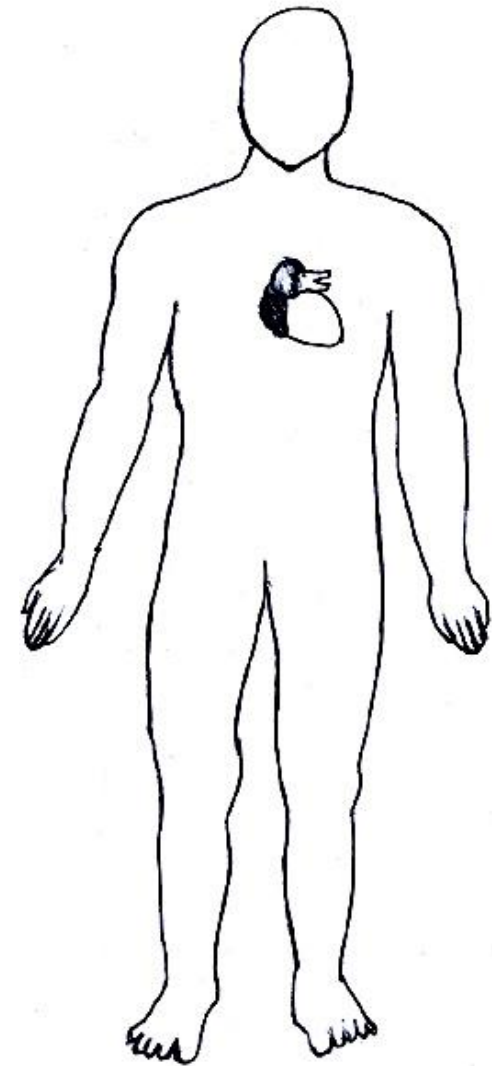
Lymph System



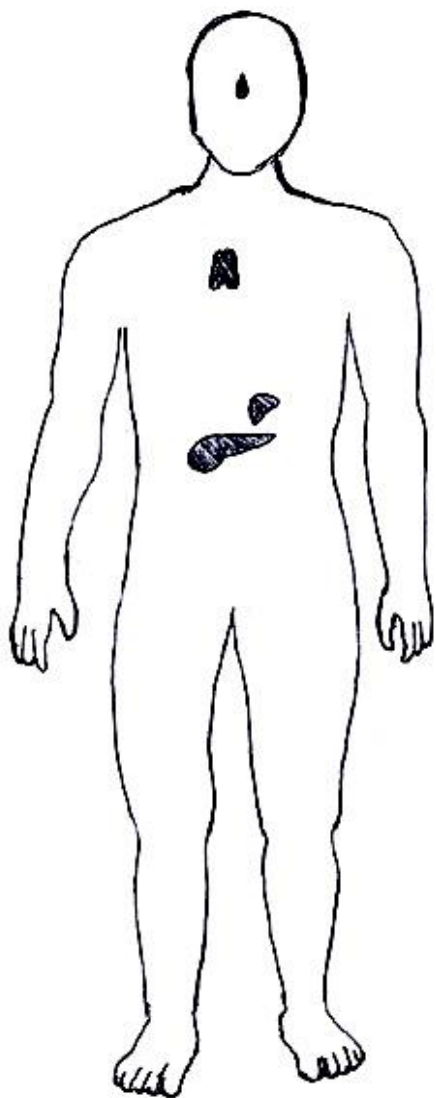
Female Reproductive System



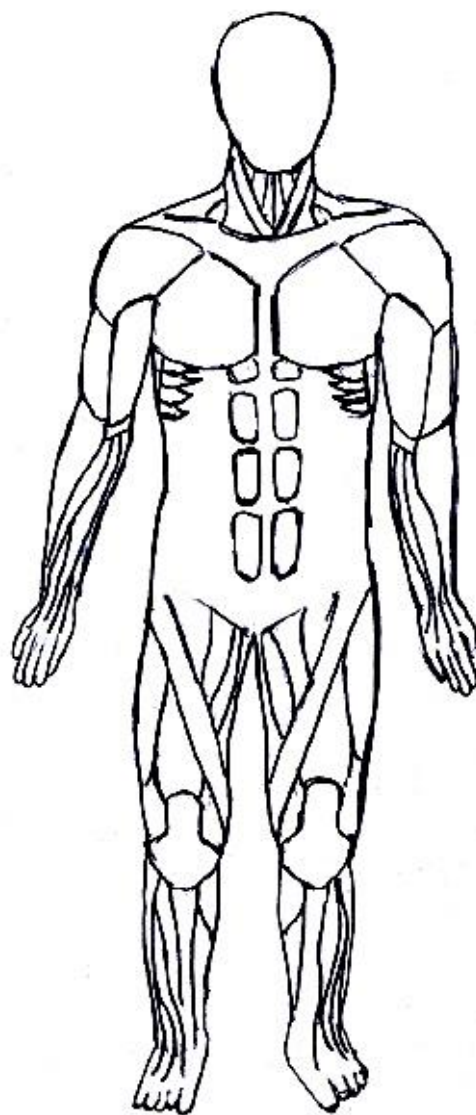
Excretory System



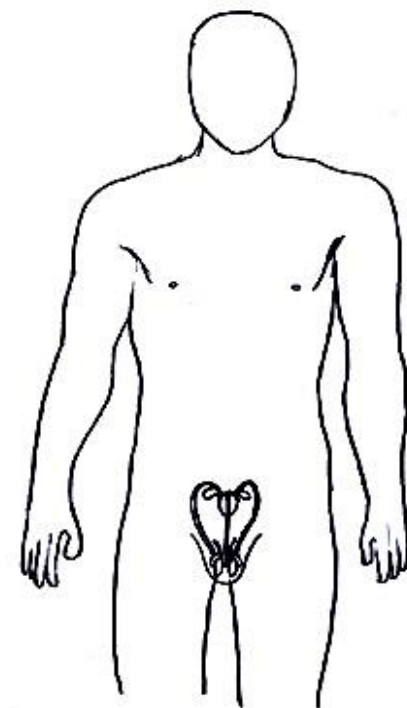
Circulatory System



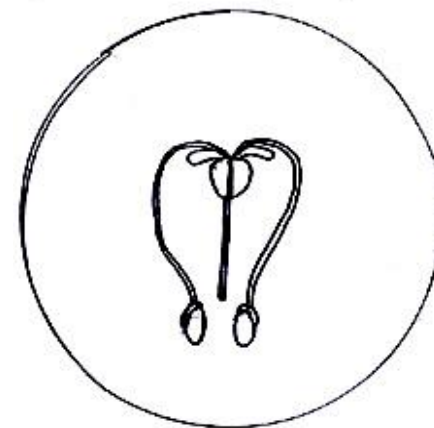
Endocrine System

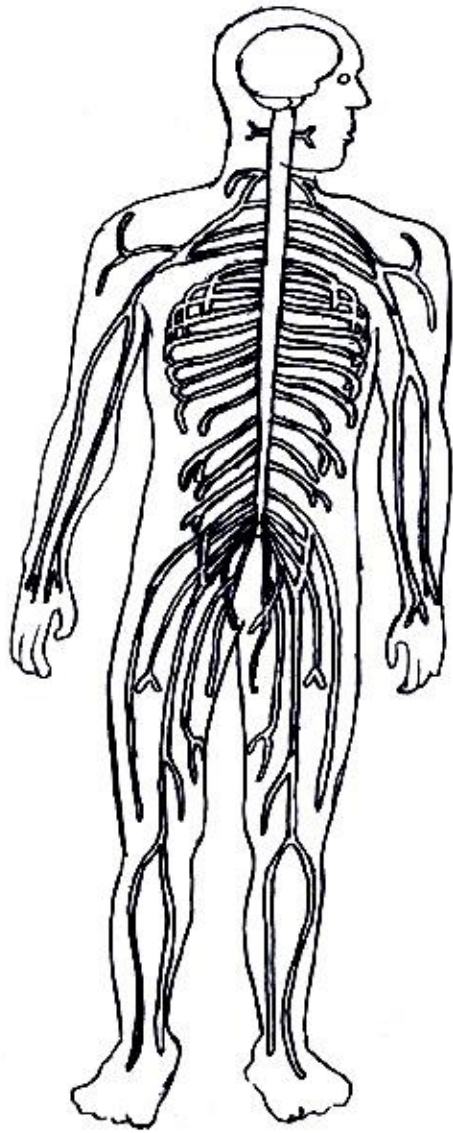


Muscular System

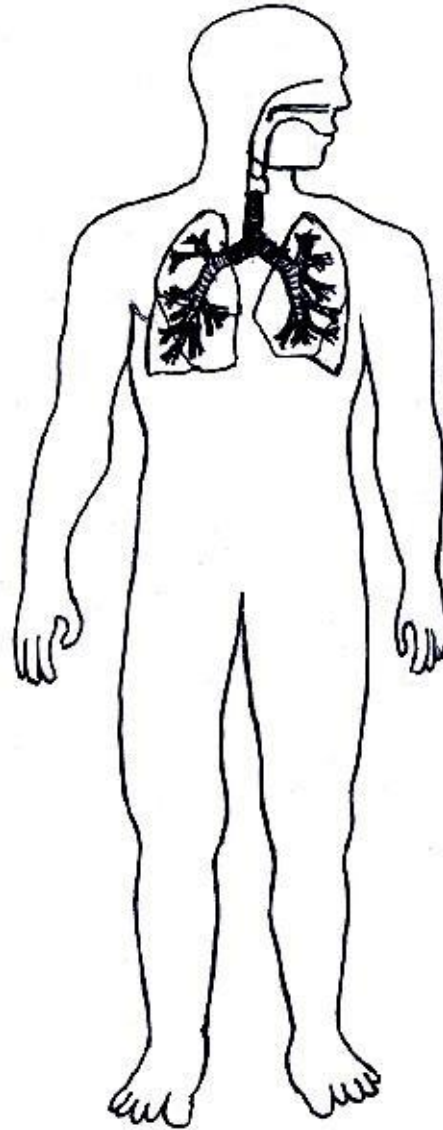


Male Reproductive System





Nervous System



Respiratory System

TEKS 8.6 C

I'm Depending on You

TAKS Objective 2 – The student will demonstrate an understanding of living systems and the environment.

Learned Science Concepts:

- ➔ **Interdependence occurs among living systems.**
 - Traits of species can change through generations.
 - The instructions for traits are contained in the genetic material of the organisms.

TEKS Science Concepts 8.6

The student knows that interdependence occurs among living systems. The student is expected to:

(C) describe interactions within ecosystems.

Overview

In the lesson the student uses plastic soda bottles to build an ecocolumn which will be used to study biotic and abiotic interactions in terrestrial and aquatic systems (e.g., food chains, food webs, competition, chemical and nutrient cycling). The ecocolumn structure will be used to further understandings about how salt, fertilizer, and acid rain upset the balance of ecosystems (TEKS 8.14 C).

Instructional Strategies

Student will work individually or in pairs to construct ecocolumns individually or in pairs. Guided inquiry will be used to deepen student understandings of ecosystems. As students gain an understanding of the control column, they will conduct investigations that explore how salt, fertilizer, and acid rain affect ecosystems.

Lesson Objectives

1. After constructing and observing the balanced ecocolumn, the learner will produce a graph or sketch to accurately describe at least one example of oxygen and carbon dioxide cycling in the ecocolumn.
2. After constructing the terrarium and aquarium for the ecocolumn, the learner will record observations and drawings for each plant and animal in the ecocolumn.
3. Using an ecocolumn, the learner will demonstrate an understanding of food chains by accurately drawing a food chain and a foodweb.
4. Using the data collected from the “Observing the Effects of Pollution on Plant and Animal Life” worksheet, the learner will write at least 50 words in their science journal describing the effects of pollution on terrestrial and aquatic plant life.

For Teacher's Eyes Only

Teacher Background: **The combination of abiotic factors and communities in an environment is called an ecosystem.** Abiotic factors include water, soil, wind, temperature, and light. A community includes the different species which interact in the ecosystem and depend on one another for survival. An ecosystem may be small, such as pond, or large such as a forest. If any part of the ecosystem suddenly changes, serious problems can result affecting the whole ecosystem. TEKS 8.14 examines the impact of natural events and human activity on ecosystems.

In an ecosystem energy flows from the sun to autotrophs and subsequently to heterotrophs as energy is transferred in a food chain. At each level, some of the energy is used by the organism and some of the energy is lost as heat. About 10% of the energy is transferred between trophic levels. Additionally, the number of organisms at a given trophic level depends on the biomass and energy present in the trophic level below it. In general, decreases in the number of organisms accompany increasingly higher trophic levels. Also, heterotrophs, depending on variations in diet, are found at different trophic levels and in different food chains. Finally, pollutants such as DDT increase in concentration as they move up the food chain due to the biological magnification.

