CHAPTER 10

BIOTECHNOLOGY AND ITS APPLICATION



(A) NCERT QUESTIONS & SOLUTIONS

1. 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 encloses toxin in a special sac.

Ans. (c) toxin is inactive.

2. What are transgenic bacteria? Illustrate using any one example.

Ans. The bacteria whose DNA is manipulated, carry and express a foreign DNA is called transgenic bacteria.

For example :- Two DNA sequence (A and B chains of human insulin) were introduced into the plasmid of bacteria *E.coil*. The transgenic bacteria start producing insulin chain.

3. Compare and contrast the advantages and disadvantages of production of genetically modified crops. [IMP.]

Ans. Advantages of genetically modified crops:

(1) Reduces the use of chemical fertilizers and pesticides which cause pollution (air, water and soil).

(2) Production of new resistant varieties against pathogen, droughts, salinity, etc.

(3) Provides raw materials to industries like pharmaceuticals.

(4) Genetically modified crops have enhanced nutritional quality and yield.

(5) These crops grow fast and produce high yield through modifications.

Disadvantages of genetically modified crops:

(1) Proteins produced by GM organisms might cause allergy and other reactions.

(2) Resistance characters might develop in intestinal bacteria against antibiotics.

(3) Resistant genes transferred by pollen to the weeds may also become resistant to pests.

4. What are Cry proteins? Name an organism that produce it. How has man exploited this protein to his benefit? [IMP.]

Ans. Cry protein (crystal protein) is a toxin coded by a gene cry and is poisonous to some insects, thus giving resistant characters to the plants.

- *Bacillus thuringiensis* produces Cry protein.
- Cry protein producing gene is transferred to the plants to provide resistance against insect larvae.
- Man has developed several transgenic crops by introducing these genes from bacteria to crop plants such as Bt cotton, Bt corn etc.

5. What is gene therapy ? Illustrate using the example of adenosine deaminase (

Ans. Gene therapy is a method which corrects or replaces the defective genes. **[IMP.]**

- ☛ In 1990, first clinical gene therapy was given to a 4-year old girl with adenosine deaminase (ADA) deficiency.
- ☛ This enzyme plays an important role in functioning of immune system. The disorder is caused due to the deletion of the gene for adenosine deaminase.
- ☛ In gene therapy, lymphocytes from the blood of the patient are grown in a culture outside the body.
- ☛ A functional ADA cDNA (using a retroviral vector) is then introduced into these lymphocytes, which are returned to the patients. However, as these cells are not immortal, hence the patient requires periodic infusion of such genetically engineered lymphocytes.

6. Diagrammatically represent the experimental steps in cloning and expressing an human gene (Say the gene for growth hormone) into a bacterium like *E.coli*.

Ans. It is possible to produce HGH (human growth hormone) by recombinant DNA technology.

This is represented diagrammatically as follows :

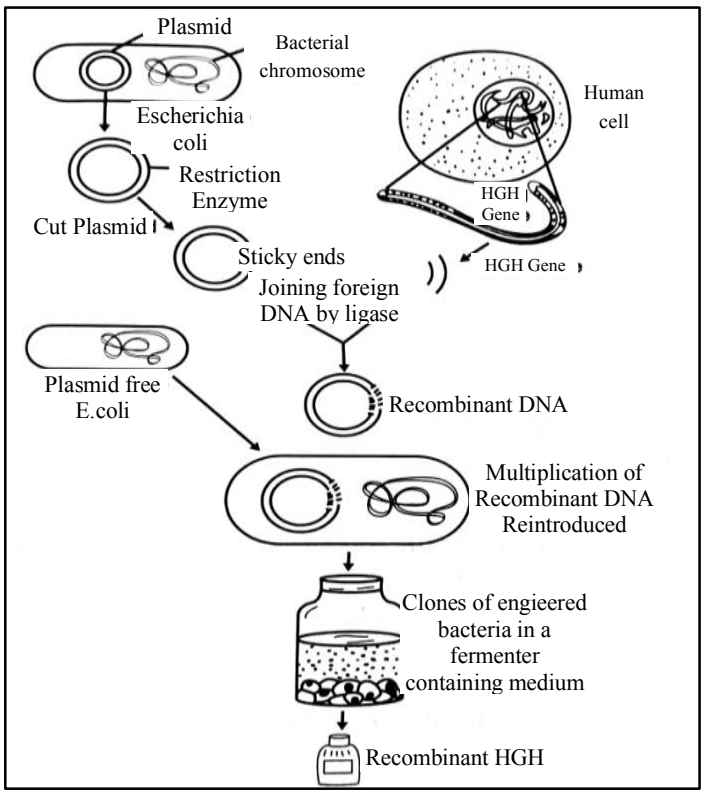


Fig. Formation of Growth Hormone by rDNA Technology.

