Role of AI and Biotechnology in the Pharmaceutical Industry

1. AI in Drug Discovery and Drug Repurposing

1.Role of Artificial Intelligence (AI)

AI uses machine learning (ML), deep learning, and big data analytics to speed up and improve drug development.

A. AI in Drug Discovery

Traditional drug discovery takes 10–15 years and high cost. AI reduces time and cost by:

- Target identification
- AI analyzes genomic, proteomic, and disease data to identify drug targets.
- Lead compound screening
- AI screens millions of compounds virtually (in silico screening).
- Structure-based drug design
- Predicts drug–receptor interactions.
- Toxicity & efficacy prediction
- Reduces failure in clinical trials.

✅ Example : AI platforms like AlphaFold predict protein structures accurately.

😶B. AI in Drug Repurposing

Drug repurposing = using existing drugs for new diseases.

AI helps by:

1. . Analyzing patient data and disease pathways
2. Identifying new indications for approved drugs
3. Reducing development time and cost

✅ Example:

AI was used during COVID-19 to identify existing antiviral drugs.

⭐Advantages of AI

- Faster drug development
- Lower cost
- Higher success rate

🌍 2. Biotechnology in Vaccine Development

🔷 Role of Biotechnology

*Biotechnology uses living organisms, cells and biological systems to develop vaccines.

⭐ A. Types of Biotechnological Vaccines

- Recombinant vaccines

(e.g., Hepatitis B vaccine)

- mRNA vaccines

(e.g., Pfizer & Moderna COVID-19 vaccines)

- DNA vaccines
- Vector-based vaccines

B. Biotechnology Process in Vaccine Development

1) Identification of antigen using genetic engineering
2) Cloning of antigen gene
3) Expression in host cells (yeast, bacteria mammalian cells)
4) Purification and formulation
5)Preclinical and clinical trials

⭐ Advantages

- High specificity
- Strong immune response
- Faster development
- Safer than traditional vaccines

😶 Applications

- COVID-19
- Cancer vaccines
- HIV, influenza, hepatitis

🌍 3. Nanotechnology in Targeted Drug Delivery

🔷 Role of Nanotechnology

Nanotechnology deals with particles in the range of 1–100 nm to deliver drugs precisely.

A. Nanocarriers Used

1) Liposomes
2) Nanoparticles
3) Dendrimers
4) Polymeric micelles Carbon nanotubes

B. Targeted Drug Delivery

**Nanotechnology enables:

- Site-specific drug delivery
- Reduced dose
- Controlled and sustained release
- Reduced side effects

🙂 Mechanism

- Drug is loaded into nanocarrier
- Nanocarrier targets diseased tissue
- Drug released at target site

🙂 Applications

Cancer therapy

- Gene therapy
- Brain drug delivery
- Anti-TB and anti-HIV drugs

🙂 Advantages

- Improved bioavailability