What the Heck is Biotech???????

Objectives

1. Students will be able to give examples of how biotechnology has been used to improve crops and livestock through selective breeding and genetic engineering.
2. Students will be able to describe certain characteristics that parents, both plant and animal, pass on to their offspring through the process of genetic inheritance.
3. Students will be able to describe the basic genetic structure found in cells: chromosomes, DNA, and genes.

Grade Level 4-6

TEKS:

S- 4.3C,D,E; 4.8A, 4.9A,B
5.3A,C,D,E; 5.10A,B
6.3A,C,D,E; 6.11A,B,C

SS- 4.21A,B,C; 4.23B,C,D,E
5.24A,B,C; 5.25B,C,D;
5.26B,C,D,E; 6.20A

R- 4.9E;4.11A,B,C;4.13C,D,F,G
5.13C,D,F,G,H; 6.13A,C,G,H

W- 4.15C; 4.16A,B; 4.17A,C,D
5.15A,C; 6.15C

TAKS:	GRADE	OBJECTIVES
Reading	4, 5, 6	1, 4
Writing	4	1, 2, 3, 4, 5, 6
Science	5	1, 2
Math	4, 5, 6	1, 2, 3, 4

Assessment Summary:

Objective 1: Students will be able to describe the basic structure of chromosomes, DNA, and genes.

Objective 2: Students will be able to describe some of the benefits and risks of biotechnology.

Writing: Students will choose one of the following topics to research and write an informative essay:

The Benefits and Risks of Biotechnology in Food Production OR
Gregor Mendel: The Father of Modern Genetics.

Extension: Have students research Punnet Squares and how they can be used to predict physical characteristics in offspring.

Project:	Students will build a model of a DNA strand using colored beads or other material to represent the various parts, with a key for reference.
Background Information:	Included in Lesson

Additional information can be obtained from the following websites:

DNA From the Beginning---http://vector.cshl.org/dnaftb/

More Websites:

www.biology.arizona.edu/default.html

www.biotechbasics.com

www.cellsalive.com

www.icmb.utexas.edu

http://gslc.genetics.utah.edu

Materials:

See material list for "Rock, Paper, Scissors" and "Plant Features" Activities	See material list in Lab exercise, "The Making of a Smoothie"

Equipment: Computers with Internet access

What the Heck is Biotech??????

Procedure

1. Introduce new vocabulary:

Grades 4-6

Biotechnology	Inheritance
Chromosomes	Traits
DNA	Dominant
Genes	Recessive
Genetic Engineering	Co-dominant

Activities

2. Have students read and discuss the background information, write the vocabulary words, and define them using context clues.
3. Discuss the concept of inheritance and how certain traits are passed on from parent to offspring through genes. To reinforce the idea of dominant and recessive genes, have students work in pairs and complete Activity 3.a "Rock, Paper, Scissors."

   Have students complete Activity 3.b "Plant Features: What Does It Look Like?".
4. Have class do the activity "DNA Dance" to demonstrate how DNA is structured, copied, spliced, and read.
5. Have students build a model of a DNA strand, with a key that describes the parts. Wire and wooden or plastic beads can be used for the model.
6. Have students send DNA-o-Grams using the website http://dna2z.com.
7. Discuss the concept of benefit versus risk with students, and then have them complete activity "Biotechnology: Risk or Benefit?".
8. Have students research the benefits and risks associated with biotechnology in agriculture and write an informative essay about the subject.

Extension

1. Complete the lab exercise "DNA In My Food??? The Making of a Smoothie."
2. Research Punnet Squares and how they are used to predict inherited traits in offspring. Have students demonstrate the use of Punnet Squares.

What is Biotechnology?

Biotechnology is the manipulation of living organisms to produce products, processes, and services that are beneficial to mankind. Biotechnology can be used to produce more abundant and nutritious food products, pest and disease resistant crops, and even pharmaceuticals that can be used to treat diseases.

Biotechnology includes the use of genetic modification and genetic transfer from one organism to another. This transfer of a specific gene allows scientists to pass desirable characteristics found in a certain organism on to other organisms without passing on undesirable traits.

An example of a genetically modified crop is the tomato. In order for us to have nice red tomatoes in the grocery store, they must be harvested and shipped while they are still green, otherwise they would be overripe and mushy when they arrive at the store. Because they are harvested green, they have not had time to develop the full flavor of vine ripe fruit. Scientists have found a way to "turn off" the gene that causes tomatoes to soften. These genetically modified tomatoes can be allowed to ripen on the vine and still be shipped all over the country without becoming soft and mushy. Scientists are finding ways to improve other food crops to make them more nutritious, more abundant, and easier to grow, harvest, transport, and store.

History of Biotechnology

For centuries, humankind has made improvements on crop plants through selective breeding and hybridization — the controlled pollination of plants. Corn (maize) was one of the first food crops known to have been cultivated by human beings. Although used as food as early as 5000 BC in Mexico, no wild forms of the plant have ever been found, indicating that corn was most likely the result of some fortunate agricultural experiment in antiquity.

