Short Answer Questions-I (PYQ)

[2 Marks]

Q.1. 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.

Ans. Source of *cry* gene is *Bacillus thuringiensis*.

The following type of cry genes are isolated from it: *cry*IAc, *cry*IIAb, *cry*IAb.
The introduction of *cry* gene acts as biopesticide. The *cry* gene produce crystals of toxic insecticidal protein. The activated toxin causes death of the insect.

Q.2. Name a genus of baculovirus. Why are they considered good biocontrol agents?

Ans. *Nucleopolyhedrovirus* is a genus of baculovirus.
They are species specific, have narrow spectrum insecticidal application and no negative impact on non-target organisms, hence they are considered good biocontrol agents.

Q.3.

a. **How does *cry*IAc gene express itself in its host?**
b. **State the role of this gene in controlling the infestation of bollworm.**

Ans.

a. *cry*IAc gene codes for a toxic insecticidal protein that controls the cotton bollworms.
b. This gene codes for a toxin that becomes active when ingested by the insect. The activated toxin binds to the surface of mid-gut epithelial cells thus creating pores which causes cell swelling and lysis, further leading to death of the insects.

Q.4. Name the insect pest that is killed by the products of *cry*IAc gene. Explain how the gene makes the plant resistant to the insect pest.

Ans.

a. cryIAc gene codes for a toxic insecticidal protein that controls the cotton bollworms.
b. This gene codes for a toxin that becomes active when ingested by the insect. The activated toxin binds to the surface of mid-gut epithelial cells thus creating pores which causes cell swelling and lysis, further leading to death of the insects.

Q.5. Explain the process of RNA interference.

Ans. RNA interference takes place in all eukaryotic organisms as a method of cellular defence. It involves silencing of a specific *m*RNA due to complementary *ds*RNA molecule that binds to and prevents translation of the *m*RNA.

Q.6. Explain how a hereditary disease can be corrected. Give an example of first successful attempt made towards correction of such diseases.

Ans. A hereditary disease can be corrected by gene therapy. In this method, genes are inserted into a person's cells and tissues to treat a disease.
The first successful attempt for gene therapy was done for adenosine deaminase (ADA) **deficiency.**

Q.7. Name the first transgenic cow developed and explain the improvement in the quality of the product produced by it.

Ans. Rosie was the first transgenic cow. It produced human protein-enriched milk (2.4 gram per litre).

Q.8. What is GEAC and what are its objectives?

OR

Describe the responsibility of GEAC, set up by the Indian Government.

Ans. GEAC (Genetic Engineering Approval Committee) is an Indian government organisation. Its objective are to:

a. examine the validity of GM (Genetic modification of organism) research.
b. inspect the safety of introducing GM for public services and for their large scale use.

Q.9. Highlight any four advantages of genetically modified organisms (GMOs).

OR

Describe any three potential applications of genetically modified plants.

Ans. Advantages of GMOs:

i. tolerance against abiotic stresses (cold, drought, salt, heat).
ii. reduces reliance on chemical pesticides.
iii. reduces post-harvest losses.
iv. increase efficiency of mineral usage by plants.

Q.10. How has recombinant technology helped in large scale production of vaccines? Explain giving one example.

Ans. Production of insulin by *r*DNA techniques was achieved by an American company, Eli Lilly, in 1983. It prepared two DNA sequences corresponding to A and B chains of human insulin and introduced them in plasmids of *E. coli* for production. The A and B

chains produced were separated, extracted and combined by creating disulfide bonds to form human insulin.

Q.11. Why do the toxic insecticidal proteins secreted by Bacillus thuringiensis kill the insect and not the bacteria itself?

Ans. The Bt toxin protein exists as inactive protoxins but once an insect ingests the inactive toxin, it is converted into an active form of toxin due to the alkaline pH of the gut which solubilise the crystals. Therefore, it does not kill the bacteria.

Q.12. Name the genes responsible for making Bt cotton plants resistant to bollworm attack.

How do such plants attain resistance against bollworm attacks? Explain.

