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# Gene Editing in Mustard:

# Less pungent, more useful

## Why in News?

- Indian scientists have developed the first ever low-pungent mustard that is pest and disease-resistant.
- It is based on CRISPR/Cas9 gene editing,
- while being non-GM and transgene-free.

mustard

canola

## Significance of Gene Editing in Mustard Breeding

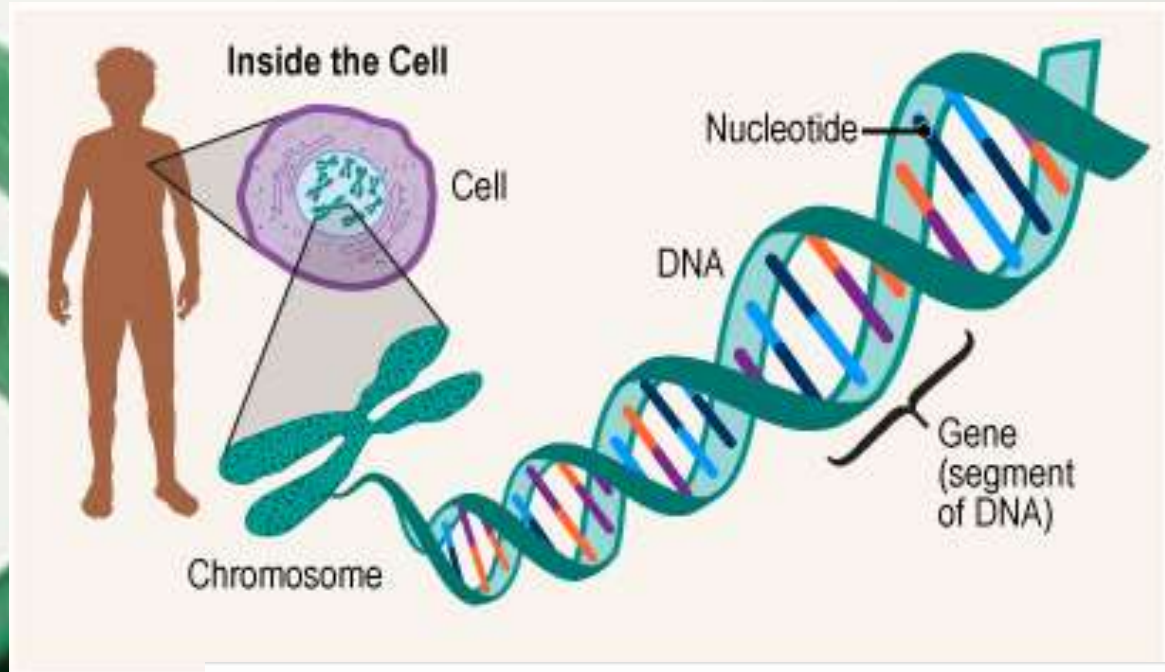
- Traditional mustard seeds contain about 120-130 parts per million (ppm) of compounds called glucosinolates,
- Glucosinolates are a group of sulphur and nitrogen-containing compounds contributing to the characteristic pungency of their oil and meal.
- Glucosinolates compounds serve as natural defenders, protecting the plant from pests and diseases.
- High glucosinolates are also known to cause goiter (swelling of neck) and internal organ abnormalities in livestock.
- In comparison, canola seeds have much fewer glucosinolates, around 30 ppm.

