

Chapter 12

Biotechnology and its Applications

1 Marks Questions

1. Name the technique based on the principle of antigen-antibody interaction used in detection of a virus (HIV).

Ans.ELISA (Enzyme linked immuno – sorbent Assay)

2. Development of a transgenic food crop may help in solving the problem of night blindness in the developing countries, name this crop plant.

Ans.Golden Rice

3. Which nematode infects the roots of tobacco plant and causes a great reduction in yield?

Ans.Meloidogyne incognita.

4. The first transgenic cow, produced human protein – enriched milk. Name the cow and the protein found in milk.

Ans.Rosie, alpha-lactalbumin

5. The insulin produced using recombinant DNA technology is more advantageous than the insulin extracted from pancreas of slaughtered cattle and pigs. How?

Ans.Insulin obtained from animal source causes allergy.

6. Name two pest resistant plants produced by using recombinant DNA technology.

Ans.Bt Cotton, Bt Corn, Bt Brinjal.

7. Name the genetically engineered human Insulin?

Ans.Humulin

8. Write the Scientific name of nematode that attacks the root of tobacco plant?

Ans.Meloidogyne incognita.

9. Define a patent?

Ans.Patent is the government protection to the inventor of biological material, Securing to him for a specific time the exclusive right of manufacturing, exploiting, using & selling an invention.

10. Expand GEAC.

Ans.Genetic Engineering Approval Committee.

12. Which vaccine was being tested on mice?

Ans.Polio vaccine.

13. Name the bacterium which is used to produce insect-resistant plants by genetic engineering.

Ans.Bacillus thuringiensis.

14. Name any disease against which vaccine is developed by Recombinant DNA technology.

Ans.Hepatitis B vaccine.

15. Name the technique which is used to detect HIV in Suspected AIDS patient?

Ans.PCR (polymerase chain reaction)

17.What is the difference between 'Cry' & 'CRY'.

Ans.Cry is the gene which codes for Bt-toxin which is an insecticidal protein while CRY is the protein coded by cry genes.

18.Name any one disease for which gene therapy has been proved effective?

Ans.Adenosine deaminase deficiency (ADA).

2 Mark Questions

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1. What are the two methods for correcting ADA deficiency in a child?

Ans.Bone marrow transplantation having functional ADA enzyme and Enzyme replacement therapy.

2. 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; increased nutritional value of food.

3. GEAC is one of the organisation set up by Indian Government. Write its full form. Give its two objectives.

Ans.GEAC – Genetic Engineering approval committee. Objectives of GEAC as below:

- (i) To make decisions regarding validity of GM research.
- (ii) Safety of introducing GMO for public use.

4. "Industrialised nations are exploiting the bioresources of under industrialised nations" . Justify the statement with a suitable example.

Ans.Industrialised nations are collecting and patenting the genetic resources of under industrialised country like India. An American Company got patent rights on Basmati rice.

Valuable biomolecules obtained from bioresources are patented and used for commercial purposes.

5.What is Golden rice? What is its advantage?

Ans.Golden rice is a transgenic variety of rice which contains a gene which codes for Vitamin A precursor. This variety have green yellow coloured grains and is rich in Vitamin A & thus nutritionally very advantageous.

6.What are the three critical research areas in the field of Biotechnology?

Ans. i) providing best catalyst in the form of improved organism usually in the form of microbe or pure enzyme.

ii) Creating optimal conditions through engineering for a catalyst to function.

iii) downstream processing to purify the protein / organic compound.

7.What are the advantages of molecular diagnostics over conventional methods?

Ans.In conventional methods, presence of pathogen is normally suspected only when pathogen has produced a disease symptom. By this time the concentration of pathogen is already very high in Body which could be harmful but with molecular diagnostics, Small amount of pathogen could be detected by amplification by PCR.

8.What are genetically modified organisms? Name two factors on which their behaviour depends?

Ans. Those organisms whose genes have been altered by manipulation, are called

genetically modified organism or transgenic organisms. The two factors on which their behaviour depends:-

- i) proper insertion of gene of interest.
- ii) Proper harvesting of Genetically modified organisms to produce desired product.

9.What do you mean by “Biopiracy” Give an example?

Ans. Biopiracy refers to the use of bio-resources by multinational companies & other organizations without proper authorizations from the countries & people concerned eg. Basmati rice grown in India is distinct for its unique flavor & aroma but an American company got patent rights on Basmati through US patent.

10.What are transgenic Bacteria? Illustrate using any one example?

