INDIAN SCHOOL AL WADI AL KABIR		
CLASS: XII	**DEPARTMENT: SCIENCE 2026 – 2027** **SUBJECT: BIOLOGY**	**DATE: 03/11/2026**
WORKSHEET NO. 10	**UNIT- IX-BIOTECHNOLOGY** **CHAPTER:10- BIOTECHNOLOGY AND ITS APPLICATION**	**NOTE:** **A4 FILE FORMAT**
CLASS & SEC:	**NAME OF THE STUDENT:**	**ROLL NO.**

I. OBJECTIVE-TYPE QUESTIONS

1. GEAC stands for:
   A. Genome Engineering Action Committee
   B. Ground Environment Action Committee
   C. Genetic Engineering Approval Committee
   D. Genetic and Environment Approval Committee
2. Which step proved to be the main challenging obstacle in the production of human insulin by genetic engineering?
   A. Splitting A and B polypeptide chains.
   B. Addition of C-peptide to pro-insulin.
   C. Getting insulin assembled into mature form.
   D. Removal of C-peptide from active insulin.
3. Choose the correct option regarding retroviruses:
   A. An RNA virus that can synthesize DNA during infection
   B. A DNA virus that can synthesize RNA during infection
   C. A ssDNA virus
   D. A dsRNA virus
4. The trigger for activation of the toxin of *Bacillus thuringiensis* is:
   A. Acidic pH of the stomach
   B. High temperature
   C. Alkaline pH of the gut
   D. Mechanical action in the insect gut
5. Which of the given statements is correct in the context of observing DNA separated by agarose gel electrophoresis?
   A. DNA can be seen in visible light
   B. DNA can be seen without staining in visible light
   C. Ethidium bromide-stained DNA can be seen in visible light
   D. Ethidium bromide-stained DNA can be seen under exposure to UV light
6. RNA interference helps in
   A. Cell proliferation
   B. Micropropagation
   C. Cell defense
   D. Cell differentiation

7. In RNAi, genes are silenced using:
   A. ss DNA
   B. ds DNA
   C. ds RNA
   D. ss RNA

II. ASSERTION AND REASONING

For the following questions, two statements are given, one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (i), (ii), (iii), and (iv) as given below:

A. Both A and R are true, and R is the correct explanation of the assertion.

B. Both A and R are true, but R is not the correct explanation of the assertion

C. A is true, but R is false.

D. A is false, but R is true

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

9. **Assertion (A):** Transposons cause insertional mutations that can be treated using gene silencing.
   Reason (R): Transposons are mobile genetic elements that self-replicate via an RNA intermediate.

10. **Assertion (A):** DNA ligase is not used in PCR.
    Reason (R): Discontinuous fragments are not formed in the amplification of DNA by PCR.

11. **Assertion (A):** The milk production by transgenic Cow Rosie was nutritionally more balanced product for human babies than natural cow milk.
    Reason (R): It was human protein-enriched milk containing human alpha lactoglobulin.

III. VERY SHORT QUESTIONS (2M):

12. Suggest and explain a procedure for possible lifelong treatment for a child who is born with ADA deficiency.
13. Why is a thermostable DNA polymerase needed in amplification in genetic engineering?
14. Dr. Arun developed a vitamin A-rich potato through his genetic research.
    a) What do you call such potato plants?
    b) Who can approve the validity and safety of introducing potatoes for public use?

IV. SHORT ANSWER TYPE QUESTIONS: (3M)

15. What are transgenic animals? Mention any two applications of transgenic animals.

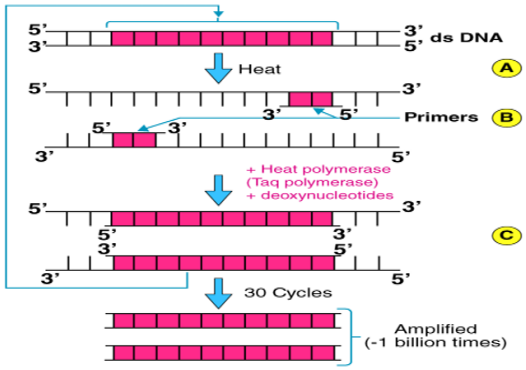
16. "RNA interference has been used to produce transgenic tobacco plants to protect them

from the infestation by specific nematodes." Explain the novel strategy exploited by the biotechnologists.

