3

The Double Helix

A Personal Account of the Discovery of the Structure of DNA

—James D. Watson

Correlation to Subject Matter

The *Double Helix* is James D. Watson's personal account of his discovery of the molecular structure of DNA, for which he won the Nobel Prize, along with Maurice Wilkins and Francis Crick. Watson and Crick, who worked together as research scientists in the new field of molecular biology during the 1950s, returned again and again to the problem of understanding the structure of the DNA molecule.

The progress and success of other scientists—including Linus Pauling and his model of the alpha-helix, and other associates who were using X-ray photographs to look at the DNA structure—contributed to the DNA research of many scientists.

Watson became curious about the structure of DNA while still an undergraduate, but his lack of interest in chemistry or physics hindered his work on the problem. The collaboration of the two scientists enabled them to understand the nature of DNA and figure out its structure. Watson and Crick created a model based on special X-ray photographs that indicated the helical structure. Their model proved the molecular nature of DNA and therefore confirmed its two-stranded, helical structure.

Student Focus

In this book you will experience the literary nonfiction elements of narrative and biography. Focus on the topics of scientific inquiry and method as well. How did Watson develop his original hypotheses about the structure of DNA despite his reluctance to learn the essential chemistry and physics? Describe the collaborative work of Watson and Crick, along with other scientists.

Correlation to Subject Matter

Biochemistry, Molecular Biology, Physics, and Genetics

Analyzing the Book

Identifying Facts

1. Describe Francis Crick's personality and approach to science.

2. What results of O.T. Avery's experiments indicated that genes were not special types of protein molecules? How did this contradict Erwin Schrodinger's theory about genes?

3. There was skepticism on the part of some scientists regarding DNA as the composition of genes. What information did Crick think DNA would provide about genes?

4. When did Watson become interested in DNA? How did he pursue his interest?

5. What did Watson learn from Maurice Wilkins's talk in Naples? Why did Watson want to associate himself with Wilkins?

6. Describe Linus Pauling's explanation of the alpha-helix. What did Watson observe about Pauling's discovery of the helix?

7. Based upon X-ray data, what hypothesis about the nature of DNA did Wilkins share with Crick?

8. How did Wilkins differ from Watson and Crick in their approach to solving the DNA problem? What prevented Wilkins from continuing his approach to research?

9. Rosalind Franklin's early X-ray data showed the DNA molecule to be compatible with two, three or four polynucleotide chains, or strands. How did Crick determine that there were a small number of solutions that corroborated information with which he and Watson were working? Why could no clear determination about the number of strands be made at this point?

10. When attempting to determine what neutralized the negative charges of the phosphate groups of the DNA backbone, Pauling had an edge over the Watson-Crick team. Why?

11. Describe the first DNA-model attempts that Watson and Crick made.

12. Why did Watson choose to work on the structure of TMV? What did he learn from TMV that he could apply to his DNA search?

13. What error did Watson discover in Pauling's DNA model that was composed of a three-chain helix with the sugar-phosphate backbone in the center?

14. What was wrong with Watson's hypothesis that gene replication could be achieved if each base in the newly synthesized chain hydrogen-bonded to an identical base? How did he solve the problem?

Interpreting Meanings

15. Give examples of the competition that developed as the scientists worked to solve the problem of DNA structure.

16. How did Pauling's discovery of the alpha-helix and subsequent work on DNA affect the work of Watson and Crick?

17. Why did Watson choose to follow Pauling's example of model-building for his work on DNA? How did he use additional X-ray data?

18. What new dramatic elements were introduced into Watson's story when Linus Pauling's son, Peter, came to Cambridge?

19. Once the helical structure of DNA was established by X-ray photos, there was still the question of how many strands composed the helix. What led Watson to believe that the DNA molecule might consist of two chains?

20. Why were Watson and Crick concerned about releasing their DNA findings before the model was built?

21. How did Watson and Crick feel about their mistakes and difficulties while working on the DNA structure?

22. What was the main difference between Pauling's attempts to build the DNA structure and the final, successful attempt of Watson and Crick?

23. Give some examples of Watson's desire to be the first scientist to solve DNA. How did this desire affect his work?

24. By the time they were finished, Watson and Crick had used elements of biology, chemistry, mathematics, engineering, and common sense to discover the structure of DNA. Why did the structure of a single molecule require all of these areas?

Applying Meanings

25. Explain the importance of hydrogen bonding to the structure of DNA.

Writing About the Book

On a separate sheet of paper, write the answers to each of the following.

Extending the Story

1. Watson and Crick's discovery of the structure of DNA opened the door for further genetic research that has lead to current use of DNA testing for many purposes. Imagine that you are Watson. Write a short narrative in which you extend his story by hypothesizing about future uses of DNA testing.

Thinking about Assumptions

2. Throughout the time of the research on DNA, Rosalind Franklin assumed that DNA was not a helical structure. Since she was in a position to produce the best X-ray data on DNA, her assumption directly affected the research efforts to discover its structure. Write a summary of how the research process might have differed had Franklin assumed that the DNA molecule was a helix.

Responding to a Review

3. *The Double Helix* was published amid controversy over Watson's forthright portrayal of his colleagues. The Harvard University Press refused to publish the book. *The Harvard Crimson* commented editorially that such a work was "bound to offend somebody." Write an essay in which you react to this statement. Do you think Watson's book is offensive to anyone? Were his comments about his colleagues necessary for him to tell the story? Cite examples from the book to support your opinion.

Evaluating a Character

4. James Watson would not have been able to complete the structure of DNA without Francis Crick. Write a description of their joint discovery from Crick's perspective.

Writing a Journal Entry

5. Suppose that you are a scientist working on the problem of DNA during the time that Watson and Crick discover the structure. You have just heard and seen a presentation by these two men, detailing the DNA structure. Write an entry in your journal describing your response to their discovery and why you think it is important.

Analyzing the Discovery

6. If you were James Watson what would you think and feel about your discovery? Was there a step in the process that you feel led directly to discovering the structure of DNA? Cite examples that support your response. Do you feel that Linus Pauling, Maurice Wilkins, and Rosalind Franklin deserve part of the credit for their work on the problem? Which parts of their work, and why?

Testing on the Book

On a separate sheet of paper, write the answers to each of the following.

Critical Thinking and Writing

1. Watson states, "There had been far too many days when Francis and I worried that the DNA structure might turn out to be superficially very dull, suggesting nothing about either its replication or its function in controlling biochemistry." Why would this type of finding have been such a disappointment to them?

2. The personalities of both Watson and Crick, as well as their friendship, contributed to their research abilities. Cite examples of how these nonscientific aspects affected the discovery of the DNA structure.

3. The structure of DNA is considered one of the major scientific discoveries of the twentieth century. Why? Describe another scientific discovery that you feel is as important. Include a brief profile of the scientist(s) who made the discovery.

4. Watson did not possess extensive mathematical knowledge, and neither he nor Crick was as proficient in chemistry as Linus Pauling. How were they able to circumvent these deficiencies?

5. *The Double Helix* is Watson's personal history of the discovery of the structure of DNA. Is it an accurate historical account?