Minimal-Genome Cells Evolve as Fast as Normal Cells

Source: TH

Why in News?

Researchers from Indiana University, Bloomington, shed light on the **evolutionary potential of cells with minimal genes** (smallest set of genes that are **essential for the survival and reproduction of an organism).**

- Their study, published in the ***journal Nature***, explores how **cells stripped down to only essential genes can adapt and evolve**, challenging conventional **notions of genetic flexibility and mutation rates.**

What are the Key Findings from the Study?

- The study concentrated on a synthetic minimal-cell version of **Mycoplasma mycoides, a bacterial species** that can cause respiratory disease in goats and cattle.
  - This minimal version **has only 493 essential genes,** in contrast to the non-minimal strain with 901 genes, and the study spanned over 300 days.
  - **Mycoplasma mycoides has the highest recorded mutation rate for any cellular organism.**
- Cells with minimal essential genes can adapt and evolve at a rate comparable to normal cells.
- Minimal cells exhibited **mutation rates similar to non-minimal cells,** despite their reduced genetic material.
  - Genome minimization **did not hinder the rate of adaptation in minimal cells.**
- Understanding the evolution of minimal cells has implications for fields like **synthetic biology**, where researchers **employ engineering principles** to design organisms for applications in **medicine and fuel production.**
  - This study reveals that **engineered cells are not static; they undergo evolution,** shedding light on how **synthetic organisms might adapt when facing the inevitable forces of evolution.**

- **Gene**:
  - A gene is a **segment of Deoxyribonucleic acid (DNA)** that codes for a specific protein or function. Genes are the **basic units of heredity** and can be **inherited from parents or mutated by environmental factors.**
- **Gene Mutation:**
  - A gene mutation is a **change in the DNA sequence of a gene** that may affect its function or expression.
  - Gene mutations can be caused by errors during **DNA replication, exposure to radiation or chemicals, or other factors.**
- **Genome:**
  - A genome is the **complete set of genetic information of an organism** or a virus.
- **Genetic Sequencing:**
  - It is the process of determining the **order of nucleotides or bases (A, G, C, and T) in a DNA or RNA molecule**

- **Genome Editing:**
  - It is a type of genetic engineering in which DNA is **inserted, deleted, modified or replaced** in the genome of a living organism.
- **Genetic Modification:**
  - It is the **process of changing the DNA of an organism,** such as a bacterium, plant or animal, **by introducing elements of DNA from a different organism.**

UPSC Civil Services Examination, Previous Year Questions

Prelims

Q. With reference to agriculture in India, how can the technique of 'genome sequencing', often seen in the news, be used in the immediate future? (2017)

1. Genome sequencing can be used to identify genetic markers for disease resistance and drought tolerance in various crop plants.
2. This technique helps in reducing the time required to develop new varieties of crop plants.
3. It can be used to decipher the host-pathogen relationships in crops.

Select the correct answer using the code given below:

(a) 1 only
(b) 2 and 3 only
(c) 1 and 3 only,
(d) 1, 2 and 3

Ans: D

Exp:

- Chinese scientists decoded rice genome in 2002. The Indian Agricultural Research Institute (IARI) scientists used the genome sequencing to develop better varieties of rice such as Pusa Basmati-1 and Pusa Basmati-1121, which currently makes up substantially in India's rice export. Several transgenic varieties have also been developed, including insect resistant cotton, herbicide tolerant soybean, and virus resistant papaya. **Hence, 1 is correct.**
- In conventional breeding, plant breeders scrutinize their fields and search for individual plants that exhibit desirable traits. These traits arise spontaneously through a process called mutation, but the natural rate of mutation is very slow and unreliable to produce all the plant traits that breeders would like to see. However, in genome sequencing it takes less time, thus it is more preferable. **Hence, 2 is correct.**
- The host-pathogen interaction is defined as how microbes or viruses sustain themselves within host organisms on a molecular, cellular, organism or population level. The genome sequencing enables the study of the entire DNA sequence of a crop, thus it aids in understanding of pathogens' survival or breeding zone. **Hence, 3 is correct.**
- **Therefore, option (d) is the correct answer**