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

V. SOURCE-BASED/ CASE STUDY-BASED QUESTIONS

18. PCR stands for Polymerase Chain Reaction. In this reaction, multiple copies of the gene (or DNA) of interest are synthesised in vitro. using two sets of primers. If the process of replication of DNA is repeated many times, the segment of DNA can be amplified to approximately a billion times, i.e., 1 billion copies are made. The figure given below shows the steps of this technique.



A. Name the steps as marked A, B, C in the figure.
B. What are the substrates used in this process?
C. What are primers, and what is their function in this process?

OR

D. What is Taq polymerase and what is its function in this process?

VI. LONG ANSWER TYPE QUESTIONS. (5M)

19. "Early and accurate diagnosis of disease is vital in medical technology."
    a) Name the conventional methods of diagnosis and their disadvantages.
    b) Which three diagnostic techniques have been developed through Biotechnology? Explain how each one helps in detecting diseases.

20. i) Explain how human pro-insulin is processed in the cell to become a fully mature, functional insulin.
    ii) Describe how human insulin is produced using the techniques of genetic engineering.

21. Any recombinant DNA with a desired gene is required in billion copies for commercial use. How is the amplification done? Explain.

22. Giving suitable examples, describe the roles of recombinant technology in agriculture.

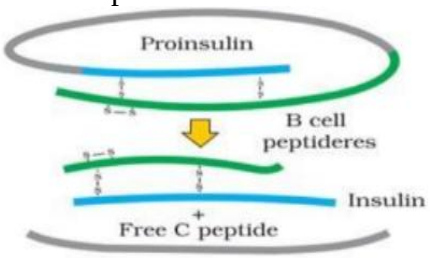
VII. BOARD QUESTIONS

23. Some cotton plants grown by farmers are known as 'Bt cotton'.
    a) What does Bt stand for?
    b) What is the advantage of this cotton plant?
    c) How did scientists achieve this?

24. A method to prevent infestation of a nematode, *Meloidogyne incognita*, on roots of tobacco is silencing the specific mRNA. What is the scientific name of the technique? How is this performed using dsRNA?

25. Describe the production of humulin briefly.

26. Identify the following image. Give its importance in rDNA technology.



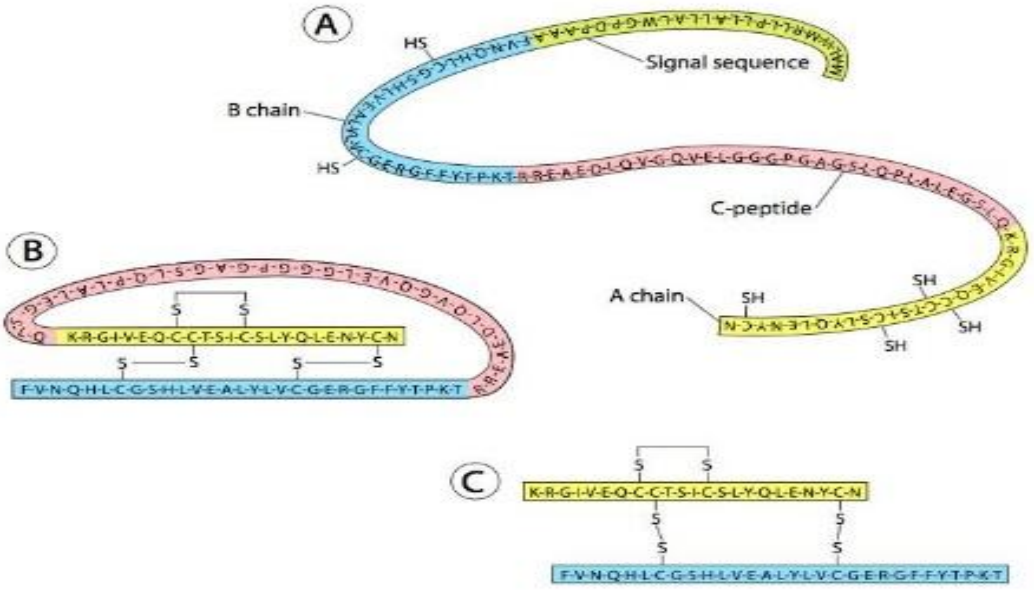
    What do you mean by humulin? Give its uses.

