BiotechnologicalApplications in Agriculture & Medicine

1 Mark Questions

1. State the role of C-peptide in human insulin. [All India 2014]

Ans. The C-peptide is an extra stretch of the peptides that connects the A and B-polypeptide chains of insulin, in prohormone. During processing to release mature and functional insulin, this C-peptide is removed

2. A boy has been diagnosed with ADA (Adenosine Deaminase) deficiency. Suggest any one possible treatment. [Delhi 2014C]

Ans. The boy diagnosed with ADA deficiency may undergo gene therapy for treatment, but it is not a permanent cure.**3. Write the possible source of RNA interference (RNAi) gene. [Delhi 2013c]**

Ans. Mobile genetic elements, i.e. transposons are the possible source of RNA interference (RNAi) gene.

4. Name any two techniques that serve the purpose of early diagnosis of some bacterial/viral human diseases. [Foreign 2011]

or

Name a molecular diagnostic technique to detect the presence of a pathogen in its early stage of infection. [Delhi 2010; All India 2008]

Ans. Techniques that serves the purpose of early diagnosis of some bacterial/viral human diseases.

(i) Polymerase Chain Reaction (PCR).

(ii) DNA recombinant technology and

(iii) ELISA are the techniques for early diagnosis of bacterial/viral diseases

5. How does ds RNA gain entry into eukaryotic cell to cause RNA interference? [Delhi 2011c]

Ans. dsRNA gain entry into eukaryotic cell either through:

(i) infection by virus having RNA genome or

(ii) mobile genetic elements (transposons) that replicate via an RNA intermediate.

6. Name the source organism of the gene cry IAc and its target pest. [Foreign 2011]

Ans. Source of gene crylAc is Bacillus thuringiensis and its target pest-cotton bollworms.

7. What is the host called that produces a foreign gene product? What is this product called? [Foreign 2010]

Ans. Transgenic organisms or genetically modified organisms are hosts that produces a foreign gene product.

Recombinant proteins are the product.

8. Name the cry genes that control cotton bollworm and com borer respectively. [All India 2009c]

Ans. The cry genes that control Cotton boll worm – cry lAc and cry llAb Corn borer-cry lAb

9. What is the significance of the process of RNA interference (RNAi) in eukaryotic organisms? [Foreign 2008]

Ans. RNA interference (RNAi) acts as cellular defence in all eukaryotic organisms

10. State the principle on which ELISA Works. [Foreign 2008]

Ans. ELISA is based on the principle of antigen-antibody interaction.

11. How does silencing of specific mRNA in RNA interference prevent parasitic infection? [Delhi 2008C]

Ans. Parasitic infection can be prevented by using RNA interference (RNAi) process, as the nematode cannot live in the transgenic host that expresses the specific interfering RNA thus, making it double stranded and unable to translate the protein or product.

12. How are tobacco plants benefited when nematode specific genes are introduced into them using certain vectors? Name the vectors used. [Delhi 2008C]

Ans. Nematode specific genes when introduced into the host plants, initiate the process of RNAi and hence, silenced the specific mRNA of nematode. The parasite cannot survive in transgenic host, so prevent the plants from pests. Vector used is Agrobacterium.

2 Marks Questions

13. State how was Agrobacterium tumefaciens been made as a useful cloning vector to transfer DNA to plant Cells. [Delhi 2014]

Ans. The bacterium Agrobacterium tumefaciens is known to be natural vector capable of passing its DNA to plants and induce tumour by integrating its DNA with host genome. The

tumour causing gene in the plasmid of this bacteria is replaced by gene of interest and is now used as a cloning vector to transfer the DNA into plant cells.

14. What is gene therapy? Name the first clinical case in which it was used. [Delhi 2014]
Ans. Gene therapy is a corrective therapy or technique of genetic engineering to replace a faulty or non-functional gene with a normal healthy functional gene,
The first clinical gene therapy was given to a 4 years old girl with ADA (Adenosine Deaminase) deficiency in 1900, due to the deletion of the gene coding for ADA

15. Why does Bt toxin not kill the bacterium that produces it, but kill the insect that ingests it? [Delhi 2014]
or
Why do the toxic insecticidal proteins secreted by Bacillus thuringiensis kill the insect and not the bacteria itself? [Foreign 2010]
Ans. Bt toxin does not kill bacteria because it exists as an inactive protoxin.
When Bt toxin is ingested by an insect, it is converted into its active form due to the alkaline pH of the gut. The activated toxin binds to the surface of the epithelial cells of the midgut and create pores. Water entered causes swelling and lysis of cells in insect body.

