The Double Helix Study Guide

The Double Helix by James D. Watson

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Introduction

Accounts of scientific discovery often go unread by the general public, falling only into the hands of members of the scientific community and students preparing for the field. When James D. Watson published *The Double Helix* in 1968, however, many readers from the general population were attracted to the book□for two reasons: it was not laden with so much scientific detail that it was incomprehensible, and, perhaps most appealing, it was controversial. Watson's story is more a personal memoir than a recording of data. While unraveling the structure of deoxyribonucleic acid (DNA) is one of the most remarkable discoveries in history, Watson's telling of *how* it was discovered is just as astounding in the world of scientific publishing.

What makes this book so unusual is the author's honesty in describing the actions and personalities of his colleagues and in admitting his own role in the ' 'shady" side of research. Sneak peeks at other scientists' data, withheld information, alcohol, attraction to women, heated arguments, and the joy of watching a competitor make a public blunder all play as large a role in *The Double Helix* as X-ray crystallography, genetics, and molecular structure. Although Harvard University Press had agreed to publish Watson's book, it reneged on that agreement when prepublication galleys caused an uproar among "offended" members of the scientific community. Picked up by Atheneum Press, this account of the discovery of the "secret of life" is one of science's most provocative, unorthodox, and fun publications.

Author Biography

James Dewey Watson was born in Chicago, on April 6, 1928. He was an exceptionally bright child who excelled far beyond his school course work, resulting in early high school graduation. As an adolescent, Watson became one of the original "Quiz Kids," named for a radio show featuring young people competing in games of intelligence. At age sixteen, Watson entered the University of Chicago, earning his bachelor's degree in zoology in 1947. Three years later he completed his graduate and doctoral studies at Indiana University, earning his Ph.D. in genetics with a dissertation concerning the lethal effect of X-rays on bacterial viruses.

Watson showed no interest in genetics as an undergraduate, concentrating instead on one of his favorite subjects, ornithology, the study of birds. During his graduate studies, however, Watson read a book called *What Is Life?* by Austrian physicist Erwin Schrödinger. Some of Schrödinger' s theories concerning the nature of genetic material were so enthralling to Watson that he decided to take up the cause of finding *the meaning of life* by studying genes.

From 1951 to 1952, Watson held a research fellowship at the Cavendish laboratory in Cambridge, England. Sent there to study proteins, he soon fell into discussions with other scientists on the nature of deoxyribonucleic acid (DNA). One of those fellow scientists was Francis Crick, with whom Watson would share a Nobel prize in 1962 (along with Maurice Wilkins) for discovering the makeup of the acid that carries genetic information in living cells. The day-by-day process of one of mankind's greatest discoveries is the topic of Watson's *The Double Helix,* which he subtitled A *Personal Account of the Discovery of the Structure of DNA.* The key words here *are personal account,* for Watson's 1968 publication is one of the most unusual, provocative stories in the history of "science" writing. Despite the anger that the publication aroused in the scientific community, Watson took the controversy in characteristic stride and went on to hold other research fellowships, teach in various universities, and become director of a laboratory at Cold Spring Harbor, New York. From 1989 to 1991, Watson directed the Human Genome Project, an international effort to "map" all the genes in the human system. Today, Watson still speaks out on issues surrounding scientific research and is a major lobbyist for federal support for human genetic engineering.

Plot Summary

Chapters 1-10

The first third of *The Double Helix* introduces the main players in the research and discovery of DNA's structure. Watson blends descriptions of personalities with an account of how he arrives at the Cavendish laboratory in Cambridge, England, and begins his relationships with other scientists, both friend and foe. As a young Midwestern man on his first big adventure, Watson decides that "a scientist's life might be interesting socially as well as intellectually," and he pursues that philosophy through jaunts to the Alps as well as ' 'midnight trips to waterfront bars."

Watson's initial purpose in going to the Cavendish lab is to study the molecular structure of proteins by building three-dimensional models of them. Upon meeting Crick, whom he claims never to have seen "in a modest mood," he is excited at finding a fellow scientist who shares his interest in studying DNA. Because the DNA molecule is too small to be looked at through a microscope, it can be "seen" only in crystallized form through an X-ray. But neither Watson nor Crick is highly skilled in crystallography, and they must turn to the experts at rival King's College in London for help in getting pictures of the molecule. This act introduces Maurice Wilkins and Rosalind Franklin into the tale. Though these two ' 'colleagues" behave more like enemies, both are involved in researching DNA through crystallography in the King's College lab.

The three male scientists become friends, but Franklin is portrayed as a woman who has ' 'belligerent moods" and who does "not emphasize her feminine qualities." Rather than kick Franklin out of his lab, however, Wilkins understands that he needs her expertise to help him compete with Linus Pauling, who is also working on the DNA mystery at his lab in California. Watson and Crick understand the dilemma, too, and decide they should glean as much information from Franklin□one way or another□in order to beat Pauling to the answer. The last line of Chapter 2, ' 'The thought could not be avoided that the best home for a feminist was in another person's lab," sums up the tense feelings that permeate the environment at the King's College lab

In Chapter 10, Watson attends a lecture given by Franklin in which she describes the DNA molecule as a helix shape with a sugar-phosphate backbone on the outside. Watson, however, neglects to take notes on the lecture, believing he can recall Franklin's theory strictly from memory. This error will prove costly in his and Crick's progress toward building a model of DNA.

Chapters 11-21

The middle third of the book describes the experiment that costs Watson and Crick about a year of DNA research work. Because Watson cannot remember Franklin's actual words during her lecture, he gives Crick misinformation about her proposal. The

major mistake in the model they build is that the backbone is on the inside, the opposite of what Franklin had said. Proud of their' 'discovery," however, Watson and Crick show off their model to Wilkins and Franklin. It does not take long for Franklin and others to shoot down the idea and prove that it is not only wrong but ridiculous. When Lawrence Bragg, the Nobel-Prize-winning director of the Cavendish lab, learns of the failure, he orders Watson and Crick to give up their research on DNA and leave it to the scientists at King's College.

For the next year, Crick spends most of his time working on his doctorate, while Watson studies the tobacco mosaic virus (TMV). As Watson notes,' 'A vital component of TMV was nucleic acid, and so it was the perfect front to mask my continued interest in DNA." Also during this time, Watson invites his sister for extended visits to England, and they both have their share of social revelry and English high-life. On the down side, Watson also struggles with the possibility of losing his research fellowship and must write letters of appeal back to the United States, feigning interest in various fields in order to retain support.

Chapters 22-Epilogue

By now Peter Pauling, son of the famous Cal Tech chemist, Linus Pauling, has arrived at the Cavendish lab, where he shares office space with Watson and Crick. The three become friends and in late 1952 Pauling shows his officemates a preliminary report from his father that he plans to publish as a proposal for the structure of DNA. Watson wastes no time scrutinizing the older Pauling's work and is delighted to find a major flaw. It is apparent to Watson that "Pauling's nucleic acid... was not an acid at all.... Without the hydrogen atoms, the chains would immediately fly apart and the structure vanish." Confirming the blunder with several colleagues□one of whom ' 'predictably expressed pleasure that a giant had forgotten elementary college chemistry"□Watson and Crick sit back and wait for Pauling to present his impossible theory to the scientific world, never once considering warning him of the humiliating mistake that he was about to make. When the Cal Tech chemist's paper is published in January, 1953, the negative reaction is quick in coming. And with their competitor licking the wounds of embarrassment, Watson and Crick become more determined than ever to resume their position in the race for DNA.

The final chapters of the book describe the various experiments they attempt before arriving at a model with the correct sequencing of the four nitrogen bases in each DNA strand. In order to reach their goal, Watson returns to Wilkins at King's College for a better look at the X rays from which he and Crick will pattern their model. Watson is happy to learn that Wilkins has secretly been copying Franklin's notes, and when he sees an X-ray photo confirming that the molecule is a helix, he cannot wait to return to the Cavendish lab to share the news with Crick. On the train back to Cambridge, Watson sketches helix-shaped molecules on the margin of a newspaper and concludes that the molecules are most likely made up of two strands of DNA□a double helix.

Once Watson and Crick publish their findings in 1953, the scientific community concedes that they have indeed revealed the secret of how genes replicate themselves. Even Linus Pauling travels from America to share in a celebration dinner. Only in the book's epilogue does Watson offer any regrets for his portrayal of Rosalind Franklin throughout his account. In the final paragraph, he admits that both he and Crick:

came to appreciate greatly her personal honesty and generosity, realizing years too late the struggles that the intelligent woman faces to be accepted by a scientific world which often regards women as mere diversions from serious thinking.

Watson ends the book by noting Franklin's struggle with cancer and commends her for ' 'working on a high level until a few weeks before her death."

Forward, Preface and Chapter 1

Forward, Preface and Chapter 1 Summary

The forward by Sir Lawrence Bragg summarizes what the book will be about, discussing first the scientific importance of Francis Crick and James Watson's Nobel Prize-winning discovery of the structure of DNA. Second, it discusses the ethical dilemma that a scientist faces when a colleague has long been working on a problem, and the scientist thinks he or she can solve that problem, based on the colleague's unpublished work. This was a dilemma that Watson faced. Finally, Bragg emphasizes the human interest of the story, which is an autobiographical account of Watson's impressions instead of a historical work.

The preface by the author reiterates that it is an autobiographical account of one man's memories and impressions. The author also includes a list of diagrams in the book, followed by an unnamed section which recounts a climbing expedition the author made into the Alps after the discovery of the structure of DNA was a thing of the past. He ran into a fellow scientist, who called him "Honest Jim." This led to the author's reflections on the scientific discovery of the structure of DNA. He concludes that the discovery involved five people. They were Maurice Wilkins, Rosalind Franklin, Linus Pauling, Francis Crick, and himself.

Chapter one begins when the author met Francis Crick in autumn of 1951. Crick was widely unknown but highly intelligent. Their unit at Cavendish Laboratory of Cambridge University was led by chemist Max Perutz and the director of the laboratory, Lawrence Bragg, and they were investigating the structure of proteins. Watson paints a picture of Crick as a loud, exciting, enthusiastic theorist and experimentalist, with a quick, incisive mind and notes that his brilliants and vociferousness caused fear among the other scientists, who saw Crick as a certain success who might expose their mediocrity.

Forward, Preface and Chapter 1 Analysis

The beginning of this autobiography introduces its main theme, that of the ethical challenges in the field of scientific discovery. It also introduces the main characters in the drama about to unfold, focusing on the brilliant and manic Francis Crick. The writer himself seems modest, putting himself in the background. The name "Honest Jim" indicates that the author will be focused on scientific ethics. By the end of the book, the irony of this name becomes evident.

Chapter 2

Chapter 2 Summary

When James Watson joined Cavendish Laboratory, he brought with him an interest in DNA. Francis Crick was interested in DNA, but the problem was difficult for him to work on because of human considerations. He was acquainted with Maurice Wilkins, who worked in London on the problem of DNA, and it would be awkward for Francis to compete with his colleague. Meanwhile, Maurice had problems with his assistant, Rosalind Franklin, or Rosy. Rosy was belligerent about her position as an assistant and the treatment of women at their laboratory. Also, Maurice, a cautious scientist, was concerned about the interest of Cal Tech chemist Linus Pauling's interest in DNA. Potentially, both Linus and Francis could start competing with Maurice on his work. His biggest problem, though, was relations with Rosy, and he had to consider firing her.

Chapter 2 Analysis

The chapter sets up the human drama that will follow in the discovery of the structure of DNA, involving the ethics of competing with colleagues in the process of scientific discovery and the personality clashes that occur in scientific laboratories, exemplified by the conflict between Rosy and Maurice.