27. Give the different roles played by transgenic animals. What is the importance of GEAC in the production of transgenic organisms?

ANSWER KEY	
I. OBJECTIVE-TYPE QUESTIONS	
1.	C. Genetic Engineering Approval Committee
2.	C. Getting insulin assembled into mature form.
3.	A. An RNA virus that can synthesize DNA during infection
4.	C. Alkaline pH of the gut
5.	D. Ethidium bromide-stained DNA can be seen under exposure to UV light
6.	D. Cell differentiation
7.	C. ds RNA
II. **ASSERTION AND REASONING**	
8.	B. Both A and R are true, but R is not the correct explanation of the assertion
9.	A. Both A and R are true, and R is the correct explanation of the assertion
10.	A. Both A and R are true, and R is the correct explanation of the assertion.

11.	C. A is true, but R is false.
III. VERY SHORT ANSWER TYPE QUESTIONS: (2M)	
12.	A possible procedure for lifelong treatment of a child born with ADA (Adenosine Deaminase) deficiency is gene therapy. 1. A functional ADA cDNA is introduced into the lymphocytes of the child using a suitable vector. 2. The lymphocytes are collected from the child's blood and cultured outside the body. 3. The genetically modified lymphocytes are returned to the child's body. 4. Since lymphocytes are short-lived, this treatment needs to be repeated periodically. For lifelong treatment: A functional ADA gene is introduced into cells at an early embryonic stage or into suitable bone marrow stem cells, so that the functional gene can continue to produce ADA enzyme for a longer period.
13.	A thermostable DNA polymerase, such as Taq polymerase, is needed because PCR involves repeated heating at high temperatures to separate the DNA strands. It remains active at high temperatures and does not get denatured during the process.
14.	They are called genetically modified (GM) plants or transgenic plants. (b) Who can approve the validity and safety of introducing the potato for public use? The Genetic Engineering Appraisal Committee (GEAC) in India evaluates and approves the environmental release and use of genetically modified organisms, as applicable under the regulatory framework.
IV. SHORT ANSWER TYPE QUESTIONS (3M)	
15.	• Transgenic animals are animals whose DNA has been manipulated to contain and express a foreign gene. • They are used to study normal physiology and development by understanding the role of specific genes. • They are also used to study diseases, test the safety of vaccines and chemicals, and produce useful biological products.
16.	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 defence. · 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..
17.	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.
V. SOURCE-BASED/ CASE STUDY-BASED QUESTIONS	
18.	A. A — Denaturation: Heating separates the two strands of double-stranded DNA. B — Annealing: Cooling allows the primers to bind to their complementary sequences on the template DNA. C — Extension (elongation): Taq DNA polymerase extends the primers by adding complementary deoxyribonucleotides, synthesizing new DNA strands.
	B. The principle substrates for DNA synthesis are the four deoxyribonucleoside triphosphates (dNTPs): dATP, dGTP, dCTP and dTTP. PCR also requires template DNA, two primers, a thermostable DNA polymerase, magnesium ions and a suitable reaction buffer.
	C**.** Primers are short, chemically synthesised, single-stranded DNA sequences complementary to regions flanking the target DNA segment. Their functions are: 1. They bind to complementary sequences on the template DNA during annealing. 2. They provide the free 3′-OH end required by DNA polymerase to begin DNA synthesis. 3. They determine the DNA segment that is amplified. OR D. Taq polymerase is a thermostable DNA polymerase obtained from the bacterium Thermus aquaticus. It synthesizes new DNA strands by adding complementary deoxyribonucleotides to the 3′ ends of primers during the extension step of PCR. Its heat stability allows it to function through repeated cycles of high-temperature denaturation and DNA synthesis without being replaced after every cycle.
VI. LONG ANSWER TYPE QUESTIONS. (5M)	
19.	a) Conventional diagnostic methods include urine analysis, stool analysis, sputum examination and serum analysis, along with clinical examination of symptoms. Disadvantages: • Many conventional methods detect disease only after symptoms appear. • The pathogen or disease marker may be present in quantities too small to detect in the early stages. • Some methods may lack the sensitivity needed for early and accurate diagnosis. b) 1. Polymerase Chain Reaction (PCR): PCR amplifies a specific DNA sequence from a very small sample. It can detect very low concentrations of pathogen DNA or disease-associated genetic material, enabling early diagnosis. 2. Enzyme-Linked Immunosorbent Assay (ELISA): ELISA is based on the specific interaction between an antigen and an antibody. Infection can be detected either by identifying antigens from the pathogen or by detecting antibodies produced against it. 3. GENE THERAPY (Nucleic acid probe-based diagnosis): A labelled single-stranded DNA or RNA probe is allowed to hybridise with its complementary sequence in the sample. Detection of the label identifies the target sequence. A mutation may prevent proper hybridisation,

