

Biotechnology and its Applications

- **Biotechnology** deals with genetically modifying living organisms (microbes, plants and animals) to produce several useful products.
- **Applications of biotechnology** –
 - Therapeutics
 - Diagnostics
 - Genetically modified crops
 - Food processing
 - Bioremediation
 - Waste treatment
 - Energy production
- Genetically modified organisms (GMO) are produced by the manipulation of the genetic material of organisms.
- **Genetically modified crops** have several advantages. Genetic modification increases a crop's tolerance to abiotic factors; it increases the efficiency of mineral uptake by the roots of a crop, etc. It also decreases the post-harvest losses in crops.
- The bacterium, *Bacillus thuringiensis* is used for producing Bt-toxin.
- It acts as a bio-pesticide in plants.

Isolation of toxin - producing gene (Bt) from bacteria



Insertion of Bt gene into plants



Gene provides resistance against insects

- The Bt-toxin gene is insect-group specific and is coded by the 'cry' gene.
 - Proteins coded by *cryIAc* and *cryIIAb* make the plant resistant for cotton bollworms.
 - Proteins coded by *cryIAb* make the plant resistant to corn borer.

- **RNA-interference (RNAi):** It is a gene-silencing mechanism that prevents translation of mRNA. It is a method of cellular defence. It involves –

Introduction of DNA



Formation of sense and antisense strand in host cell



Formation of dsRNA



Initiation of RNA interference



Slicing of mRNA

- **Applications of recombinant DNA technology in Medicine –**
 - Production of genetically engineered insulin
 - **Gene therapy:** It is the method of insertion of genes into an individual cell to cure genetic disorders.
 - Gene therapy was first used in 1990 to cure adenosine deaminase deficiency.
 - Early diagnosis and understanding of diseases: The techniques involved are –
 - **PCR (polymerase chain reaction):** It amplifies a specific gene into multiple copies. It is used for detecting mutation in a gene.
 - **ELISA (enzyme-linked-immunosorbent serologic assay):** It involves the use of antigen antibody to identify infectious diseases. It is widely used for detecting AIDS.

- **Transgenic animals:** They carry foreign genes that are purposely introduced into their genome; for example, mice, sheep, cows, fish, rabbit.
- **Transgenic animals are used for –**
 - Studying the regulation of genes
 - Understanding the development of diseases
 - Producing useful biological products
 - Testing the safety of vaccines
 - Testing the toxicity of drugs
- The manipulation of microbes/plants/animals has raised certain ethical issues.
- GEAC (Genetic Engineering Approval Committee) in India takes decisions regarding the validity of GM researches and the safety regarding genetically modified organisms.
- **Biopiracy:** It is the theft or robbery of biological resources without the knowledge of the concerned authority.
- **Patent:** It is an exclusive right which is granted for an invention, which could be a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem.
- Patents are awarded on the basis of novelty, non-obviousness, and utility.