Chapter 3

Chapter 3 Summary

Maurice Wilkins first excited the author about using X-rays to study DNA. The author recounts his lukewarm relationship with chemistry until first meeting Maurice. Trained as a biologist, Watson avoided chemistry through his graduate work and was sent on a postgraduate fellowship to study biochemistry with Herman Kalckar in Copenhagen. However, Watson was interested in genetics and had been working with phages, viruses which some scientists suspected were naked genetic material, while Herman was uninterested in genetics and difficult to understand. Watson continued phage work with a Copenhagen scientist, which was not strictly according to the terms of his fellowship. Watson's conscious was somewhat assuaged, when Herman revealed that he was going through a divorce, and was in no state to teach the student biochemistry. When Herman traveled to Naples for two months, though, Watson accompanied him with the permission of his fellowship committee in Washington.

Chapter 3 Analysis

In this chapter, Watson moves back in time to recount his own history and background. He is amusing as he describes his failed attempt to study chemistry as a graduate student, when he caused an explosion by heating benzene on a bunsen burner, saying "It was safer to turn out an uneducated Ph.D. than to risk another explosion." (22) His humor is at once self-deprecating and subtly examining the very human workings of the scientific community, where the politics of personal relationships and attitudes (such as his advisor's dislike of chemists) govern who studies what, where, and with whom.

Chapter 4

Chapter 4 Summary

Maurice Wilkins came to Naples to deliver a presentation in lieu of his boss, and by the time he arrived, Watson was disheartened with Naples. The weather was cold, made colder by the absence of heating, and Herman's biochemistry was still uninteresting to Watson. Maurice's presentation, showing an X-ray image of crystallized DNA, was the first thing to capture Watson's interest. The crystallized images were evidence that DNA had a regular structure. Suddenly, Watson saw a connection between his interest and chemistry. He introduced himself to Maurice, but only was able to speak to him briefly. Maurice seemed initially attracted to Watson's sister Elizabeth, who had come to Europe to visit him, and Watson allowed himself to fantasize that his sister would give up her unintelligent suitors for the clearly brilliant Wilkins and that Watson, therefore, would become closely involved in Wilkins's work. This, however, was not to be, as Maurice Wilkins parted without, apparently, a second thought about Watson's sister.

Chapter 4 Analysis

This chapter continues to focus on life in the scientific community. Watson is drifting aimlessly, unable to focus his concentration on studying biochemistry, touching on the theme of inspiration and motivation. When he is uninterested and unexcited, Watson doesn't work. He is interested in the question of what a gene is. Still, he can't see the connection between biochemistry and his goal.

In Naples, Watson doesn't understand many of the lectures given in Italian, and he speaks of the scientific language of some of his fellow scientists as being beyond him. He doesn't speak the language of crystallography or chemistry, any more than he speaks Italian or Dutch. This lack of communication is a new perspective on the scientific community. People often assume that scientists understand each other, but a biologist's science is shown to diverge from a chemist's science, even though knowledge from both fields is needed to understand DNA.

Chapter 5

Chapter 5 Summary

Word came that Linus Pauling had partially solved the structure of proteins. Watson depicts Pauling as a brilliant and dynamic speaker, who created jealousy among his fellows and zealous admiration among the young. Pauling was also a clever writer, and even though his journal articles went over Watson's head, the brilliance of their language was clear. Pauling's model was an ?-helix, and at an initial review, it seemed to be the correct model, although Watson was unable to truly understand the argument. If Pauling was correct, his method of discovering the protein structure could possibly be applied to discover the structure of DNA. Watson began to wonder how he could study crystallography, the field responsible for creating X-rays of crystals like Maurice's DNA crystal X-ray. The solution was Max Perutz, a scientist at Cambridge University in London. Watson's advisor arranged for him to go to the lab at Cambridge. Before going to Cambridge to finalize the move before asking permission from his fellowship committee, Watson attended the International Poliomyelitis Conference in Copenhagen, which included champagne, "receptions, dinners, and midnight trips to waterfront bars....An important truth was entering my head: a scientist's life might be interesting socially as well as intellectually."

Chapter 5 Analysis

Watson continues to examine the human aspect of the scientific community. Linus Pauling's personality is as important as his discovery. Watson's experience with the nightlife at the Copenhagen conference is more important than any scientific learning that went on there. Though he is excited about the structure of DNA, Watson portrays himself not as an intellectual being but as a social, human being.

Chapter 6

Chapter 6 Summary

Watson traveled to Cambridge and was formally invited to work there by Sir Lawrence Bragg, whose Bragg's Law was both integral to crystallography and completely unknown to Watson. Herman gave Watson his support to study at Cambridge, and Watson wrote to his fellowship committee. While awaiting permission to work in Cambridge, Watson moved to Cambridge, though the move was illegal until permission came. Herman's personal problems were common knowledge, and Watson knew that his fellowship committee would be expecting him to make a move. He was absolutely certain that they would simply approve his plan to work with the lab at Cambridge, which was approved by both his advisor and Herman.

Unfortunately, the unexpected happened. The head of the fellowship committee had been replaced, and the new chairman was more interested in taking a hand in students' lives and choices. The Fellowship Board indicated that they would approve a transfer to the cell physiology laboratory of Caspersson in Stockholm, but not his requested transfer. After consulting his advisor and arranging with English biochemist Roy Markham to pretend to work with him, Watson wrote another letter saying that he would be studying biochemistry with Markham, as well as crystallography, his only real interest. The Fellowship Board was considering his case, but it didn't look promising. However, Watson had money left over from his previous fellowship grant and was determined to stay in Cambridge. Kicked out of his rooming house for making noise at night and going out after 10:00, he found lodgings for next to nothing at the house of some friends and prepared to stay with or without income.

Chapter 6 Analysis

In this chapter, the themes of motivation and of the impact of human nature and relations on science are revisited. Watson has found the path he is truly interested in pursuing, and he sets off in pursuit. Money or no money, he will stay and study in Cambridge. His enthusiasm for the subject is more important than his fellowship committee or his grant money. Watson's problems are caused by human nature and relations impacting science. If the previous chairman of his fellowship committee was not retiring, his request would have gone through without issue. However, a different chairman with different ideas, prejudices, and friends, creates a different result. While the element of human nature causes problems, Watson's enthusiasm and motivation keeps him on track toward his Nobel prize-winning discovery.

Chapter 7

Chapter 7 Summary

When Watson started working at the Cavendish Laboratory at Cambridge, he discovered that he loved it there, particularly talking with Francis Crick, who shared Watson's enthusiasm for DNA. Watson was no help with the X-ray experiments he was supposed to be working on, but Crick taught him about crystallography and about how Pauling discovered his ?-helix structure, by fitting together models of groups of atoms that liked to link together. The DNA structure was certain to be more complex than the protein structure Pauling had discovered. Crick and Watson assumed that the nucleotides, or components of DNA, were fit together in a regular way. This would be the simplest model of DNA structure, so they chose it as a starting point. There are four types of nucleotides in DNA, and their order must be complex, since that's how DNA carries information. However, Watson and Crick hypothesized that the four different nucleotides must each be bound together in a similar way, to create a regular pattern or structure.

X-ray pictures of DNA crystals would immediately rule out some "false starts" of potential DNA structures that couldn't possibly generate the crystalline patterns in the X-rays. There was already one X-ray crystallography image of DNA that was published, but Maurice's new image was better. Watson and Crick spoke to Maurice. He didn't believe that their idea of using models, like building blocks, to put together a 3-dimensional figure of DNA would work. Instead, he thought more X-ray images were needed. The conversation turned to Rosy, who had taken over the most profitable area of Maurice's research and wouldn't even tell him her results. Rosy would be giving a talk in three weeks on her research, and Maurice invited Watson. Now, he had an incentive to learn about crystallography, so he could understand Rosy's research.

Chapter 7 Analysis

The seeds of the development of a DNA structure begin in this chapter. Watson and Crick's idea of putting together models, like pieces of a three-dimensional jigsaw puzzle, to figure out the structure of DNA, is the idea that eventually wins them the Nobel prize. In this chapter, the theme of personality differences arises again in the conflict between Rosy and Maurice. Rosy is supposed to be Maurice's assistant, but instead she has taken over a portion of the DNA research and will not communicate with him. Maurice's personal opinions also affect the research. He doesn't see the value of Watson and Crick's idea, so he doesn't pursue this path, which is ultimately successful.

Chapter 8

Chapter 8 Summary

Francis Crick's interest in DNA became temporarily eclipsed by conflict in the laboratory. Sir Lawrence published a paper that utilized a theory Francis had propounded in the lab, and Francis accused him of using his idea without giving him credit. Sir Lawrence said he had come up with the idea independently. Both were offended and argued, leading Sir Lawrence to consider removing Francis, who had contributed nothing of importance, from the lab. Luckily for Francis, he was pursuing his Ph.D. at Cambridge and could not be let go before he finished his dissertation work.

Francis studied physics at University, College, London, and was beginning graduate work at the beginning of World War II. Like many scientists, he went to work for the government, where he helped make magnetic mines. After the war, he was no longer wanted in government service and came to Cambridge to study biology. Francis wound up pursuing a Ph.D. and working at the laboratory, but he had no patience for the kind of research needed for a Ph.D. thesis. Without obtaining his doctorate or having contributed anything significant to science, Francis would have found it hard to find a new position, if he were fired. Although the argument abated and peace was restored, Sir Lawrence still found it hard to work with Francis and didn't see the value of Francis at the lab.

Chapter 8 Analysis

In this chapter, Watson gives more background on Francis Crick, filling out his history and also developing his character. Crick is not only talkative, making him difficult to work with for some, but he is also tempestuous in his reaction to Sir Lawrence's article. His confrontational behavior makes problems for him and could have lost him his position at the laboratory. This discussion of the effects of personality conflicts between Sir Lawrence and Francis again brings up the theme of how human interaction and personal quirks affect science.

Chapter 9

Chapter 9 Summary

After the problems with Sir Lawrence, Francis became interested in a theory of the diffraction of X-rays by helical molecules. These are molecules that in the form of a helix. V. Vand wrote a paper describing his idea for this theory, but Francis saw problems with it. He discussed it with Bill Cochran, another scientist in the lab, who agreed with Francis's ideas. They began working on the theory.

The author describes Francis's home life. Francis lived in an apartment called the "Green Door" with his wife Odile. Though the place was small, Odile decorated it well and also cooked well. The couple was uninterested in politics or religion, preferring *Vogue* to *The Times*. Francis was enthusiastic about young women and enjoyed his wife's circle of somewhat artistic friends.

Francis and Bill Cochran simultaneously came up with equations to explain X-ray diffraction by helical molecules. While Cochran's equations were more elegant, both had reached the same conclusion, one that also worked with Linus Pauling's research. They published a paper, which was Francis Crick's first real scientific triumph.

Chapter 9 Analysis

This chapter is divided between Francis's discovery of the theory of X-ray diffraction by helical molecules and Francis's home life. The author's attitude emphasizes that the scientist's life is not truly separable from the scientist's work. The author's depiction of women is worthy of note. Rosy throughout is depicted as a negative character, stodgy and determined to hold onto her work, not open or willing to share. This is paired with descriptions emphasizing her mannish dress and unfeminine look. The author admits that Rosy faced difficulties as a female scientist in the 1950's, working at a lab where men's and women's gathering areas were separated, but she is still shown in a negative light. Meanwhile, Francis's womanizing is depicted as harmless and even approved by his cosmopolitan wife.

Chapter 10

Chapter 10 Summary

Rosy gave her talk on her crystallographic research into DNA, with Watson attending. She did not mention model building or helices, ignoring Linus Pauling's ideas. She seemed to believe that research on DNA structure required much plodding crystallographic research. Maurice seemed pleased that Rosy hadn't made any important steps forward and also that Watson, a phage researcher, was interested in DNA, which much of the scientific community felt was not important. However, Rosy's attitude and "characteristically tense small talk" left a pall on the evening.

