



Base Editing

For Prelims: Base Editing, CRISPR-Cas9 Technique, Cancer, T-cell Acute Lymphoblastic Leukaemia (T-ALL), Genetic Code, Genetic Engineering, Gene Editing.

For Mains: Base Editing Technique and its Significance.

Why in News?

Recently, scientists in the United Kingdom (UK) have **successfully tested a new form of cancer therapy, 'Base Editing' for the time** in a patient with T-cell Acute Lymphoblastic Leukemia (T-ALL).

What is Base Editing?

- **Bases are the language of life.** Just as letters in the alphabet spell out words that carry meaning, the **billions of bases in our [Deoxyribonucleic Acid \(DNA\)](#) spell out the instruction manual for our body.**
 - A **mis-arrangement in the sequence of bases** may cause cancer.
- Using the technique of **base editing, the molecular structure of just one base in a genetic code can be altered**, effectively changing its genetic instructions.
 - **Genetic code** refers to the **instructions contained in a gene** that tell a cell how to make a specific protein.
 - Each genetic code uses the four nucleotide bases of DNA: **Adenine (A), Cytosine (C), Guanine (G) and Thymine (T)** — in various ways to **spell out three-letter "codons" that specify which amino acid is needed at each position within a protein.**
- **[Clustered Regularly Interspaced Short Palindromic Repeats \(CRISPR\)](#) technology is one of the most popular approaches** that allows the genes to be altered, thereby, fixing the errors.
 - This method has been **further improvised to be able to directly change certain bases** such as a C can be changed into a G and T into an A.

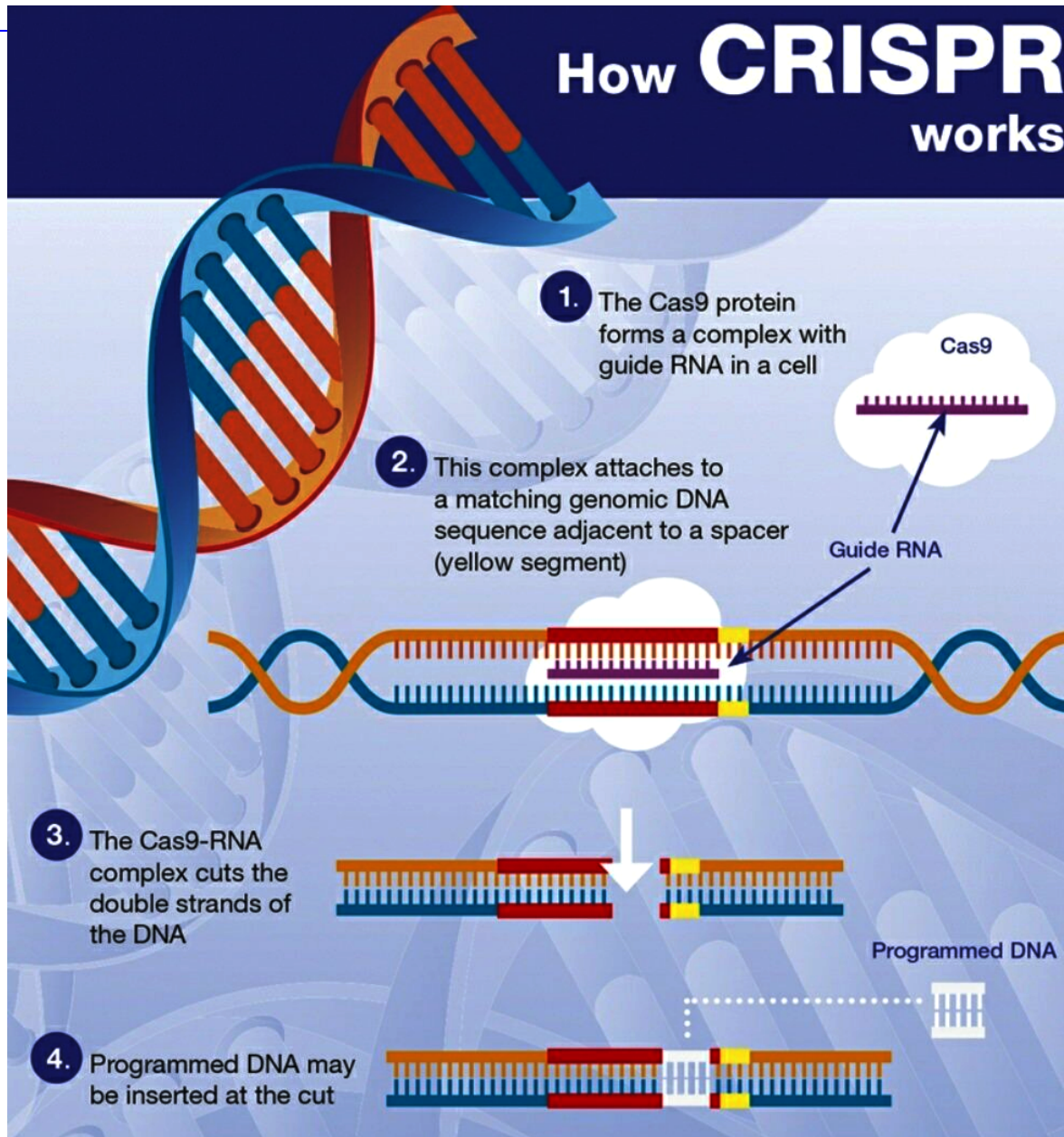
What is CRISPR Technology?

