DNA Shape Clues

Compare chromosomes and plasmids in two kinds of cells

GEN.1A.6 "Investigate the structural differences between the genomes (i.e., circular/linear chromosomes and plasmids) found in prokaryotes and eukaryotes."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline phrases that describe chromosome shapes, circle places where DNA is found, and put a star beside statements about plasmids to track the clues that distinguish these genomes.

What Can DNA Shape Tell Us?

1. Imagine a lab comparing DNA from a pond bacterium with DNA from an onion leaf cell. The bacterium is a prokaryote, a cell without a nucleus. Its main chromosome is usually one circular DNA molecule, located in a region of the cytoplasm called the nucleoid. A chromosome carries many genes needed for daily cell functions. Some bacteria also have plasmids, smaller circular DNA molecules separate from the main chromosome. A plasmid may carry a gene that helps a bacterium survive an antibiotic. Not every bacterium has plasmids, and a cell may carry more than one kind.

2. The onion cell is a eukaryote, a cell with a nucleus. Its nuclear genome is divided among multiple linear chromosomes, which sit inside that nucleus. Each chromosome has ends, unlike a circular chromosome, whose DNA forms a continuous loop. Onion leaf cells also contain mitochondria and chloroplasts. These structures have their own small, usually circular DNA molecules outside the nucleus. So finding circular DNA does not, by itself, prove that a cell is prokaryotic. Location and the arrangement of the main chromosomes matter too. A cell's genome includes DNA in these separate places.

3. Now suppose a technician finds two DNA samples but loses their labels. Sample A contains one large circular chromosome and two smaller circular molecules that carry optional genes. Sample B contains several linear chromosomes plus small circular molecules in energy-producing compartments. Sample A is consistent with a bacterium, and its small circles could be plasmids. Sample B fits a eukaryotic cell because its main chromosomes are linear, while its small circles could come from mitochondria. A plasmid is not simply any small circular DNA molecule: mitochondrial DNA belongs to an organelle, while a plasmid is separate from the main chromosome.

2 ANSWER WITH EVIDENCE

Use the passage

1. How do the number, shape, and location of the bacterium's main chromosome differ from those of the onion cell's nuclear chromosomes?

2. A bacterium has a small circular DNA molecule separate from its main chromosome. What could that molecule be, and how might it help the cell?

3. Why would finding circular DNA in an onion leaf cell not rule out a eukaryote? Name the structures that could contain it.

4. Which DNA structures distinguish Sample A from Sample B? Include what the smaller circles could be in each sample.

3 YOUR TURN

Your own words

A lab team finds circular DNA in an unknown cell and announces that it must be a bacterium. Write four sentences that propose two more observations, predict what each would show if the cell were a eukaryote, and explain why the team's conclusion is premature.

ANSWER KEY

DNA Shape Clues

HIGH SCHOOL · GEN.1A.6

PART 1 · READ AND MARK

Underline phrases that describe chromosome shapes, circle places where DNA is found, and put a star beside statements about plasmids to track the clues that distinguish these genomes. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How do the number, shape, and location of the bacterium's main chromosome differ from those of the onion cell's nuclear chromosomes?	**The bacterium usually has one circular main chromosome in a nucleoid. The onion cell has multiple linear chromosomes in a nucleus.**
2	A bacterium has a small circular DNA molecule separate from its main chromosome. What could that molecule be, and how might it help the cell?	**It could be a plasmid carrying a gene that helps the bacterium survive an antibiotic.**
3	Why would finding circular DNA in an onion leaf cell not rule out a eukaryote? Name the structures that could contain it.	**Onion leaf cells are eukaryotes, and their mitochondria and chloroplasts can contain small circular DNA molecules.**
4	Which DNA structures distinguish Sample A from Sample B? Include what the smaller circles could be in each sample.	**Sample A has one large circular chromosome and smaller circles that could be plasmids. Sample B has several linear chromosomes and smaller circles that could be mitochondrial DNA.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Circular DNA alone cannot identify this cell as a bacterium. First, look for multiple linear chromosomes inside a nucleus, which would support a eukaryotic identity. Second, check whether the circular DNA is inside mitochondria, which would also support a eukaryotic identity. The team needs these clues because eukaryotic cells can contain circular DNA outside the nucleus.

Accept observations about the shape and location of the main chromosomes and the location of circular DNA in organelles. Students should not treat every small circular DNA molecule as a plasmid.