Nutrients must be recycled in the ecosystem. The processes of photosynthesis and cellular respiration are used to recycle oxygen and carbon. It is also possible for carbon to be stored in organisms and fossil fuels. Nitrogen is released by decomposers and fixing bacteria utilized by plants provides a source of nitrogen that may be used by other organisms to form proteins and nucleic acids. Nitrogen may be returned to the soil via fertilizer.

Water cycles through living organisms. For example, plants take up water through their roots and water exits plant leaves during transpiration. Similarly, animals take in water when they eat or drink. This water is subsequently returned to the environment via urination, water vapor from respiration, and sweat. The **water cycles in the environment** is powered by the sun, and moves water between the earth's surface and the atmosphere through the processes of precipitation, evaporation, and transpiration.

Misconceptions

Misconception

Plants do not carry on respiratory functions.

Science Concept

Plants require energy for cell functions. Plants use stomata to take in oxygen instead of lungs or gills.

Rebuild Concept

Provide experiences that demonstrate how plants are affected with O_2 levels are low.

Misconception

The majority of O_2 is provided by terrestrial plants.

Science Concept

The majority of O_2 is produced by phytoplankton and algae living in the oceans.

Rebuild Concept

Compare the biomass of phytoplankton, algae, and terrestrial plants. Since the world is about 70% ocean and phytoplankton are distributed throughout the ocean, they provide about 90% of the O_2 some of which stays in the ocean, but most of which escapes as a gas into the atmosphere.

Student Prior Knowledge

The teachers should make sure students are familiar with the components of an ecosystem (TEKS 7.12 A) and the flow of energy in living systems including food chains and food webs (TEKS 6.8 C). The role of ecological succession with regard to environmental change and equilibrium (7.12 D and 7.5 B) as well as the relationship between producers, consumers, and decomposers in an ecosystem should be reviewed. Finally, students should have an understanding about the relationship between organisms and the environment they are found in (7.12 C).

5 E's

ENGAGE

Show pictures of the Exxon Valdez oil spill.

EXPLORE

Create an ecocolumn to help students review prior knowledge about ecosystems. The ecocolumn will be used in tandem with TEKAS 14 C which investigates the effects of pollution on an ecosystem (TEKS 14 C).

Materials:

3 – 2-liter plastic soda bottles (labels removed)

1 – 2-liter plastic soda bottle cap

3 – 10 oz plastic cups

Metric ruler

Plastic spoon

Hand lens

Dip net

Terrarium

- 1 – 8 cm. square of fiberglass screen
- 2 cups soil
- 1 cup water
- 1 cup gravel
- Various seeds (rye, alfalfa, mustard)
- 1 rubber band
- 2 pill bugs
- 2 crickets

Aquarium

- Water conditioner
- 1 cup gravel
- 1 liter prepared water
- 2 sprigs Elodea
- 20 mL algae
- 2 pond snails
- 1 small aquatic frog or two mosquito fish

Procedure to create an ecocolumn:

Bottle #1

1. Create a terrarium by measuring 23 cm. from the top pouring spout of the first 2-liter plastic soda bottle and marking a circle around the circumference of the bottle. Use scissors to cut off the bottom of the bottle. Save the bottom of the bottle.

Bottle #2

2. Create a connector for the terrarium and aquarium by measuring 9 cm from the top pouring spout of the second 2-liter plastic soda bottle and marking a circle around the circumference of the bottle. Measure 23 cm. from the top of the same 2-liter plastic soda bottle and mark a second circle around the circumference of the bottle. Use scissors to cut off the top and the bottom of the bottle. Save the middle of the bottle (connector). Discard the top and bottom of the bottle in a recycling bin.

Bottle #3

3. Create an aquarium by measuring 11 cm. from the top of the third 2-liter plastic soda bottle and marking a circle around the circumference of the bottle. Use scissors to cut off the bottom of the bottle. Discard the bottom of the bottle in a recycling bin.

Terrarium Setup:

1. Wrap the square of fiberglass screen over the pouring spout of the bottle. Use a rubber band to secure the fiberglass screen.
2. Stand the bottle pouring spout down in a plastic cup.
3. Add 1 cup of gravel to the bottle.
4. Add 2 cups of soil on top of the gravel.
5. Add at least 10 seeds to the bottle. If more than one type of seeds is added be sure to use a permanent marker to indicate their location on the outside of the bottle.
6. Add water until the water begins to drip from the fiberglass screen over the pouring spout of the bottle. Replace the bottle cap.
7. After 14 days, add two crickets and two pill bugs. In order to prevent the crickets from jumping out of the terrarium, cover the terrarium with a suitable material (e.g., net) until the ecocolumn is fitted together.

Aquarium setup:

1. Add 1 cup gravel to the bottom of the aquarium
2. Fill the aquarium with conditioned* water. Leave approximately 4 cm of space between the waterline and the top of the aquarium.
3. Add 20 mL of algae and 2 sprigs of Elodea to the aquarium.
4. Use a dip net to transfer an aquatic frog OR mosquito fish to the aquarium.
5. Use a plastic spoon to transfer two pond snails to the aquarium.

Fitting the pieces together:

Use the connector to join the terrarium to the aquarium. The aquarium goes on the bottom of the ecocolumn and the terrarium goes on the top of the ecocolumn.

EXPLAIN

Ask students to explain the relationship between O₂ and CO₂ in the ecocolumn. Students should be able to articulate the role of solar energy, respiration and photosynthesis. The students should understand that the process of photosynthesis combines solar energy, water and carbon dioxide which is used to sustain autotrophic organisms. Simultaneously, the process of respiration is used by organisms which take in oxygen used for energy and expel carbon dioxide as a waste product. Finally, there is a continuous cycling of oxygen and carbon dioxide in our environment. The teacher may want the students to make a diagram of this relationship.

There are also a number of observations students can make about the plants in the aquarium and the terrarium (e.g., shape, size, color, root system, adaptations, and life cycle). Similarly, a number of observations can be made about the animals in the aquarium and terrarium (e.g., locomotion, competition, respiration, feeding, molting). Students should also create food chains and webs based on their observations and answer questions about how the two ecosystems are related.

ELABORATE

Use the ecocolumn design to conduct pollution experiments (TEKS 8.14 C in chapter 5). Work with a partner to determine which type of pollution to investigate (i.e., acid rain, chemical fertilizers, salt). Decide on the concentration of the pollution solution and how often the pollution solution will be administered (e.g., daily and/or weekly).

Pollution Solutions:

1. Normal rain has a pH of 5.6. Acid rain has a pH of less than 5.6. A solution of imitation acid rain can be made by combining 10 mL or more of vinegar with 1 liter of water. Create a solution of acid rain. Record the ratio of vinegar to water in your science journal. Use the handout to record observations about the effect of pollution on plant and animal life.

2. Chemical fertilizers used in agriculture artificially increase available nutrients to organisms. The recommended amount of fertilizer used in agriculture is 1.25 mL per liter of water. However, agricultural runoff can add 10 times the recommended amount of fertilizer to our water. Create a solution of fertilizer. Record the ration of fertilizer to water in your science journal. Use the handout to record observations about the effect of pollution on plant and animal life.
3. Every year, the highway department spread a mixture of salt and sand to help melt ice on roads. The edge of the road is polluted with approximately 6 ml per liter of water. Eventually, salt filters through the soil and contaminates water systems. Create a solution of salt water. Record the ratio of salt to water in your science journal. Use the handout to record observations about the effect of pollution on plant and animal life.

EVALUATE

5. After constructing and observing the balanced ecocolumn, the learner will produce a graph or sketch to accurately describe at least one example of oxygen and carbon dioxide cycling in the ecocolumn.
6. After constructing the terrarium and aquarium for the ecocolumn, the learner will record observations and drawings for each plant and animal in the ecocolumn.
7. Using an ecocolumn, the learner will demonstrate an understanding of food chains by accurately drawing a food chain and a foodweb.
8. Using the data collected from the “Observing the Effects of Pollution on Plant and Animal Life” worksheet, the learner will write at least 50 words in their science journal describing the effects of pollution on terrestrial and aquatic plant life.

Observing the Effects of Pollution on Plant and Animal Life

Observing the Effects of Pollution on Plant and Animal Life								
	Experimental Ecocolumn				Control Ecocolumn			
Date	Terrarium pH	Aquarium pH	Plant Observations	Animal Observations	Terrarium pH	Aquarium pH	Plant Observations	Animal Observations

TEKS 8.11 A AND B

To Be or Not to Be...

TAKS Objective 2 – The student will demonstrate an understanding of living systems and the environment.

Learned Science Concepts:

- Interdependence occurs among living systems.
- ➔ **Traits of species can change through generations.**
- The instructions for traits are contained in the genetic material of the organisms.

TEKS Science Concepts 8.11

The student knows that traits of species can change through generations and that the instructions for traits are contained in the genetic material of the organisms. The student is expected to:

- (A) identify that change in environmental conditions can affect the survival of individuals and of species; and
- (B) distinguish between inherited traits and other characteristics that result from interactions with the environment.

Overview

Developing a sustainable planet will involve both awareness and action on the part of our students as future citizens. There are a number of resources that everyone shares on this planet (e.g., oceans and air). Furthermore, economically we are moving quickly toward a global economy in which the viability of one country will significantly impact that of another

country. If a country relies on ocean fishing for economic prosperity, then clean water will be essential to the people of that country.

Habitat destruction occurring worldwide will result in the loss of potential plants for food and medicinal purposes as well as disrupt delicate ecosystems. Effective management of these resources before they disappear is important to us all. And, developing a sustainable planet should not only be a national concern, it should be a local concern. Everyone needs must be accountable for guarding renewable, nonrenewable, and inexhaustible resources or we are only left with a “hope” that technology will developed to bail us out and save us from an unsustainable global environment.

Finally, interactions with a polluted environment can have detrimental effects on the health of organisms that live there. Fish and oysters can become so polluted with contaminates, such as mercury, that they are inedible. Some pollutants even cause genetic change to organisms (e.g., lung cancer). Illegal drug use and biological/chemical agents can also have damaging and/or lethal effects on living things, and mutations resulting from these effects can be passed to future generations and potentially increase susceptibility to parasites, bacteria, and viruses.

Instructional Strategies

Students will work in groups to examine the nature of science inquiry as students investigate possible causes of malformed frogs. Students will conduct and inquiry investigation to examine the effect of sunscreen and sunglasses on UV-B radiation. “Project Safety materials use a direct instruction to increase student understandings about the effects of radiation on humans.

The Gold Coqui Extinction Dice Game using a gaming simulation to help students learn about environmental pressures that can lead to extinction. Students investigate habitat destruction, predation, lack of resources, and poaching as they interact with one another during the game.

The Internet and digital camera is used to locate images of environmental traits and dominant or recessive traits to create a picture portfolio.

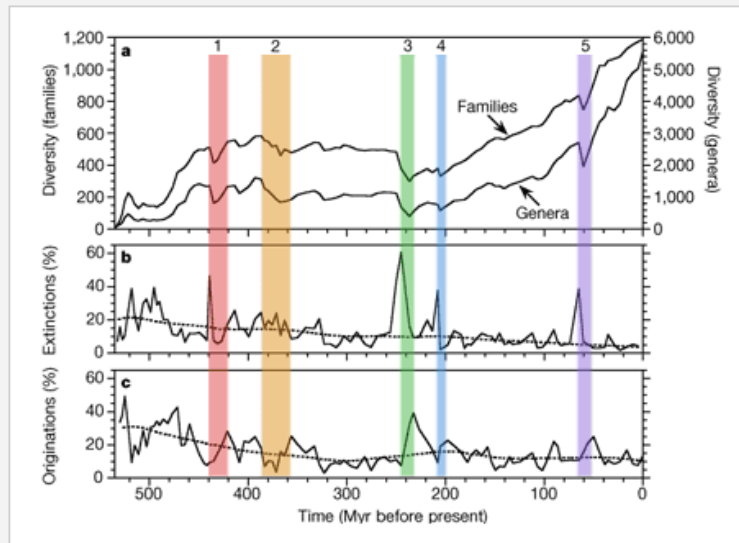
Lesson Objectives

1. The student will be able to describe environmental conditions that can have significant impact on the survival of individuals and species.
2. The student will conduct web research to determine the cause of extinction for at least three animals
3. Using a digital camera, the Internet, or other resource, the student will create a picture portfolio that demonstrates understanding of the differences between genetic and environment traits
4. The student will write a research paper about a birth defect of their choice.
5. The student will communicate scientific experimentation by recording hypotheses, illustrations of the experimental setup, data collection instruments and conclusions for an experiment

For Teacher's Eyes Only

Extinction is not a new phenomenon, but rather has been going on for millions of years and was due to natural causes such as volcanoes, climatic changes, and extraterrestrial impact. In fact, **scientists believe extinction is one of the avenues, which allows evolution to occur.** For example, after the extinction of dinosaurs, there was an increase in the number of mammals (adaptive radiation). This expansion was in response to the presence of vacant living space, which was previously occupied by the dinosaurs.