16. Explain how Eli Lilly, an American company, produced insulin by recombinant DNA technology.
[Foreign 2014]
Ans. Insulin production by Eli Lilly company
(i) DNA sequences corresponding to the two polypeptide, A and B-chains of insulin are synthesised in vitro.
(ii) They are introduced into plasmid DNA of E. coli.
(iii) This bacterium is cloned under suitable conditions.
(iv) The transgene is expressed in the form of polypeptides A and B, secreted into the medium.
(v) They are extracted and combined by creating disulphide bridge to form human insulin.

17. What do 'cry genes' in Bacillus thuringiensis code for? State its importance for cotton crop. [All India 2014C]
Ans. 'cry genes' in Bacillus thuringiensiscodes for toxic insecticidal proteins that exist as inactive prototoxins.
These proteins when expressed in cotton crops through genetic engineering confers pest resistance against cotton bollworms and prevents damage. As the larva of these insects when feed upon cotton plant parts, the toxin gets activated in their gut, lysing their cells and leads to death thus, making them pest resistant.

18. Human insulin when synthesised in the body needs to be processed before it can act. Explain giving reasons. [Delhi 2014c]
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 prohormone. It undergoes processing or splicing to release the functional mature insulin that can carry out its normal functions. During processing, the C-peptide is removed. Only A and B-chains contribute to form the functional insulin.

19. Write any two ways how genetically modified plants are found to be useful? [All India 2014C]
Ans. Then genetically modified plants are found to be useful as, they :
(i) reduce or minimise the use of chemicals,fertilisers, insecticides, herbicides, etc.
(ii) reduce post-harvest losses and enhance nutritional value of crop.

20. Name the disease that was first to get the gene therapy treatment. Write the cause of the disease and the effect it has on the patient. [Delhi 2014C]

Ans. The ADA (Adenosine Deaminase) deficiency disease was the first to get the gene therapy treatment.

The disease is caused due to the deletion of gene that codes for Adenine Deaminase (ADA) enzyme. The deficiency of the ADA enzyme effects the functioning of immune system.

21. Why is proinsulin so called? How is insulin different from it? [All India 2013]

Ans. Proinsulin contains an extra stretch called C-peptide that needs to be removed to become fully mature insulin, therefore it is called proinsulin (prohormone). The mature functional insulin contains only A and B-peptide chain

22. (i) State the role of DNA ligase in biotechnology.

(ii) What happens when Meloidogyne incognita consumes cells with RNAi gene? [Delhi 2012]

Ans. (i) DNA ligase enzyme is used to join two DNA fragments from their ends.

(ii) When Meloidogyne incognita (parasite) consumes cells with RNAi gene, parasite cannot survive and this prevents infection. The introduced DNA forms both sense and anti-sense RNA. These two strands being complementary to each other form ofsRNA, leading to RNAi. Thus, the mRNA of nematode is silenced and the parasite cannot survive there. This produces Meloidogyne incognita resistant tobacco plants.

23. (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. [All India 2012]

Ans. (i) ADA is caused due to deletion of gene for adenosine deaminase. Immune system of body is affected due to this.

(ii) Retroviral vector is used to transfer ADA-DNA into the recipient cells of human.

Recipient cells-Lymphocytes.

24. Explain how a hereditary disease can be corrected. Give an example of the first successful attempt made towards correction of such disease? [Delhi 2011]

or

How is gene therapy being used in treating ADA deficiency patients? [All India 2008C]

Ans. Hereditary disease can be corrected by gene therapy. It is a collection of methods that allows correction or replacement of defective gene. The first gene therapy was given in 1990 to a 4 years old girl with Adenosine Deaminase (ADA) deficiency. It is caused due to the deletion of gene for adenosine deaminase.

The treatment involves following steps:

(i) Lymphocytes from the blood of patient are grown on culture outside the body.

(ii) A functional ADA, cDNA (using a Retro viral vector) is then introduced into these lymphocytes.

(iii) Such genetically engineered lymphocytes are returned to the blood of patient.

(iv) Periodic infusion of such genetically engineered lymphocyte is required by the patient.