Chapter 10 Analysis

Again, Rosy, the most prominent female character in the book, is portrayed as painfully closed-minded and stodgy. The author states, at the beginning of the lecture, "Momentarily I wondered how she would look if she took off her glasses and did something novel with her hair." This emphasis on Rosy's looks makes the reader wonder about her struggles as a woman to be taken seriously as a scientist, which are largely absent from Watson's portrait of her. Her scientific tack and education is characterized as "careful, unemotional...rigid." Was this overly cautious approach related to the struggles, as a woman, to become accepted in a male-dominated academic field in the 1950's? This is not the focus of the book, but it is a question that is implicit in the book's treatment of women.

Chapter 11

Chapter 11 Summary

Watson and Francis went to Oxford for the weekend. Watson hadn't taken notes at Rosy's lecture, and his recollection of the information she dispersed was frustratingly vague, especially her report of the amount of water in her DNA samples. Francis would have understood the lecture better and come back with detailed notes, but his presence would have been awkward for Maurice. However, based on Watson's reported water value, Francis narrowed down the possible DNA structures to several models and was optimistic that they could come up with an answer in about a week. They thought the structure must have two, three, or four chains of nucleotides, called polynucleotide chains.

Around a year before, three prominent members of the Cambridge lab, Bragg, Kendrew, and Perutz, published a paper on polypeptide chains which had "missed the point." This failure stung the lab, making them look bad next to Linus Pauling. The work on DNA was a chance to make up for this blunder.

In Oxford, Watson and Crick bought a copy of Pauling's book *The Nature of the Chemical Bond*, which contained information they needed to build a model of DNA. They also met with Dorothy Hodgkin, the foremost English crystallographer, but by that time Francis was more subdued and the discussion focused on Dorothy's work with insulin. The trip ended with dinner and claret with friends, and Watson went home "pleasantly drunk."

Chapter 11 Analysis

Francis Crick goes through a stage of manic excitement and believes that the solution to the structure of DNA will be simple. Then, he loses steam, and the discussion with Dorothy Hodgkin seems off the topic of DNA. Again, Crick's personality is affecting the progress of his scientific thought and his interaction with other scientists. This chapter also continues the self-deprecating attitude of the author, who says that his knowledge was not strong enough of crystallography to remember Rosy's lecture well and that Francis should have been the one to go. Again, the decision not to send Francis was not because of science, but because it would have been awkward for Maurice.

Chapter 12

Chapter 12 Summary

Watson was enthusiastic about beginning to work with the different possible molecular models of DNA. He and Francis knew that the models of the components that were at the lab weren't exactly what they needed. Instead of waiting for new models, they added copper wire to existing models to make the larger-sized phosphorus atoms necessary for DNA. They also needed to represent inorganic ions, but they wouldn't know the correct configuration before understanding the final structural model. Still, they dived in. While Francis reviewed the X-ray images, Watson began assembling pieces of a model. Over lunch, when Francis was usually gregarious and interested in other scientists' problems, he and Watson discussed ideas about the DNA structure. Once they started building, they had problems. The atom models kept falling down, and they saw some problems. The bonds that held together DNA, they found, might be different shapes, allowing many possible variations. By the afternoon, though, things looked better. They developed a model with three chains that fit with the X-ray images. They were pleased. While Francis's wife didn't understand their work, she was happy that Francis seemed at the point of an important breakthrough. After a bit more work to finalize the model, they called Maurice to come view it, and he arranged to visit the next day along with Rosy.

Chapter 12 Analysis

Watson and Crick dive into the problem of the structure of DNA with little information. They begin putting together the model, and after some initial frustrations, they seem to be met with immediate success. The savvy reader will realize that the title *Double Helix* indicates that the final model will have two helices, not three. The three-chain model the scientists construct must be wrong. This leads to dramatic irony. The reader knows what the scientists, at the time, did not. They are headed for a disappointment.

Chapter 13

Chapter 13 Summary

The scientists from King's College laboratory arrived to look at the model, and the meeting was disappointing. Rosy was openly critical of the model, pointing out how it didn't fit with her research. Watson and Crick realized Watson hadn't remembered the amount of water Rosy's measurements showed in her DNA samples correctly. The number they'd been working with was wrong. Rosy, meanwhile, didn't believe that helices were the answer to the structure of DNA and stated that there was no evidence for it. Watson and Crick realized that their arguments weren't standing up. Rosy wasn't going to change her course of research based on their ideas, which she felt had no worth. After the others left, Watson and Crick didn't want to look at their model anymore. "All its glamour had vanished..."

Chapter 13 Analysis

The anticipated letdown happens in this chapter. The imagined success with the initial model of DNA seems in retrospect too easy, and Rosy's approach, which takes development of a model in slow, methodical steps, seems certainly a safer road than the emotional rollercoaster of development than Watson and Crick are traveling on, in which they are searching for inspiration. Watson and Crick, we know, are ultimately successful, but is their approach to science better, worse, or a necessary companion to Rosy's?

Chapter 14

Chapter 14 Summary

Maurice's boss at the London laboratory spoke to Bragg and convinced him that Watson and Crick shouldn't be working on the problem of the structure of DNA. Sir Lawrence, already annoyed with Francis's behavior and attitude, had them stop working on the project. The two scientists didn't try to change the decision, although they kept thinking about DNA. To move forward, they would need a fresh start, and because of the bad relationship with King's College laboratory, they wouldn't be getting any new data. Francis moved on to work on his Ph.D. thesis. Meanwhile, Watson studied chemistry, focusing on *The Nature of the Chemical Bond,* and Crick gave him a copy of that book for Christmas.

Chapter 14 Analysis

After the initial disappointment, Watson and Crick's work is brought to a swift end. The past problems between Sir Lawrence and Crick resurface, combining with the clash with King's lab (and particularly Rosy), to force Watson and Crick to stop their work. They don't think that King's lab will make the progress that they believe could be made, but they can do nothing about the situation. The interaction and clash of personalities threatens to slow the course of science, bringing forward that theme. For now, Watson and Crick only think and study about DNA.

Chapter 15

Chapter 15 Summary

Watson went to Carradale, the home of a friend's parents, for Christmas. They were reputed to have interesting, intelligent guests. Watson also invited his sister, who was being courted by a Danish actor. Watson, who "sensed impending disaster" on the basis that the man was a successful actor, wanted to get his sister away from Copenhagen. He enjoyed the company and the games at the country estate, and he was sorry to have to leave for London to speak at a meeting of the Society for Experimental Biology. Back in Cambridge, he still hadn't heard about his fellowship, which was bad news. When the letter arrived, he found his fellowship had been cancelled. The board had given him a new fellowship that was $1,000 less, and the head of the fellowship board invited him to speak at a meeting in the United States in June. It was an incentive, it seemed, to pull Watson out of Cambridge. Watson declined, unwilling to leave the lab at Cambridge.

Chapter 15 Analysis

This chapter creates a Christmas break in the story, just as Watson himself had a Christmas break from his quest. Nothing moves forward, but Watson is clearly committed to staying in Cambridge and continuing his pursuit of DNA structure. The news from his fellowship is not as bad as it might have been. He was prepared to be cut off with no money whatsoever. His fellowship committee seems to be trying to manipulate him from afar by cutting his money and enticing him back to the United States, again the impact of personality on science. Watson, though, stands by his intuition that Cambridge is where he needs to be.

Chapter 16

Chapter 16 Summary

Watson began working on tobacco mosaic virus (TMV), which contains a nucleic acid called RNA. He hoped that his studies would help him eventually learn about DNA. Watson began learning how to make X-ray crystallography images in order to try to show that TMV had helically stacked protein. As he struggled unsuccessfully to make decent X-ray photographs, he accompanied Crick's wife to parties that her husband didn't want to go to. At the end of the chapter, Linus Pauling is expected to arrive in England for a conference.

Chapter 16 Analysis

Watson portrays himself as constantly behind, with less knowledge than others and always struggling to understand. One of the characteristics of Watson in this book, though, is that he is always learning. In the past, he has avoided learning X-ray crystallography. In this chapter, he finds a use for this knowledge and therefore begins to learn the skill. This is, throughout, the force that drives Watson's learning. If he has a practical reason to learn something, it motivates him to learn.

Chapter 17

Chapter 17 Summary

Linus Pauling never got to London. He was held up at the airport. Due to his political views, opposing Senator McCarthy, who led the American Senate's investigation (ultimately deemed unconstitutional) of communism in the United States, Pauling was not permitted to travel to England to speak at the scientific conference. The English scientists were appalled that the United States would take this action. The conference was, overall, uneventful. Watson found out from Maurice that King's lab had not used the molds that the Cambridge lab had lent them for working on building a structural model of DNA. Maurice promised to return the molds. He felt certain that Watson and Crick were no longer working on DNA.

Chapter 17 Analysis

Yet another way that human interaction affects science is addressed in this section. Pauling's personal politics prevent him from travelling to England to speak at a scientific conference. This chapter also serves to relate the scientific events of the time to their social and political context in the 1950's, when the communist scare of the cold war was rampant in America and Senator McCarthy and the House Unamerican Activities Committee were violating Constitutional rights to investigate communism.

Chapter 18

Chapter 18 Summary

As the Cavendish laboratory had recently developed a new kind of X-ray tube, Watson was able to take pictures twenty times faster and probe that TMV was helical in shape. Francis confirmed that Watson's picture did indeed show that TMV was a helix. There was nothing else of interest to him that Watson could learn from TMV, so he knew he must attack DNA directly.

A scientist named Chargaff had done experiments showing interesting relationships between the purine and pyrimidine bases in DNA. The number of adenine molecules in DNA was the same as the number of thymine molecules. Similarly, the number of guanine molecules was the same as the number of cytosine molecules. No one knew what this meant and there was some controversy about his data. However, Francis believed it was important. He worked to show that there was attraction between the bases that had similar quantities. Watson and Crick got to meet Chargaff, when he visited Cambridge, but they made a poor impression on him by not knowing enough about chemistry.

Chapter 18 Analysis

Watson's success with TMV clears the way for more work on DNA. Chargaff's experiments will prove to be extremely important in the final structure of DNA. It may be difficult to keep track of the different parts of DNA. The bases are divided into two types, purine and pyrimidine. Altogether there are four bases of adenine (A), thymine (T), guanine (G) and cytosine (C.) When the structure of DNA is solved, it must allow A, T, G, and C bases to appear in a variable order within a regular overall shape.

Chapter 19

Chapter 19 Summary

Watson saw Chargraff again, briefly, at the International Biochemical Congress in Paris, but they didn't speak. Watson spoke to Max Delbruck, who had offered him a job at Cal Tech which Watson would go to next year. Delbruck wasn't as enthusiastic about Watson's TMV discovery as Watson thought he would be, and he was unenthusiastic, when Watson compared Crick to Linus Pauling.

Pauling appeared unexpectedly at the meeting, but he revealed no new information about his protein structure. Maurice also was in town, on his way to Brazil and appearing unhappy. Watson tried to entertain him, but Maurice had eaten some bad food and spent the rest of his stay recovering.

Chapter 19 Analysis

The meeting in Paris is unproductive. Watson mingles with scientists and goes on outings, but this interlude contributes more to Watson's social experiences than his professional life. His clothes are stolen during his trip, and he is afraid he will have nothing appropriate to wear to a country house. However, he is able to borrow a jacket and tie, disappointing the lady of the house, who had expected a "mad Englishman" to appear in shorts.

Chapter 20

Chapter 20 Summary

Watson began to diverge from the problem of DNA, instead studying the sexes of bacteria. Scientists knew that there were male and female bacteria, and Watson worked on the process by which bacteria reproduce. Francis was uninterested. He felt that Chargraff's work was a key to DNA, but he made no progress. Watson felt that they didn't know enough to productively take up DNA again. He was not interested in another failure, like the previous model. Peter Pauling, Linus Pauling's son, arrived at Cambridge as a student, and the scientists were reassured by his information that Linus Pauling was working on how his protein helixes created coils within coils. This was an issue that Francis was interested in, so Francis rushed to work on it and publish a paper before Linus could. Francis did come up with a solution and published it in *Nature*, creating a better reputation for himself and garnering him a job offer in Brooklyn for a year, which he accepted for the following fall.