Research shows that following a mass extinction, biodiversity is decreased during a survival interval. Some new species form through adaptive radiation and pre-existing species struggle to survive. Niches undergo change as well. Since former habitats are destroyed, they must be replaced with new niches as new species and new relationships develop. This recovery takes a very long time, at least 10 million years. **While extinction is not a new phenomenon, the rate at which extinction is occurring today is.** The following graph shows the relationship among extinction, biodiversity, and origination of species.



The fossil record of marine animal biodiversity. Standing diversity of genera and families through the Phanerozoic (a), and corresponding percentages of extinction (b) and origination (c) of genera in each stratigraphic interval. Shaded bands highlight recovery intervals (between extinction rate peaks and subsequent origination rate peaks) for the 'Big Five' mass extinctions: end-Ordovician (1), late Devonian (2), end-Permian (3), end-Triassic (4) and Cretaceous-Tertiary (5). Dotted lines in b and c show the long-term trends (estimated using LOWESS, a robust curve-fitting technique¹⁹) that are subtracted from extinction and origination time series before calculating cross-correlations.

http://www.pbs.org/wgbh/evolution/library/03/2/image_pop/l_032_03.html

Changes in the environment can have significant impact on the survival of individuals and species. For example, a loss of genetic diversity is a worldwide problem. Presently, there are almost 500 populations of trees that are endangered. This loss is of particular concern to agriculturists in that sense that many countries use the same genetic strains of corn, wheat, and rice and the native species that provide other sources for diversity are rapidly disappearing. The impact of little diversity is readily seen when a virus outbreak threatened the variety of corn we used in 1970s. In 1984 the Florida citrus canker outbreak also resulted from losses in genetic diversity. Given the low diversity of corn, wheat, and rice around the world since the Green Revolution, outbreaks could occur at any time creating a disaster threatening food supplies worldwide. This loss of heterozygosity is a dangerous trend that leads to increased susceptibility of species with regard to viruses and parasites.

Also gene banks have been used to slow the loss of genetic diversity, the cost is high and there are risks of mechanical failure at the seed banks. There are also reports that seeds collected have already been lost or are no longer viable.

Other changes in the environment that can have significant impact on the survival of individuals and species include:

- mutagenic effects of UV light
- exposure to other forms of radiation such as uranium miners, atomic bomb survivors, and medical workers in radiology.
- Human activity involving chemicals released into soil, air, and water pollution.
- Legal and illegal drugs
- Availability of resources such as food, clean water, space, and shelter.
- Climatic changes
- Human activity (e.g., habitat destruction and pollution)
- Natural disasters (e.g., flooding and volcanic activity)
- Parasites bacteria, and viruses

It is important for students to be able to distinguish between characteristics that result from interactions with the environment and inherited traits. For example, Down’s syndrome, Turner’s syndrome, height, skin coloration, eye color, blood pressure, and heart rate are examples of genetic traits.

In some cases, the environment can interact with genetics enhancing the chances that an individual will develop a certain type of trait or disorder. For example, good nutrition maximizes growth, a healthy diet will ward off Type II diabetes, and practicing sun safety will decrease a

fair skin individual's chance of skin cancer. On the other hand, individual who frequent tanning salons, and fail to practice sun safety increase their risk of developing skin cancer and a diet with too much processed sugar contributes to development of Type II diabetes. Americans represent most of the population where Type II diabetes is present.

In the case of legal and illegal drugs, permanent changes may occur to the individual depending on the drug used. The drug ecstasy damages brain cells that release the chemical serotonin. In brain tissue sample taken from monkeys, scientists found damage to brain cells from ecstasy use to be severe even seven years after exposure to the drug. **Students should understand the short and long term effects of legal and illegal drug use.** Recently, there is a growing population of smokers in spite of research that showing the link to cancer. The effects of tobacco and alcohol are cumulative and frequent use can lead to a variety of health problems.

Finally, viruses, such as HIV can be acquired through contact with HIV contaminated body fluids such as blood and semen and it is possible for an HIV infected mother to pass the HIV virus to her unborn child during pregnancy. Biological agents such as anthrax and smallpox as well as chemical agents dispersed as liquids, vapors, gases and aerosols that attack your body's nerves, blood, skin or lungs can have damaging or lethal effect on humans, animals, or plants.

Student Misconceptions

Misconception

Biodiversity is unrelated to survival.

Science Concept

Students may not realize the importance of biodiversity and the problems associated with homozygosity such as inbreeding depression, susceptibility to disease, and threatened/endangered status and extinction.

Rebuild Concept

Introduce concepts of inbreeding depression and homozygosity as they relate to biodiversity. For example, the cheetah is an extraordinarily homozygous species and a patch of skin from one cheetah can be grafted onto another without rejection.

Misconception

With intervention any species can be saved from extinction.

Science Concept

Once a species is threatened or endangered it is not always possible to remove the threat or endangerment. Once a species drops past a critical number of individuals, the species will most likely go extinct regardless of what we do to intervene.

Rebuild Concept

Provide student with examples of species that no longer exist in Texas such as the jaguar, red wolf, and grizzly bear.

✘ Misconception

Environmental dangers are usually visible.

☑ Science Concept

There are many environmental problems that are not always obvious. For example, UV radiation, CFCs, microscopic organisms/viruses, and many forms of pollution cannot be seen or detected without special equipment. For this reason, the dangerous nature of the problems is not readily internalized by the student without significant learning experiences.

✂ Rebuild Concept

Provide students learning experiences such as the activity with UV beads that demonstrate hidden environmental dangers.

Student Prior Knowledge

The student should already understand and identify what biodiversity is from studying TEKS 7.10 (A) the role of sexual reproduction producing more diverse offspring and asexual reproduction results in more uniform offspring. They should also know that some traits enhance survival of an organism; the concept of simple dominance [TEKS 7.10 (B)]; and that inherited traits are contained in DNA of cells and are expressed by genes [TEKS 6.11 (C) (B) (C)]. Changes in DNA at the phenotypic level can occur through mutation and selective breeding [TEKS 6.11 (A)].

5 E's

Don't leap to conclusions: The case of the malformed frogs

Engage

Initiate a discussion about what might cause this problem in frogs.

Special thanks to Dr. Stanley K. Sessions for permission to include this activity about his research on malformed frogs. Dr. Sessions may be contacted at the Department of Biology - Hartwick College in Oneonta, NY 13820.

Explore

Select students read aloud the introduction to “Don’t Leap to Conclusions: Deformed Frogs in Minnesota.”

In 1995, students were taking a field trip to a wetland near Henderson, Minnesota. To their surprise, they found many malformed frogs. Some frogs had missing or extra legs. Others had malformed eyes as well as other malformed body parts. This information was reported and not long after this discovery near Henderson, malformed frogs were turning up in other places in the Minnesota River Valley and in less than a year, there were reports about this phenomenon all over the state and even in other states.

Scientists were very alarmed by this problem since frogs are highly sensitive to pollutants in the environment because frogs breathe through

their skin and inhabit both the land and water. Scientists studied a number of possible causes they hypothesized might be related to this problem. Some scientists wondered if increased UV radiation from the sun due to CFCs and thinning ozone could be responsible for this problem. Other scientists thought pesticides might the problem. Methoprene, a chemical that is used to control insects, was dissolved in water and resulted in malformed frogs compared to a control group. Still others thought it could be caused by predation or some kind of a parasite such as a trematode or a virus.

Explain

Use the following questions to explore the role of environmental conditions with regard to survival of individuals and species.

Teacher Question: Think about at least one more hypotheses about why these frogs were malformed? Write an If...then hypothesis statement for each possible cause of malformation.

Answers will vary, but should be similar to the following examples.

If frogs are exposed to a constant level of UV radiation, then a significantly higher number of malformations will be observed compared to a control group.

If frogs are exposed to water contaminated with methoprene, then a significantly higher number of malformations will be observed compared to a control group.

If frogs are exposed to a trematode parasite, then a significantly higher number of malformations will be observed compared to a control group.

If frogs with no malformations are exposed to predation, then a significantly higher number of malformations will be observed compared to a control group.

Teacher Question: Now let's test each of the hypothesis statements you have written. How would you go about setting up an experimental design for each of these hypotheses?

Answers will vary but responses should include a control group, testing of a single variable, and documentation/collection of quantifiable information.

Teacher Direction: Let's see what a group of researchers found out.

The teacher will distribute one of the information pages from the following websites to each group of students. Students will work in groups of 3-4 and complete the activity sheet, "Leaping to Conclusions: The Case of the Malformed Frogs."

Teacher Question: Which of the hypothesis does the research support?
Parasites and predation.

The students should understand that research involves the testing of multiple hypotheses. Often, this process allows us to narrow the research focus by rejecting some of the hypotheses.

Elaborate

Students may learn more information about the possible causes of malformed frogs from the following websites:

<http://www.pca.state.mn.us/hot/frog-bg.html>

<http://cgee.hamline.edu/frogs/science/malform.html>

Evaluate

After completing the learning experience, "Don't Leap to Conclusions: The Case of the Malformed Frogs," the student will be able to describe in their journal at least seven environmental conditions that can have significant impact on the survival of individuals and species.

Teacher will monitor student progress during the activity and provide assistance as needed. Peer tutoring arrangements are used for ESL students.

Killer Rays

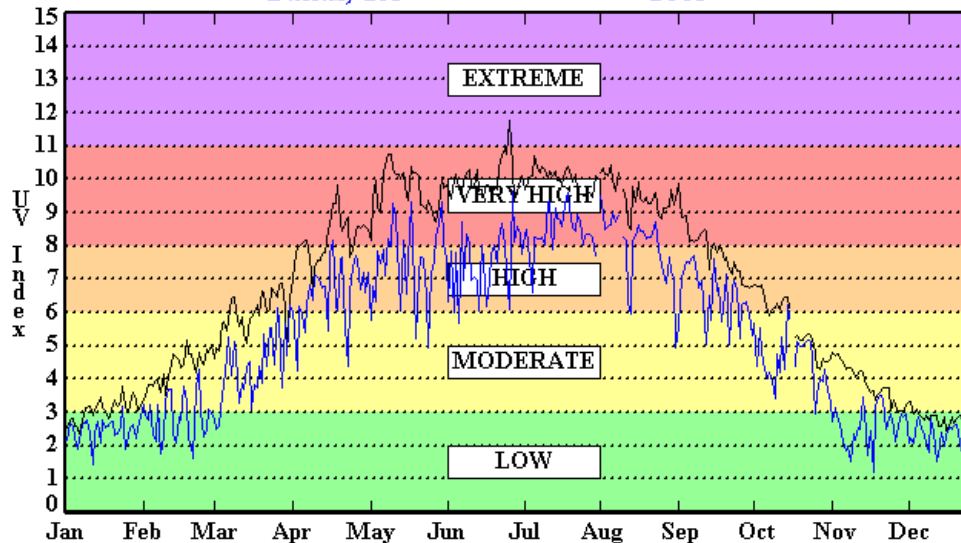
Engage

The UV Index is a daily prediction of ultraviolet exposure and is determined at noon. This information is important to know because the effects of UV exposure range from aging and wrinkling of the skin to sunburn to skin cancer. Exposure to UV rays can also cause damage to your eyes and suppress the immune system. Refer to the table below to interpret the Index Value for UV exposure. This information can be found in a newspaper, heard on the radio or television, and found on the Internet at the following website <http://www.epa.gov/sunwise/uvindex.html> The Daily UV Index for Dallas, Texas during 2003 is shown in the graph below. Analyze the graph using the UV Index from the UV Index Table. What conclusions can you make about the relationship between the UV index and season?

UV Index	
Index Value	Exposure Level
0-2	Minimal
3-4	Low
5-6	Moderate
7-9	High
10+	Very High

http://www.cpc.ncep.noaa.gov/products/stratosphere/uv_index/gif_files/dfw_03.png

Daily UV Index Dallas, TX 2003



Number of Days in Each Exposure Category

Clear Sky UV Index	UV Index Forecast
Extreme = 1	Extreme = 0
Very High = 151	Very High = 68
High = 58	High = 25
Moderate = 116	Moderate = 48
Low = 36	Low = 104

Explore

Ask students to bring in sunglasses to evaluate how well they block out harmful ultraviolet rays. Place UV beads in a plastic Ziploc® bag. Rub one side of the baggie with a very thin layer of sunscreen and let dry. Expose to direct sunlight and see if the beads turn colors. Try different types of sunscreen.

Place some beads under a sunglass lens in an area that is exposed to direct sunlight. If the beads remain white, then your sunglasses are blocking harmful ultraviolet rays. Test different pairs of sunglasses.

Explain

The UV beads contain a pigment that changes color in the presence of ultraviolet radiation from the sun. The UV beads are not affected by light bulbs that do not emit ultraviolet light. The UV beads remain white indoors when they are shielded from the sun. Students should understand that UV light is invisible and can cause sunburn or injury to unprotected eyes (e.g., glaucoma). Sunscreen and sunglasses can be used to absorb UV photon to prevent injury to the skin and eyes.