	helping identify certain genetic abnormalities.
20.	i) • Insulin is initially synthesised in pancreatic β-cells as a precursor called proinsulin. • Proinsulin contains three regions: the A chain, the B chain and an extra connecting segment called the C-peptide. • During processing, the C-peptide is removed by proteolytic enzymes. • The mature insulin molecule consists of two polypeptide chains, A and B. • The A and B chains remain connected by disulphide bonds, producing biologically active insulin.  ii) 1. In 1983, Eli Lilly, an American pharmaceutical company, prepared DNA sequences corresponding to the two polypeptide chains of mature human insulin. 2. The DNA sequences for the A and B chains were introduced separately into plasmids of Escherichia coli. 3. The recombinant bacteria were cultured separately to produce the A and B polypeptide chains. 4. The two chains were extracted and purified. 5. The chains were combined in vitro under suitable conditions to form the required disulphide bonds, producing functional human insulin. The genetically engineered human insulin was marketed as Humulin.
21.	Amplification is carried out using the Polymerase Chain Reaction (PCR), an in-vitro technique that produces many copies of a specific DNA segment. The reaction mixture contains template DNA, two primers, the four dNTPs, Taq DNA polymerase, magnesium ions and buffer. PCR involves three main steps: 1. Denaturation: The reaction mixture is heated to approximately 94–95°C to separate the two DNA strands. 2. Annealing: The mixture is cooled, typically to around 50–65°C depending on primer design, allowing primers to bind to complementary sequences on the template DNA.