7. Can you suggest a method to remove oil (hydrocarbon) from seed r understanding of rDNA technology and chemistry of oil?

Ans. To remove oil from seeds, the genes responsible for formation of glycerol or fatty acids need to be identified and removed which is responsible for this synthesis. So, by rDNA technique one can obtain oil-less seeds by preventing the synthesis of fats.

8. Find out from internet what is golden rice.

Ans. Golden rice is a genetically modified rice that contains β-carotene (provitamin A).

This rice is modified in order to enhance the quantity of vitamin - A in it. It is called golden due to the gold like colour it gets from β - carotene.

9. Does our blood have proteases and nucleases?

Ans. Blood does not contain proteases and nucleases because their function is to breakdown proteins and nucleic acids.

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

Ans. Orally active protein pharmaceutical can be made by lining it with a substance that will dissolve after it has passed through the stomach. The major problem encountered is that the stomach enzymes and acids may denature the therapeutic protein and render it ineffective.

(B) PREVIOUS YEAR QUESTIONS

1. (a) Name (i) a GM cereal crop having enhanced nutritional value, (ii) the nutrient it is rich in.

(b) State any two benefits of Genetically modified crops. [CBSE 2023]

Ans. (a) (i) Golden rice. (ii) Vitamin 'A' enriched

(b) GM plants have been useful in many ways. Genetic modification has:

(i) Increased tolerance against abiotic stresses (cold, drought, salt, heat).

(ii)Reduced reliance on chemical pesticides (pest-resistant crops).

2. "RNA interference has been used to produce transgenic tobacco plants to protect them from the infestation by specific nematodes." Explain the novel strategy exploited by the biotechnologists. [CBSE 2023]

Ans. 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 produced 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.

3. Eli Lilly's contribution for diabetic patients through r-DNA technology has been overwhelmingly accepted. Explain how? [CBSE 2023]

Ans. Insulin used for diabetes was earlier extracted from pancreas of slaughtered cattle and pigs. Insulin from an animal source, though caused some patients to develop allergy or other types of reactions to the foreign protein.

In 1983, Eli Lilly an American company prepared two DNA sequences corresponding to A and B, chains of human insulin and introduced them in plasmids of E. coli to produce insulin chains. Chains A and B were produced separately, extracted and combined by creating disulfide bonds to form human insulin.

4. What are cry–proteins? With the help of a suitable example, explain a biological pesticide. [CBSE Term-II 2022]

Ans. Cry Protein: The insecticidal protein which is produced by soil bacterium named Bacillus thuringiensis is called cry protein.

For example - The proteins encoded by the genes *cryIAc* and *cryllAb* control the cotton bollworms, that of *cryIAb* controls corn borer.

5. Read the following paragraph and answer the questions that follow :

Biotechnology revolves around the "gene of interest", with an objective to open various avenues for human welfare in health, medicine pharma, agriculture etc, using different techniques, tools and process. One of the breakthroughs of biotechnology in medicine is the gene therapy.

(i) Name the human disease for which of gene therapy was used for the first time.

(ii) Explain the steps of gene therapy carried to cure the disease using the lymphocytes of the patient. Why is this therapy not a permanent cure of the disease?

(iii) Write the possible permanent cure of the disease by the gene therapy that is in progress.

[CBSE Term-II 2022]

Ans. (i) ADA deficiency [Adenosine deaminase deficiency]

(ii) As a first step towards gene therapy, lymphocytes from the blood of the patient are grown in a culture outside the body. A functional ADA cDNA (using a retroviral vector) is then introduced into these lymphocytes, which are subsequently returned to the patient. However, as these cells are not immortal, the patient requires periodic infusion of such genetically engineered lymphocytes.

(iii) If the gene isolate from marrow cells producing ADA is introduced into cells at early embryonic stages, it could be a permanent cure.

