CRISPR: A Revolution in the field of Evolution

Why in news?

In the 10 years since it was developed, the genome editing technology called CRISPR has begun to deliver the near unlimited potential to improve the quality of human life.

What is CRISPR?

- CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats.
- CRISPR-Cas9 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.
    1. **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.
    2. **Guide RNA (gRNA)**- The gRNA is designed to find and bind to a specific sequence in the DNA.
- The Cas9 follows the guide RNA to the same location in the DNA sequence and makes a cut across both strands of the DNA.
- At this stage, the cell recognises that the DNA is damaged and tries to repair it.
- The DNA repair machinery is used to introduce changes to one or more genes in the genome of a cell of interest.
- The technology replicates a natural defence mechanism in some bacteria that uses a similar method to protect itself from virus attacks.

What are the advantages of this technology?

- **Faster and Cheaper**- It is faster and cheaper than previous techniques of editing DNA.
- **High accuracy**- Genetic engineering has made the work more accurate by allowing scientists to have greater control on trait development.
- **Viable compared to GMO**- CRISPR technology proves viable against the criticisms of Genetically Modified Organisms (GMO).

Genome editing does not involve the introduction of foreign genetic material while genetic engineering does.

What are the applications?

- **Health**- CRISPR-Cas9 can act as a tool for treating a range of medical conditions that

have a genetic component, including cancer, hepatitis B or even high cholesterol.
- It was shown in mice that it is possible to shut down HIV-1 replication and even eliminate the virus from infected cells.
- In sickle cell anaemia, a single gene mutation makes the blood sickle-shaped, which can be reversed using gene editing technology.
- Some scientists are working to create sterile mosquitoes to prevent the vector based transmission of diseases like Malaria.
- **Agriculture**- CRISPR/Cas9 technology has been used to optimize the shape and size of the crops according to consumer preferences.
- CRISPR genome-editing technology opens new opportunities to engineer disease resistance traits.
- Japan has already approved the commercial cultivation of a tomato variety that has been improved using CRISPR-based intervention.

The 2020 Nobel Prize in Chemistry was awarded to Jennifer A. Doudna and Emmanuelle Charpentier, in recognition of their discovery of CRISPR-Cas9 gene scissors.

What are the issues with CRISPR technology?

- **Ethical concerns**- In 2018, a Chinese researcher's disclosure of creating a '**designer baby**' has caused widespread concern in the scientific community.
- **Biological concerns**- Though the technology is not 100% precise and has the risk of causing mutations, side effects and undesirable changes like antibiotic resistance.
- **Genetic drive** - Once the manipulated genes get transferred on to next generations, they become part of the environment.
- **Gene gap**- CRISPR can be very expensive and get limited to those who can afford it.

Where does India stand in the field of gene editing and CRISPR?

- India is at its infancy when it comes to genome editing.
- Research in gene editing is not so abundant but it is growing steadily.
- Although the funding for biology has been steadily growing, a lot of investment is needed in infrastructure.
- **India's draft gene-editing rules** allows genome-edited organisms without any "foreign" genes to be subjected to a different regulatory process than the one applied to genetically engineered products.

Genetic Engineering Appraisal Committee (GEAC), Ministry of Environment, Forest and Climate Change is the final technical body that certifies a Genetically Modified product as safe for commercial release.

References

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