25. How is recombinant DNA technology help in detecting the presence of mutant gene in cancer patients? [All India 2011c]

Ans. A single stranded DNA or RNA, tagged with a radioactive molecule (probe) is allowed to hybridise with its complementary DNA in a clone of cells followed by detection using autoradiography.

The clone having the mutated gene will not appear on photographic film, because probe will not be complementary with mutated gene thus, helpful in detecting the presence of mutated gene in cancer patients.

26. Explain the process of RNA interference. [Delhi 2011]

Ans. Process of RNA interference (RNAi) is related with silencing of a specific mRNA. It is a method of cellular defence in all eukaryotes.

(i) A complementary RNA binds to the mRNA making it double stranded and prevent its translation.

(ii) This complementary RNA could be from an infection by viruses having RNA genomes or mobile genetic elements (transposons) that replicate via an RNA intermediate.

(iii) Using Agrobacterium vectors, nematode specific genes were introduced into the host plants.

(iv) It produces both sense and anti-sense RNA in the host cells.

(v) These two RNAs being complementary to each other form a double stranded RNA (dsRNA) that initiated RNAi, silencing the specific mRNA of the nematode.

(vii) Due to this, parasite could not survive in a transgenic host expressing interfering RNA. So, transgenic plant is protected.

27. Why is the infroduqtion of genetically engineered lymphocytes into an ADA deficiency patient not a permanent cure? Suggest a possible permanent cure. [Delhi 2010]

Ans. The genetically engineered lymphocytes have a lifespan. Hence, the patient requires periodic infusion of genetically engineered lymphocytes so, the cure is not permanent. The cure can be permanent, if the gene isolated from marrow cells producing ADA is introduced into the cells at early embryonic stages.

28. How did Eli Lilly synthesise the human insulin? Mention one difference between this insulin and the one produced by the human pancreas. [All India 2010]

Ans. (I) Insulin production by Eli Lilly company

(i) DNA sequences corresponding to the two polypeptide, A and B-chains of insulin are synthesised in vitro.

(ii) They are introduced into plasmid DNA of E. coli.

(iii) This bacterium is cloned under suitable conditions.

(iv) The transgene is expressed in the form of polypeptides A and B, secreted into the medium.

(v) They are extracted and combined by creating disulphide bridge to form human insulin.

(II) Differences between insulin produced by rDNA and insulin produced by pancreas are:

Insulin produced by *r*DNA	Insulin produced by pancreas
It has A and B-polypeptides.	It has three polypeptides. A, B and C-chains before maturing, called the prohormone.
It directly synthesises mature hormone.	It undergoes processing to form mature and functional hormone.

29.How is Bt cotton made to attain resistance against bollworm? [Delhi 2010C]

Ans. Bt toxin genes cryl Ac and cryllAb control cotton boll worms. These genes are isolated from the bacterium and are incorporated into cotton plants.

'cry genes' in Bacillus thuringiensiscodes for toxic insecticidal proteins that exist as inactive prototoxins.

These proteins when expressed in cotton crops through genetic engineering confers pest resistance against cotton bollworms and prevents damage. As the larva of these insects when feed upon cotton plant parts, the toxin gets activated in their gut, lysing their cells and leads to death thus, making them pest resistant.

30.Highlight any four advantages of Genetically Modified Organisms (GMOs). [Foreign 2009; All India 2008C]

1.Advantages of GMOs are as follows :

(i) Tolerance against abiotic stresses, such as cold, drought, salt, heat.

(ii) Reduces dependence on chemical pesticides.

(iii) Reduce post harvest losses.

(iv) Increase efficiency of mineral usage by plants.Advantages of GMOs are as follows

31. List the three molecular diagnostic techniques that help to detect pathogens from suspected patients, Mention one advantage of these techniques over conventional methods. [Delhi 2009c]

Ans. Molecular diagnostic techniques to pathogens are as follow:

(i) Polymerase Chain Reaction (PCR).

(ii) Recombinant DNA technology.

(iii) Enzyme Linked Immuno Sorbent Assay (ELISA).

The advantage of these techniques is that they help in early detection and treatment of diseases, which is not possible by the conventional diagnostics.

32. Expand ELISA. On what principle is ELISA test based? List two ways by which an infection can be detected by this test. [All India 2009C]

Ans. ELISA – Enzyme Linked Immuno Sorbent Assay.

