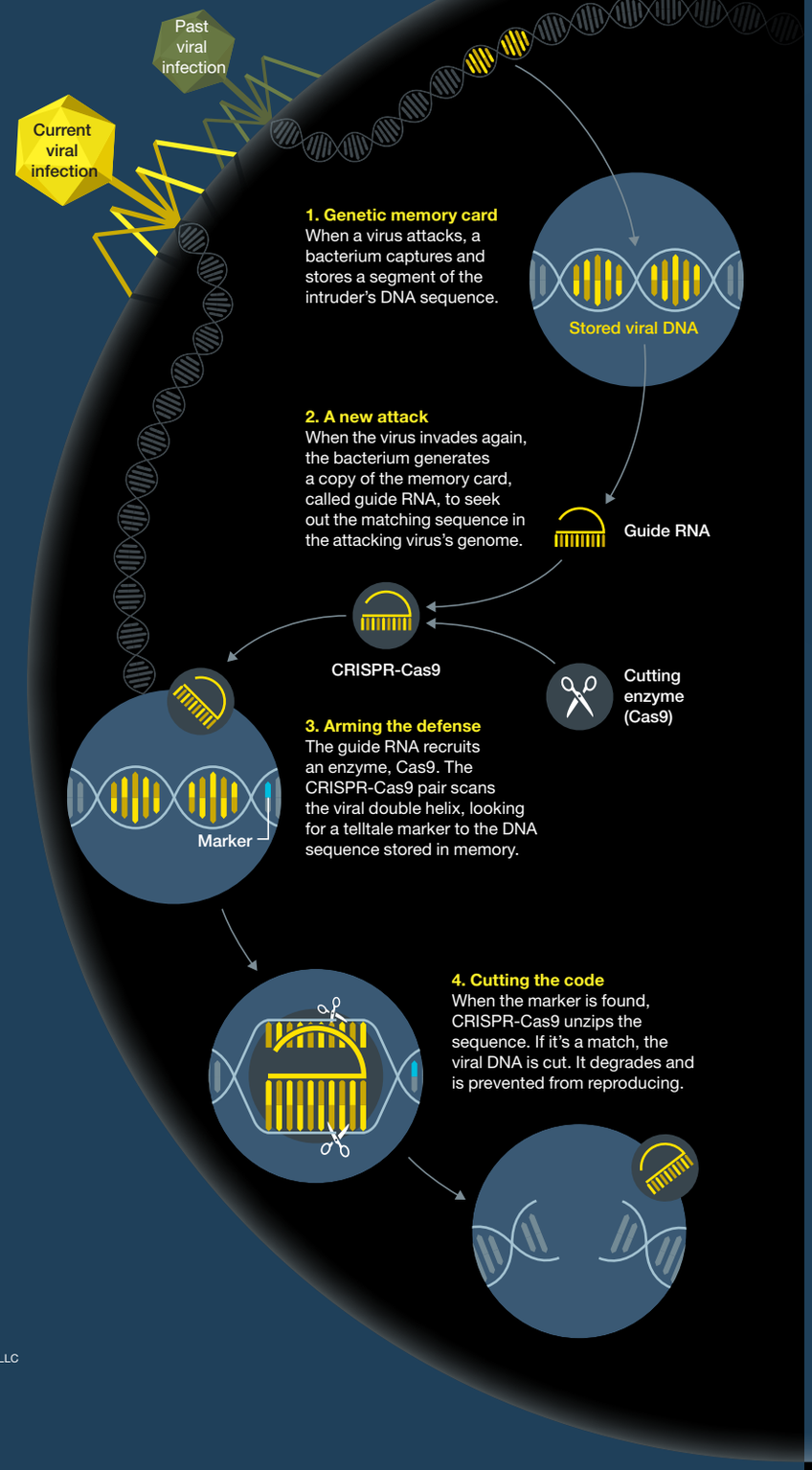
How to Hack DNA

Some bacteria have evolved a powerful system, called CRISPR, to fight viral infections. When a virus strikes, a bacterium captures and stores a short, identifying sequence of the virus's DNA—a sort of genetic "memory card." If the same virus attacks future generations of the bacteria, they use the memory card to guide a killer enzyme to the identical sequence in the new invader and cut it away. Scientists have co-opted this natural molecular machinery not only to turn off the action of a gene but also to insert new genetic code into living organisms, including humans. CRISPR has sparked an explosion of research—and a heated ethical debate.