- CRISPR is a **[gene editing technology](#)**, by which research **scientists selectively modify the DNA of living organisms using a special protein called Cas9.**
- CRISPR/Cas9 edits genes by precisely cutting DNA and then letting natural DNA repair processes to take over. The system consists of two parts: the **Cas9 enzyme and a guide [Ribonucleic Acid \(RNA\)](#).**
 - **Cas9:** a CRISPR-associated (Cas) endonuclease, or enzyme, that acts as "molecular scissors" to cut DNA at a location specified by a guide RNA.
 - **Guide RNA (gRNA):** a type of RNA molecule that binds to Cas9 and specifies, based on the sequence of the gRNA, the location at which Cas9 will cut DNA.
- **CRISPR-Cas9 technology** is often described as **'Genetic Scissors'**.
- Its mechanism is often compared to the **'cut-copy-paste', or 'find-replace'** functionalities in common computer programmes.
- A **bad stretch** in the DNA sequence, which is the cause of disease or disorder, is **located, cut,**

and removed and then replaced with a 'correct' sequence.

- The technology replicates a natural defence mechanism in some bacteria that uses a similar method to protect itself from virus attacks.

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What is T-ALL?

- It affects the stem cells in the bone marrow that produce a particular kind of White Blood Cells (WBCs) called T lymphocytes (T-cells).
 - T-cells provide a person with immunity by killing cells carrying infections, activating other immune cells, and regulating the immune response.
- T-ALL is a rapid and progressive type of blood cancer in which the T-cells start destroying healthy cells instead of helping in immunity (that's T-cells' normal function).
- It is usually treated by chemotherapy, radiation therapy and stem cell/bone marrow transplant.

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims

Q. What is Cas9 protein that is often mentioned in news? (2019)

- (a) A molecular scissors used in targeted gene editing
- (b) A biosensor used in the accurate detection of pathogens in patients
- (c) A gene that makes plants pest-resistant
- (d) A herbicidal substance synthesized in genetically modified crops

Ans: (a)

Exp:

- CRISPR-Cas9 is a unique technology that enables geneticists and medical researchers to edit parts of the genome by removing, adding or altering sections of the DNA sequence.
- CRISPR is an acronym for “Clustered Regularly Interspaced Short Palindromic Repeats.”
- Cas9 is basically an enzyme that is used like a pair of scissors to cut two strands of DNA at a specific location to add, remove or repair bits of DNA.
- **Hence, option (a) is the correct answer.**

Mains

Q. What are the research and developmental achievements in applied biotechnology? How will these achievements help to uplift the poorer sections of society? (2021)

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