ELISA is based on antigen-antibody interaction.

The two ways to detect the presence of infection or disease by ELISA are as follow:

(i) The presence of antigens (proteins, glycoproteins, etc) are detected.

(ii) Antibodies produced against the pathogen are detected.

3 Marks Questions

33.How did the process of RNA interference help to control the nematode from infecting the roots of tobacco plants.

Ans. When the nematode infects the roots of tobacco plants and feeds upon cells containing RNAi gene. This DNA produced both sense and anti-sense RNA in the host cells (tobacco plant) and is complementary to the functional mRNA of the nematode. This complementarity between both RNA makes it double stranded and, hence silenced by not being translated into protein. Interference with RNA expression and protein synthesis makes it difficult for the pathogen to survive in tobacco plants and hence killed. In this way RNA interference protects and control the nematode infection.

34. Name the host plant and its part that Meloidogyne incognita infects. Explain the role of Agrobacterium in the production of dsRNA in the host plant. [Delhi 2014C]

Ans. The nematode Meloidogyne incognita infects the roots of tobacco plants.

The Agrobacterium are used as vectors carrying nematode specific genes to be introduced in host plant. These genes when expressed inside host plant produces sense and anti-sense RNA strands, complementary to nematode's functional mRNA. This binding results in formation of double stranded RNA and inhibiting or silencing the translation of RNA specified. This process is called RNA interference.

35. Name the pest that destroys the cotton bolls. Explain the role of Bacillus thuringiensis in protecting the cotton crop against the pest to increase the yield. [All India 2013]

or

How is the Btcotton plant created as a GM plant? How is it protected against bollworm infestation? [Delhi 2013C]

Ans. The pest that destroys the cotton balls are cotton boll worms and cotton borer. Bt cotton

is created by using some strains of a bacterium, Bacillus thuringiensis (Btis short form).
(i) This bacterium produces protein that kill certain insects such as lepidopterans (tobacco budworm and armyworm), coleopterans (beetles) and dipterans (flies and mosquitoes).
(ii) Bacillus thuringiensis forms protein crystals during a particular phase of their growth. These crystals contain a toxic insecticidal protein.
(iii) Bt toxin protein exist as inactive protoxins, but once an insect ingests the inactive toxin, it is converted into an active form due to the alkaline pH of the gut which solubilise the crystals.
(iv) The activated toxin binds to the surface of midgut epithelial cells and create pores that cause cell swelling and lysis leading to death of insect.
(v) Specific Bttoxin genes were isolatedfrom Bacillus thuringiensis and incorporated into several crop plants.
(vi) Most Bttoxins are insect-group specific.Hence, the toxin is coded by a gene named cry. For example, the proteins encoded by the genes cry I Ac and cry IAb control the cotton boll worms and cry IAb controls corn borer.

36. Name the genes responsible for making Bt cotton plants resistant to bollworm attack How do such plants attain resistance against bollworm attacks. Explain. [Delhi 2012]
Ans. Genes cry IAc and cryIIAb control cotton bollworm.
'cry genes' in Bacillus thuringiensiscodes for toxic insecticidal proteins that exist as inactive prototoxins.
These proteins when expressed in cotton crops through genetic engineering confers pest resistance against cotton bollworms and prevents damage. As the larva of these insects when feed upon cotton plant parts, the toxin gets activated in their gut, lysing their cells and leads to death thus, making them pest resistant.

37. (i) Tobacco plants are damaged severely when infested with Meloidogyne incognita. Name and explain the strategy that is adopted to stop this infestation,
(ii) Name the vector used for introducing the nematode specific gene in tobacco plant. [All India 2012]
or
How does RNA interference help in developing resistance in tobacco plant agamst nematode infection? [Delhi 2010]
Ans. (i)Infestation of tobacco plant can be stopped by using RNA interference (RNAi) process.
Process of RNAi
Process of RNA interference (RNAi) is related with silencing of a specific mRNA. It is a method of cellular defence in all eukaryotes.
(i) A complementary RNA binds to the mRNA making it double stranded and prevent its translation.
(ii) This complementary RNA could be from an infection by viruses having RNA genomes or mobile genetic elements (transposons) that replicate via an RNA intermediate.
(iii) Using Agrobacterium vectors, nematode specific genes were introduced into the host plants.
(iv) It produces both sense and anti-sense RNA in the host cells.
(v) These two RNAs being complementary to each other form a double stranded RNA (dsRNA) that initiated RNAi, silencing the specific mRNA of the nematode.
(vii) Due to this, parasite could not survive in a transgenic host expressing interfering RNA. So, transgenic plant is protected.
(ii) Vector used for introducing the nematode specific gene in tobacco plant *is* Agrobacterium.