The ozone layer reflects or absorbs 99% of damaging UV rays from the sun, preventing them from reaching the earth's surface. However, pollution is compromising the ozone layer allowing more and more of the UV rays to reach the earth's surface.

Remember: the ozone layer is a protective covering that surrounds most of the earth and protects us from harmful UV rays. It has three oxygen atoms, rather than two oxygen atoms like the form of oxygen we breathe during respiration. There are a number of activities and events that cause ozone destruction.

- Hydrogen bomb testing
- CFCs (chlorofluorocarbons) in aerosols and refrigerants
- Exhaust gases from supersonic aircraft
- Fertilizers and
- Volcanic eruptions.

When CFCs are broken up by UV radiation, a chlorine atom is released. The chlorine atom collides with an ozone molecule and steals one of the oxygen atoms forming a molecule of chlorine monoxide. When this happens, the ozone molecule is destroyed.

Elaborate

Elaboration 1

Place some beads under the different colors and types of fabric in an area that is exposed to direct sunlight. Which colors and types of fabrics best protect the beads from the UV rays.

Elaboration 2

MD Anderson Hospital’s “Sun Awareness For Educating today’s Youth” (Project Safety) provides excellent materials related to learning about skin cancer. These materials are free to Texas teachers. Three-lesson CD-ROM with an accompanying 80-page Teacher's Guide, targeting students in grades 4-9. Information about ordering these materials can be found at the following website:

<http://www.mdanderson.org/departments/projectsafety/dIndex.cfm?pn=D444418B-1C91-11D5-811000508B603A14>

Evaluate

During the learning activity, “Exploring the Effect of UV Radiation, the student will record hypotheses, illustrations of the experimental setup, data collection instruments and conclusions for each experiment in the science journal. A completion grade will be given.

Did it come from the water or the genes?

Which traits are inherited and which traits are environmental?

Engage

Show students pictures of dominant and recessive traits. Such images are easily obtained from <http://www.google.com/> by conducting a search for images. Common dominant traits include presence of hitchhiker thumb, Darwin's ear bump, tongue rolling, and hanging earlobes. Common recessive traits include five fingers, cleft chin, no ability to roll the tongue, and attached earlobes.

Explore

Make cards with pictures of these traits and have students work with a partner to sort them according to whether they are environmental traits or genetics traits and why. Images may be obtained from http://www.google.com by conducting a search for images.

Environmental traits	Genetic traits
skin cancer	Downs syndrome
Kaposi sarcoma	Widow's peak
Bomb victim	Polydactyl
Thalidomide baby	Webbed fingers
Lung cancer	Eye color

Explain

Teacher Questions:

Which of the traits are genetic? Why do you think this is a genetic trait. Take a poll. How many students agree this is a genetic trait? If not, why not?

Which of the traits does the environment cause? Why do you think interacting with the environment causes this trait? Take a poll. How many students agree interacting with the environment causes this trait? If not, why not?

NOTE: The teacher should continue scaffolding the discussion to help students understand why a trait is genetic. The discussion should not isolate all of the genetic or environmental traits first, but rather should provide a mixing of traits as the discussion continues.

Instructions to the class: Use a digital camera, the Internet, or other resource to create a picture portfolio that demonstrates understanding of the differences between genetic and environment traits. The portfolio should include a total of at least ten (10) different pictures with ten (10) different captions. After instruction, provide each student with a copy of the assessment rubric BEFORE they begin the project. Discuss the following elements of the rubric.

Pictures

At least five genetic and five environment traits should be included in the picture portfolio.

The pictures can be from magazines, newspapers, images on the Internet, personal photos, etc. Student should not take pictures of people without their permission. Please do not take pictures at shopping malls and similar places that do not allow photos to be taken.

Caption:

There should be a different caption for each picture classifying the trait as genetic or environmental and describing the cause. The length of each caption should be between 25-50 words.

Portfolio:

The following pages are contained a folder or binder:

Title page (name, date, and title of assignment)

One picture and caption per page (total of 10 pictures with captions)

50-100 word typed description that includes a discussion about the differences between genetic and environmental traits.

Elaborate

Student may conduct independent research about birth defects by providing research information to the student or by using the March of Dimes website:

<http://www.modimes.org/pnhec/4439.asc>

The research paper should include information about the following:

1. What is the disease?
2. What does it look like?
3. What causes it?
4. Can it be treated?
5. Can it be prevented?

Assessment:

Using a digital camera, the Internet, or other resource, the student will create a picture portfolio that demonstrates understanding of the differences between genetic and environment traits. A score of at least 70% on the rubric is required.

Using research materials provided by the teacher or using the March of Dimes website, the student will write a research paper about a birth defect of their choice. A score of 70% on the rubric is required.

Birth Defects Rubric			
Revise and Resubmit	70	80	100
Less than 3 questions are correctly answered and include at least 2 sentences to answer each question.	At least 3 questions are correctly answered and include at least 2 sentences to answer each question.	At least 4 questions are correctly answered and include at least 2 sentences to answer each question.	All questions are correctly answered and includes with at least 2 sentences to answer each question.
Grade:			

Black History Months

DON'T LEAP TO CONCLUSIONS

THE CASE OF THE MALFORMED FROGS

Group Member Names _____

In 1995, students were taking a field trip to a wetland near Henderson, Minnesota. To their surprise, they found many malformed frogs. Some frogs had missing or extra legs. Others had malformed eyes as well as other malformed body parts. This information was reported and not long after this discovery near Henderson, malformed frogs were turning up in other places in the Minnesota River Valley and in less than a year, there were reports about this phenomena all over the state and even in other states.

Scientists were very alarmed by this problem since frogs are highly sensitive to pollutants in the environment because frogs breathe through their skin and inhabit both the land and water. Scientists studied a number of possible causes they hypothesized might be related to this problem. Some scientists wondered if increased UV radiation from the sun due to CFCs and a thinning ozone could be responsible for this problem. Other scientists thought pesticides might the problem. Methoprene, a chemical that is used to control insects, was dissolved in water and resulted in malformed frogs compared to a control group. Still others thought it could be caused by predation or some kind of a parasite or virus. Use the research on frog malformation and write answers to the following questions.

1. Write an If...then hypothesis statement for this experiment.

2. In 100-150 words, describe the experiment(s) conducted?

INTRODUCTION

The widespread occurrence of "deformities" (or "malformations") in natural populations of amphibians, especially anurans, has recently been perceived as a major environmental issue (Tietge et al., 1996; also see Links to other web pages). The majority of observed abnormalities are frogs with missing limbs or parts of limbs, or with one to several partial or complete extra limbs. Similar kinds of deformities have been found in the past (past research), but renewed attention has been focused on them since 1996 when a group of school kids found some deformed frogs in Minnesota and broadcast their findings on the World Wide Web with the help of the Minnesota Pollution Control Agency (Helgen et al., 1998). Reports of these deformities are geographically widespread across the United States and Canada (Narcam), and are thought to be linked with the general problem of amphibian decline. There is current concern that recent reports reflect a sudden increase in the incidence of deformities in natural populations of amphibians, possibly indicating an environmental problem of possible risk to other organisms, including humans (Ouellet et al., 1997; Gardiner and Hoppe, 1999). Leading hypotheses to explain these deformities are predation, parasitism, UV-B radiation, and chemical pollution.

Predation

One possible hypothesis to explain frog deformities is that the deformities are caused by predators or by cannibalistic acts of the tadpoles themselves. If this happens during the early stages of tadpole development, then it is likely that the missing limb will regenerate and one would never know that it was missing at all. On the other hand, when a tadpole begins morphing into a frog, there is a decline in their ability to regenerate a limb and if a predator successfully bites off a limb after or during this decline, then the limb may not regenerate at all and all that will remain of the missing limb after metamorphosis is a little growth, a spike of cartilage.

Scientists have observed captive tadpoles in a fish tank with stickleback fish. They observed the stickleback fish nipping at developing tadpoles limbs. According to the scientist's observations, the stickleback fish do indeed bite off the limbs of toad tadpoles and also of Woodfrog larvae.

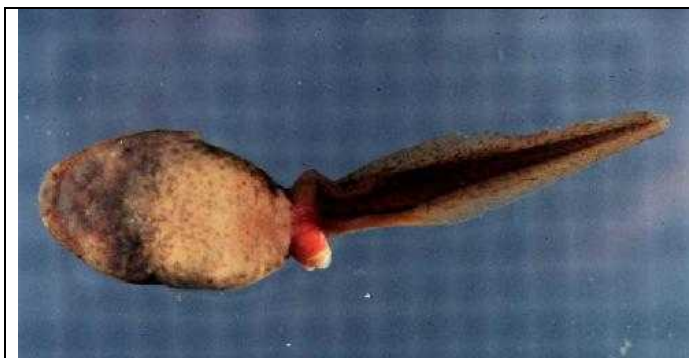
In order to test the predation hypothesis, Dr. Sessions and his team of science researchers set up an experiment. First they collected tadpoles from places where frogs with missing limbs were found. They predicted that if predation were the cause of the missing limbs, then they would find tadpoles in different stages of development with evidence that their limbs had been attacked.



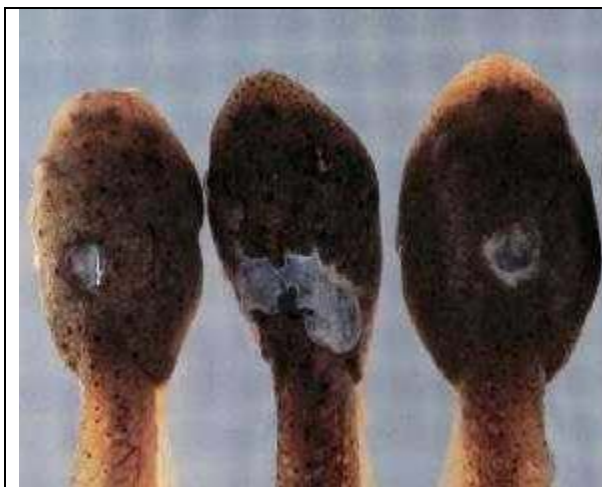
A left hind limb showing a cartilaginous spike. The presence of the spike indicates that the limb was lost *after* it had developed.



A deformed bullfrog caught at a confirmed location where deformed frogs were found.



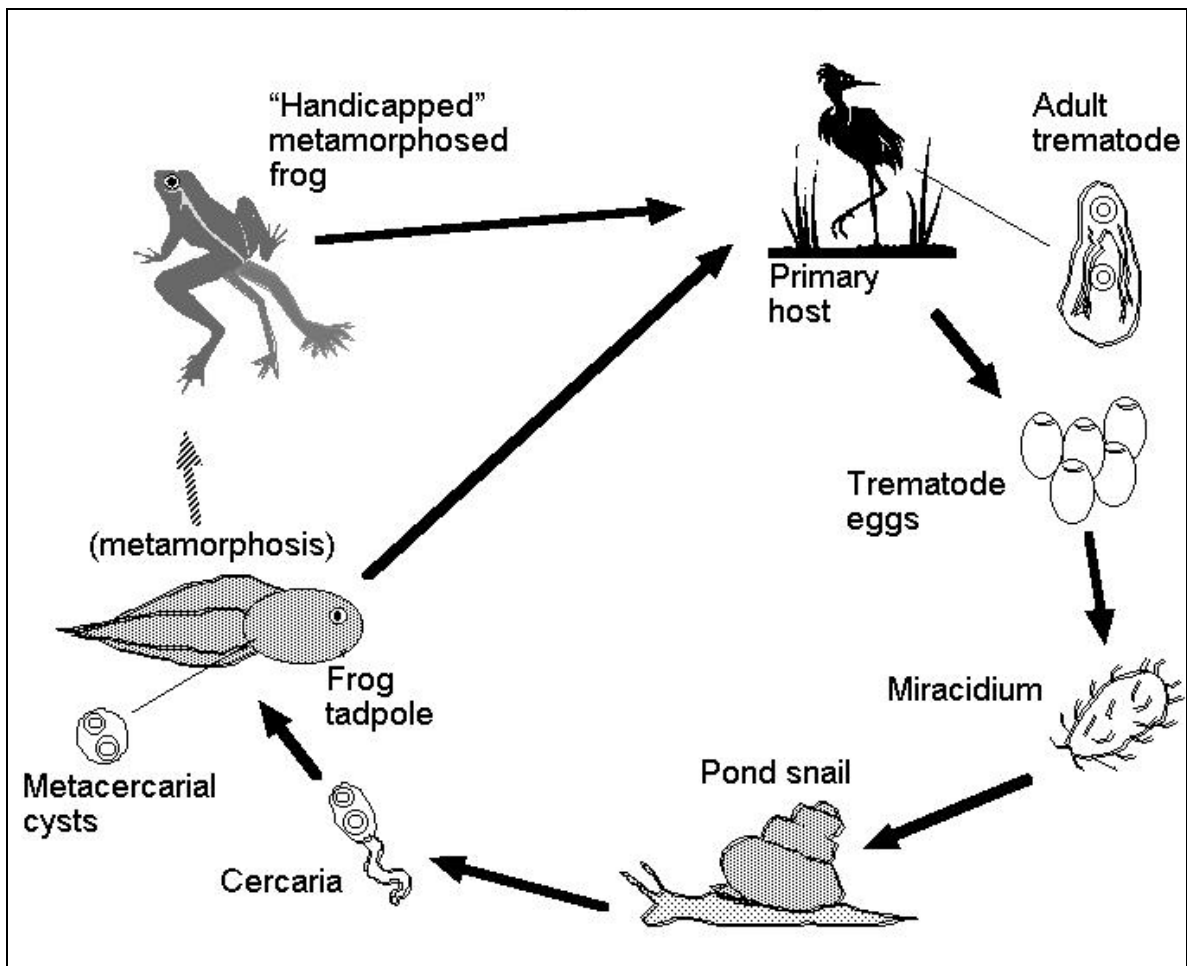
A tadpole missing both hindlimbs.



