



Article: Sickle Cell Disease

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The Power of CRISPR



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Cover art: Cas9 (green) and guide RNA (gold) bound to a target DNA site (blue), making a cut in each strand (white flashes). Copyright © 2022, Janet Iwasa, for IGI.

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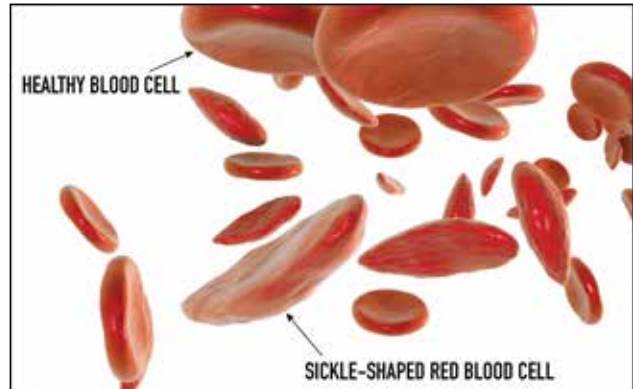
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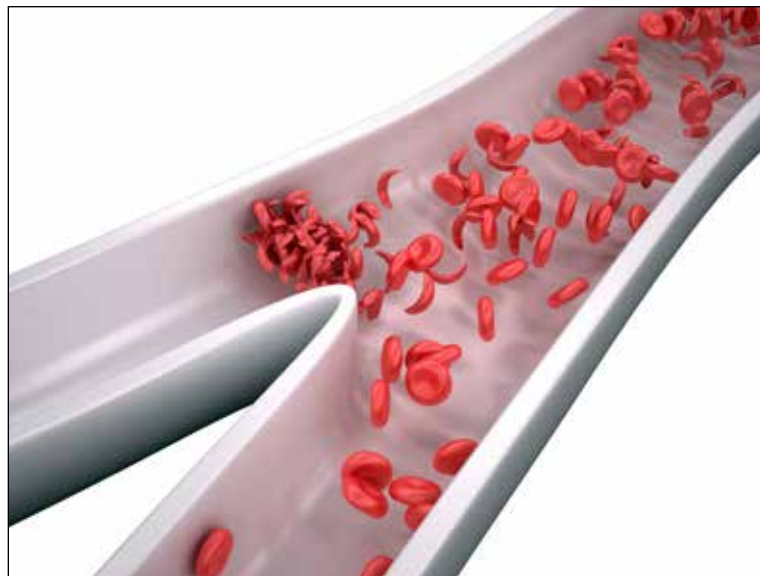
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Article: Sickle Cell Disease

Red blood cells are found in almost all animals, and their function is to carry oxygen to tissues throughout the body. Typically, red blood cells are smooth and round, allowing them to easily glide through blood vessels throughout the body. However, in *sickle cell disease*—an inherited blood disorder—the red blood cells become stiff and irregularly shaped. Their shape looks like a crescent moon, or sickle, which is where the disease gets its name. The misshapen red blood cells in people with sickle cell disease do not glide through the blood vessels like the smooth, round ones. They tend to pile up, blocking proper blood flow and preventing oxygen from getting to vital organs and tissues. This leads to fatigue, episodes of pain, swelling of the hands and feet, and frequent infections. Complications such as stroke and organ damage can even lead to death.



Sickle cell disease affects a person’s red blood cells, giving them an irregular shape.



Round red blood cells glide easily through blood vessels (right vessel). Sickle-shaped red blood cells tend to cause blockages (left vessel) that prevent oxygen from reaching some organs and tissues.

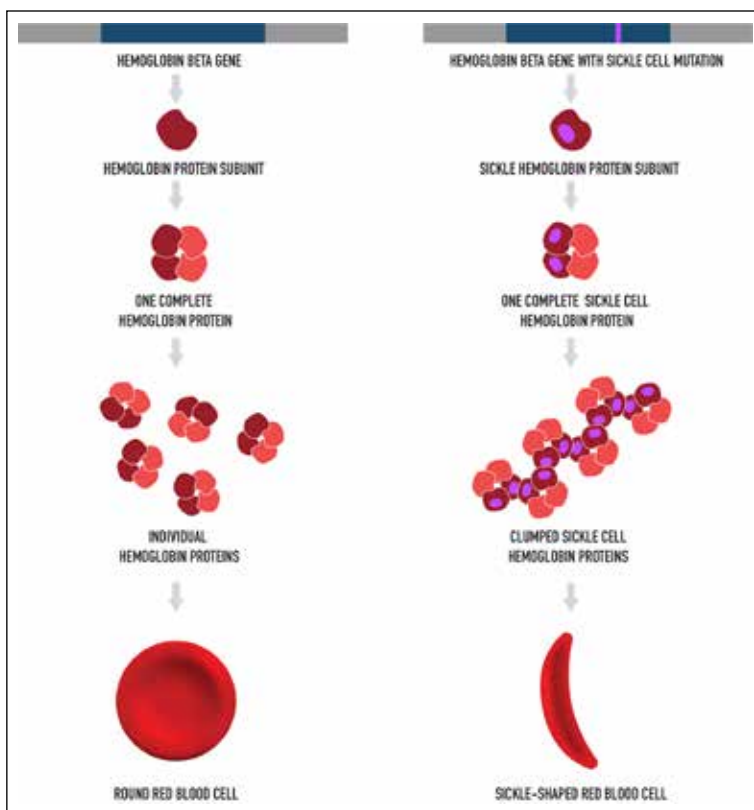
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Article: Sickle Cell Disease (continued)

Why Are Blood Cells Misshapen?

