

# EMS Lesson 4: Ladders of Life

## (Pre-Exhibit Visit)

### Objective:

By constructing a paper model of a strand of DNA, students will show the importance of the sequencing of four nitrogen bases in the genetic code.

### Curriculum Link:

This lesson should be presented after students are familiar with the parts of a cell. A basic introduction to Mendel's work with genes would also provide a good foundation for understanding the location and function of DNA.

### Exhibit Link:

#### *Giant Double Helix; What is DNA?; Zip/Unzip!*

These sections of the exhibit depict the double-helix shape of DNA, as well as explain how DNA unwinds and unzips into new strands.

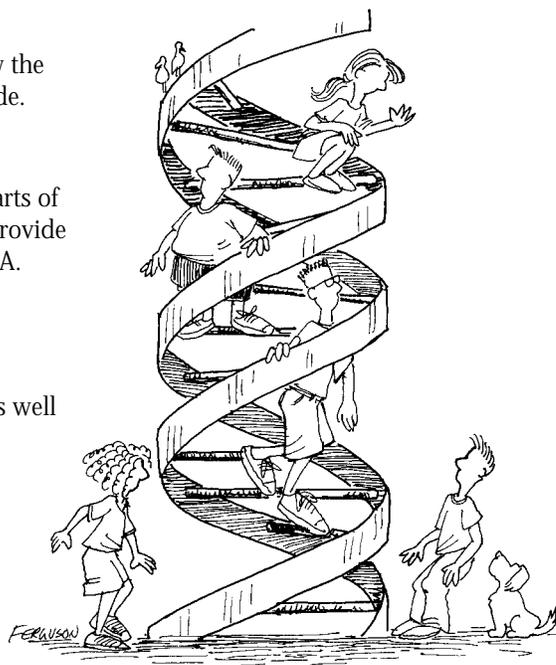
### Time Required:

**Teacher Preparation:** 45 minutes to one hour

**Class Time:** 45 minutes

### Materials Needed:

- For every student, two each of 1-inch-wide strips of construction paper cut into the following colors and lengths: green, 2 inch; yellow, 2 inch; red, 4 inch; blue, 4 inch, (representing DNA's nitrogen bases)
- For every student, one 11-inch strip of paper that alternates black and white — white strips with black stripes drawn one inch apart with a magic marker (representing the sugar-phosphate molecule to which nitrogen bases attach in DNA)
- Glue or tape



### Lesson Steps/Activity:

1. Use a chart or transparency to familiarize students with the DNA model. Explore DNA in a way that students recall prior knowledge of DNA and that allows you to gauge their understanding.
2. Before class, figure out a color scheme to represent the nitrogen bases. For example, Thymine = green, Guanine = blue; Cytosine = yellow; Adenine = red; sugar and phosphate molecules = white and black strips. Write this on the board.
3. Explain the rule that Adenine must always pair with Thymine (red with green) and Guanine must always pair with Cytosine (blue with yellow). Emphasize that the sequence of nitrogen bases in a gene forms a code that tells the cell what protein to produce. Traits are the result of actions of proteins in the organism.
4. Pass out two strips of each color to each student, and remind students what each color represents.
5. Have students work in pairs to attach seven nitrogen bases to the paper representing the sugar-phosphate molecule, and point out that the sequence they make is like a portion of the sequence in a gene. They may work out any sequence or code they want, leaving a small space between each colored strip.
6. Have pairs of students exchange strands and assemble a strand that is complementary to the one they receive. Have them attach the two strands with tape or glue.
7. If they have made the correct matches, the finished product should resemble a ladder that is always the same width.

### Extensions & Modifications:

Elementary:

- Omit the names of the nitrogenous bases, but emphasize that in order for the code to be correct, red must always pair with green, and yellow with blue.
- Explain that the order of the colors along the gene is the code that makes each of us unique.
- Have pairs of students mount their "ladders" on a large piece of white butcher paper and try to find two completed ladders that are exactly the same.

- Have students look up references on James Watson and Francis Crick and write brief reports on one or both of them.

Middle:

- Instruct students to write the initials of the nitrogenous bases on each of their strips before attaching them to the gene.
- Have students write out the sequence of the nitrogenous bases of the strand they receive in the exchange, and then figure out on paper what the sequence of the complementary strand should be.
- When each group has a finished ladder, compile a chart that lists all the “genetic codes.” Challenge the students to find any two ladders that are the same.
- Have students look up references on James Watson and Francis Crick and write brief reports on one or both of them. The report should include how they came to collaborate on the double helix model.

Important terms: gene, chromosome, strand, code, ladder, DNA

Additional Middle School terms: nitrogen base, adenine, thymine, guanine, cytosine

### **Writing Prompts/Discussion Questions:**

1. What would happen to the DNA ladder if one of the rungs did not fit correctly?
2. Does it help you to have a visual image that represents DNA and colors that represent the parts of DNA?
3. If someone said that they didn't understand how DNA is like a ladder, how would you explain it to them?
4. If you built a three-dimensional version of the DNA ladder, how would you do it? Explain.

### **National Standards Addressed:**

K-4 Content Standard C – Characteristics of Organisms

- Each plant or animal has different structures that serve different functions in growth, survival, and reproduction. For example, humans have distinct body structures for walking, holding, seeing, and talking.

5-8 Content Standard C – The Molecular Basis of Heredity

- Every organism requires a set of instructions for specifying its traits. Heredity is the passage of these instructions from one generation to another.
- Hereditary information is contained in genes, located in the chromosomes of each cell. Each gene carries a single unit of information. An inherited trait of an individual can be determined by one or by many genes, and a single gene can influence more than one trait. A human cell contains many thousands of different genes.