Chapter 20 Analysis

As the trail of the DNA structure becomes cold, both Watson and Crick pursue other avenues of investigation. Watson jumps into the discussion on bacteria sexes, while Crick shows his competitiveness in wanting to beat Pauling to workable equations for supercoiling of proteins, the creation of coils within coils. The reasons why these two scientists pursue these avenues of investigation are interesting. Watson gets interested in some new research, and he is, as always, motivated to work by having his curiosity piqued. Meanwhile, Crick's motivation to work is generated by his competitive nature. So, here we have two aspects of human nature that contribute to scientific investigation. They are curiosity and competitiveness.

Chapter 21

Chapter 21 Summary

Watson had moved into Clare College by entering a Ph.D. program at Cambridge, though he didn't intend to seriously pursue another doctorate. He started developing stomach problems eating food from the cheap local restaurants, and he began to fear he had an ulcer. Crick and his wife Odile had moved to a larger place on Portugal Place. Odile promised to try to get Watson into dinners at Pop's boarding house, where he could eat less spicy food than that at the local restaurants.

Meanwhile, Watson continued to ponder issues of DNA. Peter Pauling, Linus Pauling's son, shared an office with Watson and Crick while he studied at Cambridge. Through Peter, Watson and Crick learned that Linus had developed a structure for DNA. They tried to intuit what it could be, so that they could share credit, when they found out his discovery, but they had no success. They hoped Linus was wrong, but doubted it.

Chapter 21 Analysis

Again this chapter contains dramatic irony. While the characters are convinced that Linus Pauling has come up with the correct structure, the reader knows that he cannot have. Otherwise, Watson and Crick could not have won the Nobel Prize.

Chapter 22

Chapter 22 Summary

Watson and Crick didn't hear anything from Pauling's lab in Pasadena through Christmas. Watson told Maurice that Pauling was working on the problem of DNA structure, but Maurice was more concerned with the happy news that Rosy was leaving King's lab in several months and discontinuing her work on DNA, leaving Maurice free to pursue it. Then, Peter and Bragg received copies of a manuscript by Pauling, explaining his new model for the structure of DNA. Watson was crushed until, on reading the paper, he realized that there was a fundamental and basic flaw in Pauling's model. The phosphate molecules were not ionized. The DNA acid was not acidic. This error was confirmed by other scientists in the lab. The model was flawed. Pauling hadn't won the race, and Watson and Crick still had a chance to discover the correct structure of DNA.

Chapter 22 Analysis

In this chapter, Watson's worst fears come true, when he is faced with Pauling's claim of having discovered the structure of DNA. This highlights an interesting point about Watson. He is not only interested in furthering science by learning the structure of DNA as quickly as possible. He is interested in beating out Pauling. This idea comes up a number of times, often couched as the scientists "this side of the Atlantic" against the American Pauling, although Watson himself is American-born.

Chapter 23

Chapter 23 Summary

Watson went to King's lab to tell Maurice the news about Pauling's faulty model. Since Maurice was busy, he walked into Rosy's lab. Immediately, Rosy seemed confrontational. Watson offered her Pauling's manuscript to read, and their discussion of the idea of a three-chain helical structure for DNA became more and more heated. When Rosy came toward Watson, he thought she was going to physically assault him. Then, Maurice entered the room, diffusing the situation. When Maurice and Watson spoke, Maurice opened up to him about the difficult time he'd had with Rosy. He also told Watson that he'd been secretly copying some of Rosy's photographs. He showed Watson the most impressive one. It was a form of DNA they called the B form, created by surrounding DNA with water. Watson became instantly excited. The image gave new information about the structure of DNA and would make creating a model much easier. After the meeting, Watson decided that the correct model for DNA was a two-chain one, because things in biology came in pairs.

Chapter 23 Analysis

Following closely on the heels of Pauling's misstep, Watson learns new experimental data about DNA. However, his discovery raises the question of scientific ethics. Rosy has been difficult for Maurice to work with, but does he have the right to secretly copy her images? Does he have a right to show those images to Watson, and does Watson have a right to use these images to move forward his own work? Does Rosy have a right to keep her work secret, when it could be used to further science?

On another level, this chapter also further reveals Rosy's character. She has been shown to be single-minded and even cold. In this chapter, the author depicts her as coming close to violence. Where does this fit of temper come from? Is it truly as the author describes it or is it somehow misinterpreted by him?

Chapter 24

Chapter 24 Summary

Watson ran to tell Bragg and Max about the new X-ray photographs of the B form of DNA. He brought us Linus, who he feared would soon be on his way to revising his ideas and solving the DNA structure. Bragg gave Watson permission to start working on DNA models again, and Watson ordered the machine shop to begin work on components for the model.

When Francis entered the office, he was full of private issues. A very handsome student, Bertrand Fourcade, was taken with Watson's sister Elizabeth, and Francis's wife took advantage of the friendship to meet this sought-after man. Watson's mind was not on personal relations, and soon Francis realized the breakthrough of the X-ray of the B form of DNA. Francis, though, was not convinced that the model must have two chains and wanted to work on both two-chain and three-chain models.

Any building, though, had to wait for the machine shop to construct parts for the models. Watson spent the time in non-work-related activities. Then, he began working on models with the backbone in the center. However, this yielded no fruit. He eventually composed a promising looking backbone for the outside of the DNA model. When Francis saw Maurice, he probed him about the B pattern of DNA. In the end of their conversation, Watson and Crick asked Maurice if he minded if they began working on DNA models. Maurice slowly answered no, a relief to both men, who would have continued working on the models in any case.

Chapter 24 Analysis

The search for the DNA structure heats up, and with it, the ethical issues involved in the human interaction come to the fore. Maurice is prevented from working on DNA models by Rosy's continued presence. Though he gives the other scientists permission to work on it, he is reluctant, realizing that with the new X-ray images they may be successful before he can begin his own work. The scientists, meanwhile, though they want Maurice's permission, do not require it. They would continue their already-begun work anyway. Is this ethical? Is their enthusiasm motivated by a desire to further humanity's knowledge more quickly, a desire to further their own careers, or both?

Chapter 25

Chapter 25 Summary

Francis became annoyed that Watson was not spending all his time on the DNA models. Watson, however, felt that they could not move forward without a new idea about the bases. Instead, Watson went to films in the evening and thought constantly about bases. The backbone had been checked against Rosy's measurements, which Rosy didn't know the Cambridge lab had. However, the bases were a problem. Watson would work on them at night, using their chemical structure out of a book. Then, one night, an idea hit him. If the bases were paired in like pairs, each side of the DNA molecule would be identical. This meant that the DNA chain could split in half and replicate itself. There was a slight problem, because the bases weren't all the same sides, but despite this, Watson was enthusiastic.

Chapter 25 Analysis

The theme of integrating the work of science with outside diversions, merging a scientist's work with his life, emerges here as Watson uses films to keep his mind off of the problem of the bases in the DNA structure. In the end of the chapter, Watson has a breakthrough, an ingenious idea with implications for the puzzle of how DNA replicates. The problem with the size of the bases foreshadows the fact that his solution is not the correct one.

Chapter 26

Chapter 26 Summary

Watson's idea of like pairs of bases turned out to be untenable, because he was using the wrong type of chemical structure for the bases. Though he had copied the structures out of a chemistry book, the textbook authors, Jerry Donohue told him, picked the structure arbitrarily. Watson went back to work, hoping to make his idea still possible with the new structures. However, it didn't work. After lunch, he didn't want to go back to work. When he did, though, he discovered that with the new chemical structures of the bases, he could construct two pairs of bases that were identical in shape. Additionally, the base pairs were the same as the sets of bases that appeared in the same quantity in Chargraff's work. Though Watson was still tentative and uncertain, Francis enthusiastically propounded that they had found the secret of life.

Chapter 26 Analysis

Note that it is input from other scientists, in this case Jerry Donohue, that continuously corrects Watson and Crick's mistakes and ultimately leads them to the right path. The idea of the base pairs is a crucial moment in the discovery of the structure of DNA. The base pairs are fundamental to the double helix. They also reveal the way that DNA replicates, since each half of a double helix can serve as a template to form a new chain. Watson, however, is now cautious about proclaiming success, because he has experienced so many false steps.

Chapter 27

Chapter 27 Summary

Francis became unable to concentrate on his thesis, excited about the base pairs Watson had discovered. The two scientists had to wait for the metal models of the bases to be finished before they could construct their model based on Watson's idea. When the bases were finished, the model was constructed. The scientists decided not to tell King's lab yet, because they wanted to verify their measurements first. Bragg also wanted the two to consult Todd to make sure their chemistry was accurate. Watson and Crick made careful measurements of the model and found it accurate, and Bragg invited Maurice to come view the model.

Chapter 27 Analysis

Watson says that "much of our success was due to the long uneventful periods, when we walked among the colleges or unobtrusively read the new books that came into Heffer's bookstore." His observation brings up the theme of balancing life with work, particularly in science. Throughout the book, Watson goes on trips and vacations, attends social events, and, in short, has a life. His position is that life is inseparable from science and that periods of relaxation are essential to periods of work.

Chapter 28

Chapter 28 Summary

Maurice immediately saw the beauty of the DNA structure, accepting all the arguments that went into its construction. The author comments how essential it was to the development of DNA that Jerry was sharing an office with Watson and Crick. Without his expertise in structural chemistry, the team would certainly not have hit on the correct structure, when they did.

King's lab began comparing their experimental results to the double helix structure, and determined that it supported the model. Rosy also supported the model, which surprised Watson. She had, though, come to realize that her X-rays did support a helix and the model supported her idea that the backbone was on the outside and the bases on the inside. Her attitude changed to a much more colleagueal one. Todd confirmed that the sugar-phosphate backbone chemistry was correct and agreed about the form of the bases.

Watson went to Paris for a week, a trip that had been previously planned, despite Francis's desire for him to stay and work on the double helix.

Chapter 28 Analysis

The pace of the book is fast in these final chapters, with all of the pieces of the DNA puzzle falling into place. Everyone who sees the model seems to immediately realize its value and correctness. When Watson refuses to cancel or postpone his trip to Paris, he is continuing his pattern of living his personal life as fully as he continues to live his professional life.

Chapter 29

Chapter 29 Summary

Delbruck at Cal Tech told Pauling about the double helix structure, even though Watson had asked him not to. Both Pauling and Delbruck were thrilled because of how important and elegant the structure was. More evidence for the structure continued to mount, including the identification of a form of cytosine (equal to the amount of guanine) in a kind of DNA previously thought to lack cytosine. Francis worked on the A form of DNA, and the two scientists drafted a paper on their discovery. Rosy and Maurice both prepared papers on their X-ray photography in support of the DNA structure. Elizabeth typed Watson and Crick's paper. Linus came to Cambridge to see the model and X-ray evidence and to visit Peter. Soon, Watson and Elizabeth went to Paris before she took off for the States and then Japan to get married.

Chapter 29 Analysis

This chapter serves as a denouement, wrapping up the story of the structure of DNA with the publication of the scientists' papers. As Watson's sister leaves for America and for her marriage, Watson reflects, "I was twenty-five and too old to be unusual." This ending comment strikes the reader as ironic. At twenty-five, Watson has secured the Nobel Prize, not a usual accomplishment.

Epilogue

Epilogue Summary

Watson ends his book by discussing what the various people involved in the discovery of the structure of DNA are doing at the time of the writing. The one character most discussed is Rosy. She died at the young age of thirty-seven. Since the writer had a negative impression of Rosy during the search for the DNA structure, he explains that her work was both excellent and important, that he and Crick came to appreciate her positive qualities, and that they realized years after their discovery the struggles Rosy faced as a woman trying to gain acceptance as a scientist. He notes Rosy's courage in continuing to work until shortly before her death.

