CRISPR-Cas9 - Gene Editing

Part of: GS-III- S&T (PT-MAINS-PERSONALITY TEST)

Background

A Chinese researcher recently claimed that he had altered the genes of a human embryo that eventually resulted in the birth of twin girls. The genes were claimed to be “edited” to ensure that they do not get infected with HIV, the virus that causes AIDS. If proven, it would be the first instance of human offspring having been produced with specific desired attributes, using newly-developed tools of gene “editing”.

What are Genes and what is gene-editing?

Genes contain the bio-information that defines any individual. Physical attributes like height, skin or hair colour, more subtle features and even behavioural traits can be attributed to information encoded in the genetic material.

An ability to alter this information gives scientists the power to control some of these features. Gene “editing” — sometimes expressed in related, but not always equivalent, terms like genetic modification, genetic manipulation or genetic engineering — is not new.

What is CRISPR-Cas9?

The clustered, regularly interspaced, short palindromic repeats, or CRISPR/CRISPR-associated protein 9 (Cas9) (CRISPR-Cas9) system has revolutionised genetic manipulations and made gene editing simpler, faster and easily accessible to most laboratories.

CRISPR technology is basically a gene-editing technology that can be used for the purpose of altering genetic expression or changing the genome of an organism.

- The technology can be used for targeting specific stretches of an entire genetic code or editing the DNA at particular locations.
- CRISPR technology is a simple yet powerful tool for editing genomes. It allows researchers to easily alter DNA sequences and modify gene function.
- Its many potential applications include correcting genetic defects, treating and preventing the spread of diseases and improving crops. However, its promise also raises ethical concerns.

How it works?

CRISPR-Cas9 technology behaves like a cut-and-paste mechanism on DNA strands that contain genetic information.

- The specific location of the genetic codes that need to be changed, or “edited”, is identified on the DNA strand, and then, using the Cas9 protein, which acts like a pair of
scissors, that location is cut off from the strand. A DNA strand, when broken, has a natural tendency to repair itself.

- Scientists intervene during this auto-repair process, supplying the desired sequence of genetic codes that binds itself with the broken DNA strand.

**Concerns:** Tampering with the genetic code in human beings is more contentious. Leading scientists in the field have for long been calling for a “global pause” on clinical applications of the technology in human beings, until internationally accepted protocols are developed.

**Issues:**

Study by Stanford University, U.S., found that the CRISPR-Cas9 system *introduces unexpected off-target (outside of the intended editing sites) effects in mice*. The fear that the CRISPR system is being prematurely rushed for clinical use lingers. Three recent reports have exacerbated this fear even further.

- Studies highlighted that CRISPR-Cas9-edited *cells might trigger cancer*.
- May increase the risk of mutations elsewhere in the genome in those cells.
- Although, CRISPR-Cas9 technology has been successfully used to cure several diseases however, it remains many things are not clear like how we should determine which disease or traits are appropriate for gene editing.

**Ethical concerns:** In addition, there are concerns with manipulating human embryos for own interest.

**Conclusion:** This CRISPR technology is indeed a path-breaking technology, to alter genes in order to tackle a number of conventional and unconventional problems, especially in the health sector. However, experiments and tests to validate its use must be subjected to appropriate scrutiny by the regulators, and their use must be controlled to prevent commercial misuse.