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Chapter 11

Biotechnology Principles and Processes

The techniques of using live organisms or enzymes from organisms to produce products and processes useful to humans. Many processes like in vitro fertilization leading to 'test-tube' baby, synthesizing gene and using it, developing a DNA vaccine or correcting a defective gene are also parts of Biotechnology.

The **European Federation** of **Biotechnology (EFB)** has given a definition of biotechnology that comprises both traditional and modern molecular biotechnology. The definition is as follow- "**The integration of natural science and organisms, cells, parts thereof, and molecular analogous for products and services".**

Principles of Biotechnology

Modern biotechnology is based on two main principles-

• **Genetic Engineering** – Genetic Engineering is defined as the direct manipulation of genome (DNA and RNA) of an organism. It involves the transfer of new genes to improve the function or trait into host organisms and thus changes the phenotype of the host organism.
• Maintenance of sterile condition in chemical engineering process to enable growth of only desired microbes for manufacture of biotechnological products like antibiotics, vaccine, enzymes etc.

• Traditional hybridization used in plants and animal breeding leads to inclusion and multiplication of undesirable genes along with the desired traits. The technique of genetic engineering which include creation of recombinant DNA, use of gene cloning and gene transfer allow us to isolate and introduce only one or a set of desirable genes without introducing undesirable genes into the target organism.

• In a chromosome there is a specific DNA sequence called the origin of replication, which is responsible for initiating replication. Therefore, for the multiplication of any

alien piece of DNA in an organism, it needs to be a part of a chromosome which has a specific sequence known as '**origin of replication'**. Thus, an alien DNA is linked with the origin of replication, so that, this alien piece of DNA can replicate and multiply itself in the host organism. This is known as **Cloning** or making multiple identical copies of any template DNA.

• The construction of the first recombinant DNA emerged from the possibility of linking a gene encoding antibiotic resistance with a native Plasmid of *Salmonella typhimurium*.

- Stanley Cohen and Herbert Boyer in 1972 isolated the antibiotic resistance gene by cutting out a piece of DNA from a **plasmid** (autonomously replicating circular extra-chromosomal DNA) of *Salmonella typhimurium*. The cutting of DNA at specific locations became possible with the discovery of the so-called 'molecular scissors'– **restriction enzymes**.

• The cut piece of DNA was then linked with the plasmid DNA. These plasmid DNA act as **vectors** to transfer the piece of DNA attached to it.A plasmid can be used as vector to deliver an alien piece of DNA into the host organism.

• The linking of antibiotic resistance gene with the plasmid vector become possible with the enzyme ligase, which acts on cut DNA molecules and joins their ends. This makes a new combination of autonomously replicating DNA created in vitro and known as **recombinant DNA**.

• When this DNA is transferred into E.coli, it could replicate using the new host DNA polymerase enzyme and make multiple copies. The ability to multiply copies of antibiotic resistance gene in E.coli was called cloning of antibiotic resistance gene in E.coli.

"Recombinant DNA technology" or also called "Genetic Engineering" deals about, the production of new combinations of genetic material (artificially) in the laboratory. These "recombinant DNA" (rDNA) molecules are then introduced into host cells, where they can be propagated and multiplied.

Steps of Recombinant DNA Technology –

I. Identification of DNA with desirable genes.

II. Introduction of the identified DNA into the host.

III. Maintenance of introduced DNA in the host and transfer of the DNA to its progeny.