Genome India Project

For Prelims: Genome India Project**,** Whole-genome sequencing**,** Applications of Genome Sequencing.

For Mains: Procedure of Genome Sequencing, Goal of Genome India Project.

Source: TH

Why in News?

The **Genome India Project**, a project funded and coordinated by the Department of Biotechnology (DBT), announced that it had finished sequencing 10,000 Indian genomes.

What is the Genome India Project?

- DBT initiated the ambitious Genome India Project (GIP) on 3rd January 2020. It is led by the **Centre for Brain Research at the Indian Institute of Science, Bengaluru,** and involves collaboration with 20 institutions.
- The project involves **whole-genome sequencing** and data analysis of **10,000 individuals** to understand disease nature in the Indian population and develop predictive diagnostic markers.
    - India's population of 1.3 billion comprises over 4,600 population groups, many of which are **endogamous (Matrimony in Close Ethnic Groups),** contributing to **genetic diversity** and disease-causing mutations.
- This huge dataset of 8 petabytes will be stored at the **Indian Biological Data Centre (IBDC) in Faridabad.**
    - Inaugurated in 2022, the IBDC is **India's first national repository for life science data.**
- **Significance:**
    - An India-specific genetic database is crucial because mutations like MYBPC3, linked to early **cardiac arrest**, are more prevalent locally than globally, affecting **4.5%** of the Indian population.
    - India, boasting the world's largest genetic laboratory, plays a pivotal role in driving the country's burgeoning biology sector, which has seen exponential growth from **USD 10 billion in 2014** to over **USD 130 billion in 2024**, shaping India's future trajectory.

Note

The **first whole human genome** was sequenced with the collaboration of an international team. It took 13 years and $3 billion, and **was completed in 2003**. India announced its **first complete human genome in 2009.**

- However, now, it takes only about 5 days to sequence an entire human genome and perform all the quality checks.

What is Genome Sequencing?

- **Gene and DNA**: DNA (Deoxyribonucleic acid) is the molecule that carries the genetic instructions for the development, functioning, growth, and reproduction of all known living organisms and many viruses.
    - Genes are specific segments of DNA that contain the instructions for producing proteins, which are essential for various biological functions.
- **Genome:** The genome represents the **entirety of an organism's hereditary information,** serving as a biological instruction manual inherited from parents.
    - Composed of four nucleotide bases: **adenine (A), cytosine (C), guanine (G), and thymine (T),** the genome contains approximately 3 billion base pairs in humans.
    - This complex sequence encodes **essential information governing an individual's physical characteristics**, susceptibility to diseases, and other biological traits.
- **Genome Sequencing**: Genome sequencing is the process of determining the **precise order of** nucleotides within an organism's genome.
    - Whole genome sequencing is a laboratory procedure that determines the order of all four bases in the genome of an organism in one process.
- **Procedure of Genome Sequencing:**
    - Firstly, the researchers extract DNA from a sample, typically obtained from blood.
    - Then, the DNA is fragmented into smaller, more manageable pieces, which are then tagged with fluorescent markers.
        - These tagged fragments undergo sequencing using **specialised equipment known as DNA sequencers**, which read the sequence of nucleotide bases.
    - Finally, computational algorithms are employed to reconstruct the complete genetic sequence from the generated data, providing valuable insights into the individual's genetic makeup.
- **Applications:**
    - **Biomedical Research:** Genome sequencing aids in understanding the genetic basis of diseases, **identifying disease-causing mutations, and discovering potential drug targets.**
        - It helps researchers study genetic variations associated with complex diseases such as cancer, diabetes, and neurological disorders.
    - **Pharmacogenomics:** Genome sequencing helps in predicting how individuals will respond to different drugs based on their genetic makeup.
        - This information can optimise drug selection, dosage, and treatment strategies leading to more effective and personalised therapies.
    - **Agricultural Genomics**: Genome sequencing is utilised in crop improvement programs to identify **genes responsible for desirable traits such as disease resistance, yield, and nutritional content.**
        - It aids in breeding efforts to develop improved crop varieties with enhanced agronomic traits.
    - **Evolutionary Biology:** Genome sequencing provides insights into the evolutionary history and relationships among species.
        - It helps in studying genetic diversity, population dynamics, and evolutionary adaptations in different organisms.
    - **Conservation Biology:** Genome sequencing assists in conservation efforts by assessing genetic diversity, identifying endangered species, and developing strategies for species preservation and management.

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Q1. 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)