

**Lesson title**

Building a DNA Model

**Grade level**

6–8

**Subject area**

Life science

**Duration**

Two class periods

**Objectives**

Students will:

1. Understand that chromosomes are structures in the nucleus of a cell that carry genes
2. Understand that genes are smaller units that contain the hereditary code, DNA
3. Understand that the genetic code is transmitted biochemically through molecules called deoxyribonucleic acid (DNA)
4. Understand the structure of the DNA molecule

**Materials**

For each student:

- Two 24-inch pieces of fishing line
- Eight 2-inch pieces of blue chenille stems (pipe cleaners)
- Eight 2-inch pieces of green chenille stems
- Eight 2-inch pieces of purple chenille stems
- Eight 2-inch pieces of orange chenille stems
- Eighteen pieces of dried pinwheel pasta
- Sixteen pieces of dried ziti cut pasta
- One copy of Take-Home Activity Sheet: Crack the DNA Vocabulary Code

**Procedure**

1. Ask students to brainstorm traits they have that are passed on from their parents, such as eye color, hair texture, and facial characteristics. Then ask them how these traits are passed on from one generation to the next. The answer is *DNA*, or *deoxyribonucleic acid*. Explain that all organisms carry an elaborate blueprint containing the information necessary to develop and

maintain life. This “manual of instructions” is located in a chemical molecule called DNA. DNA is found within a person’s *genes*. Genes are small structures found in *chromosomes*, structures within the nucleus of cells.

2. Tell students that DNA works something like the alphabet. While the alphabet has 26 letters, DNA’s “alphabet” has only 4 letters. These letters are guanine (G), adenine (A), cytosine (C), and thymine (T). Just as the 26 letters of the alphabet can be used to form millions of words for communication, DNA’s alphabet can be combined to form codes with more than 5 billion combinations of G’s, A’s, T’s, and C’s. The differences in these combinations result in differences among human beings.
3. The DNA molecule consists of 2 strands that form a double helix, a spiraling shape much like a twisted ladder. The DNA molecule has a sugar component, a phosphate component, and 4 different bases—adenine, thymine, cytosine, and guanine. To help students understand how these components fit together to form DNA, have each student make a model of DNA with fishing line, dried pasta, and different-colored pipe cleaners.
4. First, give each student 2 pieces of line, 18 pieces of pinwheel pasta, 16 pieces of ziti pasta, and different-colored chenille stems (pipe cleaners). Explain that the pinwheel pasta represents the sugar component, the ziti pasta the phosphate, and the chenille stems each of the bases.
5. Tell students to start with the pinwheel pasta and alternate with the ziti pasta as they thread the pasta on the line. On each line, they should string 9 pieces of pinwheel pasta alternating with 8 pieces of ziti. Wrap the line around the final piece of pasta at the end of each line so that the pasta does not fall off. After pasta has been strung on both lines, each line should have a total of 17 alternating pieces of pasta. Have students lay the 2 lines side by side.
6. Then give students the “code” for the chenille stems—the blue stem represents adenine; the green stem, thymine; the purple stem, cytosine; and the orange stem, guanine. Explain that the bases in DNA are found in pairs and that adenine always pairs with thymine and cytosine always pairs with guanine.
7. Have students represent these base pairs with twisted chenille stems. First, have them twist the 8 blue stems and 8 green stems together, making a total of 8 blue-green stems, about 2 inches long. Likewise, have them twist the 8 purple and 8 orange stems together, making a total of 8 purple-orange stems, about 2 inches long. Students will find that the chenille stems twist together easily.
8. Now, have students create a “ladder” using the pasta lines as the sides and the twisted chenille stems as steps. Beginning at the top, students should connect the 2 ends of a twisted chenille stem to the top pasta pieces on the 2 lines. Then use a second chenille

stem to connect the next 2 pasta pieces directly across from each other. They should continue building their ladder, one step at a time, until they have connected the bottom 2 pieces of pasta. Remind them that they can place the twisted chenille stems in any order. (The blue-green stems do not have to alternate with the orange-purple stems.) After all the stems have been woven, the DNA model is complete.

9. Using the DNA models, discuss the following questions with the class. To enhance the discussion, you may want students to look up additional information in other resources.
  - How do the bases pair up in a DNA molecule? How does your model help you figure this out?
  - What differentiates one DNA molecule from another? How could you change your DNA model to reflect changes among DNA molecules?
  - How do you think a DNA molecule makes an exact copy of itself? How does its structure help it do so?
  
10. Assign the Take-Home Activity Sheet: Crack the DNA Vocabulary Code for homework. Then go over the vocabulary words to make sure that students have mastered them.