Each red blood cell contains millions of hemoglobin proteins that carry oxygen to the cells of the body. People with sickle cell disease have hemoglobin proteins in their red blood cells that can still carry oxygen, but the hemoglobin molecules stick to one another. All the hemoglobin sticking together makes the red blood cells sickle-shaped.

The changes in the hemoglobin protein that lead to sickle cell disease are caused by a mutation in one of the genes that provides instructions to make the hemoglobin protein. Genes are sections of DNA that give a cell instructions to make a particular protein. *Hemoglobin* is a protein made of four individual protein subunits. The mutation that leads to sickle cell disease is found on the gene that codes for two of those subunits. A small change to the gene changes the instructions, causing the cell to produce slightly different hemoglobin proteins that stick to one another in long fibers. These fibers are what lead to the trait of sickle-shaped red blood cells.



The healthy hemoglobin beta gene gives instructions for two of the subunits that make up the hemoglobin protein, leading to the trait of round red blood cells. The mutated hemoglobin beta gene has a change to the DNA that gives instructions for a different protein. The sickle protein subunit causes the hemoglobin proteins to clump together, which leads to the trait of sickle-shaped red blood cells.

Article: Sickle Cell Disease (continued)

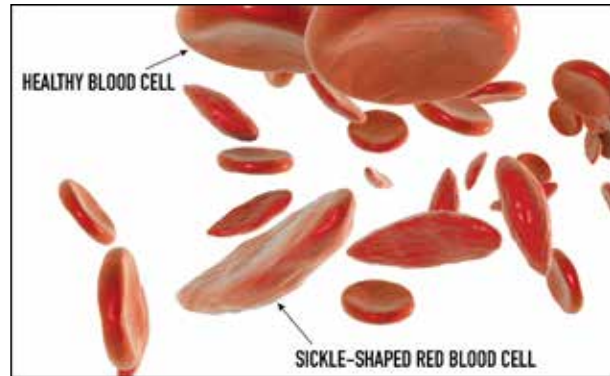
Hope for a Cure

Sickle cell disease affects approximately 100,000 people in the United States. Globally, 300,000 infants are born every year with sickle cell disease. The cause of the disease has been understood for almost a century, but there has been no safe and reliable cure. The recent development of a new technology—CRISPR, a gene-editing technique that lets scientists make changes to an organism’s DNA—offers new hope. This technology is still very new and carries certain risks. However, for diseases like sickle cell, which is most prevalent in the African American community in the United States and people of African descent across the world, CRISPR may be the cure that many patients have been waiting for.

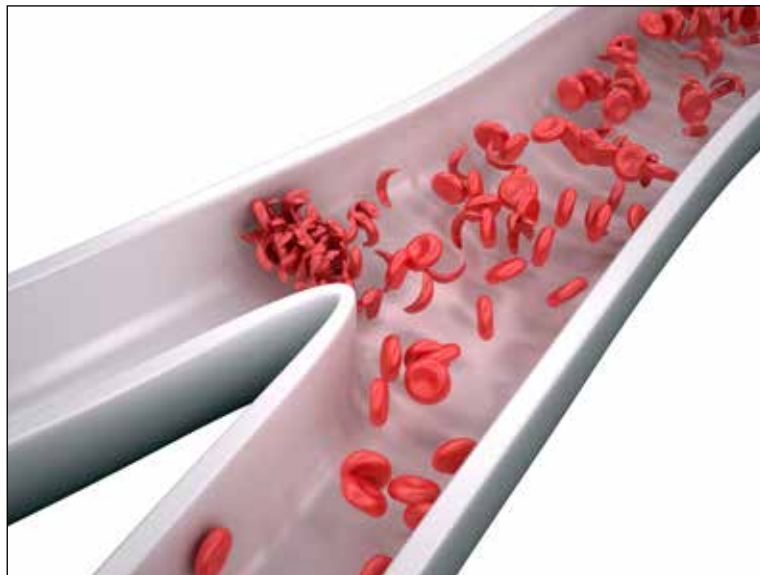
Funding for research on sickle cell disease is limited, and many patients don’t have good treatment options. However, in 2019, the first sickle cell patient to be treated with CRISPR, a 34-year-old African American woman, received a transfusion of her own CRISPR-edited blood cells. Almost a year after her transfusion, she noticed significant reduction in her symptoms and a vast improvement in her quality of life. In 2021, this treatment is still in the testing phase, with a long road ahead before it can receive government approval as a treatment for sickle cell disease in any patient. However, this patient’s outcome demonstrates the potential of CRISPR to help patients who, until recently, had no realistic hope for a cure.

Article: Treating Sickle Cell Disease

Sickle cell disease is an inherited blood disorder affecting approximately 100,000 Americans. Typically, red blood cells are smooth and round, but a person with sickle cell disease has red blood cells that are stiff and irregularly shaped. Their shape looks like a crescent moon, or sickle, which is where the disease gets its name. The irregularly shaped red blood cells do not glide through the blood vessels like the round, smooth ones. They tend to pile up, stopping proper blood flow and preventing oxygen from getting to vital organs and tissues. This leads to fatigue, episodes of pain, swelling of the hands and feet, and frequent infections. Complications such as stroke or organ damage can even lead to death.



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