Chapter 10

Biotechnology: Principles and Processes

- Principles of Biotechnology
- Tools of Recombinant DNA Technology
  - Restriction Enzymes
  - Cloning Vectors
  - Competent Host
- Processes of Recombinant DNA Technology
  - Isolation of the Genetic Material (DNA)
  - Cutting of DNA at Specific Locations
  - Amplification of Gene of Interest using PCR
  - Insertion of Recombinant DNA into the Host Cell/Organism
  - Obtaining the Foreign Gene Product
  - Downstream Processing

PRINCIPLES OF BIOTECHNOLOGY

It is a methodology that employs living organisms, their cellular constituents, or enzymes to generate beneficial products and processes for human use. As per the European Federation of Biotechnology (EFB), "Biotechnology entails the fusion of natural sciences with organisms, cells, their components, and molecular analogs to produce goods and services." The term "biotechnology" was first introduced by Karl Ereky in 1917.

The evolution of biotechnology can be categorized into two phases:

(i) Old or Traditional Biotechnology: Also referred to as conventional technology, this approach has been practiced for centuries. Various products such as curd, bread, wine, ghee, alcoholic beverages, idli, dosa, cheese, and paneer have been traditionally manufactured using this biotechnological method.

(ii) Modern Biotechnology: Emerging as a new branch in the 1970s, modern biotechnology involves the development of innovative traits in crop varieties and animal breeds through genetic engineering. Examples include in vitro fertilization leading to the birth of a "test tube baby," synthesis and utilization of genes, creation of DNA vaccines, and correction of defective genes.

The foundational techniques that facilitated the fusion of genetic components from two or more living cells, paving the way for the advent of modern biotechnology, are:

(i) Genetic Engineering: Genetic engineering, also known as recombinant DNA technology, involves the manipulation of the genetic material (DNA & RNA) to introduce alterations and integrate them into host organisms. This process leads to the modification of the phenotype of the host organism.

(ii) Bioprocess Technology: Bioprocess technology focuses on maintaining a sterile environment devoid of microbial contamination in chemical engineering processes. This sterile environment facilitates the growth of only the desired microbe or eukaryotic cell in large quantities, essential for the production of various biotechnological products such as antibiotics, vaccines, and enzymes.

The concept of genetic engineering stemmed from two crucial discoveries in bacterial research:

(i) The identification of extrachromosomal DNA fragments known as plasmids within bacterial cells, which replicate alongside the chromosomal DNA.

(ii) The discovery of enzymes called restriction endonucleases, which have the capability to cleave DNA at specific sites. These enzymes are commonly referred to as "molecular scissors."

The fundamental principle underlying recombinant DNA technology is DNA cloning, which involves the replication of multiple identical copies of any template DNA.

The process of DNA manipulation involves three fundamental steps:

(i) Identification of DNA containing desirable genes

(ii) Introduction of the identified DNA into the host organism

(iii) Maintenance of the introduced DNA within the host and its transfer to subsequent generations.