# From Code to Cell

Trace how inherited information can affect cell behavior.

**FB.4.2** "Obtain and communicate information illustrating the relationships among DNA, genes, chromosomes, and proteins to the basis of life."

NAME _____ DATE _____

## 1 READ AND MARK

Read it twice

**YOUR JOB** Underline where the passage connects a gene to DNA and a chromosome, then number the steps that connect HBB information to beta-globin and red blood cell shape.

### A Small Change in an Oxygen Carrier

1. When a person climbs a steep hill, red blood cells deliver oxygen to working muscles. Most of these cells cannot make new proteins, but the developing cells that produce them can. In those developing cells, chromosomes hold long molecules of DNA. A gene is a stretch of DNA with information for making a product, often a protein. The HBB gene sits on chromosome 11 and contains instructions for beta-globin, one part of the oxygen-carrying protein hemoglobin. Each person inherits one copy of chromosome 11 from each biological parent, so developing red blood cells usually have two copies of HBB.

2. To use HBB, a developing red blood cell makes an RNA copy of the gene's information. The cell reads that RNA to join amino acids in a specific order, forming a beta-globin chain. Other protein chains join beta-globin to make hemoglobin. Hemoglobin binds oxygen in the lungs and releases it to body tissues, including muscles on that hill. The order of DNA building blocks in HBB helps determine the order of amino acids in beta-globin. A different DNA sequence can therefore change the protein, although some DNA changes do not alter its amino acid sequence.

3. One HBB variant changes a single DNA building block and replaces one amino acid in beta-globin. This version helps form hemoglobin S. When oxygen is low, hemoglobin S molecules can stick together inside red blood cells, making some cells stiff and curved. Stiff cells may block small blood vessels and deliver oxygen less effectively. A person with two copies of this HBB variant can have sickle cell disease; a person with one copy usually has sickle cell trait instead. The path from a chromosome's DNA to a gene, a protein, and cell behavior explains why a tiny inherited change can matter throughout the body.

## 2 ANSWER WITH EVIDENCE

Use the passage

1. How are chromosome 11, DNA, and HBB related?

2. Trace how information in HBB becomes part of hemoglobin.

3. How can a change in one DNA building block affect the beta-globin protein?

4. How can the changed protein affect a red blood cell's shape and its work?

## 3 YOUR TURN

Your own words

Imagine a plant gene on chromosome 4 that gives instructions for a protein that helps leaf cells make purple pigment. In four sentences, explain how a change in the gene's DNA might affect the protein and the leaf color, and why the color might remain unchanged.

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## PART 1 · READ AND MARK

Underline where the passage connects a gene to DNA and a chromosome, then number the steps that connect HBB information to beta-globin and red blood cell shape. Accept any marking that follows this job and points at the right text.

## PART 2 · ANSWERS

| # | QUESTION | ANSWER |
|---|---|---|
| 1 | How are chromosome 11, DNA, and HBB related? | **Chromosome 11 holds DNA, and HBB is a stretch of that DNA.** |
| 2 | Trace how information in HBB becomes part of hemoglobin. | **A developing red blood cell makes an RNA copy of HBB information. It reads the RNA to assemble beta-globin, which joins other chains to make hemoglobin.** |
| 3 | How can a change in one DNA building block affect the beta-globin protein? | **The change can replace an amino acid in beta-globin, producing a different version of the protein.** |
| 4 | How can the changed protein affect a red blood cell's shape and its work? | **When oxygen is low, hemoglobin S can stick together, making cells stiff and curved. These cells may block small vessels and deliver oxygen less effectively.** |

## PART 3 · YOUR TURN (SAMPLE ANSWER)

Chromosome 4 contains the DNA of the gene that gives instructions for the protein. A change in that DNA might change the protein the leaf cells make. If the changed protein works less well, the leaves might make less purple pigment. The color might remain unchanged if the DNA change does not alter the protein or its function.

Accept other clear explanations that connect chromosome, DNA, gene, protein, and leaf color. For the final question, accept any passage-supported reason a DNA change might not change the protein.