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 thuriengiensis* is used for producing Bt-toxin.
- It acts as a bio-pesticide in plants.

Isolation of toxin-producing gene (Bt) from bacteria

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Insertion of Bt gene into plants

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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

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Formation of sense and antisense strand in host cell

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Formation of dsRNA

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Initiation of RNA interference

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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.