Plant biotechnology is an extension of this traditional plant breeding with one very important difference. Plant biotechnology allows for the transfer of a greater variety of genetic information in a more precise, controlled manner.

Traditional plant breeding involves the crossing of hundreds or thousands of genes, whereas plant biotechnology allows for the transfer of only one or a few desirable genes. This more precise science allows plant breeders to develop crops with specific beneficial traits and without undesirable traits.

Many of these beneficial traits in new plant varieties fight plant pests, including insects, weeds, and diseases that can be devastating to crops. Others provide quality improvements, such as tastier fruits and vegetables; processing advantages, such as tomatoes with higher solids content; and nutrition enhancements, such as oil seeds that produce oils with lower saturated fat content.

Crop improvements like these can help provide an abundant, healthful food supply and protect our environment for future generations.

Genetics

Biotechnology includes the science of genetics. Genetics is the study of how genes are passed from parent to offspring, and how specific genes cause certain characteristics to be expressed in an organism.

The modern age of genetics began in the early 1800s when Jean Baptiste Lamarck (1744-1829) suggested that animals passed on acquired traits. This means that Lamarck believed that a baby giraffe's neck was long because its parents stretched their necks as they tried to graze on the leaves of tall trees. However, we now know his hypothesis was false. For example, if a man loses his right leg in a car accident, we don't expect his child to be born missing a right leg.

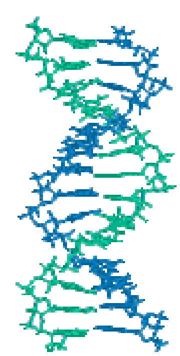
In the mid-1800s, Sir Charles Darwin (1809-1882) and Alfred Wallace (1823-1913) suggested that an organism inherited some type of biological factor from its parents. At the time, Darwin didn't know what this "factor" was, but we now know it to be the chromosome. Darwin's book, *The Origin of the Species* (1859), was a milestone in science.

Gregor Mendel (1822-1884), an Austrian monk, studied peas in his garden. He found that when he crossed smooth peas with wrinkled peas, they'd always produce smooth peas. If he crossed these second-generation smooth peas with each other or with wrinkled peas, he'd get some smooth peas and some wrinkled peas. However, if he crossed wrinkled peas with other wrinkled peas, he'd get only wrinkled peas. He published his findings in 1865, but unfortunately nobody paid much attention to his reports.

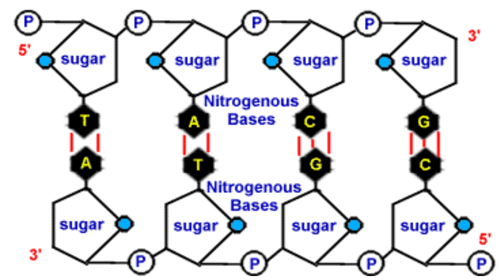
In the early 20th century, scientists rediscovered Mendel's work, and Mendelian genetics was born.

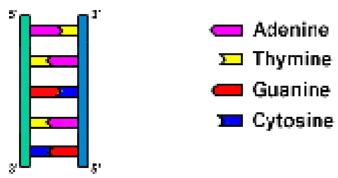
Chromosomes, DNA, and Genes

Individual characteristics in plants and animals, including humans, are passed from parents to offspring. This is called inheritance. Some characteristics are easily identifiable, such as smooth and wrinkled peas in Mendel's experiments. Some characteristics are not as easily seen, such as disease resistance in a corn plant. But, whether it is the color of our eyes and hair or whether we can roll our tongue, we can thank our parents and ancestors for passing these traits on to us.

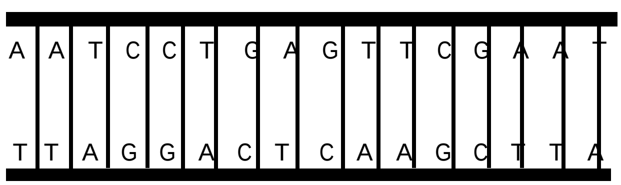


All living things are made up of cells. Within each cell is a nucleus which contains chromosomes. These chromosomes are rod- shaped structures that are made up of tightly coiled DNA. If could uncoil the DNA it would look like a twisted ladder. This DNA "ladder" is composed of sugar and phosphate, which make up the sides. The rungs of the "ladder" are made up of four bases; adenine, thymine, guanine and cytosine. These bases attach to each other only in certain combinations; thymine to adenine and cytosine to guanine. A gene is a segment of the DNA "ladder" that contains these four bases combined and arranged in a certain way. Each gene serves as a blueprint or pattern for the production of a protein that causes a specific trait or function in an individual.





A strand of DNA is like a ladder.
Sides of the "ladder" are made up of sugar and phosphate molecules.



"Rungs" of the "ladder" are made of 4 nucleotides; A,T,C,G.
A gene is a segment of the DNA "ladder."

