

Greatest Discoveries With Bill Nye: Genetics

Teacher's Guide

Grade Level: 6–8

Curriculum Focus: Life Science

Lesson Duration: One class period

Program Description

The Basics of Genes – Explore how genes are transmitted, where they are located, and how they work. *Transposons* – Examine the work of scientist Barbara McClintock and learn about transposons, the “jumping genes” in all living organisms. *Understanding DNA* – Explore the structure and functions of DNA. *RNA and DNA Manipulation* – Learn how RNA works and explore some exciting discoveries that allow us to manipulate and examine DNA. *The Future of Genetics* – Take a closer look at RNA interference and investigate the future of genetics.

Discussion Questions

- What are some important discoveries in genetics?
- What is the structure and function of DNA?
- Where is DNA located?
- Why are some traits passed from parent to offspring?
- What are the responsibilities of genes?
- What are transposons?

Video Index

Segment 1: The Basics of Genes (10 min.)

Description

See how experiments with pea plants, the common fruit fly, and bread mold helped explain how genes are transmitted, where they are located, and how they work.

Pre-viewing question

Q: What do you know about genetics?

A: Answers will vary.

Post-viewing question

Q: What does the term “Mendelian Trait” describe?

A: Mendelian Trait describes a characteristic caused by a single gene that may reappears in one quarter of the offspring. Examples include freckles and cystic fibrosis, a hereditary disease.

Segment 2: Transposons (5 min.)

Description

Before geneticist Barbara McClintock conducted her experiments, scientists thought genes were stable in their transmission. Learn about McClintock's discovery of transposons, or jumping genes that exist in all living things.

Pre-viewing question

Q: What do you know about genetic mutations?

A: Answers will vary.

Post-viewing question

Q: What are transposons?

A: Found in the genes of all living things, transposons are sequences of DNA that move to different positions within the genome of a single cell. In a process known as transposition, they can move from one chromosome to another, causing genetic mutations. Transposons may be responsible for causing gene mutations in response to changes in an organism's environment, a process that may have spurred the evolution of a species.

Segment 3: Understanding DNA (6 min.)

Description

Explore how scientists Alfred Hershey, Martha Chase, James Watson, and Francis Crick discovered the functions and structure of DNA, the genetic material considered the blueprint of life.

Pre-viewing question

Q: What do you know about DNA?

A: Answers will vary.

Post-viewing question

Q: Describe the structure of DNA.

A: DNA is made of the four bases adenine, thymine, cytosine, and guanine, which are arranged in a double helix; the twin strands of the helix are composed of the four bases, linked together by hydrogen bonds. The whole structure resembles a spiral ladder and easily pulls apart to make copies of itself with the same genetic information.

Segment 4: RNA and DNA Manipulation (14 min.)

Description

The discovery of messenger RNA revealed to scientists how DNA communicates instructions for making proteins. Learn how RNA works and explore discoveries that allow us to manipulate and compare DNA.

Pre-viewing question

Q: How is the study of genetics used outside of clinical research?

A: Answers will vary.



Post-viewing question

Q: How does RNA work?

A: RNA transmits instructions from DNA for making protein. Like DNA, RNA is made of four chemical bases. When three bases align in a sequence called a triplet, the triplet codes for a specific amino acid. The order of the triplets is the blueprint for the production of proteins, the genetic code. DNA is copied into RNA, and RNA contains the information that determines the sequence of amino acid and proteins.

Segment 5: The Future of Genetics (7 min.)

Description

Examine a biological mechanism that holds great promise for the future, and take a look at a project that hopes to identify the functions of all the possible human genes.

Pre-viewing question

Q: What do you think will be some future applications of genetics?

A: Answers will vary.

Post-viewing question

Q: What are the possible future applications for RNA interference?

A: One application of RNA interference may be to understand it as a biological mechanism; another is using it as a tool to screen gene function; and a third might be to cure genetic diseases.

Lesson Plan

Student Objectives

- Understand that DNA is responsible for inherited traits in living organisms.
- Understand that each genetic trait is controlled by dominant and recessive genes.
- Make Punnett squares.

Materials

- *Greatest Discoveries With Bill Nye: Genetics* program
- Paper and pencils
- Chalkboard or overhead projector
- Computer with Internet access (optional)

Procedures

1. Hold a class discussion about different physical traits your students exhibit: straight and curly hair, blue and brown eyes, the ability to roll the tongue. Discuss DNA and explain that this is



responsible for the traits that a living organism inherits from its parents. Some traits are passed through dominant and recessive genes. Introduce this topic by viewing *Greatest Discoveries With Bill Nye: Genetics*.