A series of Bullfrog tadpoles that were raised in the lab, showing the kind of damage that they can do to each other. These tadpoles have sharp mouth parts that they can use to inflict damage on each other.

Parasites

Other researchers hypothesized that frog deformities are caused by parasites. For example, trematodes are small flat worms which parasitize aquatic birds. They have a very complex life cycle that is shown below.



As shown in the life cycle diagram above, aquatic birds acquire the trematodes by eating infected tadpoles. Adult trematodes use the bird to lay their eggs and then the eggs of the trematode are passed from the bird and grow into an organism called a miracidium. The miracidium infects snail as that is the organism it uses in order to develop and grow into the next stage which is called cercaria. Eventually, the cercaria exit the snail and the next host in their life cycle is the tadpole where the cercaria form metacercarial cysts.

In order to test the parasite hypothesis, Dr. Johnson and his research team designed lab experiments in which tadpoles were exposed to a level of trematode infestation similar to what was found in areas where deformed frogs were found. They discovered that the cercaria targeted the hind limbs of the tadpoles and the more cercaria they added to the experimental habitat, the more severe the deformities were that appeared in the frogs.

The following figures show the types of deformities that were observed in the frog limbs.

		<p>Note how the single frog limb has two sets of digits and attached bones. In this diagram and photo, the duplication runs from digit 5 to 1 and then continues from 1 to 5. This is called a posterior double mirror image duplication</p>
		<p>The photo to the left shows a different orientation for a single frog limb. In this diagram and photo, the duplication runs from digit 1 to 5 and then continues from 5 to 1. This is called double anterior mirror image duplication.</p>
		<p>In some frog limbs, a mirror image triplication has been observed.</p>

Parasite induced deformities are characterized by large numbers of metamorphosing or newly metamorphosed froglets which show a wide range of effects, including skin fusions, extra legs and toes, and missing limbs that are all found associated with these parasites. Dr. Sessions and Ruth found large cohorts of young frogs, where 40- 70% were infected and deformed. This is very different from fully metamorphosed frogs that simply have missing limbs which are usually found individually, not in large groups, and show no evidence of trematode/cyst involvement.

UVB Radiation

It is well known that there is a problem with ozone depletion leading to increased levels of harmful ultraviolet irradiation on different parts of the globe. Some scientists feel that this irradiation may be sufficient to cause major developmental changes in amphibians (who have weak defenses against this type of attack), leading to some of the deformities seen in the wild. While scientists who support this hypothesis feel that UV-B is not responsible for the multi-legged amphibians found, they do believe that UV can be a cause for many of the other deformities that are being found, especially limbless frogs. It has been known for many years that UV irradiation (at high levels) can prevent limb development and regeneration in amphibians.

It has been shown that UV-irradiation in the lab can cause limb deformities such as missing limbs and limb parts. Field experiments show that UV can cause abnormal development and death in early embryos, but the effects of ambient UV-B on limb development in older larvae in the field have not been shown to cause the kinds of deformities that are being reported in natural populations of amphibians. Furthermore, the effects of UV exposure on developing limbs are predicted to affect both sides of the body equally, but this is not what is seen in field-caught deformed frogs.

Frogs with missing limbs have been the most difficult deformity to explain so far, partly because examination of adult specimens has revealed few clues. For example, most of the limbless frogs that we have examined do NOT show a close relationship between deformities and trematode cysts. Nevertheless, there is one important piece of evidence in adult deformed limbless frogs that all but eliminates UV (or chemical pollution) as a cause for cartilaginous spikes.

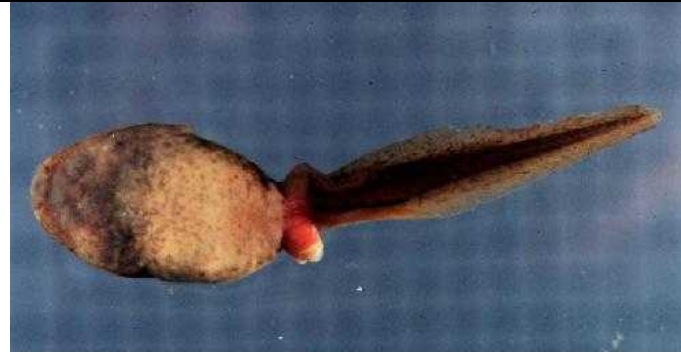


Notice a cartilaginous (regenerative) spike on the left hind limb. The presence of the spike indicates that the limb was lost *after* it had developed, and is a normal regenerative response for a frog. Note that this was an otherwise very healthy looking frog, and that the right hind limb is normal in every respect.

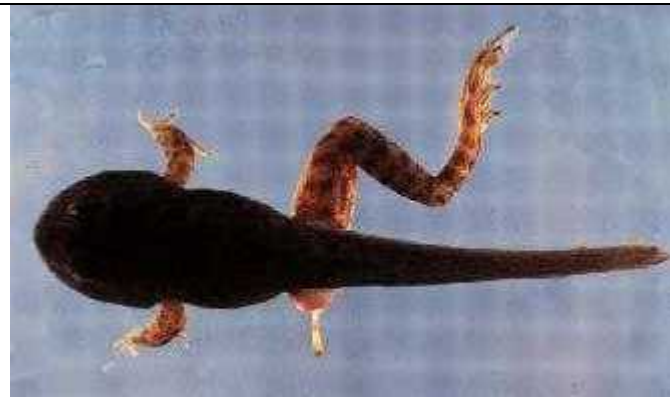
Cartilaginous spikes as shown in the picture above are a normal regenerative response of limb amputation in an older tadpole or frog with a diminished ability to regenerate limbs. Such spikes are inhibited by both UV and retinoids which are important to embryonic development. Excess retinoids have been shown to cause birth defects in humans. Thus, if an adult limbless frog exhibits a spike, it tells us at least two important things:

1. the limb was lost *after* it had developed (i.e. it was amputated by something and was not a birth defect or malformation), and
2. there was no harmful UV or chemical pollution around to *prevent* the regeneration of a cartilaginous spike.

It is important to realize, however, that the opposite is not true: cartilaginous spikes only form in a fraction of cases under normal circumstances, so the *absence* of a spike tells you nothing! It is only the *presence* of a cartilaginous spike that provides a useful clue. Sorry, but that's just the way it is. Cartilaginous spikes are consistent with traumatic loss of limb such as would occur with predation or cannibalism in which the limb was damaged or cut off. We now have evidence that this is what is causing at least some of the deformed amphibians with missing limbs.



A bullfrog tadpole with both hind limbs gone. The ragged ends of the stumps and the reddish inflammation indicate that its limbs have been lost through trauma (predation or cannibalism).



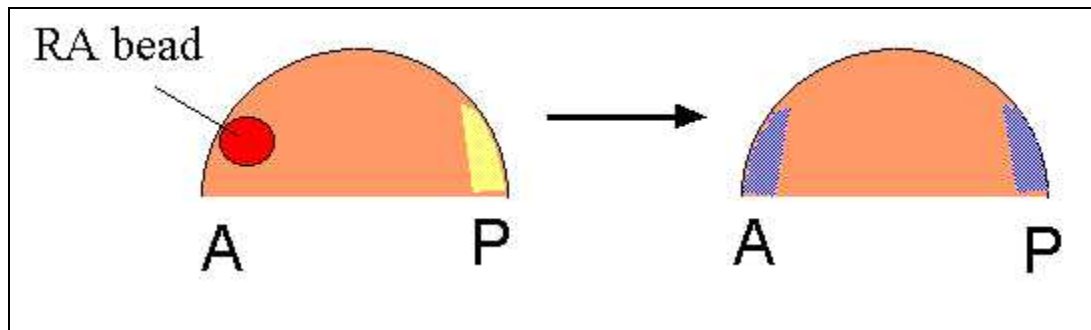
A Bullfrog tadpole showing an obvious case of traumatic loss of one of its hind limbs (the thigh bone can be seen protruding from the limb stump).

It is important to note that while this hypothesis and the retinoid hypothesis currently stand fairly weakly on their own, some researchers continue to consider them as serious possibilities. There is no evidence that the effects of UV and/or chemicals directly lead to deformities in frogs, but they may weaken the amphibians in such a way as to make them more susceptible to factors that do cause the deformities. For example, it is possible that UV and/or chemicals can interfere with the immune system, making frogs less able to defend themselves from parasites and other disease causing organisms.

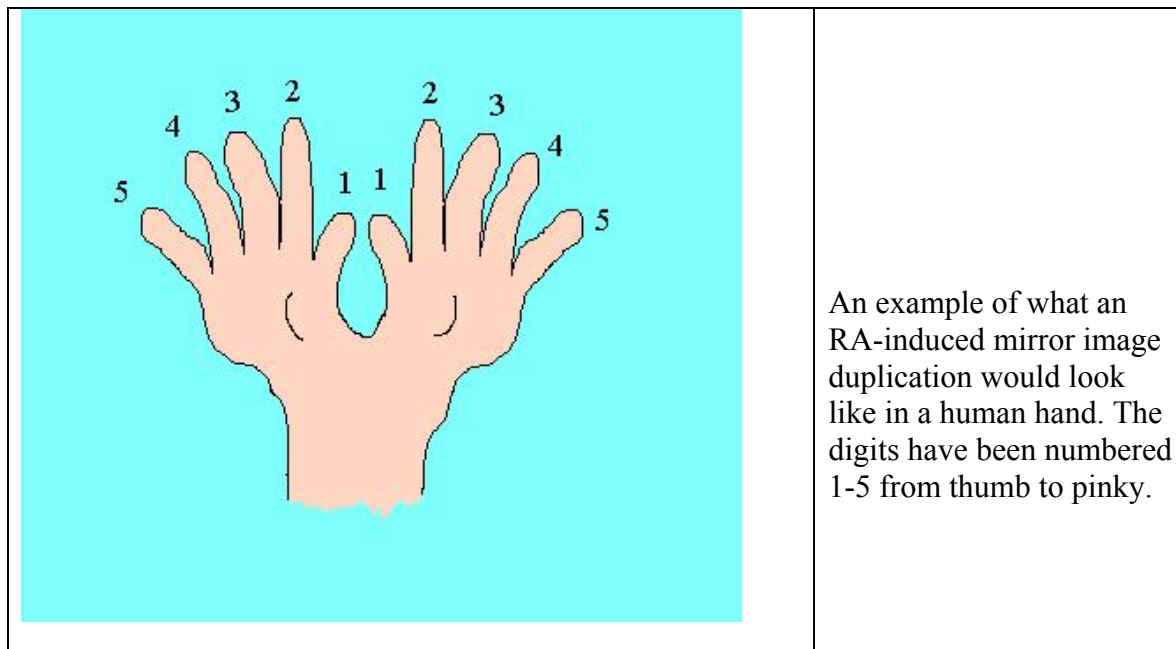
Chemical Pollution

Many scientists working on the deformed frog problem believe that the cause is a chemical one. For several reasons, the most likely candidate is some kind of retinoid. Retinoids belong to a family of biochemicals that include vitamin A, and are extremely important in embryonic development. In excess, retinoids can be a dangerous teratogen, causing serious birth defects in humans. One retinoid that has been used extensively in research on amphibian limb development is retinoic acid (RA).

RA causes certain things to happen during the development of limbs so it is not surprising that excess RA can disrupt this process. The scientists implanted RA in the *anterior* region of a chick limb bud. Without the RA implant, a thumb would grow in the anterior region and a pinky finger in the posterior region with other fingers in the middle. However, after the RA implant, BOTH areas functioned as posterior cells resulting in a mirror image duplication.



The diagram below shows what a mirror image duplication would look like in a human hand.



Scientists also wondered what would happen if it would make a difference if RA was implanted in the *posterior* instead of the anterior region of a chick limb bud. When they performed this experiment, the limb just developed normally.