Dominant and Recessive Genes

When an offspring is formed, each parent contributes one gene for each trait. For example, there is a single gene that determines the color of skin on a potato. So, an offspring's characteristics are determined by a combination of genes from each parent. In the simplest cases, genes are either dominant or recessive. When a dominant gene combines with a recessive gene, the dominant gene's characteristics are expressed in the offspring. When two recessive genes combine, the offspring expresses the characteristics of the recessive genes. Co-dominance occurs when genes for a particular trait are equally strong. In this case, the two variations are expressed in equal strength.

In agriculture, some examples of dominant, recessive, and co-dominant traits are:

- Red potato skin is dominant over white potato skin.
- Green peas are dominant over yellow peas.
- Red cherry tomatoes are dominant over yellow cherry tomatoes.
- Red and white snap dragon flowers are co-dominant and produce pink flowers.
- Short and tall corn plants are co-dominant and produce medium height corn plants.
- Tall sunflower plants are dominant over short sunflower plants.
- Yellow kerneled corn is dominant over white kerneled corn.

Genetic Engineering

Scientists have discovered that each gene carries the code for a specific, assigned function (such as whether a pea is wrinkled or smooth)Genetic engineering is the process in which a specific gene is taken from the DNA of one organism and inserted into the DNA of another, or a specific gene is repositioned on a chromosome in the same organism. The new "altered" organism then performs new functions or expresses new characteristics based on its new DNA.

Genetic engineering can perform three functions.

- It can improve the ability of an organism to do something it already does. For example, an adjustment in the amino acid balance in peanuts can extend their shelf life. This benefits candy and peanut butter manufacturers because it keeps their product fresher for a longer period of time.
- It can suppress or stop an organism from doing something it already does. For example, the gene that codes for the softening of tomatoes is "turned off" in a genetically engineered variety.
- It can make an organism do something new that it never did before. For example, bacteria and yeast have been genetically engineered to produce chymosin, an enzyme used in cheese production.

Benefits of Biotechnology

As food and fiber needs increase around the world, and as more and more farmland is lost to urbanization, farmers must find ways to increase yields for the crops they grow. Genetic engineers are continually searching for ways to assist agriculture in producing more and better crops, particularly in less developed countries. A few examples are:

- Golden Rice with increased beta carotene to prevent blindness.
- Rice with increased iron content to decrease anemia in women of childbearing age.
- Salt tolerant crops (mangroves have a gene that enables them to grow in salty water).
- Herbicide tolerant cotton, corn, and soybeans. Reduces the total amount of herbicide sprayed on a crop.
- Cotton and other crops that produce insecticidal proteins, reducing the need for chemical pesticides.
- And the list goes on...

Background information and activities from the following sources:

- California Foundation for Ag in the Classroom, "Where'd You Get Those Genes?" —www.cfaitc.org
- http://gslc.genetics.utah.edu
- http://library.thinkquest.org/20830/main.htm
- Monsanto — www.biotechbasics.com
- www.cellsalive.com
- http://dna2z.com — Send a DNA-o-gram
- University of Texas Institute for Cellular and Molecular Biology –www.icmb.utexas.edu

Evolution of Food Biotechnology

2500 BC Egyptians begin to domesticate geese to make larger, tastier birds for cooking.

1800 BC With the use of fermentation, man first harnesses microorganisms to produce wine, beer, and leavened bread.

1860's Louis Pasteur develops pasteurization and defines microbiology. Gregor Mendel experiments with pea plants to learn that traits (later called genes) can be passed on through generations.

1930 U.S. corn production through 1965 increases 600% due to a hybrid seed corn that farmers first purchased and started using in 1922.

1953 The code of DNA is discovered by James Watson and Francis Crick.

1970 Norman Borlaug becomes the first plant breeder to win a Nobel Prize for his work in Green Revolution wheat varieties (high yield).

1973 A gene, or a specific piece of DNA, is successfully relocated from one organism to another by Stanley Cohen and Herbert Boyer.

1982 Biotechnology is used to develop human insulin for diabetes treatment.

1983 Plants are first produced from modern biotechnology practices.

1990 Through biotechnology, an enzyme called chymosin is created to replace rennet, a mixture extracted from calves' stomachs used to coagulate milk for cheese production. Now used and consumed worldwide, chymosin has greatly improved the production of cheese because of the purity and quality of the enzyme.

1994 The Flavrsvr® tomato, the first whole food enhanced through biotechnology, is first approved in U.S. grocery stores. This tomato was developed to be more flavorful than conventionally grown tomatoes.

1995 Soybeans produced through biotechnology are first introduced on the market.

1997 18 crop applications of biotechnology are fully accepted by the US government.

1999 "Golden Rice," rich in beta-carotene and a pre-cursor to vitamin A, is developed by researchers. This rice can help prevent childhood blindness in developing countries.

2000 Today, plants produced through biotechnology fall into four main categories:

- *Improved Nutrition Profiles* - higher levels of nutrients in crops that may reduce the risk of heart disease or certain cancers.
- *Insect Protection* - crops with built-in protection from destructive insects.
- *Herbicide Tolerance* - allows for more effective weed control with fewer herbicide applications.
- *Disease Protection* - crops with built-in protection from specific viral or fungal diseases.