38. How has biotechnology helped in producing Meloidogyne incognita resistant tobacco

plant?

(ii) Why does this nematode die on eating such a GM plant? [Delhi 2010C]

Ans. (i) When Meloidogyne incognita (parasite) consumes cells with RNAi gene, parasite cannot survive and this prevents infection. The introduced DNA forms both sense and anti-sense RNA. These two strands being complementary to each other form ofsRNA, leading to RNAi. Thus, the mRNA of nematode is silenced and the parasite cannot survive there. This produces Meloidogyne incognita resistant tobacco plants.

(ii) Due to the RNAi process, specific mRNA of nematode is silenced. The result is that the parasite could not survive on eating such GM or transgenic plant (host), expressing, specific interfering RNA

39. Explain the effect of deletion of the gene for ADA in an individual.

(ii) How does the gene therapy help in this case? [All India 2010c]

Ans. (i) Deletion of the gene for ADA in an individual leads to ADA deficiency disorder. Adenosine Deaminase (ADA) enzyme is crucial for immune system to function.

(ii) Gene therapy is helpful in case of ADA deficiency.

Hereditary disease can be corrected by gene therapy. It is a collection of methods that allows correction or replacement of defective gene. The first gene therapy was given in 1990 to a 4 years old girl with Adenosine Deaminase (ADA) deficiency. It is caused due to the deletion of gene for adenosine deaminase.

The treatment involves following steps:

(i) Lymphocytes from the blood of patient are grown on culture outside the body.

(ii) A functional ADA, cDNA (using a Retro viral vector) is then introduced into these lymphocytes.

(iii) Such genetically engineered lymphocytes are returned to the blood of patient.

(iv) Periodic infusion of such genetically engineered lymphocyte is required by the patient.

40.Plasmid is boon to biotechnology. Justify this statement quoting the production of human insulin as an example. [All India 2009]

Ans. Plasmid is an autonomously replicating extra chromosomal circular DNA found in bacterial cells. Because it can replicate within a bacterial cell, it is used as a vector in rDNA technology.

Production of insulin polypeptide chains separately by plasmids of E. coli have enabled the artificial production of mature human insulin.

(I) Insulin production by Eli Lilly company

(i) DNA sequences corresponding to the two polypeptide, A and B-chains of insulin are synthesised in vitro.

(ii) They are introduced into plasmid DNA of E. coli.

(iii) This bacterium is cloned under suitable conditions.

(iv) The transgene is expressed in the form of polypeptides A and B, secreted into the medium.

(v) They are extracted and combined by creating disulphide bridge to form human insulin.

Differences between insulin produced by rDNA and insulin produced by pancreas are:

Insulin produced by *r*DNA	Insulin produced by pancreas
It has A and B-polypeptides.	It has three polypeptides. A, B and C-chains before maturing, called the prohormone.
It directly synthesises mature hormone.	It undergoes processing to form mature and functional hormone.

41. Name the source and the types of cry genes isolated from it for incorporation into crops

by biotechnologists. Explain how have these genes brought beneficial changes in the genetically modified Crops. [All India 2009]

Ans. The source is Bacillus thuringiensis.

Types of crygenes cry IAc, cry IIAb, cry IAb.

Changes caused by cry genes in GM crops:

(i) The cry genes code for certain crystal proteins that have Bt toxin.

(ii) Bt toxin exists as inactive protoxin and gets converted into active form (toxin) in the alkaline pH of the gut of the insect.

(iii) The activated toxin binds to the epithelial cells lining the surface of the midgut and creates pores leading to swelling and lysis of the cells and ultimately cause death of the insect.

(iv) This way GM crops show resistance against insect pests.

42. How did Eli Lilly company go about preparing the human insulin? How is the insulin thus, produced different from that produced by the functional human insulin gene? [Foreign 2009]

Ans. Insulin production by Eli Lilly company

(i) DNA sequences corresponding to the two polypeptide, A and B-chains of insulin are synthesised in vitro.