Epilogue Analysis

E F cters in the book. Although throughout much of the book she functions as an antagonist, causing problems for the other scientists, the author reveals that he recognizes, in hindsight, the reasons for some of her actions. He attributes to her in this epilogue the positive traits of exemplary intelligence and workmanship, generosity, honesty, and courage. In some ways, this entire book is an apology for the author's winning of the Nobel Prize, which was controversial, because Watson and Crick's work so closely depended on Maurice and Rosy's and led to the ironic comment, "Honest Jim," noted at the beginning of the book. The author ends with an apology of a different sort, for coloring Rosy in the negative tones in which he first perceived her.

Characters

Erwin Chargaff

Erwin Chargaff is an Austrian-born biochemist conducting his research at Columbia University in New York. He is an expert in DNA and the first to propose the correct pairing of the four base molecules of its structure: adenine pairing with thymine and guanine pairing with cytosine. When Watson and Crick learn of this theory, they begin to explore it, too. Eventually, they discover how to make a DNA model that allows for ' 'Chargaff s rules," yet another step in uncovering the mystery of the molecule.

Francis Crick

Francis Crick is Watson's closest partner in the search for and discovery of the structure of DNA. Crick is twelve years older than Watson and is described by his younger colleague in *The Double Helix* as ' 'almost totally unknown" and ' 'often not appreciated." Watson points out that other colleagues think Crick talks too much and that his booming voice and laughter are very annoying to people around him. He also stresses that Crick is exceptionally bright and quick to pick up on new theories, but that he had not had the opportunity to prove himself the accomplished scientist that everyone thought he would be. As Watson notes, Crick knew he "could produce novel ideas," but "he could claim no clear-cut intellectual achievements and he was still without his Ph.D."

Crick came from a middle-class family in England and was working on his advanced degree when World War II broke out. To support the war effort, he joined the English Admiralty's scientific establishment, where he was very successful at producing magnetic mines for the armed forces. After the war, however, he was not offered a future with the scientific civil services and eventually lost interest in physics. Turning his attention to biology, Crick wound up with a grant to study at the Cavendish lab, and it was there that he met Watson. At this point, neither man was concentrating specifically on DNA. As Crick's relationship with Watson grows, so does his enthusiasm for discovery. The two become partners in an admittedly underhanded scheme to gather information from other scientists, in order to speed up the process of their own research.

Rosalind Franklin

Rosalind Franklin is trained in crystallography and uses X rays of DNA to try to determine its structure, as opposed to experimental model building. She arrives at the King's College laboratory in Cambridge to work with Maurice Wilkins□who is using the same method to study the acid, but who is not as well trained in the field. Franklin is portrayed by Watson as an emotional, hot-tempered feminist who either "had to go or be put in her place." Her "place," as far as most of her male colleagues are concerned, is as a doting assistant who needs to "keep her emotions under control." No one, however, doubts that' 'she had a good brain."

Franklin puts her good brain to work in perfecting the use of X rays in studying DNA. In 1951, she announces that the structure of the molecule is a large helix with a sugar-phosphate backbone on the outside. Watson openly admits in his book that he and Crick are attracted to Franklin's theory and are not above taking a peek at her notes and pictures. Maurice Wilkins, also willing to be deceptive, secretly copies Franklin's data and shows it to Watson and Crick, along with an X-ray picture. This information points Watson and Crick in the right direction and leads specifically to an accurate model of the structure of DNA. When the Nobel Prize is awarded in 1962 for the discovery, however, Franklin is not among the recipients. In 1958, at age 37, she died of cancer without ever knowing how her work had been used to propel three male colleagues into scientific history.

Linus Pauling

Linus Pauling is a chemist at the California Institute of Technology (Cal Tech) in Pasadena, California. He is considered one of the world's foremost scientists and is Watson and Crick's greatest rival in the race to discover the structure of DNA. In 1951, before Watson begins concentrating solely on DNA, Pauling appears to be getting closer to the answer. He writes to Wilkins in London asking for copies of the crystalline DNA X-ray photographs that Wilkins and Franklin have produced. Wilkins, however, stalls Pauling by telling him the data needs a closer look before he can release the pictures.

Watson knows up front that his chief competitor is Pauling and that Watson's own deficiency in understanding X rays is a stumbling block in catching up to the Cal Tech chemist, much less surpassing Pauling in his research. This is one of the major reasons that Watson ends up at the Cambridge lab to learn the mathematical details of crystalline X-ray photography without having to let Pauling know that he is a' 'mathematically deficient biologist," as he calls himself.

Pauling has already discovered the "alpha helix' ' molecule (the structure of other proteins and a precursor to the double helix structure of the DNA molecule), and he did so by building models of possible configurations out of molded plastic pieces. Watson and Crick copy Pauling's method in their own research when building the double helix. When Pauling finally announces that he has solved the DNA problem with a triple helix structure, it does not take long for the scientific community to prove the theory wrong. Watson and Crick know that Pauling is about to embarrass himself by publishing an erroneous theory, but, instead of warning him, they bask in their rival's humiliating defeat.

Peter Pauling

Peter Pauling is the son of Linus Pauling. Peter is accepted as a research student at the Cavendish lab in Cambridge, where he eventually shares an office with Watson and Crick. Peter shares letters from his father in which the older Pauling describes his DNA

research at Cal Tech. Peter also shows his officemates the preliminary paper his father has written on the triple helix□an erroneous theory that the older Pauling will publish with no forewarning from his eager competitors.

Max Perutz

Max Perutz is an Austrian-born chemist working at the Cavendish lab primarily in the area of X-ray diffraction. He is a close colleague of Bragg and is the leader of Crick's unit at the lab. When Watson arrives in Cambridge, his first assignment is to work under Perutz learning X-ray crystallography. Perutz is a tolerant, friendly person who often acts as a mediator between Crick and Bragg.

Rosy

See Rosalind Franklin

James D. Watson

As the author and main figure in *The Double Helix,* James Watson presents exactly what the subtitle of his book claims: *a personal account* of his work as a scientist. Watson is a young genius in his field at the time the events in the book take place, but he does not demonstrate a know-it-all arrogance. He is also willing to criticize himself, which he does fairly often in the book. During the two years he spends at the Cavendish laboratory, his work on X-ray crystallography and on building a model of DNA often leads him down the wrong path, and he readily admits it.

Watson's closest colleague is Francis Crick, but there are three other people who play a major role in this story. In the book's opening paragraphs, Watson claims,' 'I knew the tale was not simple and certainly not as the newspapers reported. Chiefly it was a matter of five people: Maurice Wilkins, Rosalind Franklin, Linus Pauling, Francis Crick, and me." Watson makes Crick the topic of the first chapter, stating,' 'Francis was the dominant force in shaping my part." He credits Crick's role so highly not only because the two men share a passion for finding the secret of DNA but also because they are able to tolerate each other's personality quirks and annoying habits. Watson's relationship with Rosalind Franklin is also important but for a much different reason. Female scientists are not always highly regarded in the male-dominated profession, and Watson's account demonstrates the subtle undermining of Franklin's contribution to the discovery of DNA, as well as blatant discriminatory language, which he later regrets.

Watson does not pretend to be all business in his endeavor to unravel one of science's greatest mysteries. He enjoys drinking and spends many evenings in English pubs. He is always on the lookout for a pretty face and does not shy away from discussing his attraction to a variety of women. Furthermore, some have said that his account is unprofessionally candid when it comes to describing colleagues and their relationships with him, as well as among themselves. Perhaps the most striking characteristic about

Watson is his childlike honesty in telling a story the way that he remembers it. Regardless of whose toes are stepped on or whose personal conflicts are paraded in public, Watson is simply blunt when speaking his mind, never hesitating to display his own faults along with everyone else's.

Maurice Wilkins

Maurice Wilkins is a physicist-turned-biologist working at the University of London's King's College. (There is also a King's College in Cambridge, and both are mentioned in the book.) Wilkins is the foremost scientist studying the molecular structure of DNA, at least before Watson and Crick arrive on the scene at the Cavendish lab in Cambridge. Wilkins becomes acquainted with Crick first, and he is the primary reason that Crick does not turn his attention to the study of DNA prior to meeting Watson. As Watson points out, there is a scientific code of ethics in England that prevents one scientist from honing in on a problem that a colleague has been studying for years, and solving the DNA puzzle at that time was "the personal property of Maurice Wilkins." Ironically, Watson also credits Wilkins with being the one ' 'who had first excited me about X-ray work on DNA." Wilkins had given a lecture on the topic at a scientific conference in Naples in early 1951, and Watson was in attendance.

Throughout Watson's account, Wilkins is a leading figure in sharing information with Watson and Crick, even though he and Rosalind Franklin are actually competing with the two Cavendish scientists. There is no malicious tension between these two teams as there is between Watson and Crick and their rival in America, Linus Pauling. For Wilkins, the greatest tension comes from his own "partner," Rosalind Franklin. According to Watson, Wilkins treats Franklin more as an assistant (and Watson refers to her as such) instead of an equal□even though she is an expert crystallogra-pher and a great asset in learning about DNA through X-ray diffraction. The tension between Wilkins and Franklin is a major distraction to their work. Both persist, however, and Wilkins eventually ends up sharing the 1962 Nobel Prize with Watson and Crick.

Themes

Honesty in Reporting

When Watson set out to record the events that led to the discovery of DNA's structure, he did not *plan* to offend, malign, or publicly humiliate the people who would be a part of his book.intention was to present an honest, accurate account that would naturally include the bad along with the good aspects of how science gets done. As he claims in the preface to *The Double Helix,* "science seldom proceeds in the straightforward logical manner imagined by outsiders. Instead, its steps forward (and sometimes backward) are often very human events in which personalities and cultural traditions play major roles." Watson admits that his perception of some colleagues and events had changed in the years between 1953, when the discovery was made, and the mid-to-late 1960s, when he was writing the book. However, he defends his decision to compile material based on first impressions by claiming that doing otherwise "would fail to convey the spirit of an adventure characterized both by youthful arrogance and by the belief that the truth, once found, would be simple as well as pretty."

As with most "adventures," the race to be the first to make a major scientific discovery provides multiple opportunities for human pride and "youthful arrogance" to override pure process and fair play. Watson is so up-front about his own follies and conniving that it is difficult to condemn him for exposing the same faults in others. His attempt in *The Double Helix* to come clean about common scientific research practices retains an air of innocence throughout the account. Even in his blunt reporting of the problems he and his male colleagues face with female scientist Rosalind Franklin, the candor is naïve and childlike: "There was never lipstick to contrast with her straight black hair, while at the age of thirty-one her dresses showed all the imagination of English blue-stocking adolescents." Watson does not explain what a scientist's lips and clothing have to do with the discovery of a gene's makeup, nor does he apologize for the odd, offhand comments. He simply records his first impression of "Rosy" as he remembers it, all in keeping with his goal of presenting the whole picture.

While Franklin and Watson exhibit no sign of friendship between 1951 and 1953, Watson does not show his closest comrade, Francis Crick, any greater mercy in regard to personal exposure in the book. In addition to noting Crick's quick wit and scientific prowess, Watson also portrays him as a loud-mouthed, impulsive womanizer who likes to drink and attend parties. One story recounts a mistake Crick made in attending a costume party dressed as the red-bearded Irish playwright George Bernard Shaw:' 'As soon as he entered he realized that it was a ghastly error, since not one of the young women enjoyed being tickled by the wet, scraggly hairs when he came within kissing distance."

Cultural differences fare no better in Watson's recollections. He despises English food but appreciates the ' 'English sense of fair play" in regard to one scientist's respect for another's first crack at solving a problem. France, however, is a place "where fair play

obviously did not exist," and in the United States,' 'One would not expect someone at Berkeley to ignore a first-rate problem merely because someone at Cal Tech had started first." Again, Watson charges ahead with accusations□ founded or unfounded□all in the spirit of youthful arrogance and simple truth.