Source: Council for Biotechnology Information

Activity 3.a

Dominant and Recessive Traits

PURPOSE

The purpose of this activity is to understand the terminology of dominant and recessive genes and how genes determine the characteristics of offspring.

CONCEPTS

, Genetics is the study of the passing of traits from one generation to the next.

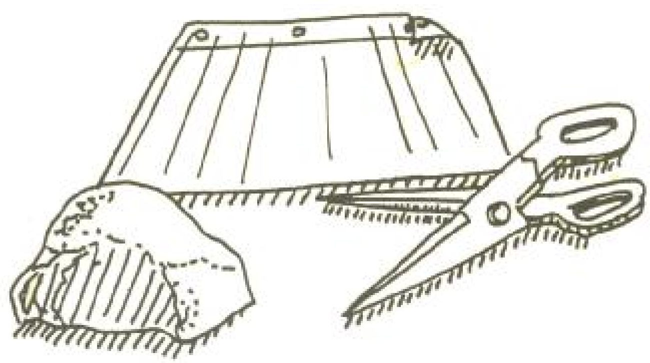
, Genetic make-up is determined by both parents, and is often expressed as traits which can be predicted.

, Genes can be either dominant, recessive, or co-dominant.

MATERIALS

For each partnership:

, Rock, Paper, Scissors Recording Chart



For each student:

, Plant Feature Page

, map colors and scissors

, What Does It Look Like? activity sheet

For the class:

, Five "gene pool" boxes made from shoe boxes

TIME

Two 40-minute sessions

BACKGROUND INFORMATION

When an offspring is formed, its traits are determined by a combination of genes from each parent. Each parent contributes one half of the genes for each trait. In the simplest cases, genes are either dominant or recessive. When a dominant gene combines with a recessive gene, the dominant gene's characteristics are expressed in the offspring. When two recessive genes are combined, the recessive characteristic is expressed in the offspring. Co-dominance occurs when the genes for a particular trait are equally strong. In this case, the two variations of the gene are expressed in equal strength.

In Agriculture there are many examples of dominant, recessive, and co-dominant traits. Some examples are listed.

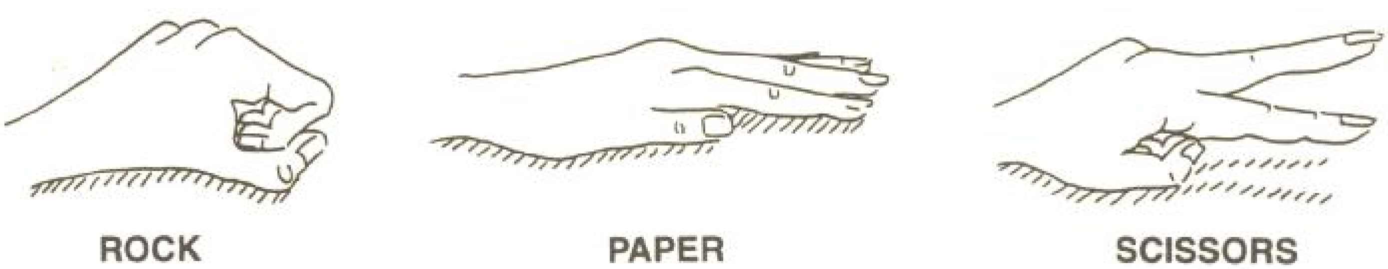
- Red potato skin is dominant over white potato skin.
- Russet colored potato skin is dominant over white potato skin.
- Green peas are dominant over yellow peas.
- Red cherry tomatoes are dominant over yellow cherry tomatoes.
- Red and white snapdragon flowers are co-dominant and produce pink flowers.
- Short and tall corn plants are co-dominant and produce medium height corn plants.
- Tall sunflower plants are dominant over short sunflower plants.
- Yellow kerneled corn is dominant over white kerneled corn.

PROCEDURE

Have students list words that are associated with the words “dominant” (dominated, dominating, dominate, domain, dominance, predominant, dominator, etc.) Then, discuss the differences between the concept of dominating a situation and receding in the same situation. For instance, if two people wanted to climb up the ladder of a slide at the same time, one person might dominate the situation by yelling it was his or her turn or by pushing someone out of the way to go up first. Someone else might recede by walking away and playing something else. The receding person may play at the slide later when there is less competition (similar to genes?). Role play a few situations such as lining up after recess or participation in class discussion.

Rock, Paper, Scissors

Describe the game “Rock, Paper, Scissors” using the words “dominant” and “recessive.” Discuss that rock dominates scissors, scissors dominate paper, and paper dominates rock. Have the students play this game with a partner, recording on a chart (provided) each partner’s contribution and each outcome for several rounds. The outcome column will say either “Rock,” “Paper,” or “Scissors.” If both people choose the same item then it is a tie and the item that both people chose will be written in the outcome box. The procedure for playing the game is described below.