So retinoic acid does NOT convert posterior cells into anterior cells. Here is a list of what RA has been found to do in limb buds:

1. converts anterior cells into posterior cells (but not vice versa)
2. converts dorsal cells into ventral cells (but not vice versa)
3. converts distal cells (e.g., wrist) to proximal cells (e.g. shoulder) (but not vice versa)

In other words, the effects of RA on developing limb buds can be mighty bizarre and difficult to analyze, but they are not completely random, which means we can make predictions concerning the kinds of limb deformities RA can and cannot cause! These are very important results which will help us evaluate the possible role of retinoids in deformed amphibians.

RA has been shown to also cause deformities in amphibians. For example, if developing limb buds are treated with RA it prevents the limb bud from growing at all. Thus RA

would appear to be a good explanation for deformed frogs with missing limbs. Also, if a limb is regenerating when exposed to RA, it can cause extra limbs.

It has been suggested that an insecticide called methoprene may act as a retinoid. Methoprene is commonly sprayed on wetlands to control mosquito populations. However, the results of recent experiments conducted by the Environmental Protection Agency show that methoprene does not cause limb deformities in amphibians (and nobody has been able to establish a link between where methoprene is used and where deformed amphibians are found). Additional problems with the chemical pollution hypothesis have been noted:

1. There is no relationship between the areas where high rates of deformities are found and high retinoid activity.
2. It takes an incredibly high concentration of RA to produce a duplicated frog limb. This level of RA would turn pond water a milky white color and cost millions of dollars to pollute a single small pond!
3. RA is necessary to development of all vertebrates. If this were the cause why don't we see the same deformities in fish, birds, reptiles, and mammals?
4. If RA caused the deformed limbs, then both limbs should be affected, not just one.
5. One type of limb deformity caused by RA has never been found in wild caught frogs. It is shown below.



Example of a proximal-distal (PD) duplication induced by retinoid treatment of a regenerating salamander limb (from Maden, 1982). The limb was amputated through the wrist (top), and then treated with retinoic acid (RA). The RA converted the distal (wrist) cells into proximal (shoulder) cells, causing the regeneration of a complete limb, including shoulder, from the original wrist area.

Dr. Gardiner and Hoppe claim to have found another diagnostic deformity (bony triangles) that indicates retinoids as the cause of deformed amphibians. Bony triangles are long bones that appear to be bent back on themselves such that the middle of the bone forms an apex, like a triangle or pyramid of bone. Bony triangles can also be produced through mechanical perturbation of limb buds, and are commonly seen in parasite induced deformities. So one thing we know for sure, and that is bony triangles are absolutely not diagnostic of retinoids!



Example of a bony triangle in the limb of a deformed Pacific Treefrog from California; trematode cysts can be seen as dark spots (photo by S.K. Sessions).

Note: It is important to realize that just because chemical pollution is an unlikely explanation for deformed (or malformed) amphibians does not mean that chemical pollution is not harmful to amphibians. Chemical pollutants are expected to have a range of harmful effects on amphibians (and other organisms), and may be contributing to amphibian declines in some areas.

Genetic/Environmental Picture Portfolio			
	Pictures	Captions	Portfolio
100%	Unique pictures for at least five genetic and five environment traits are present.	There is a different caption for each of 10 pictures classifying the trait as genetic or environmental and correctly describing the cause. The length of each caption is between 25-50 words.	Includes all of the following in a folder or binder : title page (name, date, and title of assignment); one picture and caption per page (total of 10 pictures with captions); 50-100 word typed discussion about the differences between genetic and environmental traits.
80%	Unique pictures for at least 4 genetic and four environment traits are present.	There is a different caption for each of 8-9 pictures that classifies the trait as genetic or environmental and correctly describes the cause of the trait. The length of at least 8-9 captions with 25-50 words.	Includes 80% of the following in a folder or binder: title page (name, date, and title of assignment); one picture and caption per page (total of 10 pictures with captions); 50-100 word typed discussion about the differences between genetic and environmental traits; information in a folder or binder.
70%	Unique pictures for at least 7 pictures are present. A minimum of 3-4 pictures of genetic and environmental traits is present.	There is a different caption for 7 pictures classifying the trait as genetic or environmental and describing the cause. The length of at least 7 captions is between 25-50 words.	Includes 70% of the following in a folder or binder: title page (name, date, and title of assignment); one picture and caption per page (total of 10 pictures with captions); 50-100 word typed discussion about the differences between genetic and environmental traits; information in a folder or binder.
Revise and Resubmit	There are less than 7 unique pictures. There is less than a minimum of 3 genetic and environmental traits pictures present.	There are less than 7 different captions for each picture classifying the trait as genetic or environmental and describing the cause OR the length of these each caption is less than 25-50 words.	Includes less than 70% of the following in a folder or binder: title page (name, date, and title of assignment); one picture and caption per page (total of 10 pictures with captions); 50-100 word typed discussion about the differences between genetic and environmental traits; information in a folder or binder.

TEKS 8.11 C

Who's da Mama?

TAKS Objective 2 – The student will demonstrate an understanding of living systems and the environment.

Learned Science Concepts:

- Interdependence occurs among living systems.
- Traits of species can change through generations.
- ➔ **The instructions for traits are contained in the genetic material of the organisms.**

TEKS Science Concepts 8.11

The student knows that traits of species can change through generations and that the instructions for traits are contained in the genetic material of the organisms. The student is expected to:

- (C) make predictions about possible outcomes of various genetic combinations of inherited characteristics.

Overview

Why do students need to be able to understand Punnett squares? Punnett squares are often one of the first screens used to identify the likelihood of passing on a particular trait to our children or the likelihood of our parents having passed the trait to us. This knowledge allows us to make intelligent decisions about the appropriateness of using available diagnostic tests to detect certain genetic diseases like diabetes and high cholesterol which are common in the population, and also birth defects which are less common.

In these activities students will have several opportunities to perform experiments to determine the probability of the occurrence of certain

events. The students will then be able to use Punnett squares to apply probability statistics to genetics problems. Students will also do research about genetic traits and creatively communicate what they discover by developing brochures.

Instructional Strategies

Direct instruction is used to introduce students to using Punnett Squares to predict the outcome of a genetic cross. A guided inquiry activity reviews the concept of probability, and an interactive CD utilizes technology as a method to elaborate the concepts and processes involved in using Punnett Squares.

Lesson Objectives

1. Students will apply their understanding of probability by making predictions.
2. Students will be able to complete monohybrid cross problems.
3. Students will apply their knowledge of Punnett squares to real-world situations.
4. Students will communicate information about genetic disorders by creating a brochure for publication.

For Teacher's Eyes Only

A Punnett square is used to predict the genetic outcome of a cross between two parents with known genotypes. The Punnett square is named after Reginald Punnett, an English geneticist who discovered some basic principles about sex linkage and sex determination while researching the feather color of chickens as a predictor of gender. The monohybrid cross is used to investigate the probability of one trait occurring. A dihybrid cross investigates the probability of two traits simultaneously. Many researchers believe there are at least 100,000 genes in the human genome. Just imagine how difficult it would be to investigate all of these traits at once. In these learning activities, the monohybrid cross will be used to help students visualize two of Gregor Mendel's postulates: (1) individual factors that control gene traits occur in pairs and (2) genes exhibit dominance or recessiveness.

The Punnett square uses letters of the alphabet to symbolize the trait that is being investigated. For example, you might want to use the letter "T" to symbolize the ability to roll the sides of your tongue into a "U" or taco shape. An uppercase letter is assigned to the **dominant trait**. Remember, a dominant trait occurs when a piece of DNA called an **allele** is expressed in the physical appearance of an organism. With regard to simple dominance involving two possible alleles, it takes the presence of only one dominant allele in order for the trait to be expressed. That is, if a person inherited even one tongue-rolling allele from either parent, they would be able to roll their tongue into a "U" shape. So, TT and Tt individuals would be able to roll their tongue into a "U" shape.

Any trait that is not expressed (hidden) in the presence of a dominant trait is called a **recessive trait**. Since having no ability to roll your tongue into a "U" shape is a recessive trait, this trait would be assigned a lowercase "t." The only letter combination that would represent an individual who could not roll their tongue into a "U" shape would be "tt." This would mean that the mom and the dad both contributed one "t" in the fertilization process.

The combination of alleles inherited from your parents is called a genotype. When a person shows a dominant trait, they do not know exactly what their genotype is. The alleles could be identical. For example, a person could receive a tongue-rolling allele from the mom and the dad and be a tongue-rolling kid. Their genotype would be "TT." This combination of alleles is referred to as homozygous from the Latin words, homo meaning same, and zygote, what is formed at conception.

Sometimes the combination of alleles inherited from your parents is different. For example, you could receive a tongue-rolling allele from your mom, but not your dad. In this case, your genotype would be “Tt.” This combination of alleles is referred to as heterozygous from the Latin words, hetero meaning different and zygote, what is formed at conception.

In a simple inheritance pattern involving only two alleles, the person who shows up with a recessive trait always knows what their genotype is because no dominant traits are present. So, an individual who cannot roll their tongue would have the genotype “tt.”

The physical appearance of the person, that is if they are a tongue-roller or not a tongue-roller is called their phenotype. A phenotype is what you look like or in the case of a blood test, what the results of the blood test look like.

A six-step procedure for using a monohybrid cross to predict the outcome of a genetic cross involves, making a key, identifying parental genotypes, segregation of alleles, filling in the Punnett square, predicting genotypes and predicting phenotypes. Using this 6-step procedure will help students to avoid errors when working genetics problems.

Example: In humans the ability to taste phenylthiocarbamide (PTC) is controlled by two alleles and is a dominant trait. If a man heterozygous for the ability to taste PTC (Tt) marries a woman who is also heterozygous for this trait (Tt), what are the expected phenotypes and genotypes of their offspring?

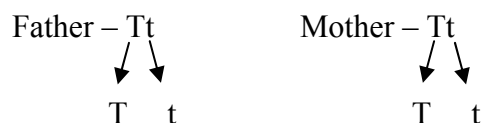
1. Write down a “KEY” for the symbols used to represent each allele.

T = ability to taste PTC (dominant)

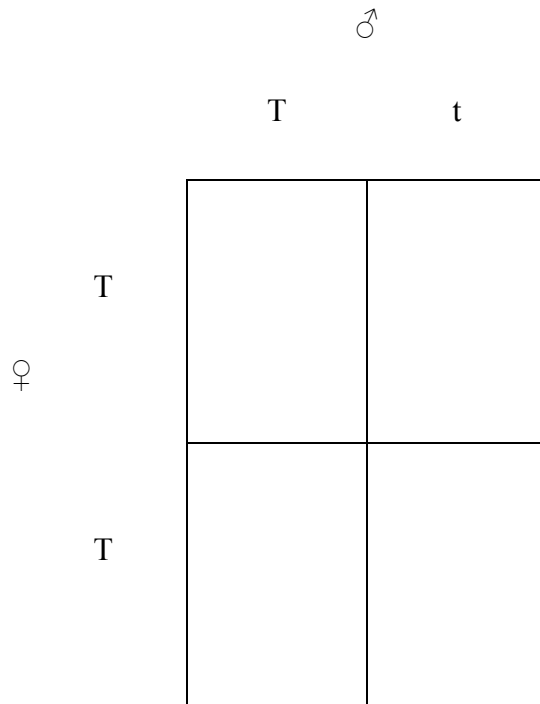
t = no ability to taste PTC (recessive)

2. Determine the genotypes of the parents from the information given.

3. List all of the possible gametes (eggs or sperm) each parent can make.



4. Set up a Punnett Square. Place the possible alleles from the sperm along the top of the square and place the possible alleles down the left side. The male is always shown at the top of the Punnett Square.



5. Fill in the Punnett Square. This process works similar to a matrix multiplication table. The alleles are placed within each of the four squares at the point of intersection for each row and column. The male's alleles are shown in red and the females are shown in blue to help track the alleles.

		♂	
		<i>T</i>	<i>t</i>
♀	T	TT	Tt
	T	TT	Tt

6. Answer the original question:

Phenotypes - There are 3 PTC tasters and 1 nontaster.

Genotypes - 1 TT: 2 Tt: 1 tt

Misconceptions

Misconception

Dominant traits are always the most common trait found in a population.

Science Concept

Dominant traits are not always the most common trait found in a population. For example, having six fingers is a dominant trait for humans, but most humans are recessive for this trait and have only five fingers.

Rebuild Concept

Introduce students to uncommon dominant alleles such as Huntington's Disease, polydactyl and syndactyle alleles.

Misconception

Males have more dominant traits than females.

Science Concept

Males are no more likely than females to have dominant traits

Rebuild Concept

Gather class data about the frequency of dominant traits for males and females. Use this activity and class discussion to dispel this myth.

☒ Misconception

Dominant traits are good to have.

☑ Science Concept

Many genetic diseases are caused by dominant traits (e.g., Huntington’s Disease and Marfan’s Syndrome).

✂ Rebuild Concept

Show examples of dominant traits caused by genetic diseases. Make the examples profound so they will be remembered by students.

☒ Misconception

Some students think the theoretical probability is what happens in real life.