Scientific Discovery

While the theme of scientific discovery may seem obvious in a book about just that, the topic is somewhat clouded by the saucy manner in which it is described. Nonetheless, Watson's account is foremost a celebration of science□an earnest recognition of its possibilities in spite of naysayers who often warn against the results of research that overstep certain boundaries. While *The Double Helix* does not address this concern at length, one need only read later material written by Watson to understand his mission, then and now, to keep science moving forward. In a *Time* article entitled "The Double Helix Revisited," Watson discusses his work with the Human Genome Project (which normally brings "cloning" to mind for the general public), saying that "no other big science project ... has been carried out with such zeal for the common good." Citing possibilities for cures for diseases that are often hereditary, such as cancer and Alzheimer's, Watson's zest for supporting research is unmistakable□and the obvious force behind his discovery of the structure of DNA.

Style

Setting

The Double Helix is set primarily in England in the early 1950s. As Watson notes in the preface, he wants his book "to catch the atmosphere of the early postwar years in England," depicting the public's eagerness to rebuild spirits, as well as buildings, in the aftermath of World War II. He accomplishes this by including such trivialities as what type of wine is enjoyed with certain dinners and conversations that take place over morning coffee or lunches with gooseberry pie. He entwines his account of scientific data with comments on movies he sees, intellectual games he plays with members of high-society, and the fun he has playing ' 'Murder"□a whodunit role-playing game□in the dark upstairs floors of friends' houses. He goes on at some length about Crick's half-French wife, Odile, who "came to Cambridge and hastened [Crick's] revolt against the stodginess of the middle classes." Watson favors Odile's cooking and spends many evenings in the Crick's home enjoying good wine and good conversation, but he is dismayed about the couple's disinterest in political issues. He attributes their neutrality toward politics to ' 'the war, whose grimness they now wished to forget."

But World War II, of course, was a conflict in which science played a greater role than at any previous time. The atomic bomb introduced a particular type of' 'grimness" that resulted in unprecedented destruction. Physicists in particular knew that, left unchecked, their research could bring about as much evil as good. So the pace quickened to learn more about, and to control better, all prospects of scientific research. This was the western European world that Watson entered in 1951 and the one he wished to capture in the setting of his book. It was a world of great hope and renewed spirits, as well as one of caution and competition brought on by the recent past.

Tone

The tone of *The Double Helix* is much different from what one may expect from a "science" book. Free of heavyhanded, dry-data accounting, Watson's book is accessible to a lay audience; the book is humorous in places and predominantly light in tone. Writing for the *Nation* in 1968, critic J. Bronowski claims it has "a quality of innocence and absurdity that children have when they tell a fairy story. The style is shy and sly, bumbling and irreverent, artless and good-humored and mischievous.' ' Critic Elliot Fremont-Smith, writing for *The New York Times,* describes it in terms of a good mystery: ' 'a thrilling book from beginning to end□ delightful, often funny, vividly observant, full of suspense and mounting tension." These are all adjectives that seem out of place in regard to scientific reporting, and, yet, what they suggest is actually the reason that the book has enjoyed success, as well as notoriety, in both science and lay communities. Surely, many other critics have had much more harsh things to say about the content of Watson's book, but those who have commented on its style and tone generally agree that it is more sporty and fun than intentionally hurtful.

Historical Context

Watson was teaching at Harvard University when he began to compile the notes, letters, scientific data, and photographs that would become the controversial bestseller, *The Double Helix.* It was the mid-1960s, and the United States was involved in an unpopular war in Southeast Asia. Watson was writing about events that occurred in England in the early 1950s, when many European countries were still recovering from the devastating effects of World War II. During the years between the end of the Second World War and the middle of the Vietnam War, remarkable advances occurred in many areas of science and medicine: Jonas Salk developed a vaccine for polio, Christiaan Barnard performed the first human heart transplant, Frederick Sanger discovered the molecular structure of insulin, the birth control pill was developed, and the first commercial nuclear power plants opened in America. Marshall Nirenberg' s cracking of the genetic code in the early 1960s was a direct spin-off of Watson and Crick's discovery of the structure of DNA in 1953. The DNA discovery showed that the molecule was made up of the chemicals adenine, thymine, guanine, and cytocine, but the next step was to determine how to sequence the chemicals within the DNA□that is, how to *read* the code that Watson and Crick had discovered. Nirenberg shared the 1962 Nobel Prize in medicine and physiology for his part in discovering how to interpret the DNA code.

While most of the scientific discoveries of the mid-to-late twentieth century resulted in healthier people and animals, more efficient energy, fascinating exploration of outer space, and the birth of the computer age, not all advancements have been heralded as great breakthroughs by the general public. Nothing demonstrates a less-than-positive public reception of discovery more than advancements made in the area of genetics. The ' 'acceptable' ' work done by biologists and geneticists in the 1950s and 1960s paved the way for the first attempt at genetic engineering□the alteration of genetic material□in the early 1970s. This was the beginning of the "cloning" era, which is still in full swing despite worldwide debates on the ethical issues involved. Watson was and still is one of the field's major proponents.

Genetic engineering received somewhat better reception in its use on fruits and vegetables. In the decades since DNA's discovery, scientists have experimented with plants to create a longer shelf life for various types of produce. The approach has also been used to increase proteins in the milk of dairy cattle and to reduce the amount of fat in cattle raised for meat. In the 1950s and 1960s, the work of scientists was not as highly publicized as it is today. However, the emergence of television into the homes of millions during this period, along with the onslaught of news programs, increased the ability of the average person to learn more about scientific experimentation while it was happening. In some cases, this greater awareness has led to a greater outcry. Now, with the possibility to replicate human genes, the concern is who will decide what the desirable traits are to be cloned and how cloning will be regulated. Proponents on both sides of the issue present valid points. Given the fifty years of fervent growth in genetics since Watson and Crick unraveled the first DNA mystery, it is unlikely that gene research will come to a halt. Many scientists, though, have expressed a willingness to keep an eye on issues beyond those occurring in the laboratory.

Critical Overview

The critical reception of *The Double Helix* is as much a part of the book's reputation as the content itself. One cannot read it without assuming the impact it must have had on the people whose names appear on its pages in an unfavorable light. The most telling response on how the book was received came from the two men with whom Watson shared the Nobel Prize and whom he considered friends: Francis Crick and Maurice Wilkins. When Crick and Wilkins read the publication galleys of the book, both were outraged at Watson's portrayal of them and their colleagues. Crick threatened to bring suit against Watson, and Harvard University Press decided that was enough controversy to make it bow out of the agreement to publish *The Double Helix.* After some slight watering-down and the addition of an epilogue, the book was finally sent to press by Atheneum.

After publication, the criticism was just as scornful. In an article published in *Science and Engineering* in 1968, biologist Robert L. Sinsheimer calls the account "unbelievably mean in spirit, filled with the distorted and cruel perceptions of childish insecurity. . .. This book is filled with character assassination, collective and individual, direct and indirect." There were those, however, who took an opposite viewpoint. Writing for the *New York Review of Books,* critic P. B. Medawar predicts that it ' 'will be an enormous success, and deserves to be so□a classic in the sense that it will go on being read." Perhaps the best objective suggestion came from fellow scientist Gunther S. Stent, who convinced Watson in 1980 to allow a critical edition of the book to be brought out. Stent edited this edition, which contains the entire original text, plus overviews of the historical and scientific setting of the account, as well as a selection of reviews. In Stent's words:

Although nothing could resemble less a treatise on the philosophy or sociology of science than Watson's autobiographical memoir, it nevertheless brought home, in a painless and enjoyable literary style, important insights into how the process of scientific discovery actually works.

Criticism

- Critical Essay #1
- Critical Essay #2
- Critical Essay #3

Critical Essay #1

Hill is a writer and associate editor for a university communications department. In this essay, she contends that Watson's unusual style of scientific reporting makes the work more appealing to the general public and does not deserve the severe criticism it received from the scientific community.

A set standard for science writing has long been held sacred within the scientific community, which compiles the material, writes it, reads it, and, of course, understands it. It is a standard that calls for straightforward, objective accounting with few subjective observations and no emotional outbursts or anecdotal asides. No one would argue that Watson is not a member of this community and, yet, his reporting of the discovery of DNA's structure breaks every rule in the standard of scientific writing. As predicted, the author fielded much criticism for *The Double Helix* after its publication, primarily from his own colleagues and others in the field of science. But something else resulted as well. Many people *outside* the scientific community wanted to read it, too. Here was a book that the 'average' reader could enjoy□and one whose topic, after all, could have implications on the health and future of every living being.

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Curiosity is only one aspect of human nature, but it is a powerful one. People on the ' 'outside" want to know what's happening on the "inside," and scientific research is one of those inside practices that arouses the general public's eagerness to be clued in. Usually, however, the material is too complicated to be accessible and the presentation is too formal to be interesting. *The Double Helix* is both accessible and interesting because Watson includes the real stuff of life in his account□quirky personalities, insecurities, a bit of arrogance, and much competitive spirit. Like it or not, the story of one scientist nearly coming to blows with another in the lab holds a general reader's attention more than a description of one molecule bonding to another.

But Watson also includes the matters of strict science. He recounts a variety of experiments that were tested and their results, and he is very technical in describing why the structure of the DNA molecule has to be double helix in shape. Even these seriousinstructional passages, however, at least *seem* more comprehensible with a backdrop of fine English ales, highbrow parties, and dinners at the ' 'Green Door," as

Crick and his wife's apartment is fondly known. The question, then, is whether Watson goes too far in his attempt to "tell it like it was"□whether his tale is offensive and meanspirited or simply uncharacteristically entertaining, as well as informative.

Look at Watson's treatment of the people who make up the major cast of characters in this dramatic tale of scientific discovery. First, Crick is his closest partner during the research and also one of the loudest protesters against the book's publication. Watson portrays Crick in light of other people's impressions of him, but those impressions are founded on reality. Crick does have a loud voice, he is a boisterous individual, and, no, he has not yet completed his Ph.D. The latter point is a sore spot for the scientist, but in divulging the information, Watson implies that one *does* not necessarily need a degree on paper in order to be part of one of mankind's greatest discoveries.

His personal descriptions of Crick do not appear malicious but fun loving and high-spirited. He claims that Crick's excitement over a new theory□ even when it turns out to be wrong□does ' 'a great deal to liven up the atmosphere of the lab" and that ' 'Almost everyone enjoyed these manic moments." When discussing Crick's fondness for English pubs and pretty women, Watson also mentions his colleague's solid marriage to Odile, who "did not mind this predilection, seeing that it went along with, and probably helped, his emancipation from the dullness of his Northampton upbringing." Yes, one can understand that Crick would not want the intimate details of his life to appear in a book he had no control over, but the severity of his reaction seems overdone compared to Watson's amicable tone.

Maurice Wilkins is another key member of the DNA group that harshly criticized Watson for *The Double Helix.* Perhaps Wilkins' complaints derive from a desire to protect his colleagues because he himself is portrayed very favorably in the book. Watson credits him with being the one who first aroused Watson's interest in X-ray work on DNA and who calmed the author's fears about not knowing enough chemistry. He describes Wilkins' personality in congenial terms and displays a great deal of admiration for his colleague's work. The information that Wilkins may have most wanted struck from the record was his relationship with his lab partner, Rosalind Franklin. Understandably, he would like to downplay the lack of respect that he and other male scientists showed her, especially since most of them came to regret those feelings after she died at an early age. But here again, Watson does not single out Wilkins as the ' 'bad guy" who thinks a woman has no place in a laboratory. Instead, Watson takes as much blame upon himself for the unfair treatment, and he openly states his regrets in the epilogue.