To play “Rock, Paper, Scissors”:
After a count of “1-2-3,” each player must symbolize a rock, scissors, or paper with one hand on a desk or table top. The hand symbol for rock is a fist. The hand symbol for scissors is the first two fingers cutting the air in a scissors motion. The hand symbol for paper is a flat hand on the desk top or table top. It is important that both partners reveal their chosen hand symbols at exactly the same time.

- Discuss the outcome of the game. Are there ways of making certain one person will always dominate or win?
- Discuss “dominant” and “recessive” in terms of genes and heredity.

Activity 3.a

Name ____________
Date ______________

Rock, Paper, Scissors
Recording Chart

Round	Partner A	Partner B	Outcome (Rock, Paper, Scissors)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

POSSIBLE OUTCOMES

, Rock dominates scissors
, Scissors dominate paper
, Paper dominates rock

CONCLUSION

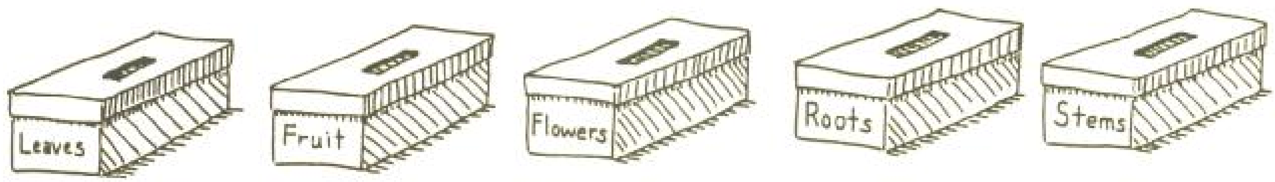
1. Which outcome was most common in your partnership? ___________________________
2. Which outcome was the least common? ____
3. Were your results similar to the results of the class? ___________________________
4. Describe one thing you learned about genetics by doing this activity. ___________

____

____

Plant Features: What Does It Look Like?

- Have each partnership color and cut out a "Plant Feature Page." Place the features into the appropriate gene pool containers (boxes, envelopes, etc.) labeled "leaves", "fruit", "flowers", "roots", and "stems". Each partnership will contribute a dominant and recessive trait for each feature. Place the 5 boxes in different locations throughout the room.



- Handout to each pair of students the "What Does It Look Like?" page. From five separate "gene pool" containers have each student randomly select one feature. Have the students fill in the gene chart as each feature is chosen. The partners then need to determine what their plant looks like. For example, if one partner chooses a dominant round fruit and the other partner chooses a recessive oval fruit, the plant will have round fruit. Have the students complete their plant by drawing the appropriate features on their plant.

- Have the students display their plants. Discuss how many dominant traits were expressed compared to recessive traits. Discuss the wide variety of plants produced from the same gene pool and how this activity show that it would be highly unlikely for two brothers or sisters to be exactly alike.

CONCLUSION FOR ACTIVITY 3

Traits are passed on from one generation to the next. A variety of outcomes can occur based on the random combinations of dominant and recessive genes.

VARIATIONS

- Have the class design their own dominant and recessive features for the gene pool.

- Rather than working in pairs, have the class create one plant on a flannel board by randomly selecting from the gene pool.

- When discussing traits that are dominant, co-dominant, and recessive, use colored chalk and a chalkboard to illustrate. Two colors can be blended for co-dominance and a recessive color can be erased.

