Building the Helix

Use experimental evidence to test a DNA model.

GEN.1A.1 "Model the biochemical structure, either 3-D or computer-based, of DNA based on the experimental evidence available to Watson and Crick (Chargaff, 1950; Franklin, 1951)."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline Chargaff's and Franklin's findings, then circle features of the DNA model that account for those findings.

What Must a DNA Model Explain?

1. Imagine trying to build a staircase when you can measure its width but cannot see its steps. In the early 1950s, scientists faced a similar problem with DNA. DNA contains long chains of nucleotides. Each nucleotide has a sugar, a phosphate group, and one base: adenine (A), thymine (T), guanine (G), or cytosine (C). Sugars and phosphates connect in a repeating backbone; the bases project from it. Watson and Crick needed a three-dimensional arrangement that fit measurements and chemical bonds. A successful model had to account for both DNA's overall shape and the way its bases fit together.

2. Erwin Chargaff measured DNA from different organisms and found a pattern: the amount of A was close to the amount of T, and G was close to C. The overall percentages varied among organisms. These results suggested pairs, but matching amounts alone could not prove which bases touched. Rosalind Franklin's X-ray diffraction images of DNA fibers revealed a helical structure with a regular repeating pattern and a nearly constant width. A model therefore needed a helix with evenly spaced parts. It also needed a reason why the same width would hold even when the sequence of bases changed.

3. Watson and Crick used the evidence and known chemical structures to build a double-helix model. Two sugar-phosphate backbones wind around the outside, with bases facing inward like rungs. A and G are larger, two-ring bases; T and C are smaller, one-ring bases. Pairing one large base with one small base helps keep the helix width steady. In the usual pairing geometry, the hydrogen-bonding sites line up for A with T and G with C, not A with C or G with T. The strands run in opposite directions; each paired base supplies a partner on the other strand.

2 ANSWER WITH EVIDENCE

Use the passage

1. A student puts A opposite A in a model. Explain two reasons this pair does not fit the model described in the passage.

2. If one strand has A, G, T, C in that order, which bases should face them? Explain why Chargaff's measurements alone are not enough to choose these partners.

3. How do Franklin's findings limit the shape and width of a DNA model? Name a model feature that meets each limit.

4. A sketch shows sugars and phosphates in the center and bases along the outer edges. How should the sketch change to match the model in the passage?

3 YOUR TURN

Your own words

In the box, sketch a DNA segment with three rungs: put A, G, and C down one strand and label their partners on the other. Show two outer sugar-phosphate backbones with arrows for their opposite directions, then write two sentences explaining how your model fits Franklin's evidence and the base-pair chemistry.

ANSWER KEY

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HIGH SCHOOL · GEN.1A.1

PART 1 · READ AND MARK

Underline Chargaff's and Franklin's findings, then circle features of the DNA model that account for those findings. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	A student puts A opposite A in a model. Explain two reasons this pair does not fit the model described in the passage.	**Two large bases would disrupt the helix's nearly constant width, and A's hydrogen-bonding sites align with T's in the usual pairing geometry, not with another A.**
2	If one strand has A, G, T, C in that order, which bases should face them? Explain why Chargaff's measurements alone are not enough to choose these partners.	**The partners are T, C, A, G. Chargaff found matching amounts, but those amounts do not prove which bases touch; the alignment of hydrogen-bonding sites supports the specific pairs.**
3	How do Franklin's findings limit the shape and width of a DNA model? Name a model feature that meets each limit.	**Her X-ray evidence indicates a regular helix with nearly constant width. The two backbones form a double helix, and large-small base pairs help maintain its width.**
4	A sketch shows sugars and phosphates in the center and bases along the outer edges. How should the sketch change to match the model in the passage?	**Move the two sugar-phosphate backbones to the outside of the helix and place the paired bases between them, facing inward.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Sketch labels: left outer sugar-phosphate backbone, arrow down, A, G, C from top to bottom; right outer sugar-phosphate backbone, arrow up, T, C, G from top to bottom; three rungs joining the facing bases. Franklin's X-ray evidence supports a regular helix with nearly constant width. A-T and G-C have aligned hydrogen-bonding sites, and each pair joins one large base with one small base.

Accept either strand orientation if the arrows oppose each other and A-T and G-C face across all three rungs. Students should connect Franklin's findings to the helix or its constant width and connect the chosen partners to hydrogen-bonding alignment.