(ii) They are introduced into plasmid DNA of E. coli.

(iii) This bacterium is cloned under suitable conditions.

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43. What are Cry proteins? Name an organism that produces it. How has man exploited this protein to his benefit? [Delhi 2009c]

Ans. Cryprotein (crystal protein) is a toxin coded by a gene cry and is poisonous to some insects. Thus, provide resistance to the plants against insects.

Bacillus thuringiensis produces cry protein.

Cry protein producing gene is transferred to the plant 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 Marks Questions

44. Name the source from which insulin was extracted earlier. Why this insulin no more in use by diabetic people?

(ii) Explain the process of synthesis of insulin by EH Lilly company. Name the technique used by the company.

(iii) How is the insulin produced by human body different from the insulin produced by the above mentioned company? [All India 2011]

or

(i) How is mature insulin different from proinsulin secreted by pancreas in human?
(ii) Explain how was human functional insuhn produced using rDNA technology.
(iii) Why is the functional insulin thus produced considered better than the ones used earlier by diabetic patients? [Delhi 2009]

Ans. (I) Insulin was extracted earlier from pancreas of slaughtered pigs and cattle animals. Insulin obtained from these sources caused some allergy or some other reactions to the foreign protein.

(II) Production of human insulin by Eli Lilly company.

Insulin production by Eli Lilly company

(i) DNA sequences corresponding to the two polypeptide, A and B-chains of insulin are synthesised in vitro.

(ii) They are introduced into plasmid DNA of E. coli.

(iii) This bacterium is cloned under suitable conditions.

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Differences between insulin produced by rDNA and insulin produced by pancreas are:

Insulin produced by *r*DNA	Insulin produced by pancreas
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It directly synthesises mature hormone.	It undergoes processing to form mature and functional hormone.

The company used rDNA technology for this.

(III) Insulin production by Eli Lilly company

(i) DNA sequences corresponding to the two polypeptide, A and B-chains of insulin are synthesised in vitro.

(ii) They are introduced into plasmid DNA of E. coli.

(iii) This bacterium is cloned under suitable conditions.

(iv) The transgene is expressed in the form of polypeptides A and B, secreted into the medium.

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Differences between insulin produced by rDNA and insulin produced by pancreas are:

Insulin produced by *r*DNA	Insulin produced by pancreas
It has A and B-polypeptides.	It has three polypeptides. A, B and C-chains before maturing, called the prohormone.
It directly synthesises mature hormone.	It undergoes processing to form mature and functional hormone.

45. Name the process involved in the production of nematode-resistant tobacco plants, using genetic engineering. Explain the strategy adopted to develop such plants. [Foreign 2011,2009; All India 2009,2008]

Ans. The process involved in the production of nematode resistant tobacco plants is called RNA interference (RNAi), which involves silencing of a specific mRNA.

46. One of the main objectives of biotechnology is to minimise the use of insecticides on cultivated crops. Explain with the help of a suitable example, how insect resistant crops have been developed using techniques of biotechnology. [Delhi 2009; Foreign 2008]

Ans. The pest that destroys the cotton balls are cotton boll worms and cotton borer. Bt cotton is created by using some strains of a bacterium, Bacillus thuringiensis (Btis short form).

(i) This bacterium produces protein that kill certain insects such as lepidopterans (tobacco budworm and armyworm), coleopterans (beetles) and dipterans (flies and mosquitoes).

(ii) Bacillus thuringiensis forms protein crystals during a particular phase of their growth. These crystals contain a toxic insecticidal protein.

(iii) Bt toxin protein exist as inactive protoxins, but once an insect ingests the inactive toxin, it is converted into an active form due to the alkaline pH of the gut which solubilise the crystals.

(iv) The activated toxin binds to the surface of midgut epithelial cells and create pores that cause cell swelling and lysis leading to death of insect.

(v) Specific Bttoxin genes were isolatedfrom Bacillus thuringiensis and incorporated into several crop plants.

(vi) Most Bttoxins are insect-group specific.Hence, the toxin is coded by a gene named cry. For example, the proteins encoded by the genes cry I Ac and cry IAb control the cotton boll worms and cry IAb controls corn borer.

47. Expand the name of the enzyme ADA. Why is the enzyme essential in the human body? Suggest a gene therapy for its deficiency. [All India 2009]

Ans. ADA-Adenosine Deaminase. It is required for the proper functioning of immune system.