EXTENSIONS

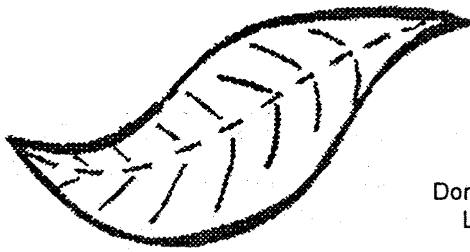
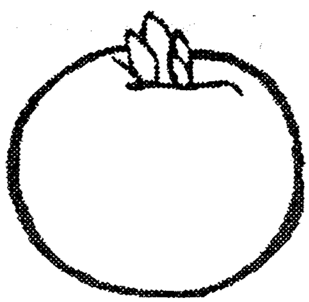
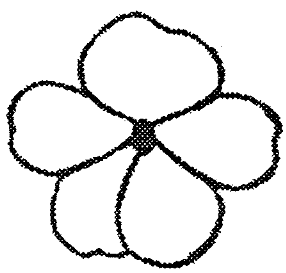
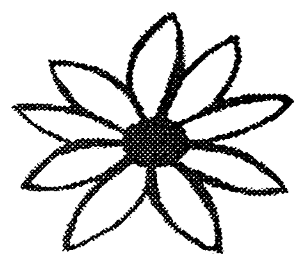
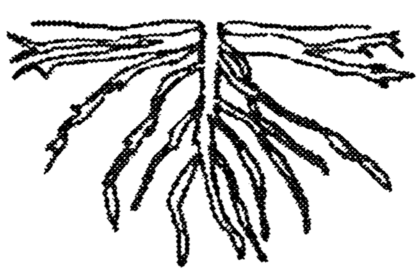
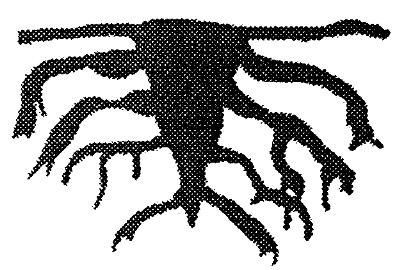
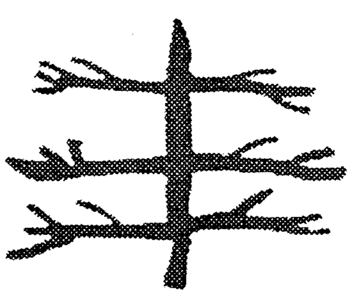
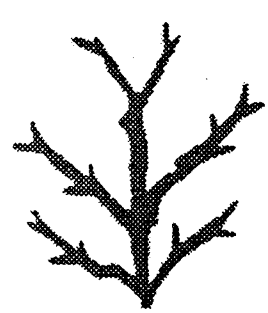
- Have two pairs of students cross their plants to produce offspring. The offspring would be created by random selection of one trait from each plant's gene pool. To arrive at a trait, students could hold their traits behind their backs while the other pair chooses right or left hand. This process could continue through several generations. The plant's family tree could be displayed on a bulletin board.

- Based on features in an offspring, discuss what the parent plants may have looked like.

Activity 3.b

Generic Plant Feature Page

Color and cut out the dominant and recessive features and place them in the appropriate boxes as explained by your teacher.

	DOMINANT	RECESSIVE
Leaf	 Dominant Leaf	 Recessive Leaf
Fruit	 Dominant Fruit	 Recessive Fruit
Flower	 Dominant Flower	 Recessive Flower
Root	 Dominant Root	 Recessive Root
Stem	 Dominant Stem	 Recessive Stem

Activity 3.b

Name ____________
Date ____________

What Does It Look Like?

Fill in the gene chart according to the kind of genes you and your partner drew from the gene pool containers.

FEATURES	PARTNER A	PARTNER B	OUTCOME
Leaf			
Fruit			
Flower			
Stem			
Root			

Draw the plant that you have created according to the outcomes on your gene chart.

Plant Diagram

Activity 5

The DNA Dance

The DNA Dance is modified from the original version by Tom Zinnen, University of Wisconsin Biotechnology Center and UW Extension, (608) 265-2420, and Tom A. Vestal, Texas Cooperative Extension, Texas A&M University, (979) 458-3406.

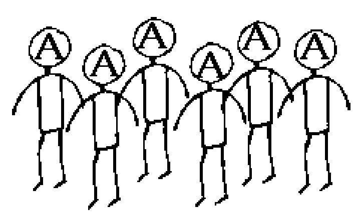
Objective:

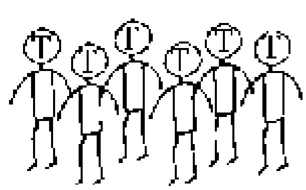
To demonstrate how DNA is structured, copied, spliced, and read. Students will understand that:

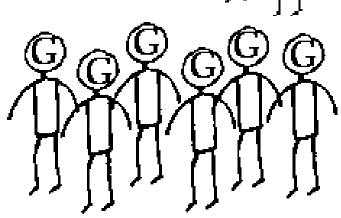
- DNA is composed of 4 nucleotides, or building blocks; A, T, G and C.
- These building blocks can be strung together to carry a message that causes cell action or function.
- A single strand can be paired with another strand (its "mate" or "complement"), to make double-stranded DNA (given A matches with T and G matches with C).
- The order of nucleotides in one strand will determine the order of its mate.
- The two mate strands face in opposite directions.
- The order of the building blocks can be used to make three-letter words that can code a message. About 600 three-letter words make up a gene.
- DNA can be copied by "unzipping" the original double strand and filling in the two separated strings or strands with spare building blocks.
- A new piece of DNA can be spliced into another piece of DNA to give new messages.

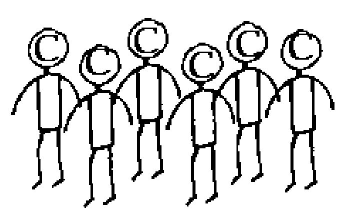
What to do:

1. Divide students into 4 groups: A, T, G, C.

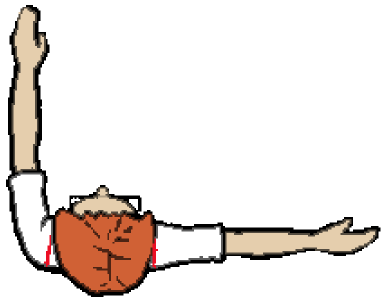






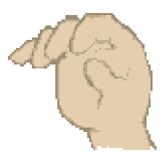


2. Assign the position so everyone's left arm is extended to the front and their right arms are extended to the side (in a top view, the arms form an L: the "L" position).

