Long Answer Questions (PYQ)

[5 Marks]

Q.1.

a. Name the source from which insulin was extracted earlier. Why is this insulin no more in use by diabetic people?
b. Explain the process of synthesis of insulin by Eli Lilly Company. Name the technique used by the company.
c. How is the insulin produced by human body different from the insulin produced by the above-mentioned company?

Ans.

a. Earlier, insulin was extracted from pancreas of slaughtered cattle and pig. This insulin is not in use as some patients developed allergic reaction to this foreign protein.
b. Eli Lilly used the following procedure for insulin synthesis:
    i. Two DNA sequences corresponding to A and B chains of insulin were prepared.
    ii. These sequences were then introduced in plasmids of *E. coli*.
    iii. The two insulin chains are produced separately.
    iv. The two chains are extracted and combined by creating disulphide bonds to form the assembled mature molecule of insulin.
c. The pro-hormone produced in the human body has an extra stretch of C-peptide.

Q.2. What are transgenic animals? Explain any four ways in which such animals can be beneficial to humans.

OR

Define transgenic animals. Explain in detail any four areas where they can be utilised.

Ans. Transgenic Animals

- Animals whose DNA is manipulated to possess and express an extra (foreign) gene are known as transgenic animals. Transgenic rats, rabbits, pigs, sheep and cows have been produced.
- Following are the common reasons for developing transgenic animals:

(i) Study of normal physiology and development

- Useful to study gene regulation, their effect on the normal functions of the body and its development.

- For example, study of complex growth factors like insulin-like growth factor.

(ii) Study of disease

- Study of genes which are responsible for diseases in human and their treatment.
- Transgenic models have been developed for many human diseases like cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's disease.

(iii) Biological products

- Useful biological products can be produced by introducing, into transgenic animals, the portion of DNA (or genes) which codes for a particular product.
- For example, human protein (α-1-antitrypsin) is used to treat emphysema.
- In 1997, the first transgenic cow, Rosie, produced human protein-enriched milk (2.4 g/L).
- The milk contained the human alpha-lactalbumin and was more nutritionally balanced for human babies than natural cow milk.

(iv) Vaccine safety

- Transgenic mice are developed to test safety of vaccines, before being used on humans.
- For example, polio vaccine.

(v) Chemical safety testing

- Transgenic animals are made to carry genes, which make them more sensitive to the toxic substances than non-transgenic animals.
- On exposing to the toxic substances, their effects are studied in less time.

Q.3.

a. **Why is *Bacillus thuringiensis* considered suitable for developing GM plants?**
b. **Explain how it has been used to develop GM crops.**

Ans.

a. Some strains of Bacillus thuringiensis produce proteins that kill some insects like lepidopterans (tobacco budworm, armyworm), coleopterans (beetles) and dipterans (flies, mosquitoes). Bt toxins are initially inactive protoxins but after ingestion by the insect their inactive toxin becomes active due to the alkaline pH of the gut which solublise the crystals. The activated toxin binds to the surface of midgut epithelial cells thus creating pores which causes cell swelling and lysis, further leading to death of the insects.

b. *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.

Q.4. 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.

Ans. Bt cotton

- Some strains of *Bacillus thuringiensis* produce proteins that kill some insects like lepidopterans (tobacco budworm, armyworm), coleopterans (beetles) and dipterans (flies, mosquitoes).
- B. *thuringiensis* forms protein crystals which contain a toxic insecticidal protein.
- Bt toxins are initially inactive protoxins but after ingestion by the insect their inactive toxin becomes active due to the alkaline pH of the gut, which solublises the crystals.
- The activated toxin binds to the surface of midgut epithelial cells thus creating pores which causes cell swelling and lysis, further leading to death of the insects.
- Specific Bt toxin genes obtained from *Bacillus thuringiensis* are used in several crop plants like cotton.
- The toxin is coded by a gene called *cry* which is of various types. For example, proteins encoded by the genes *cryIAc* and *cryIIAb* control the cotton bollworms and that of *cryIAb* control corn borer.
- Bt tobacco was first cultured to kill hornworm (*Manduca sexta*).

Q.5.

a. Name the nematode that infests and damages tobacco roots.
b. How are transgenic tobacco plants produced to solve this problem?

OR

How is a transgenic tobacco plant protected against *Meloidegyne incognitia*? Explain the procedure.

Ans.

a. Nematode *Meloidegyne incognitia* infects the roots of tobacco plant.
b. **Pest resistant plants**

- A nematode *Meloidegyne incognitia* infects the roots of tobacco plants which reduces the production of tobacco.
- It can be prevented by using RNA interference (RNAi) process which is checked by silencing of specific *m*RNA due to a complementary *ds*RNA.
- *ds*RNA binds and prevents translation of the *m*RNA (**silencing**).

- By using *Agrobacterium* vectors, nematode-specific genes were introduced into the host plants which produce both sense and anti-sense RNA in the host cells.
- These two RNAs are complementary to each other and form a double-stranded RNA (*ds*RNA) that initiates RNAi and hence silence the specific *m*RNA of the nematode.
- The parasite cannot survive in the transgenic host, so protects the plants from pests.

Long Answer Questions (OIQ)

[5 Marks]

Q.1. Explain the different uses of biotechnology in medical field.

Ans.

i. The recombinant DNA technology is used for production of therapeutic drugs which are safe and effective.
ii. About thirty recombinant therapeutics have been approved from human use in the world including India.
iii. The genetically engineered insulin helps in maintaining the glucose–glycogen balance in the body.
iv. Gene therapy treatment is used in the defective heredity by introduction of normal healthy and functional genes.
v. It is used in the treatment of diseases like cystic fibrosis, haemophilia, AIDS, cancer, Parkinson's, etc.
vi. Due to advancement in the field of biotechnology, it is now possible to develop recombinant vaccines with specific actions and less side effects.
vii. Also, monoclonal antibodies are produced with high specificity for specific antigens and are ideal for diagnosis of specific diseases. One of the major role of these monoclonal antibodies is immune suppression for kidney transplantation.

Q.2. How have pest-resistant plants been produced using biotechnology? Explain.

Ans. Pest resistant plants

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