Genomics, HGP Read and Write

HUMAN GENOME PROJECT

As the recombinant DNA and DNA sequencing technologies improved in the 1970s and 1980s, scientists began discussing the possibility of sequencing all 3.2 billion nucleotide pairs in the human genome.

These discussions led to the launch of the Human Genome Project in 1990. The initial goals of the Human Genome Project were

1. to map all the human genes,
2. to construct a detailed physical map of the entire human genome, and
3. to determine the nucleotide sequence of all 24 human chromosomes by the year 2005.

GENERAL FEATURES OF THE HUMAN GENOME

- The entire human genome contains about 3.2 billion base pairs of DNAs.
- The base-pair composition of the DNA varies across regions of the human genome.
  - On average, about 41 percent of the DNA consists of G:C base pairs. However, some regions are G:C rich and others are G:C poor.

The Human Genome Project, which operated from 1990 to 2003, provided researchers with basic information about the genetic content of the human organism, opening new avenues of discovery in fields such as cancer research.

Genome India Project

Taking inspiration from the Human Genome Project, the Department of Biotechnology (DBT) initiated the ambitious "Genome India Project" (GIP) on 3rd January 2020.

- The GIP aims to collect 10,000 genetic samples from citizens across India, to build a reference genome.
- Whole-genome sequencing and subsequent data analysis of the genetic data of these 10,000 individuals would be carried out.
- This would aid our understanding of the nature of diseases affecting the Indian population, and then ultimately support the development of predictive diagnostic markers.
- It would also open new vistas for advancing next generation personalized medicine in the country, paving the way for predicting health and disease outcomes.
- The initiative would also support the development of targeted preventive care, as it has the potential to help identify those population groups which are more susceptible to various risk factors for certain diseases.
  - For instance, if a region shows a tendency towards a specific disease, customized interventions can be made in the region, accordingly, leading to more effective treatment overall.
- This project is led by the Centre for Brain Research at Bengaluru-based Indian Institute of Science, which acts as the central coordinator between a collaboration of 20 leading institutions, each collecting samples and conducting its own research.

- This initiative reflects India's progress in gene therapies and precision medicine, and its movement towards emerging next-generation medicine which yields the possibilities for greater customization, safety, and earlier detection.
- This initiative would help lay the foundation of personalized healthcare for a very large group of persons on the planet.

Human Microbiome Initiative of select endogamous populations of India

Health and disease outcomes are determined by interactions between the genome and the environment. An important component of the "environment" in the context of human health is the human microbiota.

- The "Human Microbiome Initiative of select endogamous populations of India" aims at comprehensive characterization of human-associated microbes in carefully selected endogamous population groups with diverse dietary habits including key tribal populations which are not much influenced by modern lifestyle.
- The study is investigating the influence of diet, lifestyle, geography, and age on gut microbiome using targeted metagenomic and whole metagenomic approaches. The study would also attempt to find the association between microbial enterotypes and three distinct Ayurvedic Prakriti types.

Earth BioGenome Project

The Earth Bio-Genome Project is a project aiming at analysing and sequencing genomes and building a new basis for biology to drive solutions for biodiversity preservation and human society sustainability.

- The Earth Bio-Genome Project (EBP) is a worldwide group of scientists who plan to sequence, classify, and characterise the genomes of all eukaryotic biodiversity on Earth over the course of ten years.
  1. It is a global catalogue of life on the planet.
  2. In three phases, it hopes to sequence 1.5 million species.

The EBP project will assist in the creation of a precise genetic sequence as well as the discovery of evolutionary relationships between the species, orders, and families that will make up the Digital Library of Life.

PRELIMS QUESTION

1. 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

Genome Mapping

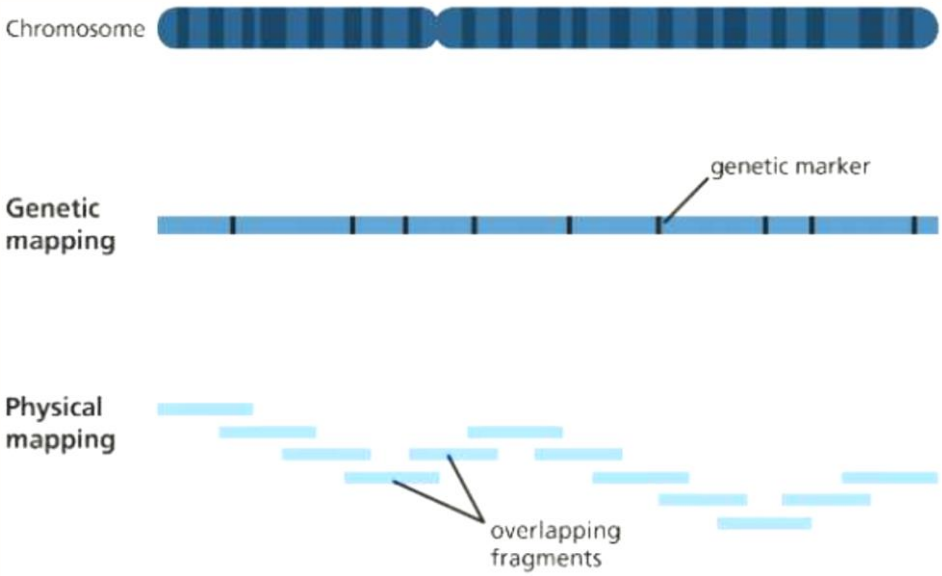
The technique of locating genes on chromosomes is known as gene mapping. Today, sequencing a genome and employing computer algorithms to evaluate the sequence to find genes' locations is the most effective method for mapping genes.

- There are two general types of genome mapping called genetic mapping and physical mapping.
- Both types of genome mapping guide scientists towards the location of a gene (or section of DNA) on a chromosome? however, they rely on very different information.
  - Genetic mapping looks at how genetic information is shuffled between chromosomes or between different regions in the same chromosome during meiosis? (a type of cell division). A process called recombination or 'crossing over.'
  - Physical mapping looks at the physical distance between known DNA sequences (including genes) by working out the number of base pairs? (A-T, C-G) between them.

Significance of Genome Mapping:

can offer firm evidence that a disease transmitted from parent to child is linked to one or more genes.

- Mapping also provides clues about which chromosome contains the gene and precisely where the gene lies on that chromosome.



PRELIMS QUESTION

1. At present, scientists can determine the arrangement or relative positions of genes of DNA sequences on a chromosome. How does this knowledge benefit us? (2011)

1. It is possible to know the pedigree of livestock.
2. It is possible to understand the causes of all human diseases.
3. It is possible to develop disease-resistant animal breeds.

Which of the statements given above is/are correct?

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