6. Differentiate between pro-insulin and mature insulin. [CBSE IMP Question]

Ans. Pro-insulin contains an extra stretch called the C peptide which is not present in the mature insulin.

7. Explain the procedure by which PCR aids in early detection of cancer.

[CBSE IMP Question]

Ans.
- A single stranded DNA or RNA is tagged with a radioactive molecule(probe)
- It is allowed to hybridize to its complementary DNA in a clone of cells followed by detection using autoradiography.
- The clone having the mutated gene will hence not appear on the photographic film,
- because the probe will not have complementarity with the mutated gene.

Hence, cancer induced mutation can be detected.

8. A farmer noticed that nematode infection in tobacco plants has resulted i n the yield. Suggest a strategy which provides cellular defense for providing resistance to this pest. Explain the technique. [CBSE IMP Question]

Ans.
- Strategy based on the process of RNA interference (RNAi) - as a method of cellular defense can be used.
- 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 produced both sense and anti-sense RNA in the host cells.
- 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.
- As a consequence, the parasite could not survive in a transgenic host expressing specific interfering RNA. The transgenic plant therefore got itself protected from the parasite.

9. When *Bacillus thuringiensis* enters a certain insect's body .The insect gets killed, but itself remains unaffected .Explain how it is possible. [CBSE 2020]

Ans. *Bacillus thuringiensis* forms protein crystals during a particular phase of their growth. These crystals contain a toxic insecticidal protein**,** which killed insects but this 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 midgut epithelial cells and create pores that cause cell swelling and lysis and eventually cause death of the insect.

10. A child is born with ADA-deficiency-

(a) Suggest and explain a procedure for possible life-long (permanent) cure.

(b) Name any other possible treatment for this disease. [CBSE 2019]

Ans. **(a) Gene therapy -** In gene therapy lymphocytes from the blood of the patient are grown in a culture outside the body A functional ADA cDNA is then introduced into these lymphocytes, these cells are returned to the patient's body at early embryonic stage.

(b) Bone marrow transplantation and enzyme replacement therapy

11. A corn farmer has perennial problem of corn-borer infestation in his crop. Being environmentally conscious he does not want to spray insecticides. Suggest solution based on your knowledge of biotechnology. Write the steps to be carried out to achieve it. [CBSE 2019]

Ans. Isolation of Bt toxin genes from *Bacillus thuringiensis*, incorporated into corn, toxin coded by gene ***cry I Ab*** in corn, kills the pests/ pest dies.

12. Why has the Indian Government set up the organization named GEA o reasons. [CBSE 2019]

Ans. (i) To check the Validity of GM research and safety of introducing of GM organisms for public services.

(ii) To approve large - scale field trials and the release of transgenic crops in the environment.

13. (a) What are transgenic animals?

(b) Name the transgenic animal having the largest number amongst all the existing transgenic animals.

(c) Mention any three purposes for which these animals are produced. [CBSE 2018]

Ans. **(a)** Animals that have had their DNA manipulated to possess and express an extra (foreign) gene are known as transgenic animals.

(b) Over 95 % of all existing transgenic animals are mice.

(c) Three purposes for which transgenic animals produced-

(1) Normal physiology and development: Transgenic animals can be specifically designed to allow the study of how genes are regulated, and how they affect the normal functions of the body and its development.

(2) Study of disease: Many transgenic animals are designed to increase our understanding of how genes contribute to the development of disease.

(3) Vaccine safety: Transgenic mice are being developed for use in testing the safety of vaccines before they are used on humans.

14. Mention the chemical change that pro-insulin undergoes, to be able to act as mature insulin. [CBSE 2018]

Ans. Removal of C - peptide (from pro-insulin).

15. What are Cry genes? In which organism are they present? [CBSE 2017]

Ans. The genes which code for Bt toxin / Cry proteins / toxic proteins, they are present in bacteria *Bacillus thuringiensis*.

16. Why do lepidopterans die when they feed on Bt cotton plant? Explain how does it happen. [CBSE 2017]

Ans. Bt cotton contains inactive toxin protein (Insecticidal protein), once an insect ingest it the inactive protoxins are converted into an active form of toxin due to the alkaline pH of the gut which solubilise the crystals, activated toxins binds to surface of midgut (epithelial cells), create pores causes cell swelling and lysis and eventually cause the death of the insect.

