DNA Tools at Work

Trace how DNA techniques solve different problems

GEN.3.1 "Explain and demonstrate the use of various tools and techniques of DNA manipulation and their applications in forensics (e.g., paternity and victim/suspect identification), agriculture (e.g., pesticide or herbicide resistance…"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each DNA tool or technique, circle what it does, and write F, A, or M beside an application in forensics, agriculture, or medicine.

From DNA to Decisions

1. At a crime scene, a tiny blood sample may contain too little DNA for direct comparison. Scientists use polymerase chain reaction (PCR) to copy several short tandem repeat (STR) regions, places where a short DNA pattern repeats a different number of times in different people. Capillary electrophoresis separates the copied pieces by size, producing a profile of repeat counts. Investigators compare many STR regions from the sample with a suspect's profile. A mismatch can exclude a suspect; a match supports a possible link but does not prove guilt. For paternity testing, a child must inherit one version of each STR region from each biological parent.

2. On a farm, weeds compete with crops for water and light. To give a soybean plant tolerance to a particular herbicide, researchers can insert a DNA sequence that makes an enzyme the herbicide cannot easily block. A bacterium called Agrobacterium can deliver the sequence into plant cells; those cells can be grown into plants. Farmers may then spray that herbicide to kill susceptible weeds while the crop survives. This approach may reduce crop losses, but it requires field tests: surviving herbicide does not guarantee a larger harvest. Repeated spraying can also favor weeds that already carry resistance traits.

3. A hospital can use DNA sequencing to read genes in a patient's tumor. If testing finds a mutation that makes a growth protein overactive, doctors may consider a drug designed to block that protein. The mutation guides treatment choice, but a targeted drug will not help every tumor. DNA manipulation also makes medicines rather than just guiding their use. Researchers place a DNA sequence encoding human insulin into a bacterial plasmid, a small circle of DNA, and grow the engineered bacteria. The bacteria produce insulin or its precursor, which is purified and processed for patients with diabetes. This production method does not change the patient's DNA.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why do investigators use both PCR and capillary electrophoresis to make an STR profile?

2. How could STR profiles help test whether a proposed father is a child's biological father?

3. How is DNA changed to make the soybean plant herbicide-tolerant, and why must researchers still test the plants in fields?

4. How can sequencing a tumor affect treatment choice, and why would the same targeted drug not help every tumor?

3 YOUR TURN

Your own words

Suppose researchers find a gene that limits root growth during dry periods. Propose how they could use CRISPR to change that gene in a crop, confirm the DNA change, and fairly test whether the edited plants grow better during drought. Include one reason the edit alone would not prove the crop will produce a larger field harvest.

ANSWER KEY

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HIGH SCHOOL · GEN.3.1

PART 1 · READ AND MARK

Underline each DNA tool or technique, circle what it does, and write F, A, or M beside an application in forensics, agriculture, or medicine. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why do investigators use both PCR and capillary electrophoresis to make an STR profile?	**PCR copies STR regions from a small sample. Capillary electrophoresis separates the copies by size so investigators can determine and compare repeat counts.**
2	How could STR profiles help test whether a proposed father is a child's biological father?	**At each tested STR region, one of the child's versions must come from the biological father. Investigators compare many regions to see whether the proposed father's profile fits that pattern.**
3	How is DNA changed to make the soybean plant herbicide-tolerant, and why must researchers still test the plants in fields?	**Agrobacterium delivers a DNA sequence that makes an enzyme the herbicide cannot easily block. Field tests are needed because surviving the herbicide does not guarantee a larger harvest.**
4	How can sequencing a tumor affect treatment choice, and why would the same targeted drug not help every tumor?	**Sequencing can reveal a mutation that makes a growth protein overactive, pointing doctors toward a drug that blocks it. Tumors without a relevant target may not respond to that drug.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Researchers could use a guide RNA to direct CRISPR to the gene and edit it to reduce its activity. They could sequence that region in the edited plants to check for the intended change. To test the effect, they could grow edited and unedited plants in the same soil and give them the same limited amount of water, then compare root growth and harvests. Better root growth alone would not prove a larger field harvest because other growing conditions also affect yield.

Accept accurate explanations that connect each technique to its result or use. For Your Turn, look for a targeted edit, a DNA check, a fair comparison, and a clear limit on claims about yield.