Gene–Editing

Background

- He Jiankui Chinese researcher shocked the scientific community in 2018 after announcing he had successfully altered the genes of twin girls born in November to prevent them from contracting HIV.
- He "privately" organised a project team and used "technology of uncertain safety and effectiveness" for illegal human embryo gene-editing, investigators said.
- Such gene-editing work is banned in most countries which includes China.

Cutting-and-pasting DNA (CRISPR-CAS9)

- CRISPR-CAS9 is a technology used by the scientists to essentially cut-and-paste DNA, raising hope of genetic fixes for a disease. However, there are also some concerns about its safety and ethics.
- It is a dynamic, versatile tool that can be used to target nearly any genomic location and potentially repair broken genes. It can be used to remove, add or alter specific DNA sequences in the genome of higher organisms.

How does it work?

- Unusual but repeated DNA structures that scientists had been observing for some time were given a name. This name assigned was "Clustered regularly interspaced short palindromic repeats" or CRISPR.
- In 2012, scientists discovered that CRISPR is a key part of the "immune system".
- For instance, when a virus enters a bacterium, it fights back by cutting up the virus's DNA.
- This kills the virus but the bacterium store some of the DNA. So in case there is an invasion again by the same virus, the bacterium produces an enzyme called Cas9 which matches the stored fingerprints with that of the invader's and If it matches, Cas9 can snip the invading DNA.
- The CRISPR-Cas9 gene editing tool thus has two components. These are:
    - ✓ First, a short RNA sequence that can bind to a specific target of the DNA and
    - ✓ Second, the Cas9 enzyme which acts like a molecular scissor to cut the DNA.

To edit a particular gene of interest, the short RNA sequence that perfectly matches with the DNA sequence that has to be edited, is introduced.
Once it binds to the DNA, the Cas9 enzyme cuts the DNA at the targeted location where the RNA sequence is bound.
Once the DNA is cut, the natural mechanism of DNA repair is utilised to add or remove genetic material or make changes to the DNA.

What are the possible advantages of Gene editing?

- The tool could be used to modify disease-causing genes in embryos, removing the faulty script from the genetic code of that person's future descendants as well. Genome editing or Gene editing could potentially decrease, or even eliminate, the incidence of many serious genetic diseases, reducing human suffering worldwide.
- It is also possible to install genes that offer lifelong protection against infection.
- CRISPR May Prove Useful in De-Extinction Efforts. For example,Researchers are using the powerful gene-editing tool to recreate the woolly mammoth.
- CRISPR Could Create New, Healthier Foods: In agricultural crops, Crispr has the potential to impact yield, disease resistance, taste, and other traits. Few experiments have been done. If successful it can help us to eradicate the problem of hunger and malnutrition.

What are the cons of Gene editing?

- Making irreversible changes to every cell in the bodies of future children and all their descendants would constitute extraordinarily risky human experimentation.
- There are issues including off-target mutations (unintentional edits to the genome), persistent editing effects, genetic mechanisms in embryonic and fetal development, and longer-term health and safety consequences.
- Altering one gene could have unforeseen and widespread effects on other parts of the genome, which would then be passed down to future generations.
- Many consider genome alterations to be unethical, advocating that nature should be left to run its own course.
- Few argue that after permitting human germline gene editing for any reason would likely lead to its ignorance of the regulatory limits, to the emergence of market-based eugenics that would exacerbate already existing discrimination, inequality, and conflict.
- It will become a tool for selecting desired characteristics such as intelligence and attractiveness.
- It can also be used to eliminate dangerous species of pests and few experiments are being carried out on mosquitoes but eliminating a species, even one that doesn't appear to have much ecological value, could upset the careful balance of ecosystems. That could have disastrous consequences, such as disrupting the food web or increasing the risk that diseases like malaria could be spread by different species entirely.

Current scientific advancements show that CRISPR is not only an extremely versatile technology, it's proving to be precise and increasingly safe to use. But a lot of progress still has to be made; we are only beginning to see the full potential of genome-editing tools like CRISPR-Cas9. Technological and ethical hurdles still stand between us and a future in which we feed the planet with engineered food, eliminate genetic disorders, or bring extinct animal species back to life.