Franklin, then, is the one who takes the brunt of the book's truly offensive language and attitude, but, ironically, she is the one who did not live to see its publication. Perhaps if she had, she would have been the one most amused by its content, rather than angered. Her unwarranted predicament is made clear by Watson's admissions of guilt, leaving Franklin no need to defend herself in the public's eye.

This leaves Linus Pauling as the final major figure in Watson's account. One would think that because Pauling is the greatest "enemy" of the Cavendish lab team that Watson would save his most discrediting remarks for the competitor in America. But again, it is

not so. Watson does nothing short of praise Pauling as "Cal Tech's fabulous chemist," and he admits being humbled before such a highly respected, brilliant scientist who was already well ahead in the race to discover the structure of DNA. It is true that Watson relates the details of what is perhaps Pauling's worst scientific blunder□Pauling publishes a possible theory for DNA's structure, forgetting a basic principle of chemistry that makes it impossible. And Watson is not able to resist mentioning how he and other scientists got such a kick out of watching the great one stumble (not fall), but Pauling is not the one who should feel belittled by this story.

Who really looks bad here? It is the storyteller himself and his reveling colleagues who appear in an unfavorable light. Even more callous than laughing at a competitor when he's down is having the opportunity to prevent a folly and not doing it. Watson and Crick are privy to Pauling's faulty theory after reading a letter Pauling wrote to his son describing the proposal. Before Pauling goes to print with the proposal, they could have warned him of the problem and spared him the embarrassment, but they make a conscious effort not to do so. The mood is, in fact, one of celebration, and a visit to a favorite pub is in order. As Watson puts it, "The moment its doors opened for the evening we were there to drink a toast to the Pauling failure." Similar to the Franklin case, Pauling is more a victim than a bully. He has no reason to hide anything from the public, since Watson's display of his own deceptive moves and juvenile behavior is enough to swing the reader's support clearly in Pauling's direction.

Other people mentioned in *The Double Helix* are as much fair game for Watson's freewheeling scrutiny as are the main players, and many of them were less than pleased with their descriptions and Watson's recollection of the way things happened.

It is not the intention of this essay to suggest that all the people involved should have laughed off any misrepresentations of themselves that wound up in a best-selling book, nor that they could have reacted in some robotic fashion, showing no concern one way or the other. It is natural to want to avoid public ridicule, and when one person seemingly forces it upon another, the desire for revenge is no surprise. Watson's detractors would have received satisfaction out of stopping the book's publication. Perhaps if they could have moved past the feeling of personal attack, they would have seen that the individual under greatest assault in this story is Watson himself. Rarely is there found such honest admission of dubious behavior and such humbling self-exposure in an autobiographical account, especially in the serious, astute world of science writing.

But does a candid confession of one man's guilt justify his public display of others who share in the "crimes" but are not so willing to admit it? The answer probably depends upon whether the person asked has his or her name in the book. What is not so ambiguous is that more people in the world were able to read, understand, and enjoy an account of a remarkable discovery because the author chose to write in a manner that welcomed the general public into the esoteric world of scientific research. And it is safe to assume that Watson's book would not be in the hands of so many students□science majors or not□had its material been presented in standard, scientific fashion

Source: Pamela Steed Hill, Critical Essay on *The Double Helix,* in *Nonfiction Classics for Students,* The Gale Group, 2001.

Critical Essay #2

In the following essay, Limon examines The Double Helix as a literary work, arguing that Watson's "sense of literature ... is unique and even (conceivably) systematically worked out."

James Watson first earned his fame in 1953 as the discoverer, with Francis Crick, of the structure of the DNA molecule; in 1968, he became generally notorious as the author of a scandalous memoir about that discovery; in 1980, he gained an expanded celebrity as the author of a canonized work of literature. One might have thought that the last two events ought to have been more nearly identical, given that they are based on the publication and republication of a single book, *The Double Helix*□ except that the memoir, which some reviewers at the time of its controversial publication dismissed along with Françoise Gilot's *Life with Picasso,* was brought out in 1980 in a Norton Critical Edition. The Norton people do this occasionally to works that would not have seemed likely candidates for literature courses (they publish a book of Darwin selections called Darwin, as well as Malthus's *Essay on the Principle of Population);* but in every such case, as clearly as I can gather from their catalogue, it has taken at least a century for nonliterature to soften into literature. The decision that *The Double Helix,* a memoir with too much science in it to be followed without aids, and printed in the Norton edition with scientific papers, can now be welcomed into the literary canon is worth contemplating.

I want to consider what it means to classify *The Double Helix* as literature□not by a profitless inquiry into the meaning of the term, but by explicating what Watson himself seems to mean by his foray into literary regions. I shall argue that his sense of literature, defined implicitly in terms of its relationship to science, is unique and even (conceivably) systematically worked out. But first I should mention the generic suggestions of Watson's early reviewers. From the beginning, reviewers□even nonliterary ones, which is what the book first attracted, since it was not immediately seen to be canonical□understood that the generic issue was critical to an evaluation of the work, and what they thought on the subject turns out to be extremely fruitful.

The most amusing generic controversy was over the alleged resemblance of *The Double Helix* to Pepys's *Diary.* Sir Lawrence Bragg, who wrote the foreword to Watson's memoir, raised the issue innocently enough: Watson writes, Bragg said,' 'with a Pepys-like frankness." Alex Comfort agreed, with only slightly enhanced specificity: ' 'The tactlessness ... is two-way, as in Pepys." Robert Merton, though inclined to think the book sui generis ("I know of nothing quite like it in all the literature about scientists at work"), nevertheless recalled Pepys while reading the section of *The Double Helix* in which Watson hopes to bond with Maurice Wilkins, who knew at the time more about DNA than the neophyte Watson, by offering Wilkins his beautiful sister.

On the other hand, the idea of Watson as Pepys redivivus has greatly dismayed certain readers of the book, notably John Lear, the science writer. Some of Lear's lucubration on the subject is worth quoting, not merely for amusement value.

This book is being acclaimed as the Pepys diary of modern science. I cannot understand why.

Samuel Pepys not only possessed a gift for dry precision in writing but his daily accounting of his life between the years 1659 and 1669 was a miniature etching of the great and small events experienced by the city of London during that period. Pepys was the secretary of the British Admiralty and its single-handed savior from accusations of scandal in the House of Commons, to which he later won election. He participated in the restoration of King Charles II, endured the visitation of London by the plague, helped to pull down the buildings to control the ruination of the city by the Great Fire. He was an amateur musician, an assiduous gamester, a skilled raconteur, a loyal friend, and enough of a scientist to belong to the Royal Society.

What comparable credentials has James D. Watson, author of *The Double Helix?*

The controversy is at this emotional point joined by Watson's editor, Gunther S. Stent, who answers in effect that it is too hard on Watson to hold against him his failure to survive a restoration, a holocaust, and an outbreak of plague at the Cavendish lab. I would like to add a further critique of Lear's statement, beginning at the end. Either Lear, I believe, has not in fact read Pepys, or he is disingenuous. First, the phrase ' 'enough of a scientist to belong to the Royal Society" means precisely nothing. Pepys was no scientist at all. He could not follow much of the science he read or witnessed. He enjoyed a scientific experiment in much the spirit he liked a play by Dryden, or a portrait by Lely, or a curiosity (a bearded woman, for example), or any attractive female. He wanted to be delighted, amused, astonished; he wanted to look at something novel, ingenious, or pretty. There is, as it happens, an interesting connection between Pepys and Watson as Baconians; but if Lear's idea is to show Pepys's manifold superiority to Watson, he picks an odd note on which to conclude.

And the penultimate term, "a loyal friend," is clearly meant to be a fatal blow to Watson's respectability, since he betrayed very many friends in *The Double Helix.* And Pepys was, in his way, loyal. But I wonder if Lear remembers the Pepys entry, not untypical, of 20 December 1664.

Up and walked to Deptford, where after doing something at the yard, I walked, without being observed, with Bagwell home to his house and there was very kindly used, and the poor people did get a dinner for me in their fashion□of which I also eat very well. After dinner I found occasion of sending him abroad; and then alone avec elle je ten toy à faire ce que je voudrais, et contre sa force je le faisoy, bien que pas à mon contentment. By and by, he coming back again, I took leave and walked home.

This is presumably what Lear calls ' 'dry precision," but it is not a passage he would admire if it appeared in Watson's work.

Nevertheless, Lear does in fact identify some of the right questions, even if he gets all the answers wrong. For if Pepys is willing to take a friend's wife, cruelty to the friend is no part of his intention; and any attempt to place *The Double Helix* generically by

reference to Pepys must begin with the fact that Pepys wrote a diary that hurt no one, and Watson a memoir that hurt everyone. The neatness of that opposition, it is true, begins to dissolve the second it is formulated. What Pepys wrote was not entirely a diary. According to his editors, Robert Latham and William Matthews, a given entry was occasionally not written on the day in question, and the manuscript was, quite certainly, intended for eventual publication. Inversely, Watson attempts to suggest artificially a diary's vigor: "I have attempted to recreate my first impressions of the relevant events and personalities rather than present an assessment which takes into account the many facts I have learned since the structure was found." But the closest we can come to assimilating the two works is to say that Pepys wrote a diary that aspires to the timelessness of (a sort of natural) history, and Watson a personal history that aspires to the immediacy of a diary. So if Lear is wrong to distinguish Watson and Pepys absolutely on moral grounds the grounds on which everyone else likens them still there is at least a relative moral distinction, a distinction that leads to a generic clue. The question is what to call a memoir that works with much artistic success to acquire the vividness of a diary, and as a corollary assumes the privileges of a diary.

Finally, though Lear's referring to Pepys as something of a scientist is wrong and illogical, nevertheless it gets us somewhere in determining what *The Double Helix* is (though, in this case, Lear inadvertently allows us to see a similarity in Pepys and Watson). For if Pepys wanted his diary to be more than a diary, it was probably not so much out of a desire for literary fame as out of a Baconian virtuoso's willingness to put forward the facts of his life for whatever value they may have to some future generalization. And if Watson wants his memoir to simulate a diary, he means he will not let ' 'the many facts [he has] learned since" obscure his first impressions. He does not classify himself in 1968 as an interpreter with deeper interpretations, but rather as a fact collector with more facts. If Pepys's *Diary* is literature, it is a literature of facts; the English novel grew out of the same Baconian, empirical factuality. By an analogy of beginnings and ends, can we think of Watson as returning literature and the novel to the fact not to realism, but to the fact? Pepys likes a fact the same way he likes a pretty woman; Watson's DNA model was "too pretty not to be true"; this is a Baconian esthetics.

My suggestion that Watson may have had not merely a literary but some novelistic intention needs to be justified. It is not justification enough that several reviewers thought that Watson's characterizations are, as Comfort said,' 'essentially novelistic," or that his social sensitivity, as Lwoff put it, is "worthy of a first-class novelist," or that some of the personal politics is the sort of "stuff," in Merton' s words, ' 'that abounds in fiction but is rare in the proper histories of scientific ideas." What all this indicates is that though several reviewers, trying to invoke a literary work of similar frankness, seemed drawn to Pepys as something similarly just beyond the bounds of the novel and fiction, other reviewers were not so generically orthodox. But certain reviewers were not the only ones thinking of novels; Watson himself did, which is why the original title of his book was *Honest Jim,* an allusion to Kingsley Amis's *Lucky Jim,* published in the same year as Watson and Crick's first papers on the DNA structure.

The title was suggested to Watson by an odd occurrence which becomes the opening anecdote of the book. It is 1955, two years after Watson and Crick's success; Watson is in the Alps, walking to a restaurant at the foot of a glacier; going up he meets a scientist coming down named Willy Seeds, who had been a tangential figure in the DNA race.

"Willy soon spotted me, slowed down, and momentarily gave the impression that he might remove his rucksack and chat for a while. But all he said was, 'How's Honest Jim?' and quickly increasing his pace was soon below me on the path." This is the entire anecdote, and is itself a fine example of the Baconian esthetics. Watson tells this extremely wounding story as if it happened to someone else.

