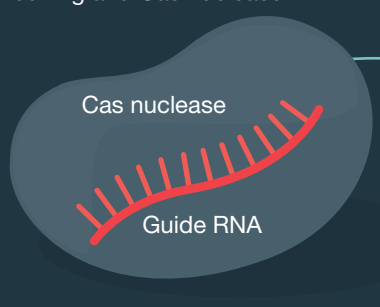
Targeting Yield and Quality

CRISPR-Cas genome editing technology complements an already robust plant-breeding innovation toolbox at Syngenta. While not a silver bullet, it's a simpler, more precise tool for making specific changes to a cell's DNA, which can help make the seed-breeding process more efficient, less time consuming and potentially subject to less regulation.

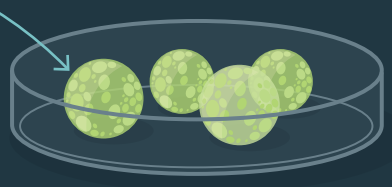
Illustrations by Lucy Reading-Ikkanda

HOW IT WORKS

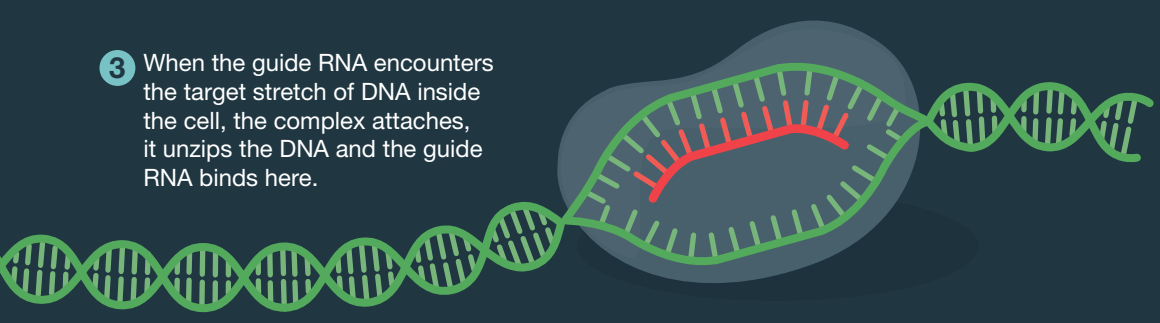
1. The CRISPR complex is prepared. The complex consists of a guide RNA molecule that matches the genetic sequence of the gene targeted for editing and Cas nuclease.



2. Scientists grow crop cells in a lab. The CRISPR complex is transferred into these cells.

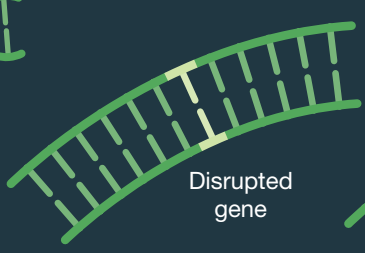


3. When the guide RNA encounters the target stretch of DNA inside the cell, the complex attaches, it unzips the DNA and the guide RNA binds here.

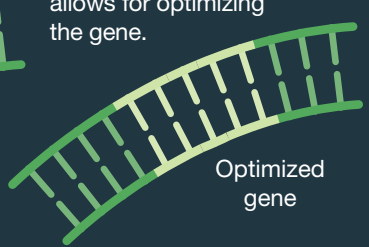


4. The Cas nuclease "snips" the double-stranded DNA at this location.

5. The cell will attempt to repair the break by joining the cut ends back together, making errors in the process. The errors effectively disrupt the gene.



If scientists package the CRISPR complex with a repair DNA template, there is a good chance that this repair DNA will enable a precise edit in the cell's genome, when the cell repairs the break. This allows for optimizing the gene.



GLOSSARY

Genome Editing
A breeding technique that improves on conventional breeding by making intentional, specific and beneficial changes in the plant genome, providing a similar outcome as via traditional breeding, but in a faster and more directed way.

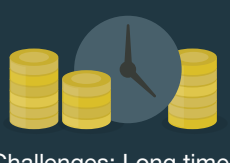
CRISPR
An acronym for **C**lustered **R**egularly **I**nterspaced **S**hort **P**alindromic **R**epeats. A collection of DNA sequences found in bacteria that led to the discovery of CRISPR-Cas genome editing technology.

Cas Nuclease
A CRISPR-associated protein. A DNA-cutting enzyme with two active cutting sites—one site for each strand of the DNA's double helix.

Guide RNA
A DNA-homing mechanism that guides the Cas nuclease protein to where it needs to cut in the target genome.

CRISPR-Cas
A system in which the Cas nuclease makes a double-stranded break in DNA at a site determined by a short (~20 nucleotides) guide RNA.

A COMPARISON: Plant-Breeding Technologies

Genome Editing (e.g., CRISPR-Cas)	Genetic Modification (GM)
	
Genome editing allows precise editing of a gene **native to the crop** to achieve desirable traits.	GM incorporates well-studied genes **from any source** to achieve desirable traits.
	
CRISPR-Cas edits the gene "text."	GM inserts a new chapter.
	
1-3 **edited genes** in play	1-10 **inserted genes** in play
	
3-5 **years** for research and development	10-12 **years** for research and development
	
Challenges: Knowing what to edit and editing commercial germplasm	Challenges: Long timeline and high cost for product development

FARM AND MARKETPLACE BENEFITS

Genome editing promises to bring novel plant varieties into the hands of growers faster, delivering many potential benefits for the entire value chain.

Grower Benefits
Improved disease resistance
Improved drought tolerance
Higher yields

Consumer Benefits
Better food quality/nutrition
Longer shelf life

A LOOK AHEAD

Syngenta crop technologies developed using genome editing are on track to reach the market in the beginning of the next decade. Relevant crops include:


Tomato


Corn


Soy


Wheat

Sunflower