4. Synthetic Biology

Prelims Level: Biotechnology

Mains Level: Science and Technology - Developments and their applications and effects in everyday life Achievements of Indians in Science & Technology; Indigenization of Technology and developing New Technology.

Context:

- The technology of Synthetic Biology is been pursued by industries despite there being no regulatory framework.

About Synthetic Biology:

- It is a field of science that involves redesigning of organisms for useful purposes by engineering them with new enhanced abilities.
- It aims to solve problems in varied fields like medicine, manufacturing and agriculture despite there being no regulatory framework in place.
- It combines chemical synthesis of DNA with growing knowledge of genomics to enable researchers to quickly manufacture catalogued DNA sequences and assemble them into new genomes.
- It is used to generate products ranging from ethanol and drugs to complete synthetic organisms such as complex bacteria that can digest and Neutralize Toxic Chemicals.

Objective:

- To create fully operational possible biological systems from the smallest constituent parts, including DNA, proteins, and other organic molecules.

Difference between Synthetic Biology and Genome Editing:

SYNTHETIC BIOLOGY	GENOME EDITING
It involves organism's genetic code	It also involves organism's genetic code
It stitches together long stretches of DNA and insert them into an organism.	It uses tools to delete or add small stretches of DNA in the genome
DNA could be genes that are found in other organisms or they could be entirely new.	It uses tools to make small changes to the organism's own DNA

Applications:

- It identifies and categorize standardized genomic parts that can be used (and synthesized quickly) to build new biological systems.
- It redesigns existing biological parts and expand the set of natural protein functions for new processes.
- For example, the Modified rice to produce beta-carotene a nutrient usually associated with carrots, that prevents Vitamin A deficiency.
- The Natural Product Synthesis is a use of microbe to produce all of the necessary enzymes and biological functions to perform complex multistep production of natural products.
- For example, Microorganisms harnessed for bioremediation use of living microorganisms to degrade environmental contaminants into less toxic forms to clean pollutants from water, soil and air.
- Synthetic Genomics is a design and construct of a 'simple' genome for a natural bacterium.
- For example, Yeast is used to produce rose oil as an eco-friendly and sustainable substitute for real roses that perfumers use to make luxury scents.

International Scenario:

- The UN Convention on Biological Diversity (CBD), has been working for more than four years in providing a global framework to deal with synthetic biology in the context of its impacts on conservation and sustainable use of biological resources.
- In the past few years, Japan's research and development into this technology has been phenomenal. Also, in Europe, the foresight assessment of this technology has brought the elements of real opportunities at par with virtual problems.

Indian Scenario:

- India established the Department of Biotechnology in 1986 to harness the emerging science to the benefit of the country.
- There is been a long-standing lack of clarity and consensus on how India needs to deal with genetic modification technology in areas like agriculture.
- Those who are developing this new technology are cautious of India's changing stance on use and protection of such technology while, on the other, the farmers are completely at a loss at comprehending how to increase productivity without having access to technology.
- Even the Ministry of Environment, Forests and Climate Change is striving hard to gain approval for commercialisation of such new technology.

Way Forward:

- The bioethics have expressed the need for enhanced public engagement and dialogue in the governance of emerging synthetic biology and genome editing technologies in order to efficiently harness its benefits.
- India's policy and regulatory framework needs to focus on issues like,
  - ✓ Defining what Constitutes the Science of synthetic biology
  - ✓ Research and Development Priorities that will be made for public sector
  - ✓ Guidance for Private Sector for Future Research
- Like any other technology, synthetic biology is an emerging science with possible positive and negative impacts.
- The science is real and its applications are varied. However, the potential harms and benefits associated with synthetic biology are required to be addressed. Countries like India, are in a dilemma where the industry is pushing ahead with investments in developing organisms and products with almost no regulatory or policy oversight on such technology.