2. Talk about inherited traits and dominant and recessive genes. How do we know which traits a child will inherit from its parents? What examples of dominant and recessive genes were featured in the program?
3. Explain to students that geneticists use a simple diagram, called a Punnett square, to predict the traits of offspring. Students will learn how to make and use such a diagram.
4. Instruct students in making a simple monohybrid punnett square one isolated trait. First have them draw a large square on a piece of paper. Next they will divide this square into four equal sections. Draw the outline of a Punnett square on the board or overhead projector to illustrate that it should look like a windowpane.
5. Tell students that scientists use two letters to represent a specific genotype in a Punnett square. Capital letters represent the dominant form of a gene, and lowercase letters represent the recessive gene. So, in the case of the eye color of fruit flies **RR** would represent red eyes, and **rr** would represent white eyes. Remind students to always use the same letters to represent both sides of a particular trait. Tell students to pretend they are attempting to determine the possible occurrence of white eyes in the offspring of one parent who has the **RR** genotype and one parent who has the **rr** genotype. Demonstrate making a Punnett square with these parents by doing the following:
 - Place the two letters of one parent on the top of the square (one letter above each column).
 - Place the two letters of the other parent on the side of the square (one letter on the side of each row).
 - Combine the letter above each column with the letter on the side of the row and fill the interior squares in with the resulting two letter combinations.
6. Tell students that the two-letter combinations created in the square are the possible eye colors of the offspring. So the resulting letter combinations in the square will read Rr, Rr, Rr, and Rr. If R is the dominant form of the gene, any combination with R in it will result in red eyes because R is dominant and it overrides the recessive r. What are the chances that the offspring of these two parents will have red eyes? (*Answer: 100 percent*)
7. Have students make a new Punnett square, this time using a parent fly with the dominant genotype Rr and a parent fly with the recessive genotype rr. The resulting two letter combinations should be Rr, Rr, rr, and rr. Will any of the offspring from these parents have white eyes? What percentage? (*Answers: Yes and 50 percent*)
8. Once students understand how to make Punnett squares, have them create squares for their own possible offspring. Allow students to choose height, eye color, or hair texture for this Punnett square. Tell them that genetics can be complex, but for the sake of this lesson assume that:



- Curly hair is dominant (HH or Hh) and straight hair is recessive (hh).
- Brown eyes are dominant (EE or Ee) and blue eyes are recessive (ee).
- Tall is dominant (TT or Tt) and short is recessive (tt).

After students have chosen which trait to use in their square, tell them to think about this trait in both their parents so they can label their own genes for this exercise. If they have curly hair (dominant), do both of their parents? If not, tell them to assume that their genotype is Hh, not HH. If they have straight hair, their genotype is hh, so they don't need to consider their parents' hair. The same goes for the other two traits.

9. Have students make three squares, each one using themselves and one of three potential mates as parents; the three potential mates would be a person who has a purely dominant genotype (HH), a person who has both dominant and recessive alleles (Hh), and a person who has a purely recessive genotype (hh). Give students time to create all three Punnett squares, then hold a discussion. What are the possibilities that they will have offspring with the dominant trait in each of the cases? What are the percentages of offspring having the recessive trait in each of the cases?
10. Ask volunteers to share the information they learned from making their Punnett squares. If time allows, students may visit the following Web sites to learn more about Punnett squares, genetics, and inherited traits:
 - <http://library.thinkquest.org/18258/Punnettsquares.htm>
 - <http://anthro.palomar.edu/mendel/>
 - http://www.biology.arizona.edu/human_bio/problem_sets/human_genetics/human_genetics.html
 - <http://www.hhmi.org/biointeractive/dna/index.html>

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- **3 points:** Students were highly engaged in class discussions; demonstrated a clear understanding that genes are responsible for certain characteristics and traits in offspring; and were able to make accurate Punnett squares and clearly identify the percentage of dominant and recessive traits in possible offspring.
- **2 points:** Students were engaged in class discussions; demonstrated a basic understanding that genes are responsible for certain characteristics and traits in offspring; and were able to make somewhat accurate Punnett squares and mostly identify the percentage of dominant and recessive traits in possible offspring.
- **1 point:** Students participated minimally in class discussions; were unable to demonstrate a basic understanding that genes are responsible for certain characteristics and traits in offspring; and made incomplete or inaccurate Punnett squares and were unable to identify the percentage of dominant and recessive traits in possible offspring.



Vocabulary

characteristic

Definition: A distinguishing quality

Context: A pair of factors determines each inherited characteristic.

chromosomes

Definition: Rod-shaped structures contained in a cell made up of a molecule of DNA threaded around proteins

Context: In females, the gene responsible for red eyes on one of the X chromosomes might be overshadowing the gene for white eyes on the other chromosome.

dominant

Definition: Of, relating to, or being an allele that produces the same phenotypic effect whether inherited with a homozygous or heterozygous allele; exercising the most influence or control

Context: Certain genes are dominant and others are recessive.

enzymes

Definition: Any of several complex proteins produced by cells that act as catalysts in specific biochemical reactions

Context: Genes direct the production of enzymes.

genes

Definition: Basic, functional units of heredity, each occupying a specific place on a chromosome

Context: In 1909 a Danish botanist coined the term "genes" to describe Mendel's factors in inherited traits.

heredity

Definition: Genetic transmission of characteristics from parent to offspring

Context: Fixed laws of nature govern heredity.

Academic Standards

National Academy of Sciences

The National Academy of Sciences provides guidelines for teaching science in grades K-12 to promote scientific literacy. To view the standards, visit this Web site:

<http://books.nap.edu/html/nses/html/overview.html#content>.

This lesson plan addresses the following science standards:

- Science as Inquiry: Understanding about scientific inquiry



- Life Science: Reproduction and heredity; Molecular basis of heredity; Characteristics of organisms
- Science and Technology: Understanding about science and technology
- History and Nature of Science: History of science; Historical perspectives; Science as a human endeavor

Mid-continent Research for Education and Learning (McREL)

McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education addresses 14 content areas. To view the standards and benchmarks, visit

<http://www.mcrel.org/compendium/browse.asp>

This lesson plan addresses the following national standards:

- Science – Life Science: Understands the structure and functions of cells and organisms; Understands the principles of heredity and related concepts
- Science – Nature of Science: Understands the nature of scientific knowledge; Understands the nature of scientific inquiry
- Language Arts – Viewing: Uses viewing skills and strategies to understand and interpret visual media
- Technology – Understands the relationships among science, technology, society, and the individual

Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- <http://school.discovery.com/teachingtools/teachingtools.html>
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