(C) MULTIPLE CHOICE QUESTIONS

1. First transgenic plant was -

(1) Cotton (2) Maize (3) Rice (4) Tobacco

Ans. (4) Tobacco

2. The proteins encoded by the genes cryI Ac and cry II Ab control the

(1) Cotton bollworms (2) Roundworm (3) Moth (4) Fruit fly

Ans. (1) Cotton bollworms

3. A transgenic rice (Golden rice) has been developed for increased content of :-

(1) Vitamin A (2) Vitamin B_1 (3) Vitamin C (4) Vitamin D

Ans. (1) Vitamin A

4. Golden rice is

(1) a variety of rice grown along the yellow river in China.

(2) long stored rice having yellow colour tint.

(3) a transgenic rice having gene for β-carotene.

(4) wild variety of rice with yellow coloured grains

Ans. (3) a transgenic rice having gene for β-carotene.

5. Some strains of *Bacillus thuringiensis* produce proteins that kill certain insects such as-

(1) *Lepidopterans* (2) *Coleopterans* (3) *Dipterans* (4) All the above

Ans. (4) All the above

6. The inactive protoxins of *Bacillus thuringiensis* are activated inside body of insect due to the-

(1) alkaline pH of the gut (2) alkaline pH of the mouth

(3) acidic pH of the gut (4) acidic pH of the mouth

Ans. (1) alkaline pH of the gut

7. The protein products of the Bt toxin genes cryIAc and cryIIAb are responsible for controlling:-

(1) Bollworm (2) Roundworm (3) Moth (4) Fruit fly

Ans. (1) Bolloworm

8. Transgenic *Brassica napus* has been used for the synthesis of :-

(1) Hirudin (2) Heparin (3) Polgalacturonase (4) Cry protein

Ans. (1) Hirudin

9. Which of the nematode infects the roots of tobacco plants(Root knot disease) and causes a great reduction in yield.

(1) *Ascaris lumbricoides* (2) *Taenia solium*

(3) *Meloidegyne incognitia* (4) *Faciola hepatica*

Ans. (3) *Meloidegyne incognitia*

10. Transgenic tobacco plant was developed by the process of RNA interference, was resistant against the infection of -

(1) Algae – *Scenedesmus* (2) Fungi - *Fusarium*

(3) Bacteria - *Bacillus thuringiensis* (4) Nematode :*Meloidegyne incognitia*

Ans. (4) *Meloidegyne incognitia*

11. The first genetically engineered insulin has been developed by Eli-Lilly comp
(1) British Company (2) Indian Company
(3) American Company (4) Chinese Company
Ans. (3) American Company
12. Genetically engineered bacteria have been used in commercial production of –
(1) Thyroxin (2) Testosterone (3) Human insulin (4) Melatonium
Ans. (3) Human insulin
13. The name of drug used in cancer treatment produced by biotechnology is –
(1) Interferon (2) Human growth hormone
(3) TSH (4) Insulin
Ans. (1) Interferon
14. During the processing of the prohormone "proinsulin" into the mature "insulin"
(1) C-peptide is added to proinsulin (2) C-peptide is removed from proinsulin
(3) B-peptide is added to proinsulin (4) B-peptide is removed from proinsulin
Ans. (2) C-peptide is removed from proinsulin
15. Which step proved to be the main challenging obstacle in the production of human insulin by genetic engineering?
(1) Splitting A and B polypeptide chains.
(2) Addition of C-peptide to pro-insulin.
(3) Getting insulin assembled into mature form.
(4) Removal of C-peptide from active insulin.
Ans. (3) Getting insulin assembled into mature form.
16. What is the disadvantage of using porcine insulin (from pig) in diabetic patients?
(1) It leads hypercalcemia (2) It is expensive
(3) It may cause allergic reactions (4) It can lead to mutation in human genome
Ans. (3) It may cause allergic reactions
17. Why insulin not administered orally to diabetic patient?
(1) Insulin is bitter in taste
(2) Insulin is sour in taste
(3) Insulin will lead to sudden increase in blood sugar if given orally
(4) Insulin leads to peptic ulcer if given orally
Ans. (3) Insulin will lead to sudden increase in blood sugar if given orally
18. The first clinical gene therapy was given in 1990 to a 4 years old girl with enzyme deficiency of
(1) Adenosine deaminase (ADA) (2) Adenosine oxidase
(3) Adenosine diaminase (4) Adenosine dehydrogenase
Ans. (1) Adenosine deaminase (ADA)
19. Why is repeated transfusions of genetically engineered cells required in SCID patients?
(1) Transfused cells have a limited life span (2) The introduced gene is mutated
(3) Transfused cells are immortal (4) Both (1) and (2)
Ans. (1) Transfused cells have a limited life span
20. The milk for Rosie cow is nutritionally a more balanced product for human babies that natural cow-milk .It contained gene of
(1) human β -lactalbumin (2) human α-lactalglobulin
(3) human β- lactalglobulin (4) human α-lactalbumin
Ans. (4) human α - lactalbumin