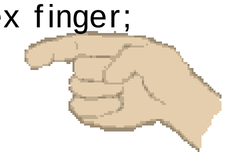


3. Each student will make a different configuration with his or her right hand (as shown) depending on the nucleotide they have been assigned. (These are designed so that A's and T's match/interlock and G's and C's match/interlock.)

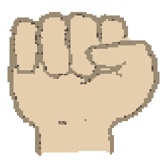
C's curve their hands partly open;



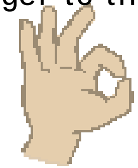
T's make a hook by extending a curved index finger;



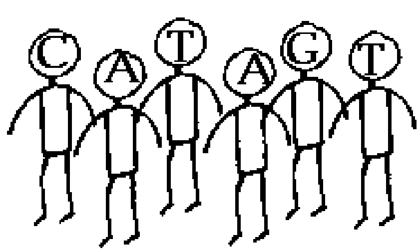
G's make a fist;

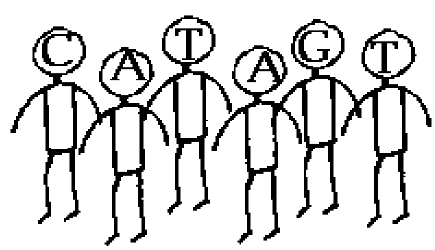


A's make an "OK" sign by touching their index finger to their thumb;



4. Mix the students so that all four types are mingled.





5. Have students find the appropriate nucleotide match and pair up using right-hand configurations only. Appropriate matched pairs are: A's match with T's and G's match with C's.

6. The paired nucleotides should now make two lines facing the instructor at the front of the room.

7. Because nucleotide pairs are transverse in nature, everyone standing on the right side should turn around and face the back of the room. Now the nucleotide pairs are transverse (facing opposite directions).

8. Instruct the students to place their left hand on the left shoulder of the student in front of them to create the characteristic bond found in real DNA. Their right arm should be extended to the side interlocked with their paired nucleotide (another real DNA bond). The final result: a double stranded DNA.

9. Demonstrating Recombinant DNA (a form of genetic engineering):
Tomatoes can be genetically engineered to delay ripening. This is done by selecting the gene that causes a protein to be produced that tells the tomato to ripen. The gene is removed, reversed and replaced in the DNA strand. Since the sequence is different, the gene now codes for a different protein.

Tomato DNA Strand
with specific gene isolated

ATCG | **GTA** | GCCTA
TAGC | **CAT** | CGGAT

Same Strand of Tomato DNA with
gene reversed and reinserted

ATCG | **TAC** | GCCTA
TAGC | **ATG** | CGGAT

More information and ideas can be found at:
www.biotech.wisc.edu/education/funfoodstuff

Activity 8

 Biotechnology: Risk or Benefit? 

Determine if each statement about biotechnology represents a risk or a benefit. In the blank, place a B for benefit or an R for risk.

1. ______ Promote human health through production of nutritionally rich grains, fruits, and vegetables.

2. ______ Produce higher yields through crops with built-in protection from destructive insects and diseases, and herbicide tolerance that allows for effective weed control with fewer herbicide applications.

3. ______ Increased usage of chemical pesticides.

4. ______ Reduce hunger by increasing crop productivity in developing countries.

5. ______ Pesticide resistance in crops transferred to related weed species.

6. ______ Transfer of allergens from other foods.

7. ______ Combat human disease through the use of more effective drugs and vaccines.

8. ______ Detrimental change in food crop nutritional value.

9. ______ Bioremediation to clean up pollutants by altering microbes or plants.

10. ______ Unforeseen enhancement of natural plant toxins or development of new toxins.

Activity 9

Benefits and Applications of Genetic Modification

- Combat human disease through the use of more effective drugs and vaccines.
- Promote human health through production of nutritionally rich grains, fruits, and vegetables.
- Reduce hunger by increasing crop productivity in developing countries.
- Produce higher yields through crops with built-in protection from destructive insects and diseases, and herbicide tolerance that allows for effective weed control with fewer herbicide applications.
- Bioremediation to clean up pollutants by altering microbes or plants.

Potential Risks of Genetic Modification

- Pesticide resistance in crops transferred to related weed species.
- Increased usage of chemical pesticides.
- Unforeseen enhancement of natural plant toxins or development of new toxins.
- Transfer of allergens from other foods.
- Detrimental change in food crop nutritional value.

DNA IN MY FOOD???

The Making of a Smoothie

Contents

- Introduction
- Materials
- Lab Instructions--Extract the DNA
- Procedure

In this protocol, students will extract DNA from bananas that have been blended with water. A portion of the banana mixture is then treated with shampoo and salt, mixed for 5-10 minutes, and then strained through a coffee filter. The filtrate is added to cold alcohol and the DNA from the banana solution precipitates (becomes visible). The remaining banana mixture is made into a delicious smoothie by adding another banana, orange juice, frozen strawberries, tofu (soft or firm), and blending.