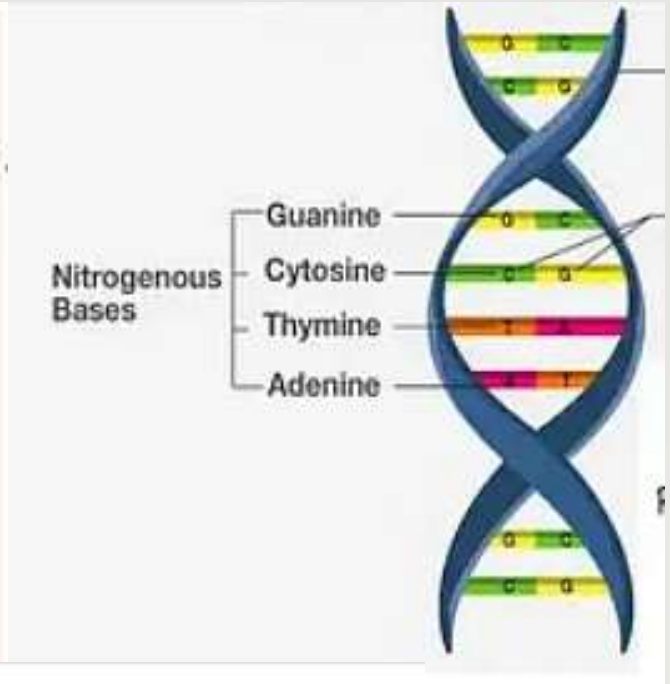
- Scientists have been working on a goal to develop mustard seeds that have fewer glucosinolates, similar to canola seeds.

- However, reducing glucosinolates in mustard seeds can weaken the plant's overall ability to defend itself against pests and diseases, which presents a challenge

