



# Metagenomics

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## Why in News?

Recently, scientists from the **Nigerian Centre for Disease Control** conducted a study utilizing **metagenomic sequencing for pathogen surveillance**.

- The devastation caused by **Covid-19 pandemic** led to the rapid development of new techniques, like **metagenomics**, and ignited a paradigm shift in **how we identify, monitor, and respond to emerging pathogens**.

## What is Metagenomics?

### ▪ About:

- Metagenomics is the **study of microbes in their natural living environment**, which involves the complex microbial communities in which they usually exist.
- The study examines the **genomic composition of an entire organism**, including each of the microbes that exist within it. It facilitates direct sequencing of patient samples, **removing the need for prior knowledge of the infectious agent**.
  - For instance, a **single gram of soil consists of 4000 to 5000 different species of microbes**, while **human intestines consist of 500 different types of bacteria**.
    - It enables us to **understand the diversity, abundance, and interaction of microbes in any system**.
  - It is different from **conventional sequencing methods**, which requires **culturing or isolating individual species** before **sequencing their genomes**.

### ▪ Applications:

- **Microbial Community Dynamics:** Longitudinal metagenome studies can reveal how microbial communities change in response to **environmental perturbations or human interventions**.
- **Biodiversity Studies:** Metagenomics allows researchers to study the diversity of microorganisms in different ecosystems, such as **oceans, soil, freshwater, and extreme environments like hot springs**.
- **Human Microbiome Research:** Metagenomics has revolutionized our understanding of the **human gut microbiome and its impact on digestion, metabolism, and overall health**.
- **Bioremediation and Environmental Cleanup:** It can **identify microorganisms with the ability to degrade pollutants** and toxic compounds, which can be harnessed for bioremediation purposes.
- **Drug Discovery and Biotechnology:** It can uncover novel genes and pathways responsible for the **production of bioactive compounds**, potentially leading to the discovery of new drugs and therapeutic agents.
- **Agriculture and Plant-Microbe Interactions:** Understanding the microbial communities in agricultural soils can help **optimize nutrient cycling and enhance crop productivity**.

## What is Genome Sequencing?

### ▪ About:

- **Genome sequencing** is the **process of determining the complete DNA sequence of an organism's genome.**
- **DNA (deoxyribonucleic acid)** is composed of a sequence of nucleotides, which are represented by the letters **A, T, C, and G**, corresponding to the four nucleotide bases: **adenine, thymine, cytosine, and guanine.**
  - Genome sequencing involves identifying the order of these nucleotides along the DNA strands.

**Note:** The genome is the entire set of genetic material within an organism's cells, and it contains all the information necessary for the growth, development, functioning, and reproduction of that organism.

- **Genomic Surveillance and Covid-19 Pandemic:** The global response to the **Covid-19 pandemic** prompted scientists to leverage genome sequencing technologies for surveillance purposes.
  - The establishment of platforms like **GISAID** facilitated the submission and sharing of **SARS-CoV-2 genome data**, aiding **high-throughput genome** surveillance activities.
    - High-throughput' refers to sequencing techniques that can parse large quantities of DNA at the same time, including a whole genome at once.
- **Potential:** Genome sequencing's potential extended to seasonal viruses like **Zika and dengue**, as well as diseases like **lumpy skin disease in cattle and drug-resistant tuberculosis.**

## 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)**