Ans. The bacteria in which genes of interest (i.e. foreign DNA fragment) have been introduced are called transgenic bacteria eg. E.coli when two DNA sequences A & B chains of insulin are introduced into plasmid of this bacteria, then it is called transgenic bacteria & start to produce insulin chain.

11.Give any two examples of products, how transgenic animals can be used to produce biological compounds?

Ans. i) Alpha-1-antitrypsin – a protein that is used to treat emphysema.
ii) Alpha – lactalbumin – protein – rich milk that is more nutritionally balanced product for human babies

13.Why did Bacterial toxin does not kill the bacteria but only the insects?

Ans. Bacterial toxin does not kill the *Bacillus* because. But toxic protein exists as inactive protoxin but once an insect ingests the inactive protoxin it is converted into active form of toxin due to alkaline pH of gut which solubilises the crystal. The activated toxin binds to surface of midgut epithelial cells & create pores that cause cell swelling & lysis.

14.Mention any four applications of Biotechnology in the field of Agriculture?

Ans. i) to make crops tolerant to abiotic stresses eg. cold, drought, salt, heat.
ii) to reduce reliance on chemical pesticide by producing pest-resistant crops.
iii) increased efficiency of mineral usage by plants.
iv) enhanced nutritional value of food eg. Vit – A rich golden rice.

15.Why is recombinant Insulin produced by genetic engineering need to be processed?

Ans. Recombinant Insulin produced by Genetic engineering need to be processed because insulin which is produced as proinsulin contains an additional C-peptide apart from α -& β -chain of insulin so, to make an active insulin vaccine; a peptidase enzyme is added to proinsulin to cleave C peptide & rejoining of α -& β -chain to form active Insulin.

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3 Marks Questions

1. Some multinational companies and other organisations are using bioresources

for commercial benefits, without proper authentication and compensation to concerned authorities.

(a) Give the term for this unauthorised act.

(b) Suggest any two ways to get rid of this.

Ans. (a) Biopiracy

(b) (i) Benefits of bioresources should be shared between developed and developing nations

(ii) Laws should be developed to prevent unauthorised exploitation of them bioresources.

2. A bacterium *Bacillus thuringiensis* produces a toxic protein named 'cry protein' that is lethal to certain insects but not to bacterium

(a) Why this toxin does not kill the bacteria?

(b) What type of changes occur in the gut of insects on consuming this protein?

(c) How man has exploited this protein for his benefit?

Ans. (a) Produced in inactive form as Prototoxins.

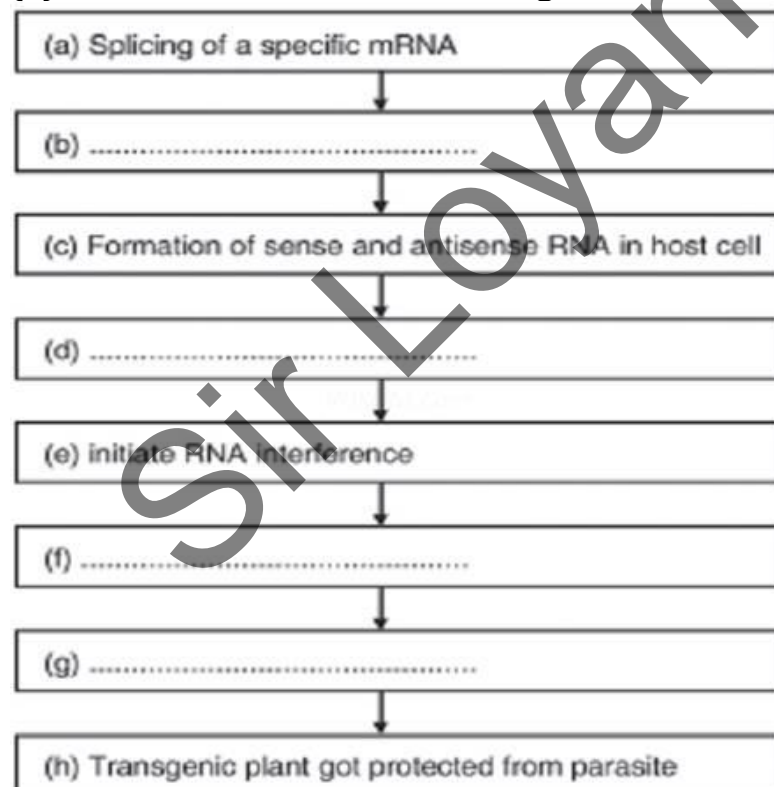
(b) Prototoxin becomes active toxin in alkaline pH of gut of insects. Toxins bind to surface of midgut and cause perforation, swelling, lysis of cells ultimately leading to death.