	3. Extension: At approximately 72°C, Taq DNA polymerase extends the primers by adding complementary nucleotides. These three steps are repeated for about 25–35 cycles in a thermal cycler. Ideally, the target DNA doubles during each cycle, leading to exponential amplification. Under suitable conditions, billions of copies can be produced.
22.	Recombinant DNA technology has helped develop genetically modified crops with desirable characteristics. 1. Insect resistance — Bt cotton: Genes from Bacillus thuringiensis (Bt), such as cry1Ac and cry2Ab, have been introduced into cotton. These genes produce insecticidal proteins that protect the crop against certain insect pests, particularly bollworms. 2. Pest resistance — RNA interference: Tobacco plants have been genetically engineered to resist the root-knot nematode Meloidogyne incognita. The introduction of nematode-specific sequences causes the production of double-stranded RNA, which silences the corresponding nematode mRNA. 3. Improved nutritional quality: Genetic modification can be used to increase the nutritional content of crops, for example, by enhancing the production of vitamins or other nutrients. 4. Tolerance to environmental stresses: Genetic engineering can introduce traits that help crops tolerate certain abiotic stresses, such as drought or salinity. 5. Reduced dependence on chemical pesticides: Insect-resistant GM crops can reduce the need for certain chemical insecticides when the crop and pest conditions are appropriate. Thus, recombinant DNA technology can improve crop protection, nutritional quality and agricultural productivity.
VII. BOARD QUESTIONS	
23.	a) *Bacillus thuringiensis* b) Built-in resistance to pests (bollworms), which reduces chemical pesticide use and increases crop yield. c) Genetic engineering, by transferring insecticidal *cry* genes from the bacterium into the cotton plant's DNA.
24.	The technique is RNA interference (RNAi). The process works as follows: 1. Scientists introduce DNA sequences corresponding to a specific nematode gene into the tobacco plant using a suitable vector. 2. The introduced sequences are arranged so that both sense and antisense RNA are produced, forming double-stranded RNA (dsRNA). 3. When the nematode feeds on the transgenic plant, the dsRNA triggers RNA interference. 4. The dsRNA leads to the degradation or silencing of complementary nematode mRNA. 5. The target gene is not expressed properly, preventing normal nematode development and helping protect the tobacco plant from infestation.
25.	• Humulin is recombinant human insulin produced using genetic engineering. • The DNA sequences encoding the A and B chains of mature human insulin were prepared separately. • These sequences were introduced into separate plasmids in E. coli. • The recombinant bacteria were cultured to produce the A and B polypeptide chains separately.

	• The chains were extracted, purified and joined in vitro by forming the required disulphide bonds. • The resulting product was functional human insulin, marketed as Humulin.
26.	(a) The image represents the processing of proinsulin into mature insulin by removal of the C-peptide. • Proinsulin contains the A chain, B chain and an extra C-peptide. • The C-peptide is removed during processing. • The mature insulin molecule consists of A and B chains joined by disulphide bonds. Importance in recombinant DNA technology: Ordinary E. coli bacteria cannot naturally process human proinsulin into mature insulin in the same way as human pancreatic cells. Therefore, in the early recombinant production method, the A and B chains were produced separately in bacteria and then joined in vitro to form functional insulin. (b) Humulin is recombinant human insulin produced using genetic engineering. Uses: 1. It is used to control blood glucose levels in people with diabetes mellitus who require insulin treatment. 2. It helps the body use glucose and regulate blood sugar levels.
27.	Transgenic animals are animals whose DNA has been manipulated to contain and express a foreign gene. They have several important applications. 1. Study of normal physiology and development: Transgenic animals help researchers understand how genes regulate normal body functions and development. 2. Study of diseases: They can be developed as models for human diseases, helping scientists investigate disease mechanisms and develop treatments. 3. Production of biological products: Transgenic animals can produce useful human proteins, which may be collected from their milk or other biological products. 4. Vaccine safety testing: They can be used to test the safety of vaccines before human use. 5. Chemical safety testing: They can help assess the toxicity and safety of chemicals and other substances. Importance of GEAC: The Genetic Engineering Appraisal Committee (GEAC) in India evaluates proposals concerning genetically modified organisms and their environmental release. It assesses relevant biosafety and environmental risks and considers whether the proposed use meets applicable regulatory requirements. Its role is to help ensure that the release and use of genetically modified organisms are evaluated for safety before approval under the relevant regulatory framework.

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