Genome India Project

For Prelims: Genome India Project, Human Genome Project, Genomes Mapping, Deoxyribonucleic acid.

For Mains: Potential of Genome India Project in the fields of biotechnology, agriculture and healthcare.

Why in News?

Government aims to sequence 10,000 genomes by the end of the year 2023 under the **Genome India Project (GIP).**

- The Department of Biotechnology, Ministry of Science and Technology has sequenced close to 7,000 genomes and 3,000 of these are already available for public access.

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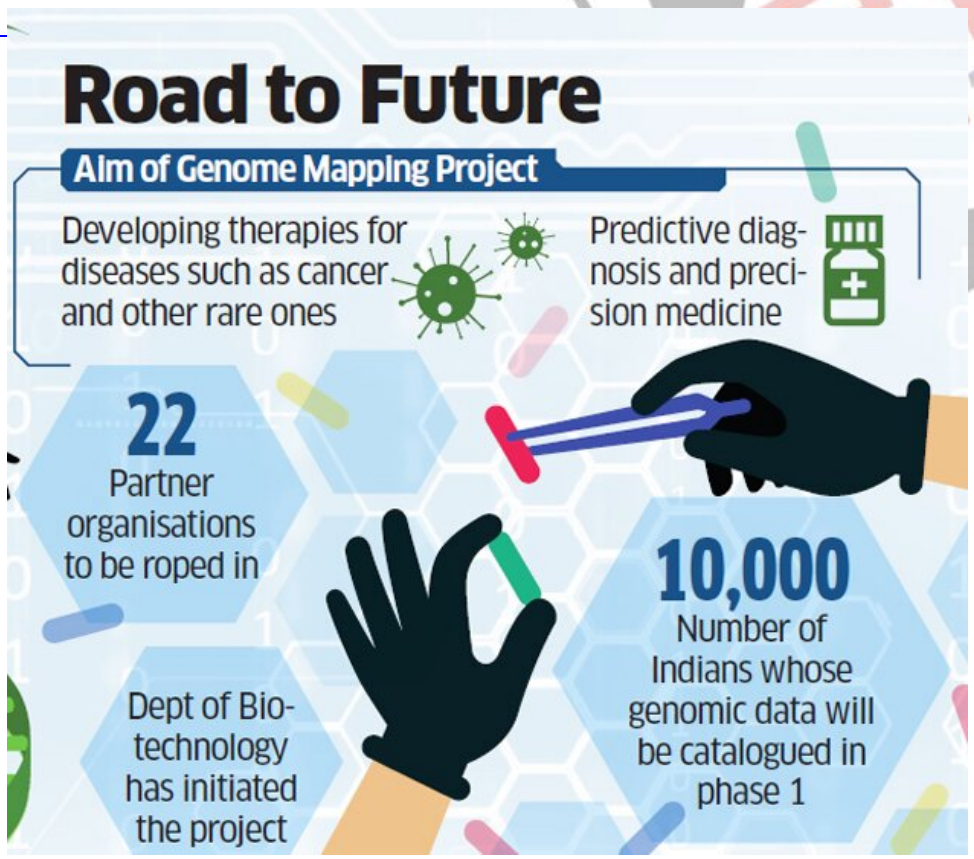

What is the Genome India Project?

- **Need:**
  - India's population of **1.3 billion is made up of over 4,600 diverse population groups**,

many of which are endogamous (Matrimony in Close Ethnic Groups). These groups have **unique genetic variations and disease-causing mutations** that cannot be compared to other populations. By creating a database of Indian genomes, researchers can learn about these unique genetic variants and use the information to create personalized drugs and therapies. The **United Kingdom, China, and the United States** are among the countries that **have programmes to sequence at least 1,00,000 of their genomes.**

- **About:**
  - It is a scientific initiative inspired by the **Human Genome Project (HGP),** an international effort that successfully decoded the entire **human genome between 1990 and 2003.**
  - The project was started **in 2020,** aiming to **better understand the genetic variations and disease-causing mutations** specific to the Indian population, which is one of the most genetically diverse in the world.
  - By sequencing and analyzing these genomes, researchers hope to gain insights into the **underlying genetic causes of diseases and develop more effective personalized therapies.**
  - The project involves the collaboration of 20 institutions across India and is being **led by the Centre for Brain Research at the Indian Institute of Science** in Bangalore.

What is the Significance of the GIP?

- **Precision Healthcare:**
  - GIP aims to develop personalized medicine based on **patients' genomes to anticipate and modulate diseases.**
  - By mapping disease propensities to genetic variations, interventions can be targeted **more effectively, and diseases can be anticipated before they develop.**
    - For example, variations across genomes may explain **why cardiovascular disease leads to heart attacks in South Asians** but to strokes in most parts of Africa.
- **Sustainable Agriculture:**
  - Similar benefits will come to agriculture if there is a better understanding of the **genetic basis of the susceptibility of plants to pests,** insects and other issues hampering productivity.
  - This can **reduce dependence** on chemicals.
- **International Cooperation:**
  - Global science will also benefit from a **mapping project in one of the world's most diverse gene pools.**
  - The project is said to be among the most significant of its kind in the world because of its **scale and the diversity it would bring to genetic studies.**

What are the Challenges?

- **Scientific Racism:**
  - The GIP raises concerns about the **potential for scientific racism and the reinforcement of stereotypes** based on heredity and racial purity. Similar scientific studies in the past have been used to **justify slavery and other forms of discrimination.**
  - In a country like India, which is already divided by identity politics, genetic mapping may **further deepen these divisions.**
- **Data Privacy:**
  - The project also raises questions about **data privacy and storage.** In the absence of a comprehensive data privacy bill in India, concerns about the possible misuse of genetic information collected by the GIP cannot be overlooked.
- **Ethical Concerns:**
  - It raises ethical questions about the **potential for doctors to privately perform gene modification** or selective breeding.
  - Such practices have always been controversial, in 2020 there was sentencing of a scientist in China who **created the world's first gene-edited babies highlighting the seriousness** of these concerns.

What is a Genome?

- The discovery of the structure of DNA by Watson and Crick in 1953 marked the beginning of the **study of genetics, which seeks to understand how genes** influence **traits and diseases.**
    - **DNA, or Deoxyribonucleic acid**, is a molecule that carries the **genetic instructions for the development, functioning, growth, and reproduction** of all living organisms.
- The genome of an organism is the complete set of its genetic material, including all of its genes. It contains all the information required to build and maintain the organism.
- In humans, the genome is **composed of more than 3 billion DNA base pairs**, arranged in a double helix structure.
- The study of genomics, which involves the analysis of genomes, has revolutionized many fields, including **biotechnology, medicine, and agriculture, by providing new insights into the mechanisms of disease,** drug development, and the improvement of crops and livestock.

What is Genome Sequencing?

- Genome sequencing is figuring out the order of DNA nucleotides, or bases, in a genome—the order of adenine (A), thymine (T), cytosine (C), and guanine (G), that make up an organism's DNA.

Way Forward

- It is important that the GIP is conducted with adequate safeguards in place to ensure that the project is conducted ethically and in a manner that respects individual privacy and human rights.
- The project has the potential to advance biotechnology, agriculture, and healthcare in India. However, **it should be approached with both speed and caution to ensure that privacy concerns** are addressed, potential misuse of data is prevented, and medical ethics are upheld.

UPSC Civil Services Examination, Previous Year Question (PYQ)

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)

- 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.**

Source: TH