(c) Specific Bt toxin genes isolated from *Bacillus thuringiensis* and incorporated into several crop plants such as cotton and corn which become pest resistant against certain insects.

3. Given below is an incomplete flow chart showing the process of production of nematode resistant tobacco plants based on RNAi technique.

(i) Write the missing steps in proper sequence

(ii) At which level RNAi silences the gene?



Ans. (i) (b) Using *Agrobacterium* as a vector, introduced into tobacco

(d) dsRNA (double stranded RNA)

(f) Silenced specific mRNA of the nematode

(g) Parasite could not survive.

(ii) RNAi silences the gene at translation level

4. Describe with example, Why transgenic animals are produced?

Ans. Transgenic animals are produced for following purposes:-

1. To allow the study of how genes are regulated & how they affect normal function of body & its development eg. information obtained about biological role of insulin like growth factor.
2. To increase our understanding on how genes contribute to development of diseases.
3. To produce useful biological compounds by introducing a portion of DNA that codes for that product from other organisms, eg. α -1 antitrypsin, a protein used to treat emphysema.
4. For testing the safety of vaccine eg. polio vaccine in transgenic mice.
5. To test the toxicity of drugs.

5. Describe how nematode - resistant transgenic plants have been obtained?

Ans. A nematode *Meloidogyne incognita* infects tobacco plant & reduces its yield. The specific genes from parasite are introduced into plant using *Agrobacterium*. The genes are introduced in such a way that both sense & Antisense RNA are produced. Since these two RNAs are complementary, they form a double stranded RNA (ds RNA). This neutralizes the specific RNA of nematode by a process called RNA interference as a result, the parasite cannot live in transgenic host & plant is protected from the pest.

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

Ans. The soil bacterium *Bacillus thuringiensis* produces crystal proteins called cry proteins that are toxic to larvae of insects like tobacco budworm, beetles & mosquitoes. The cry proteins exist as inactive protoxin & gets converted into active toxin when ingested by the insect, as the alkaline pH of gut solubilises the crystal. The activated toxic binds to surface of epithelial cells of midgut & create pores this causes lysis of cells leading to death of insects. The genes encoding this protein are isolated from bacterium & incorporated into crop-plant to make them insect - resistant.

7. Write an account on the production of human insulin in transgenic organisms.

Ans. Human insulin consists of two short polypeptide chains: chain A & B linked by disulfide bonds. Insulin is secreted as prohormone which has to be processed before it becomes a mature & functional hormone. The prohormone contains another polypeptides called C-peptide which is removed during maturation. Using genetic engineering, the two DNA sequences coding for chains A & B of human insulin are introduced into plasmid of *E - coli* - to produce insulin. The two chains produced are extracted & combined by creating disulfide bridges.

8. Compare & contrast the advantages & disadvantage of production of Genetically modified organisms?

Ans. ADVANTAGES OF PRODUCING GMOS.

1. GM crops produce desired phenotypic traits in crop plants.
2. The genes responsible for production of specific proteins are inserted into GM crops. These crops then produce that specific protein.
3. Transgenic crops synthesize new end product of specific biochemical pathway.

4. These crops also help in preventing expression of existing native Gene.

DISADVANTAGES OF PRODUCING GMOS:

1. Transgenic crops may endanger wild & native species.
2. GM crops may cause health problems by supplying allergens.
3. GM crops may damage to the natural environment.

10.What are the steps involved in synthesis of genetically engineered insulin.

Ans. Steps involved in Insulin production are :-

1. for synthesis of Insulin, RNA is extracted from β - β -cells of islets of Langerhans of pancreas.
2. With the help of enzyme Reverse transcriptase, single stranded DNA complementary to mRNA is synthesized second strand of DNA complementary to first is synthesized with enzyme DNA polymerase.
3. The two strands of copy DNA is joined to plasmid by using an enzyme called terminal transferase.
4. The two ends of DNA get annealed by enzyme called ligase thus ends of inserted DNA & plasmid are sealed & a new circular plasmid is formed. This is a molecule of recombinant DNA.
5. This recombinant DNA is then inoculated in a new bacterial cell of E-coli & inserted in a bacterial gene after having cut by restriction enzyme.
6. After proper expression of genes the bacterial cells of both cultures are lysed with appropriate chemicals. The fragments of insulin are then separated from enzyme by cyanogen bromide.