### **Adaptation for older students**

Have older students use this topic to integrate art and science. Instruct them to design and create a DNA model using materials of their own choice. Suggested materials include stained glass, clay, beads, buttons, wood pieces, recycled materials, and food items. They should include a key that explains what each item represents. After students have completed their models, have them display the models in the classroom.

### **Questions**

1. What is the relationship between chromosomes and genes and between genes and DNA molecules?
  
2. For the past several years, scientists have been working to map and sequence the human genome—that is, all the instructions needed for making an organism. Aptly called the Human Genome Project, it is considered one of the biggest milestones in scientific history. Why do you think this project is so important? What types of information could it provide?
  
3. Do you think we have a better chance of curing genetic diseases, such as muscular dystrophy or cystic fibrosis, with our increased knowledge of genetic codes? What issues does this increased knowledge raise?
  
4. Scientists have been working to understand genes since the 19th century. Research the work of the Austrian monk and biologist Gregor Mendel. Why is he considered the “father of

genetics”? What organisms did he study to learn how traits are passed on from parents to offspring?

5. In 1997, scientists were able to clone a sheep. What do you think the potential of cloning is? Do you think that scientists will be able to clone people some day? What dangers does that possibility raise?
6. If scientists can retrieve DNA from the remains of extinct animals, they might be able to clone them. What are some potential dangers of cloning extinct mammals, such as the mammoth? What are some advantages of cloning extinct mammals?

### **Evaluation**

Use the following 3-point rubric to evaluate students’ work during this lesson. Students should be able to follow directions to make their DNA models, identify the parts of the model, and participate in the class discussion about DNA.

- **Three points:** Students followed directions accurately, completed their model completely and accurately, identified each part of the model, and actively participated in the class discussion about DNA.
- **Two points:** Students followed most of the directions accurately, completed their model but had a couple of errors, identified most parts of the model, and participated somewhat in the class discussion.
- **One point:** Students followed some of the directions accurately but were not able to complete their model, identified some parts of the model, and participated a little bit in the class discussion.

### **Extension**

#### **The Pros and Cons of Genetic Research**

The Human Genome Project has generated much excitement recently. People have reacted both positively and negatively to scientists’ current findings. Have groups of 3 or 4 students conduct research on the most current information available from this project. Then have them share their findings with the class. What ethical dilemmas do your students feel should be addressed before further research is conducted? How will the Human Genome Project revolutionize the way medicine is practiced?

## **Suggested reading**

### ***Mammoths***

Adrian Lister and Paul Bahn, Macmillan, 1994.

Frozen carcasses and skeletons of mammoths have been discovered throughout the Northern Hemisphere, from Siberia to South Dakota. This book explains what scientists have learned about the origins of mammoths, their lives, and how they became extinct. The interactions of mammoths and prehistoric humans are also discussed. Dramatic and informative illustrations and photographs enrich the book. Includes a map and guide to mammoth sites and museums around the world.

### ***The Science of Jurassic Park and the Lost World or, How to Build a Dinosaur***

Rob DeSalle and David Lindley, BasicBooks/HarperCollins, 1997.

Could an extinct creature really be cloned and brought to life as we've seen in the movies? The 2 scientists who authored this book provide a light-hearted, but scientifically accurate discussion of how the movies got it wrong and what it really would take to accomplish such a feat.

## **Web links**

### **Mammoth Site Museum of Hot Springs, South Dakota**

Includes a museum tour, mammoth information and paleontology links, educational activities, and a QuickTime® video of an actual scientific excavation.

<http://www.mammothsite.com/>

## **All About Mammoths**

Specific and easy-to-read information about mammoths.

<http://www.allaboutmammals.com/subjects/mammals/mammoth/>

## **Woolly Web Links (Discovery Channel School Web Site)**

A variety of mammoth site Web links, book suggestions, and selected facts.

<http://school.discovery.com/schooladventures/woollymammoth/weblinks.html>

## **Vocabulary**

### **amino acids**

**Definition:** The essential building blocks of life.

**Context:** Amino acids provide the structural components of cells and tissues.

### **chromosome**

**Definition:** A structure found in the nucleus of cells.

**Context:** Chromosomes carry genes, smaller units that contain DNA, the code of life.

### **cloning**

**Definition:** To create progeny asexually.

**Context:** Dolly the sheep is recognized as the first mammal created through cloning.

### **DNA**

**Definition:** The genetic material contained in every cell and unique to each individual.

**Context:** DNA is responsible for the enormous possibilities for variability in the living world.

### **enzyme**

**Definition:** A complex protein that can catalyze biochemical reactions in the body.

**Context:** In addition to determining heredity, genes also carry the information needed for constructing enzymes needed for essential biochemical reactions.