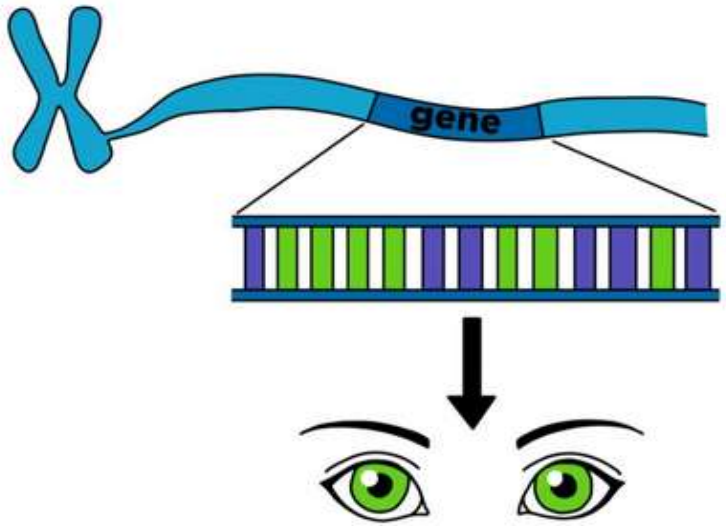
**Mustard Pests**

# Genome editing




## WHAT IS A GENE?




**Genes are segments of DNA**

**Each gene contains information about a certain trait**

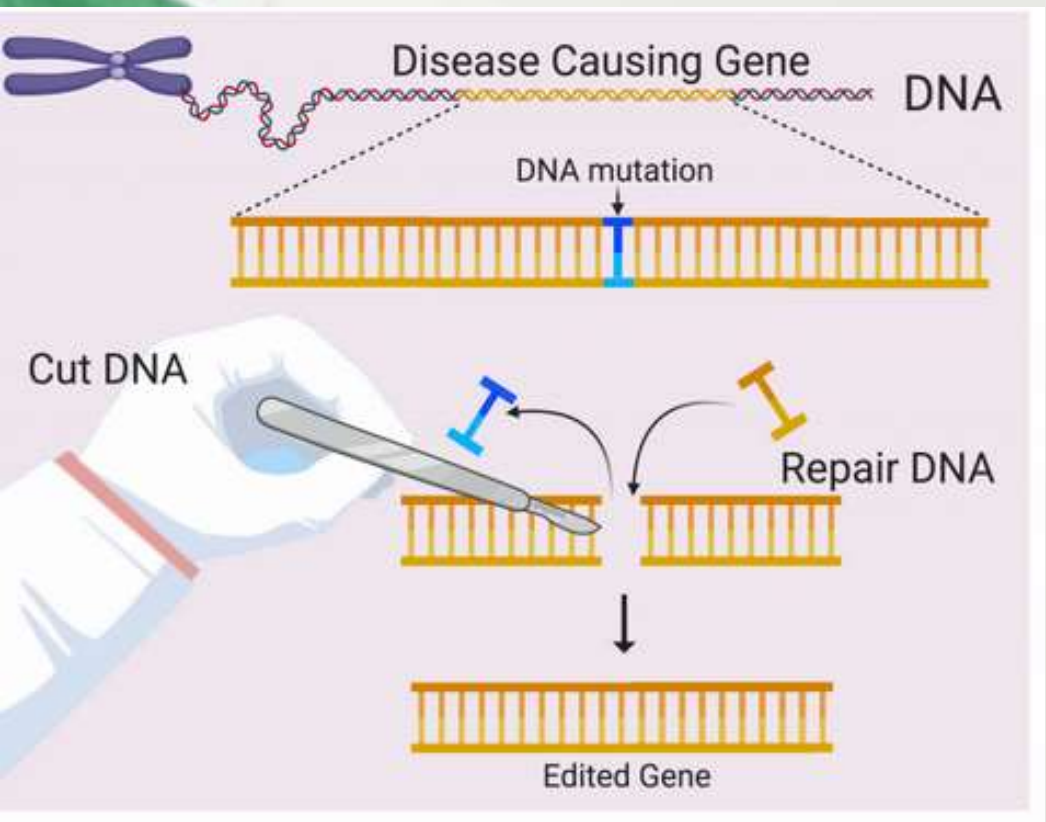
**Genes are transcribed and translated by the cell to make proteins**

