🧬 DNA Microarray Chips – 16 Marks Answer

1. Introduction

- A **DNA microarray chip** is a **biotechnology tool** used to **study many genes at once**.
- It helps to detect **gene expression levels** or **mutations** in DNA.
- Also called a **gene chip** or **biochip**.

2. Construction

- It is a **small glass or silicon slide**.
- Thousands of **known DNA sequences (probes)** are **fixed** on its surface in a **grid-like pattern**.
- Each spot contains a **specific DNA sequence** corresponding to a particular gene.

3. Working Principle

1. Extract **mRNA** from the sample (e.g., cancerous and normal cells).

2. Convert mRNA to **complementary DNA (cDNA)** and label it with **fluorescent dyes**.

3. Apply cDNA to the microarray chip – it binds (hybridizes) to its **complementary probe** on the chip.

4. After washing, scan the chip using a **laser scanner**.

5. The amount of fluorescence at each spot tells us:

   - **Which genes are active (expressed)**.
   - **How much they are expressed**.

4. Diagram Description

- A glass chip with small dots (each with different DNA probes).
- Sample DNA labeled with red/green dye binds to complementary spots.
- Scanner detects **fluorescent signals**.

Caption: *DNA microarray working – hybridization and fluorescence detection.*

5. Properties / Features

- Can test **thousands of genes at once**.
- Requires **very small sample**.
- Provides **quantitative data** on gene expression.

6. Applications

- **Disease diagnosis** – e.g., identifying cancer types.
- **Genetic mutation detection**.
- **Drug development** – checking how genes respond to drugs.
- **Personalized medicine** – tailoring treatment to the patient's genetic profile.
- **Agricultural biotechnology** – analyzing plant traits.

7. Advantages

- High-throughput – tests **many genes in one test**.
- Fast and accurate.
- Helps in **early disease detection**.
- Useful for **research and drug testing**.

8. Disadvantages

- Expensive setup.
- Requires **complex data analysis**.
- May produce **false positives/negatives** if not done carefully.
- Not ideal for **unknown genes** (only works with known sequences).

10. Summary

- DNA microarray is a **powerful tool** for studying **gene expression**.
- Works by **hybridizing sample DNA** to known sequences on a chip.
- Used in **medicine, genetics, research, and agriculture**.
- Fast, efficient, and full of **future potential** in healthcare and biotechnology.