Ans. Bt cotton has *crylAc/crylIAb* genes. These genes produce crystals of protoxin. When bollworm bites the cotton fruits, it consumes the toxic insecticidal protein. The alkaline pH in its gut activates the toxin. The activated toxin binds to mid-gut epithelial cells resulting in the lysis of cell leading to the death of the insect.

Q.13. Nematode-specific genes are introduced into the tobacco plants using Agrobacterium vectors to develop resistance in tobacco plants against nematodes. Explain the events that occur in tobacco plant to develop resistance.

OR

How has RNA*i* technique helped to prevent the infestation of roots in tobacco plants by a nematode *Meloidegyne incognitia*?

Ans.

- 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 mRNA due to a complementary dsRNA.
- dsRNA binds and prevents translation of the mRNA (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 (dsRNA) that initiates RNAi and hence silence the specific mRNA of the nematode.
- The parasite cannot survive in the transgenic host, so protects the plants from pests.

Q.14.

a. **Tobacco plants are damaged severely when infested with *Meloidegyne incognitia*. Name and explain the strategy that is adopted to stop this infestation.**

b. Name the vector used for introducing the nematode specific gene in tobacco plant.

Ans.

a. Gene expression can be controlled by using RNA molecule and this technology is called RNA interference or RNAi or gene silencing. During this process nematode specific gene is introduced into host plant (using *Agrobacterium*) which produces *ds*RNA. This silences specific *m*RNA of the nematode and parasite dies.
b. *Agrobacterium tumifaciens*.

Q.15. Why does the Bt toxin not kill the bacterium that produces it but kills the insect that ingests it?

Ans. Bt toxin exist as inactive protoxin in the bacterium. It becomes active only when it enters the gut of insect due to the alkaline pH of the gut which solubilise the crystals.

Q.16. How is 'Rosie' considered different from a normal cow? Explain.

Ans. Rosie is a transgenic cow.
Rosie produced human protein-enriched milk containing human alpha-lactalbumin.

Q.17. How did an American Company, Eli Lilly use the knowledge of *r*-DNA technology to produce human insulin?

OR

Explain how Eli Lilly, an American Company, produced insulin by Recombinant DNA technology.

Ans. Two chains of DNA sequence corresponding to A and B chains of human insulin were prepared. They introduced them into plasmids of *E. coli* to produce separate A and B chains. The A and B chains extracted were then combined by creating disulphide bonds and form human insulin.

Q.18.

a. Mention the cause and the body system affected by ADA deficiency in humans.
b. Name the vector used for transferring ADA-DNA into the recipient cells in humans. Name the recipient cells.

Ans.

a. The cause is the defective gene not producing ADA. The immune system is affected.
b. A retroviral vector is used, recipient cells are lymphocytes.

Q.19. Write the functions of adenosine deaminase enzyme. State the cause of ADA deficiency in humans. Mention a possible permanent cure for a ADA deficiency patient.

Ans. Adenosine deaminase enzyme is responsible for the proper functioning of the immune system. ADA deficiency is caused by deletion of gene for adenosine deaminase. A possible permanent cure would be gene therapy, if it is detected at early embryonic stage.

Q.20. Why is the functional insulin thus produced considered better than the ones used earlier by diabetic patients?

Ans. The insulin prepared by *r*DNA technology does not produce sensitive allergic reactions and immunological reactions whereas those used earlier produced allergic reactions and other complications to the foreign protein as earlier they were extracted from pancreas of slaughtered cattle or pigs.

Q.21. Why is the introduction of genetically engineered lymphocytes into an ADA deficiency patient not a permanent cure? Suggest a possible permanent cure.

Ans. Introduction of genetically engineered lymphocytes into a ADA deficiency patient is not a permanent cure because these cells are not immortal and the patient requires periodic infusion of such genetically engineered lymphocytes. A possible permanent cure can be isolating the gene producing adenosine deaminase (ADA) from bone marrow cells and introducing it into cells at early embryonic stages.

Q.22. Biopiracy should be prevented. State why and how.