☑ Science Concept

When we predict human traits using Punnett squares, students should remember that everyone does not have four children and even if they did, the “experimental probability” can vary greatly when the population is small. Probability is based upon a very large number of samples. The theoretical probability is NOT what happens in real life, it is a prediction of what is likely to happen.

✂ Rebuild Concept

Perform an activity to compare and contrast the probability of an outcome with an actual outcome (e.g., rolling dice, tossing coins, drawing cards, drawing the short straw). Provide a debriefing to explain why the actual outcome differs from the prediction.

☒ Misconception

Each roll, spin, toss, and/or draw is dependent on the ones that occurred before it.

☑ Science Concept

Students will often think that if the first child is a boy, then the next child will be a girl. Students should understand that the probability of the occurrence for each event is independent of the events that occurred before it.

✂ Rebuild Concept

Perform an activity where the probability of the outcome is known. Discuss the actual outcome with students and encourage them to explain why the outcome differs so often from the prediction using probability numbers.

☒ Misconception

Every genetic trait is controlled by only two alleles.

☑ Science Concept

Simple dominance is actually one of most rare forms of genetic inheritance.

✂ Rebuild Concept

Students should understand that the dominant/recessive traits in the lessons using the monohybrid cross represent only ONE of many modes of inheritance (e.g., sex-linked, sex-influenced, co-dominant, multiple alleles, and multifactoral inheritance patterns).

Prior Knowledge

To keep your lessons on Punnett Squares from draggin, first provide your students with a review of 6th and 7th grade TEKS using the “Dragon Genetics” kit from *Science Kit and Boreal Laboratories* (WW4779400). This kit contains nine roaring activities that provide students with a quick review of the role of chromosomes in genetic inheritance, dominant/recessive traits, and genetics vocabulary. Follow the link to obtain information about ordering this kit:

http://sciencekit.com/category.asp_Q_c_E_436869

Do not proceed with the Punnett Square lessons until students are fired up with prior knowledge about genetics. Prior knowledge includes TEKS 6.11 – The student knows that traits of species can change through generations and that the instructions for traits are contained in the genetic materials of the organisms. The student is expected to: (A) identify some changes in traits that can occur over several generations through natural occurrence and selective breeding; (B) identify cells as structure containing genetic material; and (C) interpret the role of genes in inheritance and TEKS 7.10 – The student knows that species can change through generations and that the instructions for traits are contained in the genetic material of the organisms. The student is expected to: (A) identify that sexual reproduction results in more diverse offspring and asexual reproduction results in more uniform offspring; (B) compare traits of organisms of different species that enhance their survival and reproduction; and (C) distinguish between dominant and recessive traits and recognize that inherited traits of an individual are contained in genetic material.

5 E's

ENGAGE

Every parent wants a perfect baby, but what if you could individually select how this baby would look and act? What if you could design your own baby? What traits would you value most?

Show the Gataca movie outtake.

We are still a long way from creating designer babies, but we do have many ways to learn about our own traits and how those traits might be passed to our children. And who knows...maybe one day we will be able to create designer babies. First let's examine the role probability plays in predicting the likelihood of a particular event occurring.

Explore

Student will work in pairs using playing cards, a die, spinner, and coin to investigate the experimental probability of: drawing a card with a heart, rolling a 3 on the die, spinning a specific number or color, and tossing a coin with the head side up. Using foreign coins can be used to provide a multicultural connection to this lesson. The information will be recorded in the table, "Exploring Probability using Playing Cards, Dice, Spinners, and Coins." Calculate the experimental probability by multiplying the total wins by the total number of attempts (100).

Explain

Each group will record results on a master data table that is shown using an overhead projector, white board, or similar method of displaying information to the whole class. Experimental probability for four attempts will be compared to the theoretical probability of the event for each student pair. Experimental probability for 100 attempts will be compared to the theoretical probability of the event. The following questions will be used to guide the discussion.

1. What is the whole class experimental probability for four attempts? *Answers will vary.* 100 attempts? *Answers will vary.*
2. How does the theoretical probability for 4 attempts compare to the experimental probability for 100 attempts? *Answers will vary.* Which is more accurate? *Answers will vary.* Why? *Increasing the number of attempts should increase the accuracy of the prediction.*
3. Why did you have to replace the card and reshuffle each time before resuming the card experiment? *If the card is not replaced and the deck reshuffled the odds of drawing another card with a 1 on it are changed.* What would happen if the card had not been replaced and/or the deck shuffled. *The odds would of drawing a card with a 1 on it would be less.*
4. What caution should always be made when using probability to predict the likelihood of an even occurring? *Probability predicts what should happen given a large number of attempts. However, probability is only a prediction, not an outcome.* Think hard: The probability of winning Texas Lotto® for Match One is 1 out of 116. If someone played this game 116 times in one gaming period would they always win? *No, they would not always win. In reality, the odd are in favor of winning, but in reality the individual may never win.*

5. Explain in your own words what probability is. *Probability is the likelihood of an event occurring under certain conditions and in a specific time frame.*

6. Relate probability to the likelihood of acquiring HIV. *The more unprotected encounters one has, the more likely they are to acquire HIV. It should be noted that HIV could be acquired with only one sexual encounter although this is unlikely. More information about HIV in Texas can be found at <http://www.tdh.state.tx.us/hivstd/stats/pdf/qu20032.pdf>*

Another tool that can be used to predict the outcome of a mating between two individuals is a Punnett square. In the next lesson we will learn about creating and interpreting Punnett squares. We will even use them to make predictions about the likelihood of passing diseases to future children.

Elaborate

Elaboration 1:

Using the interactive “Dragon Genetics CD,” the student will practice monohybrid cross practice problems. A participation grade will be given.

Use the interactive CD to practice the procedure for working genetics problems using Punnett Squares. The interactive CD provides information about: (1) dominant and recessive traits; (2) probability; (3) phenotypes ; and (4) genotypes. The student will use the interactive CD activity to make predictions about various crosses. The teacher will assist as required.

Elaboration 2:

For homework, the student will complete the activity sheet, “More Monohybrid Crosses.” A completion grade will be given.

Continue working Punnett square problems that involve humans and plants by completing “More Monohybrid Crosses.” The teacher will spot check student work for a completion grade. Selected students will demonstrate each of the problems on the whiteboard, chalkboard, or overhead projector to assure students understand the correct process for

working monohybrid cross problems. Student will self-assess during the debriefing and make corrections to their paper as needed.

Elaboration 3:

For homework, the student will conduct an out-of-class experiment demonstrating application of knowledge about Punnett squares and their use. A score of 70/100 on the rubric is required.

Students will select one of the following activities:

- (1) Conduct an out of class experiment about simple dominance to verify the results of Mendel's work with Pea Plants. The student will explain how well the data they collect fits the Mendelian model showing phenotypic ratios of 3 dominant to 1 recessive individual.
- (2) Use various tasting papers such as PTC taste papers in an attempt to determine a student and parent genotype using phenotypic results of the taste papers. Use a Punnett square to show possible genotypes of your parents. Use a question mark (?) to represent alleles that cannot be determined using the tasting papers (e.g., P? represents the heterozygous or homozygous dominant PTC taster).

The report will be scored on neatness, demonstration of concept attainment, and accuracy of data collected. A copy of the scoring rubric will be provided prior to the beginning of the learning experience.

Elaboration 4:

The student will create a brochure about a genetic disorder.

In an effort to increase awareness of other modes of inheritance, students will work with a partner to use the Internet to learn about famous people with genetic diseases. The teacher may choose to provide direct instruction about the use of Microsoft Publisher®. This activity may alternately be performed using a word processing program with columns or using paper to hand construct a brochure. Students will present findings to the class by explaining the general characteristics of the disease, the mode of inheritance, available diagnostic tests, and treatment. The following table lists examples that may be used for this learning experience. The student score will be based on accuracy of information, visual appearance of the brochure, and class presentation. A copy of the scoring rubric will be provided prior to the beginning of the learning experience.

Lincoln - Marfan's syndrome http://rarediseases.about.com/cs/marfansyndrome/a/092402.htm
Dickinson – bipolar http://www.molbio.princeton.edu/courses/mb427/2000/projects/0002/artists.html http://www.molbio.princeton.edu/courses/mb427/2000/projects/0002/overview.html
Vincent van Gogh – epilepsy http://www.charge.org.uk/htmlsite/van%20_gogh.shtml
John F. Kennedy - Addison’s disease http://www.pbs.org/newshour/character/essays/kennedy.html
Ray Charles – glaucoma http://www.glaucoma.org/learn/ http://www.glaucoma.org/Ray_Charles_psa.html
Jackie Joyner-Kersey – Asthma http://www.usatoday.com/news/health/spotlight/2002/01/31/spotlight-kersee.htm
Andre the Giant http://www.andrethegiant.com/bio.html
Josh Ryan Evans http://www.soapcentral.com/ps/theactors/evansj.php http://www.marchofdimes.com/professionals/681_1204.asp

Excellent resources that may be used to research genetic disorders include the March of Dimes:

http://search.marchofdimes.com/cgi-bin/MsmGo.exe?grab_id=29&page_id=5636352&query=glaucoma&hiword=glaucoma+

AND

the National Organization of Rare Diseases:

http://www.rarediseases.org/search/rdbdetail_abstract.html?disname=Addison%27s%20Disease

Elaboration 5:

For homework, the student will complete the Punnett square problems. A completion grade will be given.

The teacher may also introduce the Punnett Square as a way to explore other modes of inheritance such as sex-linked traits which primarily affect males (e.g., eye color and hemophilia) co-dominant traits where both alleles are expressed simultaneously (e.g., ABO blood alleles and roan color in cattle) incomplete dominance (e.g., four o'clock flowers where the heterozygous flower is an intermediate color of pink,) and sex-influenced traits such as baldness which expresses differently in men and women due to the effect of estrogen or testosterone. Selected students will demonstrate each of the problems on the whiteboard, chalkboard, or overhead projector to assure students understand the correct process for working monohybrid cross problems. Student will self-assess during the debriefing and make corrections to their paper as needed.

Evaluate

After completing the activity “Exploring Probability” using Playing Cards, Dice, Spinners, and Coins” the student will write at least 100 words in the science journal to show their understanding of probability.

Evaluation 1

Using the interactive “Dragon Genetics CD,” the student will practice monohybrid cross practice problems. A participation grade will be given.

Evaluation 2

For homework, the student will complete the activity sheet, “More Monohybrid Crosses.” A completion grade will be given.

Evaluation 3

For homework, the student will conduct an out-of-class experiment demonstrating application of knowledge about Punnett squares and their use. A score of 70/100 on the rubric is required.

Evaluation 4

The student will create a brochure about a genetic disorder and receive a score of at least 70/100 on the rubric.

Evaluation 5

For homework, the student will complete the Punnett square problems. A completion grade will be given.

Black History Months

Out-of-Class Punnett Square Investigation

10-30 point	40-60 points	70-80 points	90-100 points	Total Points
Data in the Punnett square are not shown OR are inaccurate.	Accurate representation of the data in the Punnett Square, but 3 or more parts of the 5-step method are not shown.	Accurate representation of the data in the Punnett square, but 1 or 2 parts of the 5-step method is/are not shown.	Professional looking and accurate representation of the data in the Punnett square. All parts of the 5-step method are shown.	
Explanation illustrates inaccurate understanding of scientific concepts underlying the lab	Explanation illustrates a limited understanding of scientific concepts underlying the lab.	Explanation illustrates an accurate understanding of most scientific concepts underlying the lab.	Explanation illustrates an accurate and thorough understanding of scientific concepts underlying the lab.	
Report is handwritten and looks sloppy with cross-outs, multiple erasures and/or tears and creases.	Report is neatly written or typed, but formatting does not help visually organize the material.	Report is neatly handwritten and uses headings and subheadings to visually organize the material.	Report is typed and uses headings and subheadings to visually organize the material.	

This rubric was created using information from the following website:

<http://rubistar.4teachers.org/index.php>

Exploring Probability using Playing Cards, Dice, Spinners, and Coins

Game	Theoretical Probability	# of attempts	# of wins	Experimental Probability	# of attempts	# of wins	Experimental Probability
Draw a card with a heart on it. Be sure to replace the drawn card and shuffle the cards before the next attempt.	1 out of 4 or .25	4			100		
Roll the die – Roll the number 3.	1 out of 6 or .16	4			100		
Spinner – Spin the color red.	1 out of 6 or .16	4			100		
Coin toss – The coin must land on heads.	1 out of 2 or .50	4			100		

Use the information from the table “Exploring Probability Using Playing Cards, Dice, Spinners, and Coins” to answer the following questions.