(D) ASSERTION & REASON QUESTIONS

Directions: In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:

(1) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(2) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(3) If Assertion is true but Reason is false.
(4) If both Assertion and Reason are false.

1. **Assertion :-** Bt-plant are resistant for insect because gene of *Bacillus thuringiensis* is inserted in crops.
Reason :- It is toxic to insect and cause pores in mid gut of insect.
Ans. (1)

2. **Assertion :** Transgenic food may cause toxicity or produce allergy.
Reason : Transgenic plants have high nutrient content.
Ans. (2)

3. **Assertion :** Genetically modified microbes help in crop protection.
Reason : Transgenic bacteria control insects by producing endotoxins.
Ans. (2)

4. **Assertion :** Organs of pig such as heart, pancreas, etc., for human use can be grown through transgenic animals.
Reason : Transgenic pigs show improved growth and meat production.
Ans. (2)

5. **Assertion :** A gene from *Bacillus thuringiensis* is incorporated in plant genome to increase their yield.
Reason : *Bacillus thuringiensis* has Bt toxin producing gene, which kills the larva of insects.
Ans. (1)

6. **Assertion :** Bio-patent are awarded for biological entities and all products derived from them.
Reason : Patent on use of turmeric in wound healing was cancelled in 2008.
Ans. (3)

7. **Assertion :** In gene therapy, new gene is introduced only into the somatic cells.
Reason : Genetic modification is done to replace faulty genes by normal functional gene.
Ans. (2)

8. **Assertion :** Flavr-Savr tomato was the first transgenic commercial crop that entered the market.
Reason : RNA interference involves silencing of a speecific mRNA due to a complementary RNA molecule that binds to and prevent translation of the mRNA.
Ans. (2)

9. **Assertion :** GM crops can affect human health by causing allergic reactions.
Reason : Transgenes in commercial crops can endanger native species, the Bt toxin gene expressed in pollen might endanger pollinators like honeybees.
Ans. (2)

10. **Assertion :** The recombinant therapeutics do not induce unwanted immunological respones.
Reason : About 30 recombinant therapeutics have been approved for human used world wide.
Ans. (2)

(E) VERY SHORT ANSWER QUESTIONS

1. Which is the first transgenic cow? Which gene was inserted into it?

Ans. The first transgenic cow was Rosie. The gene inserted was human α-lactalbumin.

2. What is GEAC? What are its main objectives?

Ans. GEAC is Genetic Engineering Approval Committee. It is an Indian government organization. Its main objectives are as follows:

- To examine the validity of genetic modification research.
- To inspect whether the use of genetically modified crops is safe for public use or not.

3. For which Indian rice variety was patent filed by a USA company?

Ans. Basmati rice.

4. How was insulin obtained before the advent of recombinant DNA technology?

Ans. Before the advent of recombinant DNA technology insulin was obtained from slaughtered cattle and pigs.

5. What are the disadvantages of GMO?

Ans. The disadvantages of GMO are:

- These can harm the insects that are beneficial to our ecosystem.
- It is not a natural way to cultivate plants and hence can damage the environment.
- It causes unwanted residual effects.
- These create more weeds.

6. Why was the second amendment of the country's patent bill cleared by the Indian Parliament?

Ans. The second amendment to the country's patent bill was cleared to prevent biopiracy by other countries, i.e., unauthorized exploitation of our bio-resources and traditional knowledge by other countries.

7. What is a patent?

Ans. Patent is a form of intellectual property right that gives its owner the right to exclude others from using, and selling their invention for a limited period of time.

8. How are 'cry' and 'Cry' different from each other?

Ans. 'cry' is the gene that encodes for Bt toxin. 'Cry' is the protein coded by the 'cry' genes.

