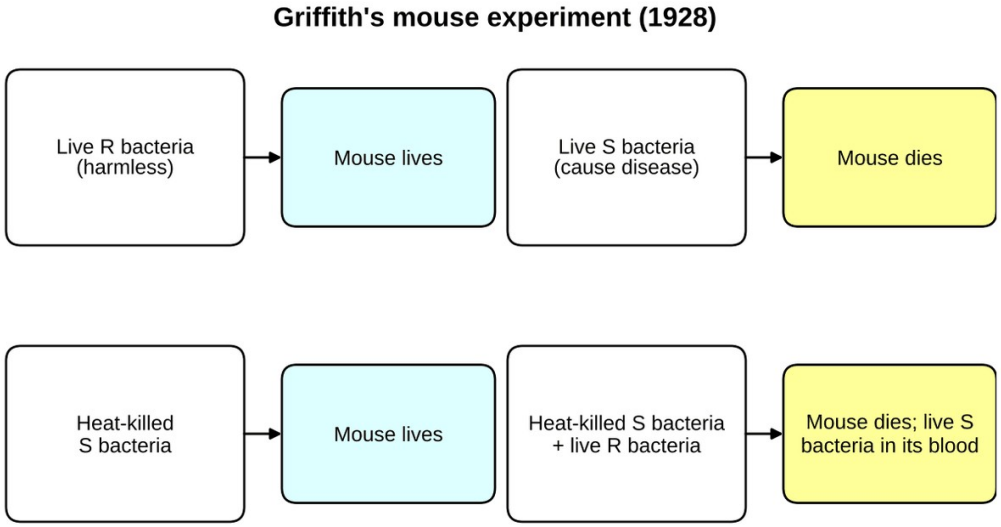
Essential Question

How did evidence from several scientists reveal the shape of DNA?

Discovery of DNA's Structure

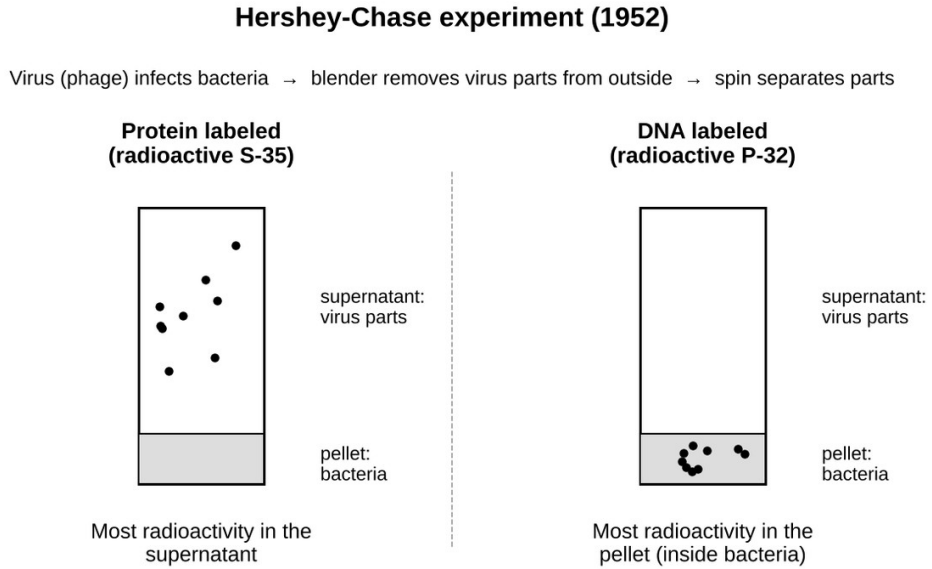
Clue 1: A Substance Can Change a Trait

- In 1928, Frederick Griffith injected mice with two strains of one kind of bacteria: harmless R bacteria and disease-causing S bacteria.
- Mice given live R bacteria lived. Mice given heat-killed S bacteria lived. Mice given heat-killed S bacteria mixed with live R bacteria died, and live S bacteria were found in them.
- Griffith inferred that some substance passed from the dead S bacteria into the R bacteria and changed them.
- In 1944, Oswald Avery, Colin MacLeod, and Maclyn McCarty tested which molecule did this. Destroying DNA stopped the change. Destroying protein did not.
- Their results pointed to DNA, but many scientists at the time were not yet convinced.