### **genetics**

**Definition:** The study of what genes are made of, how they work, and how they are inherited.

**Context:** The field of genetics includes understanding how living systems grow and are maintained during their life span and how they duplicate and pass on genetic material.

**heredity**

**Definition:** The transfer within a species of characteristics from one generation to another.

**Context:** Heredity is responsible for how we look, what we are interested in, and in some cases, what diseases we may get during our lifetime.

**nucleotide**

**Definition:** The basic structural unit of DNA.

**Context:** Each strand of a DNA molecule is a linear arrangement of nucleotides, which are each composed of one sugar, one phosphate, and one nitrogenous base.

**nucleus**

**Definition:** A body found in most plant and animal cells that contains the genetic material.

**Context:** Scientists were able to break the genetic code within the nucleus of cells.

**polypeptide**

**Definition:** A molecular chain of amino acids.

**Context:** Proteins are actually polypeptides, chains of more than 2 amino acids.

**protein**

**Definition:** A large, complex molecule made up of amino acids.

**Context:** Human beings can synthesize at least 100,000 different kinds of proteins.

**ribosome**

**Definition:** The material from which ribonucleic acid (RNA) is made.

**Context:** Ribosome is key to protein synthesis, an essential part of the genetic code.

**RNA (ribonucleic acid)**

**Definition:** A transient intermediary molecule similar to a single strand of DNA.

**Context:** The protein-coding instructions from genes are transmitted indirectly through a messenger **RNA** molecule, which serves as a template for protein synthesis.

**Academic standards****Grade level**

6–8

**Subject area**

Life science

**Standard**

Understands the genetic basis for the transfer of biological characteristics from one generation to the next.

**Benchmark**

Knows that the characteristics of an organism can be described in terms of a combination of traits; some traits are inherited and others result from interactions with the environment.

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6–8

**Subject area**

Life science

**Standard**

Knows that hereditary information is contained in genes (located in the chromosomes of each cell), each of which carries a single unit of information; an inherited trait of an individual can be determined by either one or many genes, and a single gene can influence more than one trait.

**Benchmark**

Knows that the characteristics of an organism can be described in terms of a combination of traits; some traits are inherited and others result from interactions with the environment.

**Credit**

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**DiscoverySchool.com**  
**<http://www.discoveryschool.com/>**

## Crack the DNA Vocabulary Code

See if you can crack the DNA vocabulary code by finding the words listed below. On the back, write the definitions of each word.

AMINO ACID (Hint: The 2 words are found separately in the puzzle.)

CHROMOSOME

CLONING

DNA

ENZYME

NUCLEOTIDE

POLYPEPTIDE

PROTEIN

RIBOSOME

RNA

E	Q	C	W	I	E	A	X	Z	E	E	J	N	Q	F
Q	D	Y	L	N	P	N	U	D	P	M	P	E	X	B
P	B	I	Z	O	V	D	I	O	R	O	D	H	T	U
U	K	Y	T	B	N	T	D	G	O	S	Y	I	B	O
K	M	P	U	P	O	I	M	L	T	O	H	O	C	Z
E	T	C	B	E	E	S	N	Z	E	M	N	C	E	A
D	Q	H	L	G	E	P	Y	G	I	O	G	Y	A	Q
E	W	C	K	P	L	W	Y	G	N	R	W	N	Q	R
Y	U	O	N	I	M	A	L	L	Z	H	R	N	U	F
N	E	R	Q	Z	D	C	L	O	O	C	V	H	P	G
R	I	B	O	S	O	M	E	S	N	P	G	U	O	Y
Y	Z	G	H	W	R	J	R	R	K	U	T	O	O	Z
O	K	J	T	U	J	E	T	Y	S	X	Q	H	X	X
Z	L	A	X	D	U	E	J	J	P	L	V	M	W	W
W	K	D	Z	Z	E	R	A	Y	D	U	F	F	I	N

This puzzle was created with [DiscoverySchool.com](http://DiscoverySchool.com)'s Puzzlemaker.



**Crack the DNA Code Solution**

E Q C W I E A X Z E E J N Q F  
 Q D Y L N P N U D P M P E X B  
 P B I Z O V D I O R O D H T U  
 U K Y T B N T D G O S Y I B O  
 K M P U P O I M L T O H O C Z  
 E T C B E E S N Z E M N C E A  
 D Q H L G E P Y G I O G Y A Q  
 E W C K P L W Y G N R W N Q R  
 Y U O N I M A L L Z H R N U F  
 N E R Q Z D C L O O C V H P G  
 R I B O S O M E S N P G U O Y  
 Y Z G H W R J R R K U T O O Z  
 O K J T U J E T Y S X Q H X X  
 Z L A X D U E J J P L V M W W  
 W K D Z Z E R A Y D U F F I N

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