9. Suggest a molecular diagnostic procedure that detects HIV in suspected AIDS patients.

Ans. PCR and ELISA.

10. Mention the chemical change that proinsulin undergoes, to be able to act as mature insulin.

Ans. Removal of C-peptide (from pro-insulin).

(F) SHORT ANSWER QUESTIONS

1. How is a probe used in molecular diagnostics?

Ans. A probe is a DNA or RNA fragment of variable length which can be labelled by a radioactive molecule. It hybridises to its complementary DNA and can be detected by autoradiography.

2. Is Bt-cotton resistant to all pests other than lepidopteron, dipterans, and coleopterans?

Ans. Bt cotton contains genes against lepidopteron, dipterans, and coleopterans. But, these genes are not effective against all types of pests that attack Bt-cotton.

3. Name the transgenic animal having the largest number amongst all the existing transgenic animals ?

Ans. Over 95% of all transgenic animals are mice.

4. What is gene therapy ? Name the first clinical case where it was used.

Ans. **(i)** Collection of methods that allows correction of a gene defect that has been diagnosed in a child / embryo.

(ii) Adenosine deaminase (ADA) deficiency.

5. (i) Mention the cause and the body system affected by ADA deficiency in humans.

(ii) Name the vector used for transferring ADA-DNA into the recipient cells in humans. Name the recipient cells.

Ans. **(i)** Defective gene not producing ADA, immune system is affected.

(ii) A retroviral vector is used. Recipient cells are lymphocytes.

6. Why is functional insulin produced considered better than the ones used earlier by diabetic patient ?

Ans. The functional protein is produced by rDNA. It does not produce allergic reaction and complication while earlier insulin was produced or extracted from pancreas of cattle and pig. It caused allergy and many complication to the diabetic patients.

7. What is GMO? List any five possible advantages of a GMO to a farmer.

Ans. Plants, bacteria, fungi, animals whose genes have been altered by manipulation.

Tolerance to abiotic stresses, like cold, drought, salt, heat, reduced reliance on chemical pesticides, pest resistant crops, reduce post harvest losses,

Increased efficiency of mineral usage by plants, enhanced nutritional value to create tailor made plant.

8. Why is molecular diagnosis preferred over conventional methods? Name any two techniques giving one use of each.

Ans. To allow early detection.

Example : rDNA technology / PCR / ELISA / Probe (Any two).

PCR-to detect low concentration of bacteria /virus (HIV).

9. What are transgenic animals. Give an example.

Ans. Animals whose DNA is manipulated to possess and express an extra (foreign) gene *e.g.* Rosie - transgenic cow.

10. What was the speciality of milk produced by the transgenic cow Rosie.

Ans. Rosie was the first transgenic cow. The milk produced by it was protein rich. It contained human a lactalbumin. This milk was nutritionally richer and balanced as compared to that of normal cow.

(G) LONG ANSWER QUESTIONS

1. How is the Bt cotton plant created as a GM plant ?
How is it protected against bollworm infestation ?

OR

(i) Why are certain cotton plants called Bt cotton plants?
(ii) Explain how Bt cotton is resistant to pests.

Ans. (i) Certain cotton plants are called Bt cotton because specific Bt toxin genes were isolated from *Bacillus thuringiensis* and incorporated into these cotton plants. The proteins encoded by the genes *cryIAc* and *cryIIAb* control the cotton bollworms, that of *cryIAb* controls corn borer.

(ii) Specific Bt toxin genes were isolated from *Bacillus thuringiensis* and incorporated into the several crop plants such as cotton. The choice of genes depends upon the crop and the targeted pest, as most Bt toxins are insect-group specific. 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.

2. (i) What is gene therapy?
(ii) What is meant by ADA deficiency ? How is gene therapy a solution to this problem ?
Why is it not a permanent cure ?

Ans. (i) It is a collection of methods that allows correction of a gene defect that has been diagnosed in a child or embryo.

(ii) ADA is adenosine deaminase deficiency, this enzyme is crucial for the immune system to function. The patient lacks functional T-lymphocytes and fails to fight the infecting pathogens. Children with ADA deficiency are cured by bone marrow transplantation or enzyme replacement therapy, where ADA is given by injection. By using gene therapy techniques, lymphocytes are taken from the patient's bone marrow and the normal gene for ADA is introduced into the lymphocytes using retrovirus. These cells are re-introduced in the patient's immune system.