Ans. Biopiracy is unauthorised exploitation of bioresources of developing or under-developed countries. Hence, it should be prevented. It can be prevented by developing laws to obtain proper authorisation and by paying compensatory benefits.

Q.23. How have transgenic animals proved to be beneficial in:

Q. Production of biological products?

Ans. Rosie–the transgenic cow, produced human proteins containing human α-lactalbumin. Transgenic animals have been made to produce 2- 1-antitrypsin used to treat emphysema.

Q. Chemical safety testing?

Ans. Toxicity testing – Transgenic animals are more sensitive to toxic substances, so the results are obtained in less time.

Q.24. What is gene therapy? Name the first clinical case where it was used.

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

Genes are inserted into an individual's cells and tissues to treat disease.
The first clinical case where it was used for Adenosine deaminase (ADA) deficiency.

Q.25. What is Biopiracy? State the initiative taken by the Indian Parliament towards it.

Ans. Biopiracy is the use of bioresources by organisations without proper authorisation from the countries and people concerned without compensatory payment.
The government has cleared patent terms, emergency provisions and research and development initiative.

- Some nations are developing laws, to prevent such unauthorised exploitation of their bioresources and traditional knowledge.
- To check these problems, Indian Parliament has recently cleared the second amendment of the **Indian Patents Bill**, that takes such issues into consideration.

Q.26. How has the bacterium Bacillus thuringiensis helped us in controlling caterpillars of insect pests?

Ans. *Bacillus thuringiensis* products are endotoxin which when ingested and released in the gut of the larvae of insect pest, disrupts the insect gut lining thereby killing them.

Q.27. Answer the following questions:

Q. State the role of DNA ligase in biotechnology.

Ans. DNA ligase joins the DNA fragments with same sticky ends./Link Okazaki fragments or discontinuously synthesised fragments./Link desired gene with plasmid to form recombinant DNA. (*Any one*)

Q. What happens when Meloidegyne incognitia consumes cells with RNAi gene?

Ans. The specific *m*RNA of the nematode is silenced and the parasite dies.

Short Answer Questions-I (OIQ)

[2 Mark]

Q.1. Name any four transgenic animals commonly produced. Which animal constitutes a major proportion among transgenic animals?

Ans. Four commonly produced transgenic animals are mice, pigs, cows and sheep. 25 per cent of the transgenic animals are mice.

Q.2. Name the biological products made in transgenic animal to treat emphysema. Explain.

Ans. Human protein *α*-1-antitrypsin is produced to treat emphysema. The gene for this protein is isolated and introduced into a mouse. The transgenic mouse produces the protein, which is to be isolated, purified and used on human beings after further clinical trials.

Q.3. What are the conditions for which patent is given?

Ans. Patent is given for:

i. producing new products or inventions.
ii. modification and improvement of earlier inventions.
iii. technical know-how.
iv. designing of new concepts.

Q.4.

a. Given below is a single stranded DNA molecule. Frame and label its sense and antisense RNA molecule.
5' ATGGGGCTC 3'
b. How the RNA molecules made from above DNA strand help in silencing of the specific RNA molecules?

Ans.

a. 5' ATGGGGCTC 3' sense
3' TACCCCGAG 5' antisense
5'AUGGGGCUC 3' sense
3'UACCCCGAG 5' antisense
b. The two strands of RNA (*i.e.*, sense and antisense) being complementary will bind with each other and form double stranded RNA as a result its translation and protein expression would be inhibited.

Q.5. Differentiate between gene therapy and gene cloning.

Ans.

Gene therapy	Gene cloning
The process of replacing defective gene responsible for hereditary disease by the normal gene is called gene therapy.	The technique to produce identical copies of a particular segment of DNA or a gene.

Q.6. How is a mature, functional insulin hormone different from its pro-hormone form?

Ans. Mature functional insulin is obtained by processing of pro-hormone which contains extra peptide called C-peptide. This C-peptide is removed during maturation of pro-insulin to insulin.

Q.7. Expand GMO. How is it different from a hybrid?

