

7. BIOTECHNOLOGY & ITS APPLCIATIONS

Single Page Simple Synopsis

Biotechnology utilises living organisms, cells, or biological systems to develop innovative products and processes. By integrating biology with engineering and genetics, it allows scientists to manipulate DNA for practical use, primarily driving medical advancements, agricultural optimization, and industrial or environmental sustainability.

1. Core Research Areas

To develop these applications, biotechnology relies on three critical steps:

- **Optimal Catalyst Selection:** Identifying and modifying the best microbe or pure enzyme for a specific task.
- **Engineering Optimal Conditions:** Creating ideal, sterile environments (e.g., in bioreactors) to maximize the microbe or enzyme's output.
- **Downstream Processing:** Purifying the final biological or protein compound for commercial use.

2. Major Application Sectors

Modern biotechnology shapes everyday life across three main pillars:

- **Agriculture:** Utilizes genetically modified organisms (GMOs). This includes engineering pest-resistant crops (such as Bt cotton using the *Bacillus thuringiensis* gene) and developing plants that tolerate drought or cold, significantly improving global food security.
- **Medicine:** Focuses on the industrial-scale production of biopharmaceuticals. This involves creating safer, more effective recombinant therapeutics like synthetic human insulin, vaccines, and developing targeted gene therapies and molecular diagnostics.
- **Environment & Industry:** Employs microbes and enzymes to break down industrial waste and clean up polluted environments, a process known as bioremediation. It also enables the creation of bio-based energy and sustainable industrial enzymes.

FRUIT POINTS

1. **Biotechnology** involves the industrial-scale production of biopharmaceuticals using genetically modified organisms.
2. Globally, approximately **30 recombinant therapeutics** have been approved for human use.
3. In India, **12 of these therapeutics** are currently being marketed.
4. **Genetically engineered insulin** is a primary tool for managing adult-onset diabetes.
5. Human insulin consists of two short polypeptide chains: **Chain A and Chain B**.
6. **Gene therapy** is a method used to correct gene defects diagnosed in children or embryos.
7. The **first clinical gene therapy** was administered in 1990 to a 4-year-old girl.
8. ADA deficiency is caused by the **deletion of the gene** for the enzyme.
9. **Molecular diagnosis** techniques like PCR and ELISA allow for early detection of diseases.
10. **PCR (Polymerase Chain Reaction)** can detect pathogens by amplifying their nucleic acids.
11. PCR is routinely used to detect **HIV** in suspected AIDS patients.
12. **ELISA** is based on the principle of **antigen-antibody interaction**.
13. **Transgenic animals** are those whose DNA has been manipulated to express an extra foreign gene.
14. Over **95 per cent** of all existing transgenic animals are mice.
15. In 1997, the **first transgenic cow, Rosie**, was produced.
16. Rosie's milk was enriched with **human alpha-lactalbumin** (2.4 grams per litre).
17. Transgenic mice are used to test the **safety of the polio vaccine**.
18. India's **GEAC (Genetic Engineering Approval Committee)** makes decisions on GM research and safety.
19. There are **27 documented varieties of Basmati** grown in India.
20. **Biopiracy** refers to using bio-resources without authorization or compensatory payment.
21. The **Indian Patents Bill** was amended to address issues of biopiracy and emergency provisions.

22. Viral infection is usually absent in **Apical meristem**. [NEET-2016]
23. The tehcnique of obtaining large number of plantlets by tissue culture method is called **micropropagation** [NEET-2016]
24. The capacity to generate a whole plant from any cell of the plant is called **Totipotency**. [NEET-2024]
25. **Protoplasts** are fused in somatic hybridization involving two varities of plants.[NEET-2024]
26. The Bt toxin is genetically engineered Bt cotton kills the pest by **creating pores in the mid gut**. [NEET-2024]
27. Silencing of specific mRNA is possible via RNAi because of **complementary dsRNA**. [NEET-2025]
28. Insulin cannot be given orally to diabetic patient because **it will be digested in Gastro-intestinal tract**. [NEET-2025]
29. **Bacterium** is genetically engineered organisms used by Eli Lilly to prepare human insulin. [NEET-2025]