

# Biotechnology and its Applications

## Topic 1

1. (c) : *Bacillus thuringiensis* forms protein crystals during a particular phase of their growth. These crystals contain a toxic insecticidal protein. Actually, the Bt toxin protein exist as inactive protoxins but once an insect ingests the inactive toxin, it is converted into an active form of toxin due to the alkaline pH of the insect gut which solubilise the crystals. The activated toxin binds to the surface of midgut epithelial cells and creates pores that cause cell swelling and lysis and eventually cause death of the insect, but it does not harm *Bacillus* itself.

2. Advantages of genetically modified crops or transgenic crops are as follows :

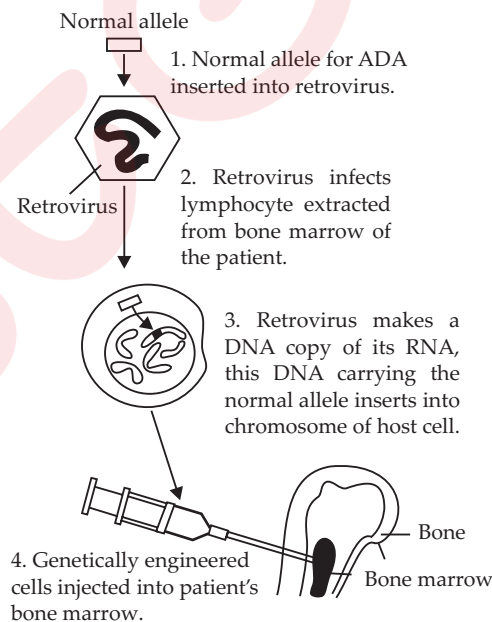
- They are resistant to pests, herbicides and diseases.
- They help to reduce post harvest losses.
- They enhance nutritional value of food, e.g., a transgenic variety of rice (golden rice) is rich in vitamin A content.
- Some transgenic plants, e.g., poplar trees are used to clean up heavy metal pollution from contaminated soil.
- They are efficient in mineral usage and thus, prevent early exhaustion of fertility of soil.

Transgenic crops have several disadvantages also which are mentioned below:

- Bt toxins expressed in pollen grains of transgenic crops are harmful for useful varieties of insects, e.g., honeybees and butterflies.
- The food produced by transgenic crops might cause toxicity and might result in allergies.
- The bacteria present in human alimentary canal can become resistant to concerned antibiotic by taking up antibiotic resistance gene present in genetically modified food and become difficult to manage.

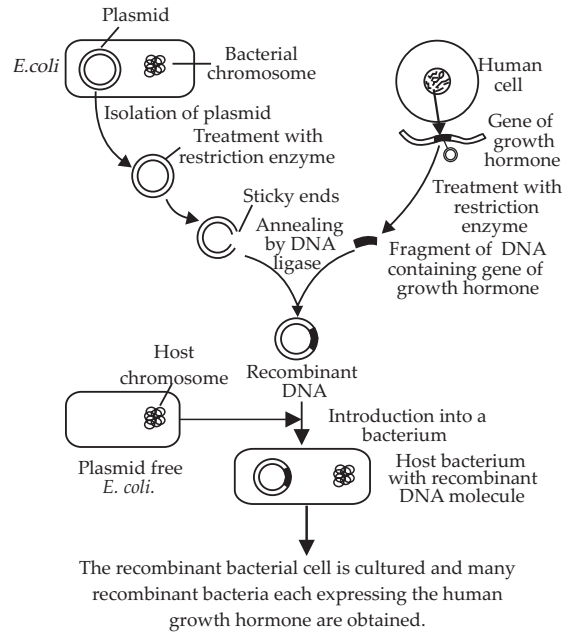
3. The bacterium *Bacillus thuringiensis* is a common soil bacterium which produces a protein toxin that kills certain insects. The toxin is a crystal (Cry) protein. There are several kinds of Cry proteins which are toxic to different groups of insects. The gene encoding Cry protein is called *cry* gene. Biotechnologists have been able to isolate the gene responsible for production of toxin and to introduce it into a number of plants to produce genetically modified plants resistant to insects, e.g., Bt cotton (resistant to bollworm).

4. Gene therapy is the technique of genetic engineering used to replace a faulty gene by a normal, healthy functional gene. The first clinical gene therapy was given in 1990 to a 4 years old girl with adenosine deaminase deficiency (ADA deficiency). This enzyme is very important for the immune system to function. Severe combined immunodeficiency (SCID) is caused due to defect in the gene for the enzyme adenosine deaminase. SCID patient lacks functional T-lymphocytes and, therefore, fails to fight the infecting pathogens. Treatment of ADA deficiency using gene therapy is shown below.



To perform gene therapy, lymphocytes are extracted from the patient's bone marrow and a normal functional copy of human gene coding for ADA is introduced into these lymphocytes with the help of retroviral vector. The cells so treated are reintroduced into the patient's bone marrow. The lymphocytes produced by these cells contain functional ADA gene which reactivates the victim's immune system. But, as these lymphocytes do not divide and are short lived, so periodic infusion of genetically engineered lymphocytes is required. This problem can be overcome, if stem cells are modified at an early embryonic stage.

5. The given diagram represents the experimental steps in cloning and expressing a human gene for growth hormone into a bacterium *E. coli* :



**6.** rDNA technology is a technique of genetic engineering that involves combining DNA from two different sources to produce a recombined or recombinant DNA (rDNA). Oils are composed of glycerol and fatty acids. Thus, to produce oil-free seeds genes coding for glycerol or fatty acids should be identified and nucleotide sequence complementary to

the sequence of these genes should be inserted adjacent to these genes in the early cells of the endosperm. During transcription, these complementary sequences will produce anti-sense RNAs to the RNAs produced by glycerol or fatty acids gene and will silence these genes. As a result, oil free seeds will be produced.

Since, glycerol is a common component of all the oils whereas various fatty acids combine with glycerol to form oils, thus it will be easier if we silence the gene for glycerol synthesis.

**7.** Golden rice is a transgenic variety of rice (*Oryza sativa*) containing good quantities of  $\beta$ -carotene (provitamin A) which is principle source of vitamin A. Since the grains of the rice are yellow in colour due to  $\beta$ -carotene, the rice is commonly called golden rice. It was developed at Swiss Federal Institute of Technology by Professor Ingo Potrykus and Peter Beyer.

## Topic 2

**1.** Bacteria having gene or genes usually from an unrelated organism incorporated into their genome are called transgenic bacteria. For example, when human insulin gene is introduced into the isolated plasmid of *E. coli* bacterium and this recombinant DNA is transferred into a fresh bacterium, then the later is said to be transgenic or transformed bacterium.