Ans. GMO stands for genetically modified organism. It differs from a hybrid because in a hybrid, cross is done between total genomes of two species or strains, whereas in a GMO, foreign genes are introduced in the organism and is usually maintained as extra-chromosomal entity or is integrated into the genome of the organism and their is change in only one phenotype.

Q.8. Mention the problems when we consume GM food.

Ans. When we consume GM food, following problems arise:

i. GM food may cause toxicity.
ii. The bacteria present in the alimentary canal of human could take up the antibiotic resistant gene which is present in GM food, that will cause problem.

Q.9. How is PCR used to detect gene mutation in case of suspected cancer patient?

Ans. A single stranded small DNA or RNA is tagged with radioactive molecule to be used as a probe. The probe is hybridised with DNA in cancer cells, to be followed by autoradiography. The clone with mutated gene will not appear in the autoradiography, because the probe will not have the complementary sequence with mutated gene.

Q.10. What is legally wrong in the US patent law? Mention the common items of biopiracy.

Ans. US patent law does not recognise technologies and methods in use to other countries as ‘prior past’. The common items of biopiracy are soil micro-organisms, plant, animals and their genetic materials.

Q.11. Why are yeasts used extensively for functional expression of eukaryotic genes?

Ans. Yeasts are simplest unicellular eukaryotic organisms and like bacteria they are genetically well characterised, easy to grow and manipulate. They can be readily cultured in small culture vessels as well as in large-scale bioreactors.

Q.12. Bt cotton is resistant to pest, such as lepidopteran, dipterans and coleopterans. Is Bt cotton resistant to other pests as well?

Ans. Bt cotton is made resistant to only certain specific taxa of pests. It is quite likely that in future, some other pests may infest the Bt cotton plants. It is similar to

immunisation against small-pox which does not provide immunity against other pathogens like those that cause cholera, typhoid, etc.

Q.13. ELISA technique is based on the principles of antigen and antibody interaction. Can this technique be used in the molecular diagnosis of a genetic disorder, such as phenylketonuria?

Ans. Yes. One can use antibody against the enzyme (that is responsible for the metabolism of phenylalanine) to develop ELISA-based diagnostic technique. The patient in which the enzyme protein is absent would give negative result in ELISA when compared to normal individual.

Q.14. Gene therapy is an attempt to correct a genetic defect by providing a normal gene into the individual. By this the normal function can be restored. Alternate method would be to provide the gene product (protein/enzyme) known as enzyme replacement therapy, which would also restore the function. Which in your opinion is a better option? Give reason for your answer.

Ans. Gene therapy would be a better option because it has the potential to completely cure the patient. It is because the correct gene once introduced in the patient, can continue to produce the correct protein enzyme. Enzyme therapy does not offer permanent cure as it needs to be given to the patient on regular basis. It is also more expensive.

Q.15. A person is born with a hereditary disease, suggest the possible corrective method for it. Illustrate by giving a specific example.

Ans. The possible corrective method is gene therapy.
For example, ADA (Adenosine deaminase) deficiency has been treated through gene therapy. Lymphocytes from the blood of the patient are grown in a culture. A functional ADA *c*DNA is introduced into these lymphocytes, which are subsequently returned to the patient. The permanent cure is done by introducing ADA *c*DNA into cells at early embryonic stages.

Q.16. How has the bacterium *Bacillus thuringiensis* helped us in controlling caterpillars of insect pests?

Ans. *Bacillus thuringiensis* products are endotoxin which when ingested and released in the gut of the larvae of insect pest disrupts the insect gut lining thereby killing them.

Q.17. *cry*IAb is introduced in a plant to control infestation by corn borer.

a. **Name the resultant plant after successful insertion of the gene desired.**
b. **Summarise the action of the gene introduced.**

Ans.

a. Bt corn
b. *Cry*IAb/Bt toxin gene codes for crystal protein; the Bt toxin protein exists as an inactive protein, but once an insect ingests it, it gets converted into an active form due to the alkaline pH of the gut which solubilises the crystal. The activated toxin binds to the surface of mid gut and creates pores that cause swelling, lysis and eventually death of the insect.