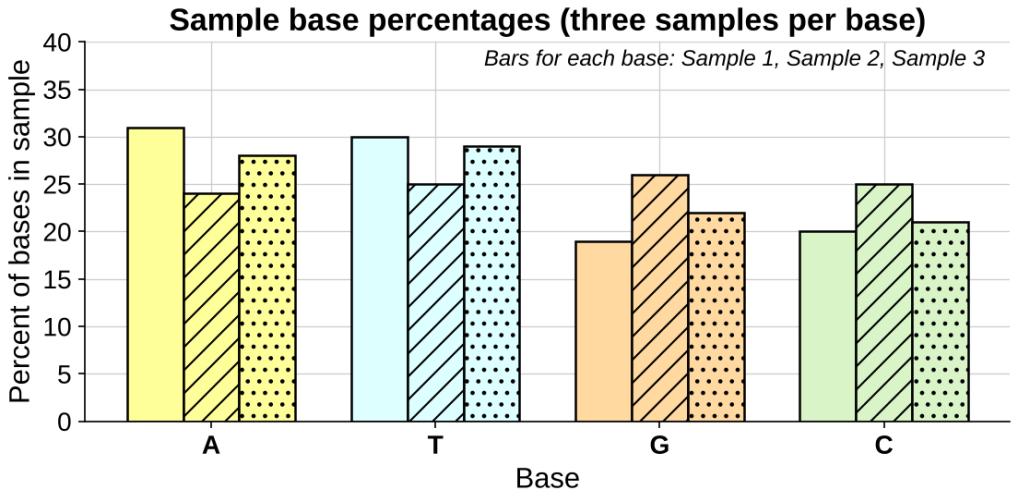
Clue 2: Viruses Inject DNA

- In 1952, Alfred Hershey and Martha Chase studied a bacteriophage, a virus that infects bacteria. The virus is made of only DNA and protein.
- They labeled the virus protein with radioactive sulfur (S-35), because protein contains sulfur and DNA does not. They labeled the virus DNA with radioactive phosphorus (P-32), because DNA contains phosphorus.
- After the viruses infected bacteria, a blender shook the virus parts off the outside of the cells. A centrifuge then separated the virus parts (supernatant) from the bacteria (pellet).
- Most of the S-35 label stayed outside the bacteria. Most of the P-32 label was inside them.
- The viral DNA, not the protein, had entered the bacteria and directed the making of new viruses.



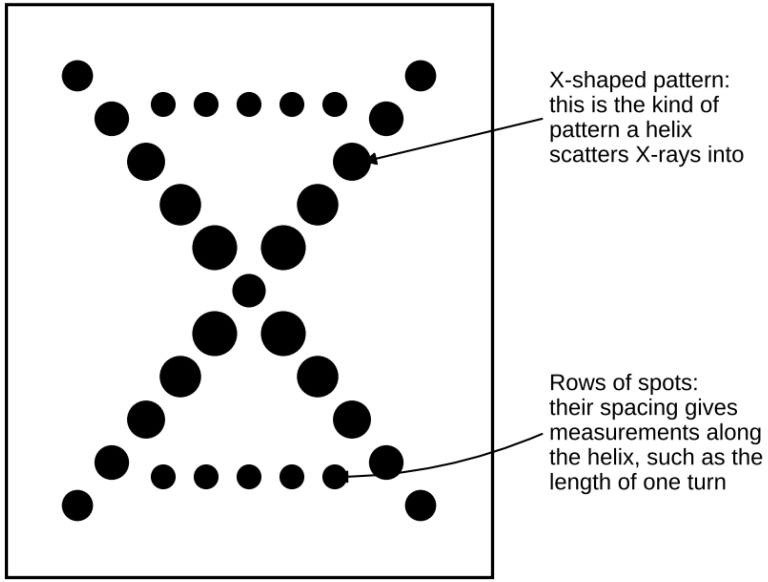
Clue 3: Chargaff's Base Ratios

- Erwin Chargaff measured the amounts of the four bases (A, T, G, and C) in DNA from many different species in the late 1940s.
- In the DNA he measured, the amount of A was close to the amount of T, and the amount of G was close to the amount of C.
- The overall base composition was different in different species. The pattern A is about T and G is about C stayed the same.
- Any model of DNA had to explain this pattern.
- The bar graph shows sample values made for practice, in the same pattern as Chargaff's results.



Clue 4: X-ray Patterns

- Maurice Wilkins and Rosalind Franklin, at King's College London, studied DNA fibers with X-ray diffraction.
- Franklin and her student Raymond Gosling produced very clear X-ray patterns of DNA in 1951 and 1952. One of them is known as Photo 51.
- The X shape in a pattern like this is what a helix produces. Measurements from the patterns gave the width of the molecule and the length of one full turn.
- The diagram is a new, simplified schematic. It is not a copy of a real X-ray image.