**Proteins create a visible phenotype**

**Example:**

**One gene might code for eye color.**

**The gene is used by cells to make proteins which create green pigment in our eyes**

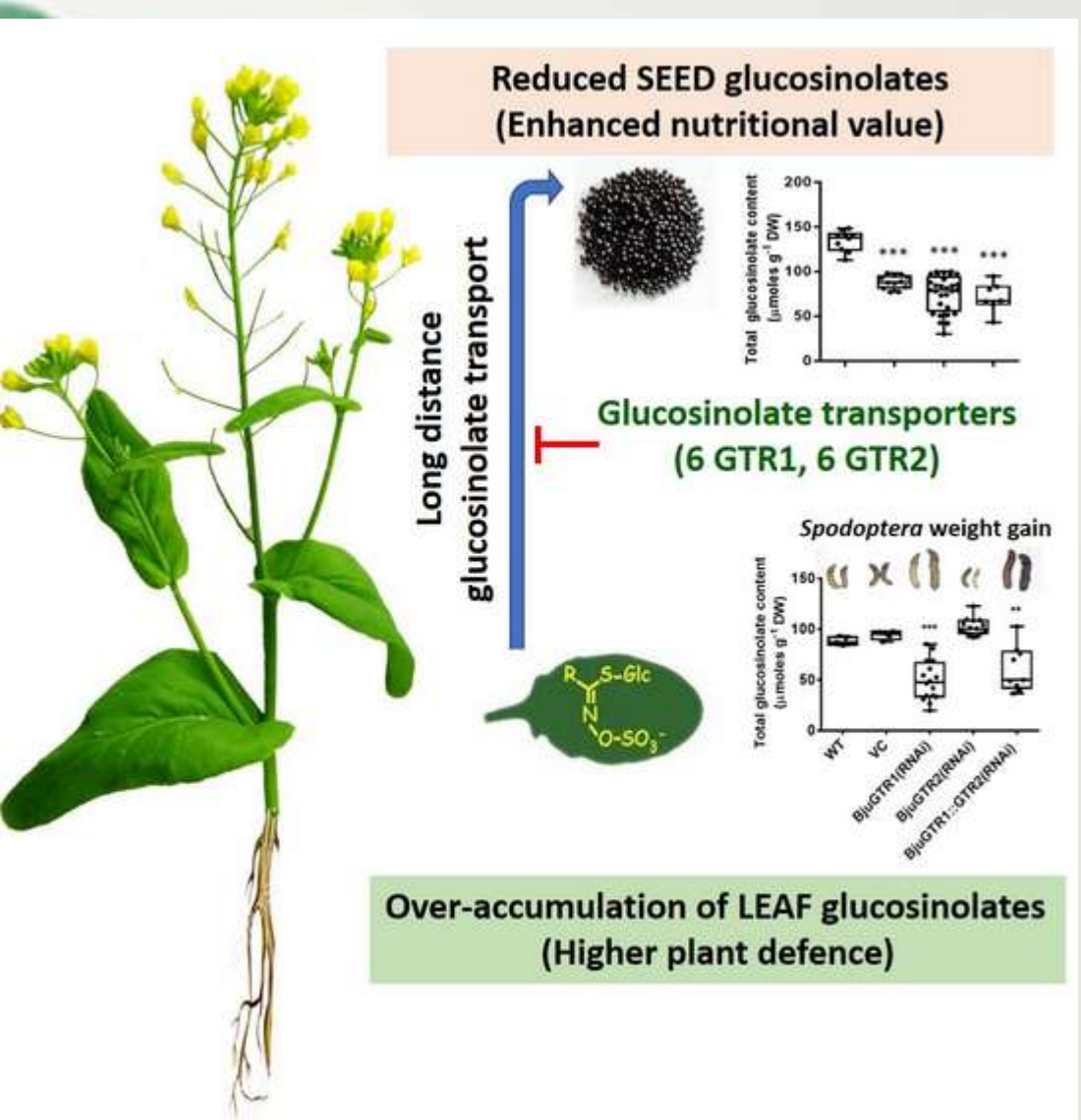



- **Genome editing –**

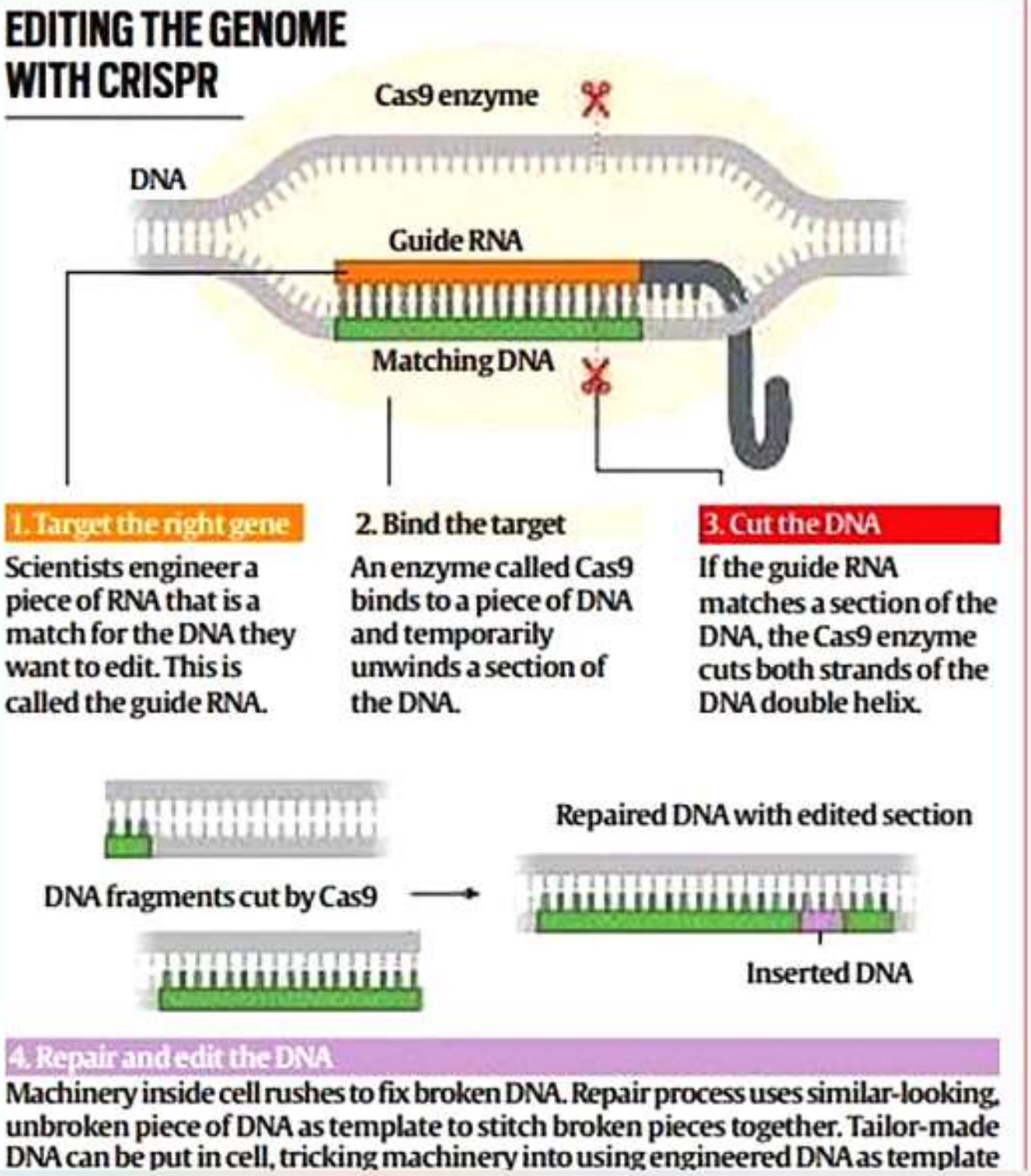
- **It involves the use of technologies that allow genetic material to be added, removed, or altered at particular locations in the genome.**