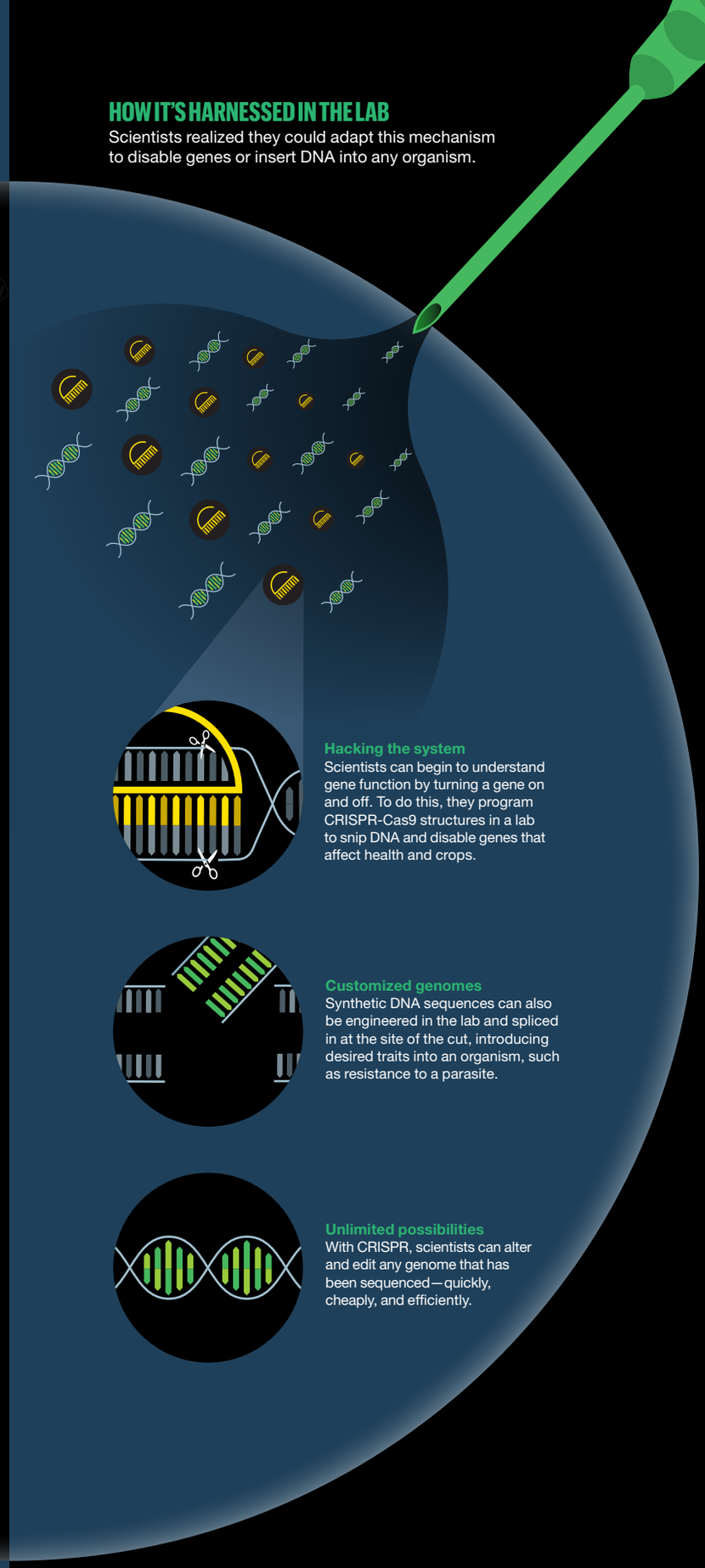
HOW IT WORKS IN NATURE

Researchers studying how viruses infect bacteria discovered a natural immune system that cuts the invader's DNA.



HOW IT'S HARNESSED IN THE LAB

Scientists realized they could adapt this mechanism to disable genes or insert DNA into any organism.



Hacking the system
Scientists can begin to understand gene function by turning a gene on and off. To do this, they program CRISPR-Cas9 structures in a lab to snip DNA and disable genes that affect health and crops.

Customized genomes
Synthetic DNA sequences can also be engineered in the lab and spliced in at the site of the cut, introducing desired traits into an organism, such as resistance to a parasite.

Unlimited possibilities
With CRISPR, scientists can alter and edit any genome that has been sequenced—quickly, cheaply, and efficiently.

APPLICATIONS FOR CRISPR TECHNOLOGY

Treating Disease
Genome-editing technology is revealing which DNA sequences are involved in diseases such as AIDS.

Altering Ecology
The spread of vector-borne illnesses like malaria could be reduced by introducing disease-resistant genes into wild insect populations.

Transforming Food
CRISPR could be used to develop drought-resistant or otherwise hardier crops. CRISPR mushrooms that don't brown have already been approved in the U.S.

Editing Humans?
Experiments with nonviable embryos show that much work will have to be done—and many questions answered—before CRISPR can be used to edit humans.

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