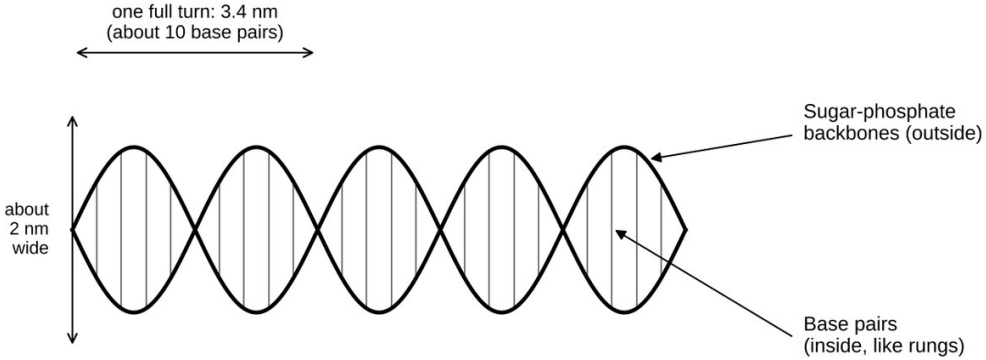


Simplified schematic, not a real X-ray image

Discovery of DNA's Structure

The Double Helix Model

- In 1953, James Watson and Francis Crick built a model of DNA that fit the X-ray measurements and Chargaff's base ratios.
- In their model, two strands wind around each other in a double helix. The sugar-phosphate backbones are on the outside and the bases are on the inside.
- A always pairs with T, and G always pairs with C. This pairing explains why the amounts of A and T match, and the amounts of G and C match.
- One full turn is 3.4 nm long and holds about 10 base pairs.
- Watson, Crick, and Wilkins shared the 1962 Nobel Prize in Physiology or Medicine. Franklin had died in 1958. Historians still discuss how the X-ray results reached Watson and Crick and how credit should be shared.



Watson and Crick model, 1953 (not to scale)

Example: Which Part of the Virus Entered the Bacteria?

In a Hershey-Chase style experiment, a virus was labeled in two ways. After infection, a blender and a centrifuge separated the supernatant (virus parts outside the cells) from the pellet (bacteria). The table gives the percent of each label found in each part. These are illustrative values. Write a Claim, Evidence, Reasoning response: which molecule is the genetic material?

Label	% found in supernatant (virus parts)	% found in pellet (bacteria)
Protein (S-35)	80	20
DNA (P-32)	30	70

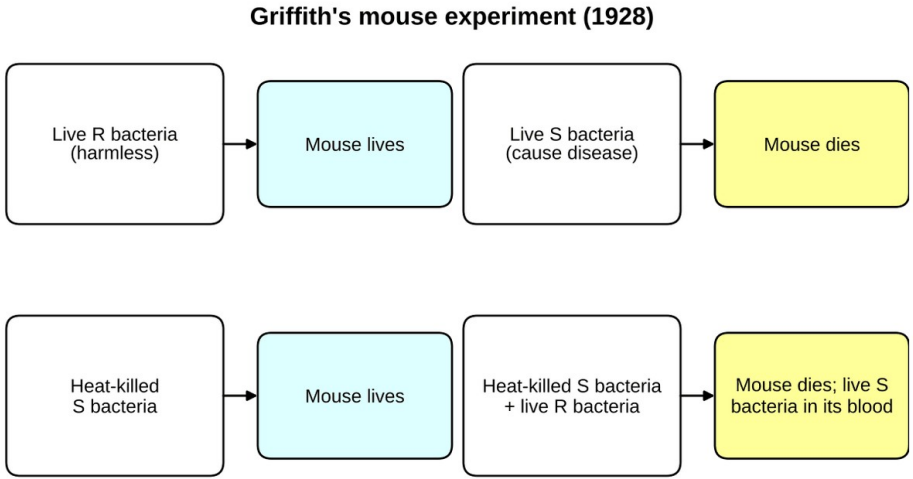
Example: Base Percentages in Three Samples

The table shows base percentages for three DNA samples (sample values for practice). Compare %A with %T and %G with %C in each sample, and compare the samples with each other. Write a Claim, Evidence, Reasoning response about the pattern and what it suggests about DNA structure.

Sample	% A	% T	% G	% C
Sample 1	31	30	19	20
Sample 2	24	25	26	25
Sample 3	28	29	22	21

Example: Predicting the Fourth Mouse

Use the diagram of Griffith's experiment. Looking at the first three treatments only, predict what a scientist would expect when a mouse is injected with heat-killed S bacteria mixed with live R bacteria. Then explain how the actual result changes the conclusion.



Discovery of DNA's Structure

Big Ideas

- Experiments by Griffith, Avery, MacLeod, McCarty, Hershey, and Chase showed that DNA carries genetic information.
- Chargaff found that A is about T and G is about C in DNA, and that base composition differs between species.
- X-ray patterns from Franklin, Gosling, and Wilkins showed that DNA is a helix and gave its dimensions.
- Watson and Crick built a double helix model, with A paired to T and G paired to C, that fit all of the evidence.
- Scientific knowledge builds on evidence from many people over many years.