Gene therapy for ADA deficiency are:

Gene therapy is helpful in case of ADA deficiency.

Hereditary disease can be corrected by gene therapy. It is a collection of methods that allows correction or replacement of defective gene. The first gene therapy was given in 1990 to a 4 years old girl with Adenosine Deaminase (ADA) deficiency. It is caused due to the deletion of gene for adenosine deaminase.

The treatment involves following steps:

(i) Lymphocytes from the blood of patient are grown on culture outside the body.

(ii) A functional ADA, cDNA (using a Retro viral vector) is then introduced into these lymphocytes.

(iii) Such genetically engineered lymphocytes are returned to the blood of patient.

(iv) Periodic infusion of such genetically engineered lymphocyte is required by the patient.

48. What is ADA deficiency? Describe three methods to cure it. [All India 2009]

Ans. ADA deficiency is caused due to the deletion of gene for adenosine deaminase.

Methods to cure ADA deficiency are:

(i) **1st method** In some cases, it can be cured by bone marrow transplantation and enzyme replacement therapy but it is not fully curative.

(ii) **2nd method** Lymphocytes from patient's blood were grown in a culture and functional ADA, cDNA was intr* iuced in these lymphocytes using a retroviral vector. The lymphocytes were then transferred into the patient's body. Periodic infusion of sucH genetically engineered lymphocytes is done because these cells are mortal.

(iii) 3rd method This is a permanent method. Genes isolated from the bone marrow cells producing ADA is introduced into cells at early embryonic stage.

49. (i) What is plasmid? (ii) What is meant by ADA deficiency? How is gene therapy a solution to this problem? Why is it not a permanent cure? [Delhi 2008; Foreign 2008]

Ans. (i) Plasmid is an extra chromosomal, self-replicating, circular, double stranded DNA molecule found naturally in bacteria.

(ii) ADA deficiency occurs due to the deletion of gene for adenosine deaminase enzyme. This enzyme is crucial for immune system functioning in humans.
In gene therapy, lymphocytes from the blood of the patients are grown in a culture outside the body. A functional ADA, cDNA is then introduced using a retroviral vector into the lymphocytes. These lymphocytes are then returned to the patient.
Because these cells are not immortal, the patient requires periodic infusion of such genetically engineered lymphocytes

50. (i) Why is Bacillus thuringiensis considered suitable for developing GM plants?
(ii) Explain how it has been used to develop GM crops. (Foreign 2008)
Ans. (ii) Bacillus thuringiensisproduces a protein, which is toxic to the larvae of insects like boll worm, budworm, flies, beetle, etc. Bttoxin gene is cloned from the bacteria and has been expressed in plants to provide resistance against insects without the need for chemical insecticides.
(ii) The method for developing GM plants involve
(a) crygene coding for proteins has been isolated using restriction enzymes. They are cloned in the vectors and then introduced into desired crop plants. The different types of crygenes that code for insect-specific cryproteins are crylAc and crylIAb that control cotton bollworm. crylAb controls corn borer.
(b) The transgenic plants, i.e. Bt cotton, Bt corn, Bt rice, produce the protein in their cells and express insect pest resistance.

51. (i) Why are certain cotton plants called Bt cotton plants?
(ii) Explain how Bt cotton is resistant to pests. [Delhi 2008C]
Ans. (i) Btcotton plants are genetically modified plants that contain crygene obtained from Bacillus thuringiensis (Bt). Bttoxin is coded by crygene and produced by bacterium Bacillus thuringiensis (Bt).
(ii) Specific Bt toxin genes were isolated from this bacterium and incorporated into several crop plants such as cotton to provide resistance against insect and pest.
Hence, these cotton plant containing Bt genes are called Bt cotton plants.
Bt toxin genes cry IAc and cry II Ab control cotton boll worms. These genes are isolated from the bacterium and are incorporated into cotton plants.
'cry genes' in Bacillus thuringiensiscodes for toxic insecticidal proteins that exist as inactive prototoxins.
These proteins when expressed in cotton crops through genetic engineering confers pest resistance against cotton bollworms and prevents damage. As the larva of these insects when feed upon cotton plant parts, the toxin gets activated in their gut, lysing their cells and leads to death thus, making them pest resistant.