1. What is the whole class’ experimental probability after four attempts? 100 attempts?
2. How does the theoretical probability for four attempts compare to the experimental probability for 100 attempts? Which is more accurate? Why?
3. Why did you have to replace the card and reshuffle each time before resuming the card experiment? What would happen if the card had not been replaced and/or the deck shuffled.
4. What caution should always be made when using probability to predict the likelihood of an even occurring? Think hard: The probability of winning Texas Lotto® for Match One is 1 out of 116. If someone played this game 116 times in one gaming period would they always win?
5. Explain in your own words what probability is.
6. Relate probability to the likelihood of acquiring HIV. More information about HIV in Texas can be found at <http://www.tdh.state.tx.us/hivstd/stats/pdf/qu20032.pdf>

MORE MONOHYBRID CROSSES

Albinism is the absence of skin pigmentation and is a recessive trait found in humans and other animals. In the human population about 1/20,000 individuals is an albino. Normal pigmentation (A) is dominant to albinism (a). If an albino woman marries a homozygous normal man, what is the likelihood that one of their children will display albinism?

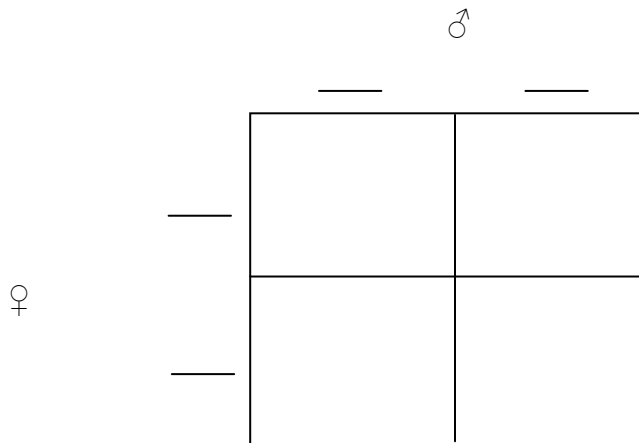
KEY: _____

PARENTAL GEOTYPES: ♀ _____ ♂ _____

POSSIBLE GAMETES (eggs and sperm): ♀ _____ and _____ ;

♂ _____ and _____

SET UP AND FILL IN THE PUNNETT SQUARE:



PHENOTYPES:

GENOTYPES:

ANSWER THE QUESTION:

BONUS: A woman with normal pigmentation marries an albino man and their first child is an albino. What are the genotypes of the couple?

PHENOTYPES:

GENOTYPES:

ANSWER THE QUESTION:

Polydactylous cats have more than five toes. In fact, the author, Ernest Hemingway is credited with establishing a large colony of about 50 feral polydactylous cats in the Florida Keys. One of his cats, Princess six-toes appeared in the *New York Times*. The polydactyl allele is dominant over the allele for five toes and fingers. Predict the offspring of a mating between a heterozygous polydactylous male cat and a female cat homozygous for five toes and fingers.

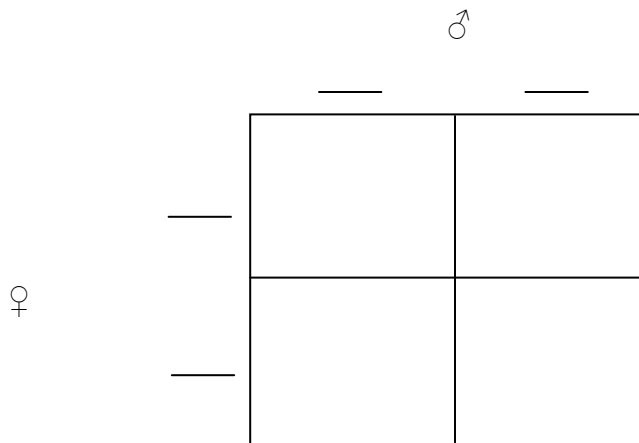
KEY:

PARENTAL GEOTYPES: ♀ _____ ♂ _____

POSSIBLE GAMETES (eggs and sperm): ♀ _____ and _____ ;

♂ _____ and _____

SET UP AND FILL IN THE PUNNETT SQUARE:



PHENOTYPES:

GENOTYPES:

ANSWER THE QUESTION:

In cattle the polled hornless condition (P) is dominant to the recessive condition of horned (p). A heterozygous polled bull breaks out of his pen and mates with the following three cows (cow #1) homozygous dominant polled hornless (cow #2) horned, and (cow #3) heterozygous polled hornless. What is the probability that all offspring will be horned? HINT: The probability of three independent events occurring at the same time is the product of the probability for each independent event.

KEY:

PARENTAL GEOTYPES:

Bull ♂ _____

Cow #1 ♀ _____

Cow #2 ♀ _____

Cow # 3 ♀ _____

POSSIBLE GAMETES (eggs and sperm):

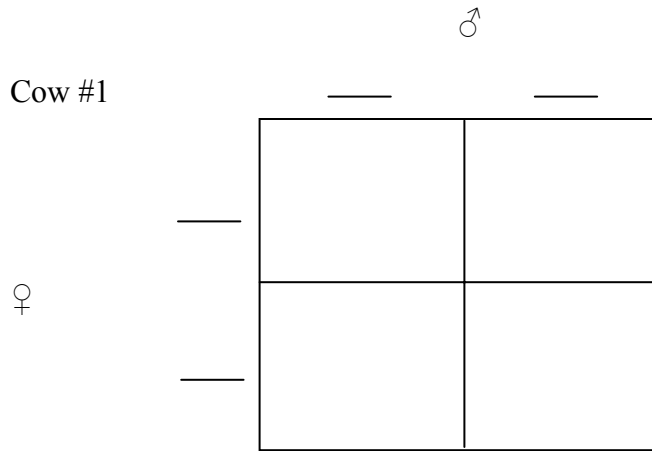
Bull ♂ _____ and _____

Cow #1 ♀ _____ and _____

Cow #2 ♀ _____ and _____

Cow #3 ♀ _____ and _____

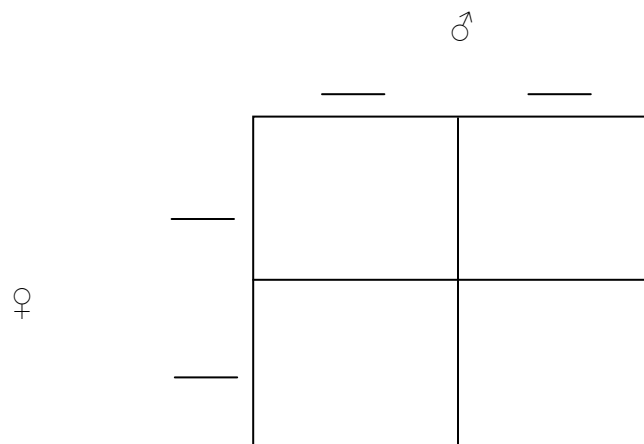
SET UP AND FILL IN THE PUNNETT SQUARE:



PHENOTYPES:

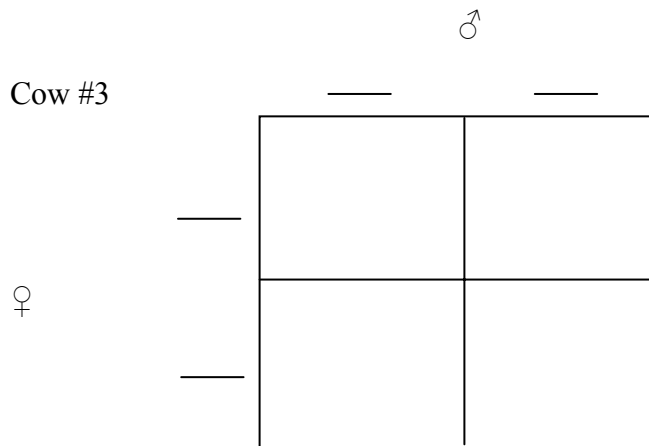
GENOTYPES:

Cow #2



PHENOTYPES:

GENOTYPES:



PHENOTYPES:

GENOTYPES:

ANSWER THE QUESTION:

Multiply Cow #1 horned offspring ($\frac{?}{4}$) X cow #2 horned offspring ($\frac{?}{4}$) X cow #3 horned offspring ($\frac{?}{4}$) to determine the probability for all three cows producing horned offspring.

Blood type in humans is controlled by two of three possible alleles. Type A and type B blood may be inherited in a heterozygous or dominant fashion, while type O blood is homozygous recessive and type AB blood is co-dominant that is both alleles express at the same time. Cross a heterozygous male with a heterozygous female. What are the phenotypic and genotypic ratios that result. Be sure to superscript the A,B, and I alleles.

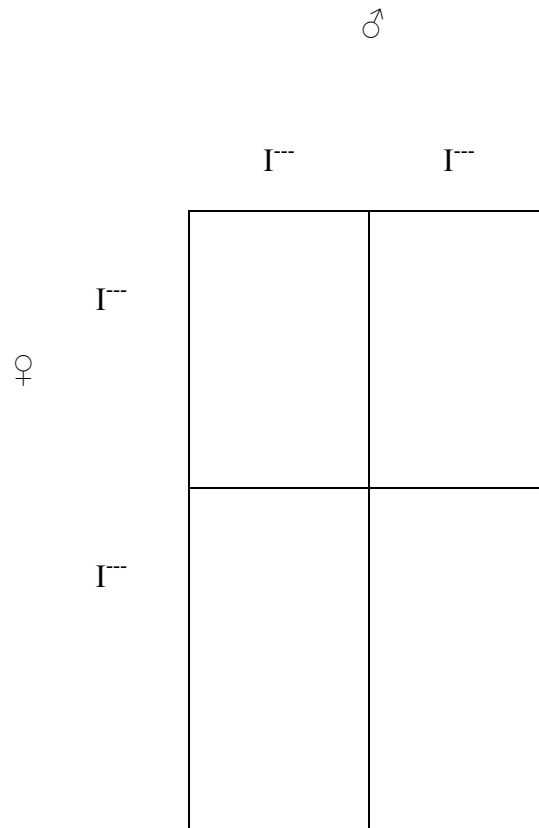
KEY:

PARENTAL GEOTYPES: ♀ _____ ♂ _____

POSSIBLE GAMETES (eggs and sperm): ♀ ____ and ____ ;

♂ ____ and ____

SET UP AND FILL IN THE PUNNETT SQUARE:



PHENOTYPES:

GENOTYPES:

ANSWER THE QUESTION:

Colorblindness is a sex-linked trait. A color-blind male marries a female who is heterozygous for color vision. What are the expected phenotypic and genetics ratios of the offspring? Be sure to superscript the sex-linked alleles.

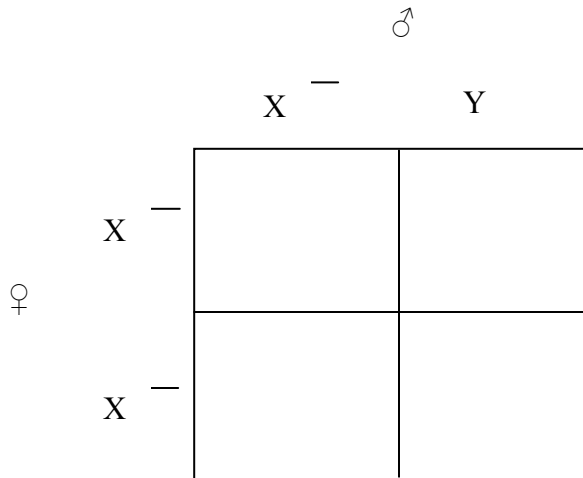
KEY: _____

PARENTAL GEOTYPES: ♀ _____ ♂ _____

POSSIBLE GAMETES (eggs and sperm): ♀ _____ and _____ ;

♂ _____ and _____

SET UP AND FILL IN THE PUNNETT SQUARE:



PHENOTYPES:

GENOTYPES:

ANSWER THE QUESTION:

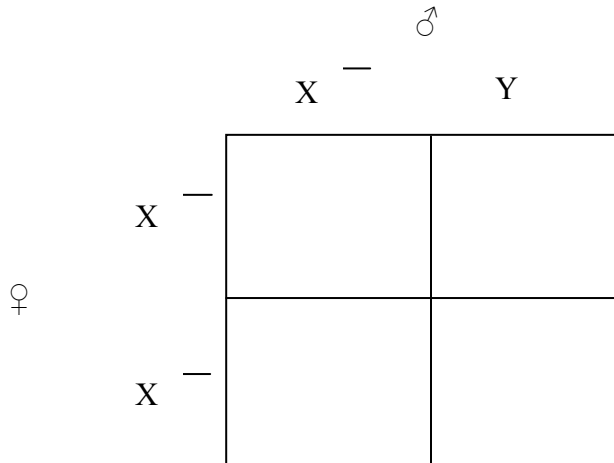
Hemophilia is a blood disorder in which the affected individual lacks a clotting factor and bleeds freely both internally and externally when bruised or cut. Hemophilia is a sex-linked trait. Cross a female who is heterozygous for hemophilia with a normal male. What are the possible genotypes and phenotypes of offspring predicted by this mating?

KEY: _____

PARENTAL GEOTYPES: ♀ _____
 ♂ _____

POSSIBLE GAMETES (eggs and sperm): ♀ _____ and _____ ;
 ♂ _____ and _____

SET UP AND FILL IN THE PUNNETT SQUARE:



PHENOTYPES:

GENOTYPES:

ANSWER THE QUESTION:
