CHAPTER

10

BIOTECHNOLOGY AND ITS APPLICATIONS

CLASS 12TH

NCERT EXERCISE AND SOLUTIONS - BIOLOGY

Q. 1. **Which part of the plant is best suited for making virus-free plants and why?**

ANSWER:-

Virus-free plants can be produced by utilizing the axillary and apical meristems, as these regions remain unaffected by viruses compared to other parts of the plant. This method has been successfully applied to generate virus-free plants of crops such as sugarcane, banana, and potato.

Q. 2. **What is the major advantage of producing plants by micropropagation?**

ANSWER:-

Micropropagation is a technique that utilizes plant tissue culture methods to produce new plants in a shorter time frame. Its key advantages include:

- Rapid propagation of many plants within a relatively short period.
- Generation of plants that are genetically identical to the parent plant.
- Development of disease-resistant crop varieties.

Q. 3. **Find out what the various components of the medium used for propagation of an explant in–vitro are?**

ANSWER:-

The medium used for in–vitro propagation of an explant comprises various components, including carbon sources like sucrose, vitamins, minerals, water, agar-agar, auxins, gibberellins, and amino acids.

Q. 4. **Crystals of *Bt* toxin produced by some bacteria do not kill the bacteria themselves because –**

(a) bacteria are resistant to the toxin
(b) toxin is immature.
(c) toxin is inactive.
(d) bacteria enclose toxin in a special sac.

ANSWER:-

(c) The toxin is inactive.

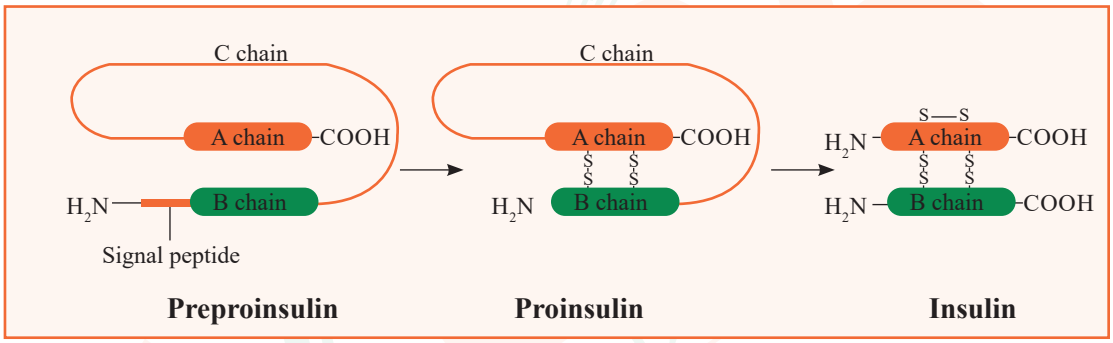
In bacteria, toxins exist in an inactive form called protoxins. These are activated only after entering the insect's body.

Q. 5. What are transgenic bacteria? Illustrate using any one example.

ANSWER:-

Transgenic bacteria carry a foreign gene intentionally introduced into their genome. These bacteria are engineered to express the desired gene, enabling the production of various commercially valuable products.

For instance, *E. coli* serves as an example of transgenic bacteria. Its plasmid is engineered to include DNA sequences corresponding to the A and B chains of human insulin. Once the insulin gene is incorporated, the bacterium becomes transgenic and starts synthesizing the insulin chains. These chains are subsequently extracted from *E. coli* and combined to produce functional human insulin.



Q. 6. Compare and contrast the advantages and disadvantages of production of genetically modified crops.

ANSWER:-

Advantages of Genetically Modified (GM) Crops:

i. Genetic modification enhances crop tolerance to abiotic stresses such as cold, drought, heat, and salinity.

ii. It enables the creation of customized plants to provide alternative resources for industries, such as fuels, starches, and pharmaceuticals.

iii. Many GM crops are pest-resistant, increasing productivity and reducing reliance on chemical pesticides.

iv. Nutritional quality can be improved through genetic modification; for example, golden rice, a transgenic rice variety that is rich in Vitamin A.

v. Post-harvest losses are minimized.

vi. Enhanced mineral usage efficiency in plants helps prevent the early depletion of soil fertility.

Disadvantages of Genetically Modified (GM) Crops:

i. Risk of introducing undesirable traits due to harmful gene combinations.
ii. Potential threat of developing superweeds.
iii. High risk of non-reproduction in GM crops.
iv. Chemical compounds produced by GM crops may lead to rejection by human systems or act as unintended insecticides.
v. GM crops may impact human health by introducing allergens or antibiotic resistance markers.
vi. Native biodiversity may be adversely affected due to genetic pollution in wild relatives of crops.

For instance, while the *Bt* toxin in GM crops reduces pesticide use and benefits insect pollinators like honeybees, if the gene expressing the toxin is present in pollen, it could harm pollinators and disrupt pollination processes.

Q. 7. What are Cry proteins? Name an organism that produce it. How has man exploited this protein to his benefit?

ANSWER:-

Cry proteins are toxins encoded by *cry* genes and produced by the bacterium *Bacillus thuringiensis*. These proteins are initially in an inactive form but become active in the alkaline environment of an insect's gut upon ingestion. Activation of the toxin leads to the lysis of epithelial cells, ultimately causing the insect's death. This property has been harnessed by humans to develop transgenic insect-resistant crops such as *Bt* cotton and *Bt* corn.

Q. 8. What is gene therapy? Illustrate using the example of adenosine deaminase (ADA) deficiency.

ANSWER:-

Gene therapy is a technique used to correct defective genes through genetic manipulation. It involves introducing a functional gene to replace the faulty one. For instance, in individuals with adenosine deaminase (ADA) deficiency, a functional ADA gene is introduced. The ADA enzyme is essential for proper immune system function.

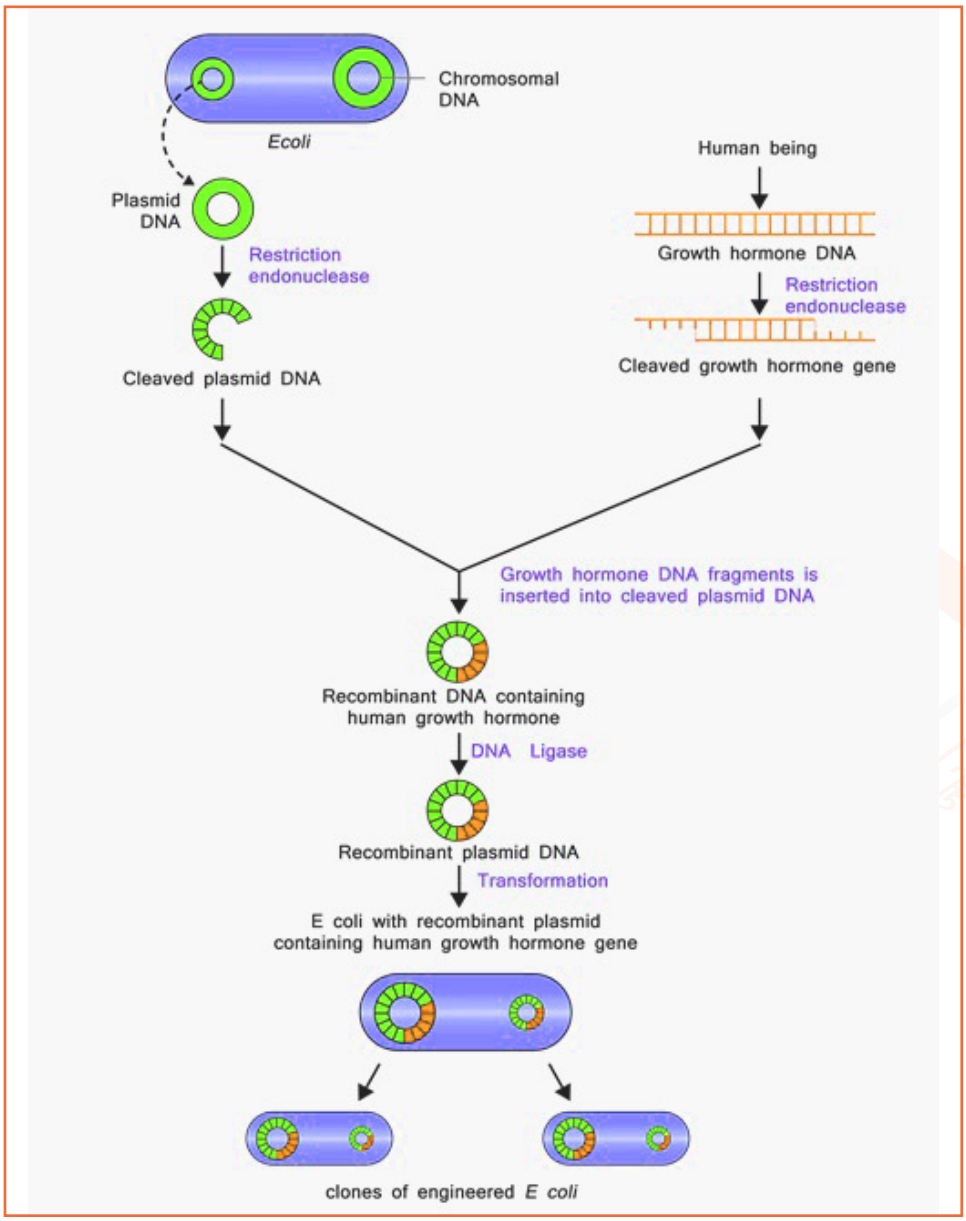
This disorder can be treated through bone marrow cell transplantation. The process begins with extracting lymphocytes from the patient's bone marrow. A functional ADA gene is then inserted into these lymphocytes using a retrovirus as a vector. The modified lymphocytes, now containing the ADA gene, are reintroduced into the patient's bone marrow. Once inside, the gene becomes active, producing functional T-lymphocytes and restoring the immune system.

Q. 9. Diagrammatically represent the experimental steps in cloning and expressing a human gene (say the gene for growth hormone) into a bacterium like *E. coli*?

ANSWER:-

DNA cloning is a technique used to create numerous identical copies of a specific DNA sequence. This process involves using a vector to transport the desired foreign DNA fragment into a host cell.

The procedure for cloning and transferring the gene for growth hormone into *E. coli* is illustrated below.



Q. 10. Can you suggest a method to remove oil (hydrocarbon) from seeds based on your understanding of rDNA technology and chemistry of oil?

ANSWER:-

Recombinant DNA technology (rDNA) is a method used to modify an organism's genetic material to achieve specific outcomes. For instance, this technology can be applied to produce oil-free seeds. Since oil consists of glycerol and fatty acids, rDNA can prevent their synthesis by targeting and eliminating the gene responsible for their production.

Q. 11. Find out from internet what is golden rice.

ANSWER:-

Golden rice is a genetically modified strain of *Oryza sativa*, created as a fortified food source for regions facing a vitamin A deficiency. It contains beta-carotene, a precursor to pro-vitamin A, which has been introduced into the rice through genetic engineering. While the rice plant naturally produces beta-carotene in its leaves, it is typically absent in the seed's endosperm, as photosynthesis does not occur there. By introducing beta-carotene into the rice, this variety aims to address the lack of dietary vitamin A, offering a simple and cost-effective alternative to vitamin supplements. However, golden rice has faced considerable opposition from environmental activists, and as a result, it is not yet available for human consumption.

Q. 12. Does our blood have proteases and nucleases?

ANSWER:-

No, human blood does not contain enzymes like nucleases and proteases. Instead, blood serum in humans contains various protease inhibitors that protect blood proteins from being degraded by proteases. Additionally, nucleases, which catalyse the hydrolysis of nucleic acids, are not present in blood.

Q. 13. Consult internet and find out how to make orally active protein pharmaceutical. What is the major problem to be encountered?

ANSWER:-

Orally active protein pharmaceuticals include biologically active substances like peptides, proteins, antibodies, and polymeric beads. These are administered orally through various formulations, often involving encapsulation in liposomes or the use of penetration enhancers. These proteins or peptides are used to treat various diseases and as vaccines. However, the oral administration of these substances presents challenges. When ingested, proteases in the stomach degrade the proteins, rendering them ineffective. Therefore, it is crucial to protect the therapeutic protein from digestive enzymes when taken orally, which is why these proteins are often injected directly into the target site.