- **It could introduce specific foreign DNA/RNA that is not available in the natural gene pool of the host plant species thereby introducing novel traits.**

## How gene edited mustard is produced?




- Glucosinolates are synthesised in the leaves of mustard plants.
- Their translocation and accumulation in the seeds happens through the action of *glucosinolates transporter or GTR genes.*
- In a particular mustard variety named 'Varuna,' the researchers focused on 10 out of the 12 GTR genes.
- Through these genetic modifications, they deactivated the proteins produced by these genes, resulting in a significant reduction in glucosinolate levels within the seeds.
- The seeds of the resultant gene-edited Varuna variety had glucosinolate content below the 30 ppm canola-quality threshold.
- To achieve this modification, they employed a gene-editing tool called CRISPR/Cas9, which works like precision scissors to alter gene sequences accurately.




## CRISPR Cas-9

It stands for **Clustered Regularly Interspaced Short Palindromic Repeats.**

It is the **most prominent technology** that **enables to edit parts of the genome** by **removing, adding or altering sections of the DNA** sequence.

The **CRISPR-Cas9 system consists of two key molecules** that introduce a change mutation into the DNA.

**Cas9-** An **enzyme that acts as a pair of 'molecular scissors'** that can cut the two strands of DNA at a specific location in the genome.

**Guide RNA (gRNA)-** The gRNA is **designed to find and bind to a specific sequence in the DNA.**

## Advantages of Gene Edited Mustard

Sclerotinia

Spodoptera litura

- **Canola quality mustard-** The seeds of the resultant targeted genes-edited Varuna mustard variety had **glucosinolate content well below the 30 ppm** canola-quality threshold. **Earlier it was 120-130ppm in mustard**
- **Pest and disease resistance** - They were **resistant against** the virulent **fungal pathogen, Sclerotinia** and the **insect pest Spodoptera litura.**
- **Transgene free-** It **does not contain foreign genes like** those of the Bacillus thuringiensis bacteria in **Bt-cotton in the GM hybrid mustard.**
- **Reduce import bill- India** is a **huge importer of edible oils. Gene edited mustard helps** in **saving foreign exchange** reserves.

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