3. How has the use of Agrobacterium as vectors helped in controlling *Meloidegyne incognitia* infestation in tobacco plants? Explain in correct sequence.

Ans.
- Using Agrobacterium vector nematode specific genes introduced into host plant
- Sense and antisense strands of mRNA are produced
- ds RNA is formed
- ds RNA initiates RNAi
- Prevents translation of mRNA / silencing of mRNA of parasite / nematode
- Parasite will not survive

4. (a) What are transgenic animals?
(b) Name the transgenic animal having the largest number amongst all the existing transgenic animals.
(c) Mention any three purposes for which these animals are produced.

Ans. **(a)** Animals that have had their DNA manipulated to possess and express an e e are known as transgenic animals.

(b) Over 95 % of all existing transgenic animals are mice.

(c) Three purposes for which transgenic animals produced-

(1) Normal physiology and development: Transgenic animals can be specifically designed to allow the study of how genes are regulated, and how they affect the normal functions of the body and its development.

(2) Study of disease: Many transgenic animals are designed to increase our understanding of how genes contribute to the development of disease.

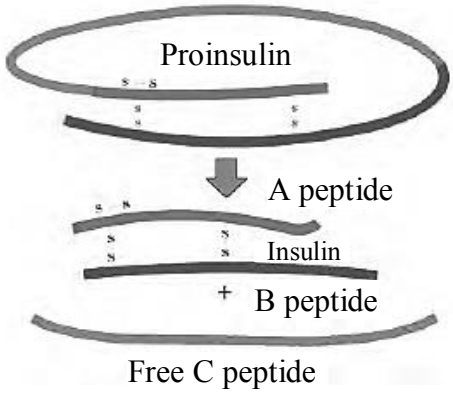
(3) Vaccine safety: Transgenic mice are being developed for use in testing the safety of vaccines before they are used on humans.

5. How does RNA interference help in developing resistance in tobacco plant against nematode infection?

Ans. With RNA interference technique transgenic tobacco plant is protected against nematode *Meloidegyne incognitia* using *Agrobacterium* as the vectors.

- Nematode – specific genes were introduced into the host plant.
- It produced both sense and antisense RNA.
- There 2 RNAs form dsRNA molecules.
- It silence specific mRNA of nematode (No protein synthesis / no translation)
- Hence nematode cannot survive in tobacco plant.

6. The maturation of pro-insulin into insulin is simplified by following diagram ,observed it and give the answer of questions that follow.



(a) What is the main challenge for production of genetically engineered insulin?

(b) What is main disadvantage of insulin obtained from the pancreas of slaughtered cow and pigs.

(c) Mention one difference between the human insulin and genetically engineered insulin.

Ans. (a) It is using rDNA technologies was getting insulin assembled into a mature form.

(b) There is potential of immune response in humans against the administered insulin which is derived from animals.

(c) The insulin in human pancreas is synthesized as a pro insulin containing the C peptide, which is removed to from mature insulin while genetically engineered insulin did not contain C peptide was directly prepared in mature form by combining of A and B polypeptide.

(H) CASE-STUDY BASED QUESTIONS

1. Read the following and answer the questions given below:

Insulin used for diabetes was earlier extracted from pancreas of slaughtered cattle and pigs. Insulin from an animal source, though caused some patients to develop allergy or other types of reactions to the foreign protein. Insulin consists of two short polypeptide chains: chain A and chain B, that are linked together by a type of bridge. A company prepared two DNA sequences corresponding to A and B, chains of human insulin and introduced them in plasmids of *E. coli* to produce insulin chains. Chains A and B were produced separately, extracted and combined to form human insulin.

(i) State the role of C-peptide in human insulin.

Ans. The C - peptide is an extra strecth of the peptides. That connect the A and B - polypeptide chains of Insulin in pro - hormone. During processing to release mature and functional Insulin, this C-peptide is removed.

(ii) Mention the chemical transformation that Proinsulin goes through to become mature insulin.

Ans. The C-peptide present in proinsulin is removed during its maturation.

(iii) Why is proinsuling so called? How is proinsulin Different from functional insulin in human?

