

Chapter-12 Biotechnology and its Applications

Very Short Answers Questions:

1. Give different types of *cry genes* and pests which are controlled by the proteins encoded by these genes?

A: *cryIAC*, *cryIIAb* and *cry IAb*

cryIAC, *cryIIAb* control the cotton bollworms

cry IAb control corn borer

2. Can a disease be detected before its symptoms appear? Explain the principle involved?

A: Yes.

After the infection and before the development of symptoms pathogen is present in very low amounts or antibodies are present in the host. Detection of the pathogen or antibodies at this stage can establish the link with the infection.

3. What is GEAC and what are its objectives?

A: Genetic Engineering Approval Committee.

Objectives:

1. It will make decisions regarding the validity of GM research in India.
2. It regulates GM research in India.
3. It will take decisions regarding safety of introducing GM organisms for public services.

4. Name the nematode that infects the roots of tobacco plants. Name the strategy adopted to prevent this infestation?

A: *Meloidogyne incognita*

RNA interference.

5. For which variety of Indian rice, has a patent been filed by a USA company?

A: Basmati rice

6. Give one example for each of transgenic plants which are suitable for food processing and those with improved nutritional quality?

A: 'Flavr Savr' tomato. Transgenic 'Golden rice' variety.

7. What is green revolution? Who is regarded As Father of green revolution?

A: It is the dramatic increase in food production due to plant breeding techniques.

Norman Borloug.

Short Answer Questions

Biotechnology and its Applications:

1. List out the beneficial aspects of transgenic plants.

Ans: Transgenic plants have been useful in many ways. In addition to the production of high yielding and disease resistant varieties, Genetic modification has:

1. Made transgenic crops more **tolerant to abiotic stresses** caused by chemicals, cold, drought, salt, heat.

E.g. Basmati rice was made resistant against biotic and abiotic stresses.

2. Reduced reliance on chemical pesticides **pest-resistant crops**.

E.g. Round up ready soybean is herbicide resistant.

3. Helped to reduce post harvest losses.

4. Increased efficiency of **mineral usage** by plants. This prevents early exhaustion of fertility of soil.

5. Enhanced nutritional value of food, e.g., **Vitamin 'A' enriched** rice.

E.g. Transgenic **golden rice** obtained from 'Taipei' is rich in vitamin 'A'

6. Transgenic plants useful for **hybrid seed production**.

E.g. Male sterile plants *Brassica napus* are used in hybrid seed production.

7. Transgenic plants suitable for food processing technology:

E.g. Transgenic tomato 'Flavr Savr' is bruise resistant and suitable for transportation to long distances.

8. Transgenic crop plants having resistance to pathogens and pests.

E.g. a) Transgenic papaya ----- resistant to ring spot virus

b) Bt cotton ----- resistant to insects

c) Tomato plants----- resistant to *Pseudomonas*.

d) Potato crop ----- resistant to *Phytophthora*.

In addition to these uses, GM has been used to create tailor-made plants to supply alternative resources to industries, in the form of starches, fuels and pharmaceuticals.

2. What some bio-safety issues concerned with genetically modified crops.

Ans: The manipulation of living organisms by the human race cannot go on any further, without regulation. Some ethical standards are required to evaluate the morality of all human activities that might help or harm living organisms.

Bio-safety issues regarding the Genetically Modified crops:

1. Genetic modification of organisms can have **unpredictable results** when such organisms are introduced into the ecosystem.
2. They **interfere with natural evolution** process.
3. The products of these plants may develop **allergies in human** population.
4. Due to natural inter-specific and inter-generic crosses the gene may spread to the other edible crop plants resulting in health problems to the humans.
5. This also causes **ecological disturbance**.
6. **Loss of indigenous plants** and there by genome of the plant.
7. They may result in gene pollution resulting in **development of super- weeds**

8. The modification/usage of living organisms for public services as food and medicine sources, for example, has created problems with patents granted for the same.

Indiscriminate granting of patents for products and technologies that make use of the genetic materials, plants and other biological resources that have been identified, developed and used by farmers and indigenous people of a specific region/country results in economic loss to the country.

Indian Government has set up organisations such as GEAC (Genetic Engineering Approval Committee), which will make decisions regarding the validity of GM research and the Safety of introducing GM-organisms for public services.

3. Give a brief account of Bt cotton.

Ans: Bt Cotton is a transgenic cotton plant. Bt cotton is resistant to **bollworm** insect pests that causes great losses to the cotton crop. A specific Bt toxin genes were isolated from *Bacillus thuringiensis* and incorporated into the cotton plant to impart protection against these insect pests.

The toxin is coded by a gene named **cry**. There are a number of them, for example, the proteins encoded by the genes *cryIAc* and *cryIIAb* control the cotton bollworms, that of *cryIAb* controls corn borer. The choice of genes depends upon the crop and the targeted pest, as most Bt toxins are insect-group specific.

Action of the Toxin: Strains of *Bacillus thuringiensis* with *Cry* genes produce proteins that kill certain insects such as lepidopterans (tobacco budworm, armyworm), coleopterans (beetles) and dipterans (flies, mosquitoes). *B. thuringiensis* forms protein crystals during a particular phase of their growth. These crystals contain a toxic **insecticidal protein**.

The Bt toxin protein exist as inactive **protoxins** but once an insect ingest the inactive toxin, it is converted into an active form of toxin due to the alkaline pH of the gut which solubilise the crystals. The activated toxin binds to the surface of mid-gut epithelial cells and create pores that causes cell swelling and lysis and eventually cause death of the insect.

With the help of Ti plasmid of *Agrobacterium tumifaciens* the gene is incorporated into the cotton plant. The *cry* gene present in the plant tissues starts expressing the toxic protein. The entire plant is now toxic to the insect pests. When insects bite the plant tissues they will be killed by the toxin. As the cotton plant is not edible to humans and humans lack alkaline pH in their guts, the toxins do not pose a threat to the human beings.

4. Give a brief account of Pest resistant plants.

Ans: **Pest Resistant Plants:** Several nematodes parasitise a wide variety of plants. A nematode *Meloidogyne incognita* infects the roots of tobacco plants and causes a great reduction in yield. A novel strategy was adopted to prevent this infestation which was based on the process of **RNA interference (RNAi)**.

RNAi takes place in all eukaryotic organisms as a method of cellular defense. This method involves silencing of a **specific mRNA** due to a complementary dsRNA molecule that binds to and prevents translation of the mRNA (**silencing**).

The source of this complementary RNA could be from an infection by viruses having RNA genomes or mobile genetic elements (transposons) that replicate via an RNA intermediate.



Using *Agrobacterium* vectors, nematode-specific genes were introduced into the host plant. The introduction of DNA was such that it produces both sense and anti-sense RNA in the host cells. These two RNA's being complementary to each other formed a double stranded (dsRNA) that initiated **RNAi** and thus, silenced the specific mRNA of the nematode.

The consequence was that the parasite could not survive in a transgenic host expressing specific interfering RNA. The transgenic plant therefore got itself protected from the parasite.