Materials:

- 2- 5 oz plastic cups
- blender
- plastic spoon for measuring and mixing
- #2 cone coffee filter
- 20 ml of distilled water
- clear-colored shampoo, such as Suave Daily Clarifying Shampoo
- 3 bananas
- table salt, either iodized or non-iodized
- 1 plastic transfer pipette or medicine dropper
- 1 sealed test tube containing 95% ethanol (grain alcohol) or 91% isopropyl (rubbing) alcohol

- 1- 10 oz package of frozen strawberries, partially thawed
- 1- 12.3 oz package of tofu- either soft or firm
- 1- cup of orange juice
- 2- Tbs. of honey
- 1- container with ice for cold alcohol tubes
- laboratory instructions

Lab Instructions

Extract the DNA

DNA is present in the cells of all living organisms. This procedure uses household equipment and store supplies to extract DNA from a banana in sufficient quantity to be seen and spooled.

The process of extracting DNA from a cell is the first step for many laboratory procedures in biotechnology. The scientist must be able to separate DNA from the unwanted substances of the cell gently enough so that the DNA does not denature (break up).

You will prepare a solution of banana treated with salt, distilled water, and shampoo (detergent). The salt allows the DNA to precipitate out of a cold alcohol solution. The detergent breaks down the cell membrane by dissolving the lipids (fatty molecules) and proteins of the cell and disrupting the bonds that hold the cell membrane together. The detergent then forms complexes with these lipids and proteins, allowing them to be filtered out of solution by the coffee filter while leaving the cells' DNA in the filtrate.

Procedure

In a blender, mix a ratio of one banana per one cup (250ml) of distilled water. Blend for 15-20 seconds, until the solution is a mixture.

In one of the 5 oz cups, make a solution consisting of 1 teaspoon of shampoo and two pinches of table salt. Add 20 ml (4 teaspoons) of distilled water or until the cup is 1/3 full. Dissolve the salt and shampoo by stirring slowly with the plastic spoon to avoid foaming.

To the solution you made in step 2, add three heaping teaspoons of the banana mixture from step 1. Mix the solution with the spoon for 5-10 minutes.
(The detergent dissolves the lipids that hold the cell membranes together, which releases the DNA into the solution. The detergent causes lipids and proteins to precipitate out of the solution, leaving the DNA. The salt enables the DNA strands to come together.)

While one member of your group mixes the banana solution, another member will place a #2 cone coffee filter inside the second 5 oz plastic cup. Fold the coffee filter's edge around the cup so that the filter does not touch the bottom of the cup.

Filter the mixture by pouring it into the filter and letting the solution drain for several minutes until there is approximately 5 ml (covers the bottom of the cup) of filtrate to test.

Obtain a test tube of cold alcohol. For best results, the alcohol should be as cold as possible.

Fill the plastic pipette with banana solution and add it to the alcohol.
(DNA is not soluble in alcohol. When alcohol is added to the mixture, the components of the mixture, except for DNA, stay in solution while the DNA precipitates out into the alcohol layer.)

Let the solution sit for 2 to 3 minutes without disturbing it. It is important not to shake the test tube. You can watch the white DNA precipitate out into the alcohol layer. When good results are obtained, there will be enough DNA to spool onto a glass rod. Or, by using a Pasteur pipette that has been heated at the tip to form a hook, you can retrieve some of the DNA. DNA has the appearance of white, stringy mucus.

Make a Smoothie

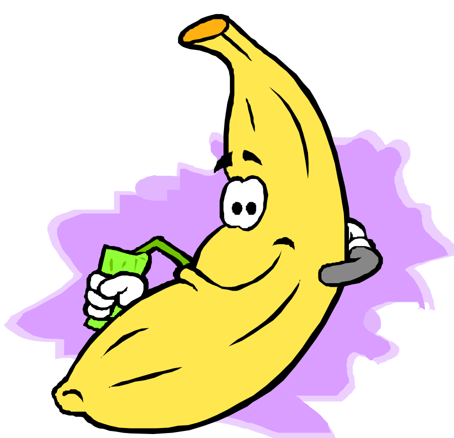
After the students start their extraction activity, follow the recipe below to make a banana strawberry smoothie.

To the remaining banana mixture in the blender, add the following ingredients and blend until smooth:

1 Package of tofu (cut up into pieces)
1 Package of frozen strawberries, partially thawed
1 ripe banana (cut up into pieces)
1 cup of orange juice (add more for a thinner consistency)
2 Tbs. of honey

Distribute the smoothie in 5 oz cups. This recipe makes enough for 10 - 5 oz cups.

Evaluate your DNA and smoothie.



ANSWER KEY

ACTIVITY 7
Biotechnology: Risk or Benefit?

1. B
2. B
3. R
4. B
5. R
6. R
7. B
8. R
9. B
10. R