Ans. Human insulin when initially synthesised in human body consists of three peptide chains - A, B and C. The C - peptide is an extra stretch of amino acids Joining the A and B - chains. This is called proinsulin or pro - hormone. It undergoes processing or splicing to release the functional mature insulin that can carry out its normal functions.

(iv) Name a molecular diagnostic technique to detect the presence of a pathogen in its early stage of infection.

Ans. (i) Polymerase chain

(ii) DNA recobinant technology

(iii) ELISA

2. Read the following and answer the questions given below:

Golden rice was engineered from normal rice by Potrykus and Beyer in the 1990s. The typical golden colour is due to the production of β-carotene a precursor of vitamin-A. Golden rice differs from its parental strain by the addition of three β-carotene genes. These included two genes from daffodil plant and third from a bacterium. The incorporation of these genes allows the rice plant to modify certain metabolic pathways in its cells to produce β-carotene.

(i) What are transgenic plants? Give some example.

Ans. Transgenic plants are plants that have been genetically engineered a breeding approach that uses recombinant DNA Techniques to create plants with new charateristics. Example:-
Bt cotton, Golden rice, flavr Savr tomato

(ii) Genese are transferred to make golden rice by?

Ans. Genese are transferred to make golden rice by?

(iii) Some crop plants are modified genetically by manipulating their genes. How are they made beneficial?

Ans. More tolerant to abiotic stresses; pest-resistant; reduction in post harvest losses; enhanced nutritional value of food.

(iv) What are genetically modified organism? Name two Factors on which their behaviour depends?

Ans. Those organisms whose gene have been altered by manipulating are called genetically modified organism.
Two factors - (i) Proper insertion of gene of interest.
(ii) Proper harvesting of genetically modified organisms to produce desired product.

3. Read the following and answer the questions given below:

The first clinical gene therapy was given in 1990 to a 4-year old girl with adenosine deaminase (ADA) deficiency. As a first step towards gene therapy, lymphocytes from the blood of the patient are grown in a culture outside the body. A functional ADA cDNA (using a retroviral vector) is then introduced into these lymphocytes, which are subsequently returned to the patient. However, as these cells are not immortal, the patient requires periodic infusion of such genetically engineered lymphocytes. However, if the gene isolate from marrow cells producing ADA is introduced into cells at early embryonic stages, it could be a permanent cure.

(i) Write the name of disease which caused due to deficiency of enzyme adenosine deaminase.

Ans. ADA Deficiency.

(ii) Mention a possible permanent cure for a ADA deficiency patient.

Ans. A possible permanent cure would be gene therapy, if it is detected as early embryonic stage.

(iii) What is gene therapy? Name the first clinical case where it was used.

Ans. Gene therapy is a collection of methods that allows correction of a gene defect that has been diagnosed in a child/embryo.

(iv) Why do children cured by enzyme replacement therapy for ADA deficiency need periodic treatment.

Ans. As enzyme replacement therapy does not cure the disease completely, it requires periodic treatment.

(v) What is the reason for ADA – Deficiency?

Ans. The disorder is caused due to the deletions of the gene for adnosine deaminase.

4. Read the following and answer the questions given below:

Several nematodes parasitise a wide variety of plants and animals including human beings. A nematode *Meloidegyne incognitia* 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). Using *Agrobacterium* vectors, nematode-specific genes were introduced into the host plant. The introduction of DNA was such that it produced both sense and anti-sense RNA in the host cells. These two RNA's being complementary to each other formed a double stranded (ds RNA) 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.

(i) State a method of cellular defence which works in all eukaryotic organisms.

Ans. RNA interference.

(ii) Which of nematode responsible for decrease in yielding of tobacco by infestation.

Ans. *Meloidegyne incognitia*

(iii) Explain the process of RNA interference.

Ans. RNA interference take place in all eukaryotic organisms as a method of cellular defence. It involves silencing of a specific mRNA due to complementary ds RNA molecules that binds to and prevent translation of the mRNA.

(iv) Given below is a single stranded DNA molecules. Frame and label its sense and antisense RNA molecules. 5′ATGGGTC3′

Ans. 5′ATGGGGTC3′ sense
3′TACCCCAG5′antisense] DNA

5′AUGGGGUC3′ sense
3′UACCCCAG5′ antisense] RNA

(v) What could be the source of complementary RNA in RNAi?

Ans. It could be an infection by viruses having RNA genomes or mobile genetic elements (transposons, that replicate via an RNA intermediate.