But the more important aspect of the opening anecdote is that it gives Watson's book, from the beginning, a relationship to the novel. Several of the first reviewers of *The Double Helix* caught the allusion: Peter Medawar titled his review ' 'Lucky Jim," and Jacob Bronowski observed that the book would have been called *Lucky Jim* ' 'if Amis had not been so inconsiderate as to make this title famous in advance." What needs to be shown is that Willy Seeds' s comment is in fact a brilliant bit of literary taxonomy, and that the connection brings out the novelistic potential of Watson's pseudo-diaristic, scientific memoir.

Perhaps most important, *Lucky Jim* and *The Double Helix* have the same basic structure: failure-failure-failure-stunning success. Thus the novel form that Watson follows in following Amis can be further classified. Watson is in the picaresque tradition; *The Double Helix* is an "intellectual knockabout," as Bronowski says. All the reader's considerable pleasure, in both Amis and Watson, is in knowing that every disaster will lead the hero by a logic of disasters to a fairy-tale triumph over all enemies.

In both cases, however, the reader's considerable pleasure in watching the disasters unfold into a triumph is balanced against an undeniable retrospective guilt. Both protagonists are wonderfully oblivious to normal considerations of British academic gamesmanship and manners; the problem is that they both can be brutal and boorish on the right side. When Watson finds himself ignoring the tutelage of Herman Kalckar, he worries that Herman "minded the fact that [he] was only seldom around." But the hope is that since Herman ' 'appeared very vague about most things" he ' 'might not yet have really noticed." Watson seems to get the terms of many of his portrayals from Amis, and certainly in this case Kalckar is rather like Welch *père* in *Lucky Jim*□what Watson remembers hoping is that Kalckar is Welchian in his vague inability to notice or remember an affront ("There was a fair chance that Welch hadn't noticed what Johns had told him, since he'd presumably only told him once"). And when Watson rather brutally dismisses the old, distinguished English biologists who give ' 'fuzzy-minded speculations over the wireless on topics like the role of the geneticist in this transitional age of changing values," he may well be congratulating himself on never having been forced to give the sort of talk that Jim Dixon gives, and travesties, on the role of the historian who remembers Merrie England in our new, valueless, consumer age.

But the two Jims are even more brutal about women than they are about the senescent and stupid□ women are "popsies" in both books. The most distressing connection

between Jim Dixon and Jim Watson is their treatment of intellectual women: if the portrait of Rosalind Franklin by Watson is not influenced directly by the Amis-Dixon demolition of Margaret Peel, it is an extraordinary coincidence. In both cases it is considered wrong, nearly a sexual sin on the part of the aggressive, often hysterically neurotic academic woman that she does not take, as Watson says of "Rosy," "even a mild interest in clothes." (Actually, it is not that Margaret Peel is uninterested in dress; she is simply always mistaken about it.) On the other hand, prettiness in women is very nearly all-in-all.

I use the term *pretty* advisedly□it is one of the key words in both books. Jim Dixon spends much of the novel ' 'aiming to secure ... the three prettiest girls in the class" for his own tutorial. And Margaret says to him, "Ah, you always were one for a pretty face, weren't you? Covers a multitude is what I always say." Jim, contemplating this, finds it ' 'profoundly true." In *The Double Helix,* the adjective is omnipresent: all the desire in the memoir is divided between the search for the ' 'pretty truth" about the pretty double helix, and the search for pretty girls. The two esthetic objects compete for the attention of both Watson and Crick. The word "beautiful," or any comparably strong synonym, almost never appears in either book. It gets attached to only two people in *The Double Helix,* one of whom is a man and one of whom is Watson's sister. As a consequence, it would seem, there is surprisingly little sex or sensuality in either book. In *Lucky Jim,* we generally discover how little sex is in fact going on: the pretty Christine Callaghan has not been sleeping with the loathsome Bertrand Welch, and Margaret had not had an affair with someone named Catchpole. In *The Double Helix,* the only sex explicitly referred to is between bacteria, and all the prettiness does not result in any erotic feeling whatever.

All this will have much importance in placing *The Double Helix* generically: when all things are correctly paired, in Watson's comprehensive vision, their pairing is ' 'pretty" and specifically asexual, including the disciplinary pair literature-science. But for now I only want to make the more limited point that Watson's retrospective view of 1953 in the English academic world is significantly derived from Amis's. For Jim Dixon is not only lucky, he is honest: "'That's good,' Dixon said, his spirits rising as opportunity for greater honesty seemed to be approaching." And Jim Watson is not only honest, he is lucky. The epigraph of *Lucky Jim,*

Oh, lucky Jim, How I envy him. Oh, lucky Jim, How I envy him

might just as well have introduced *The Double Helix.* The question of Watson's luck□is he a good scientist or was he merely in the right place at the right time?□is general among the early reviewers. Medawar has the most authoritative word:' 'I do not think Watson was lucky except in the trite sense in which we are all lucky or unlucky□that there were several branching points in his career at which he might easily have gone off in a direction other than the one he took." But then Medawar says: ' 'Lucky or not, Watson was a highly privileged young man ... [B]ecause it was unpremeditated we can count it to luck that Watson fell in with Francis Crick." In no other sense, however, is it lucky that Jim Dixon fell into an enviable bonding with Gore-Urquhart.

It may be stipulated that, finally, despite all similarities of plot, character, tone, and style, *Lucky Jim* is a novel (about fictional characters) and *The Double Helix* (about real people) is not. Thus the moral distinction that haunts the comparison of Watson and Pepys haunts the comparison of Watson and Amis as well. But academic readers of *Lucky Jim* in England perhaps know the original of all of Amis' s characters. Even if this is not the case, the possibility can get us to wonder what Watson's book would have been considered if he had changed all the names, moved the setting to Oxford, and made the subject the search for a cure for cancer. Indeed, Crick is decoding just such a roman à clef within *The Double Helix.* The moral critics of *The Double Helix* (e.g., Lear) would argue, of course, that that is precisely what Watson did not do. Even if the book is perverse in every judgment, it cannot be taken as a novel.

But as it happens, the discreteness of the category ' 'novel" was under assault just at the moment Watson was writing. Only one of Watson's reviewers seems to have noticed this; Bronowski writes:' 'I do not suppose *The Double Helix* will outsell Truman Capote's *In Cold Blood,* but it is a more characteristic criticism and chronicle of our age, and young men will be fired by it when Perry Smith and Dick Hickock no longer interest even an analyst.' ' We are reminded that the so-called nonfiction novel was a product of the decade that produced *The Double Helix.*

At first glance, it seems an attractive simplification merely to classify *The Double Helix* in this once fashionable subgenre. Insofar as Watson is a literary artist, some of his subtest technique has been devoted to the problem of making a memoir read as vividly as a diary, and giving a work that is supposed to have some of the inconsequence of a diary the suspense of a novel. The art of Norman Mailer's nonfiction novels, similarly but not identically, consists of making a diary read like a history, and submitting both diarist and history to a novelist's indecorous eye. Furthermore, the attraction of two founders of the nonfiction novel, Mailer and Tom Wolfe, to the space race may suggest that some of the impetus behind the nonfiction novel was the litterateur's desire to make peace with factuality in an era of scientific drama. To say so, of course, does not obviate the moral distinction between Amis and Watson; it merely shows that the distinction does not disqualify Watson from the society of novelists, as the society was defined in the sixties.

Even with the concept of the nonfiction novel, however, we have not found the proper classification of Watson's book. For though *The Right Stuff* and *Of a Fire on the Moon* are quite different□one about the goofy and human Mercury project, the other about the perfectionist and diabolic Apollo moonshot□in both cases there is a built-in antithesis of verbal, stylish nonfiction novelist and mute, mechanical NASA. If Mailer is antagonistic to his subject, it may be argued, Wolfe enjoys his and only wishes to match the vitality of Mercury with his own lively style. But even in Wolfe's case, the style cannot be considered in any sense borrowed from the project. In other words, there is something confrontational or at least competitive in the relationship of style and fact in the nonfiction novel from the literary end. There is not, however, anything confrontational in Watson's version of the relationship of science and literature, or of fact and style. Watson is a novelist in the era of the nonfiction novel, but his approach to the genre manifests a belief that science and literature relate to each other more intimately than any litterateur can conceive.

The first posited title of Watson's book was *Honest Jim;* the second, Bronowski tells us, was *Base Pairs.* At first glance, we seem to be shifting from a literary allusion to a scientific one: the key to the structure of DNA is the pairing of the chemical bases adenine with thymine, and guanine with cytosine, up all the steps of the DNA spiral staircase. But the title is a pun on the ignobleness of all human pairings in *The Double Helix*□which means that a literary trope gets us from the science of Watson and Crick's ' 'A Structure of Deoxyribose Nucleic Acid" to the novel *The Double Helix.*

As everyone has noticed, *The Double Helix* primarily about four onstage characters, Watson, Crick, Maurice Wilkins, and Rosalind Franklin, and one offstage character, Linus Pauling. What needs explicating is the way in which all the onstage characters bond into pairs. Watson more than the others seems to be the template looking for a complementary scientist to bond with. First, he is desirous of forming a bond with Maurice Wilkins□ the one contumacious and intuitive, the other cautious and knowledgeable. He hopes to use his sister as if she were a hydrogen atom to connect with Wilkins; at this moment, Jim Watson is morally somewhere between Jim Dixon□whose love of the pretty Christine Callaghan only happens to allow him to bond with Gore-Urquhart□and the loathsome Bertrand, who wants to manipulate Christine ruthlessly and lovelessly for the same purpose.

At any rate, that particular pair, Watson and Wilkins, base enough if judged by Watson's motivation, does not work out. Wilkins is instead part of the least successful pair of all, with Rosalind Franklin.

Not that he was at all in love with Rosy, as we called her from a distance. Just the opposite□almost the moment she arrived in Maurice's lab, they began to upset each other. Maurice, a beginner in X-ray diffraction work, wanted some professional help and hoped that Rosy, a trained crystallographer, could speed up his research. Rosy, however, did not see the situation this way. She claimed that she had been given DNA for her own problem and would not think of herself as Maurice's assistant.

Of course, Watson immediately interprets this situation on behalf of sexist politics.' 'I suspect that in the beginning Maurice hoped that Rosy would calm down. Yet mere inspection suggested that she would not easily bend. By choice she did not emphasize her feminine qualities."

One might have thought that love would be the model of a successfully complementary pair, and that, therefore, the answer to the failure of Rosalind and Maurice would be a happy sexual partnership. But so far as the book lets us know, the pair Watson-Crick, as prettily welded as adenine and thymine, is not sexual at all. Yet the bond for all its lack of sexual force seems stronger than Crick's with his wife (who allows Crick to be interested in pretty girls for the sake of social amusement), or Watson's with anyone else except perhaps his sister.

One can search the three photographs of Watson and Crick in the Norton edition for clues to the hidden sexuality of the bond without, I think, finding any. In one, Crick, at the right and somehow elevated, points upward with some sort of instrument towards

the DNA model; Watson, lower left, looks as nearly straight up as he can without tilting back his head. Between them, their DNA offspring grows to the ceiling. The temptation is to award Crick, by virtue of his superior position and raised instrument, the phallus; between them is the ' 'secret of life" to which Watson, stimulated by Crick, has given birth. The DNA molecule is ready to split apart and begin a new life itself.

On the other hand, five pages later is the reverse photograph. Now Watson, his neck stretching to his strangely alien (as sci-fi uses the term) head, is on the right. He is well above and much bigger than Crick at lower left, looking up. And the symmetry of the two photographs is reproduced in the symmetry of the cover picture. Watson and Crick are standing on a street; Crick on the left is glancing off, as if eschewing publicity or lost in his discourse; Watson on the right smiles for the immortalizing camera. Between them is a quite noticeable and sharply defined empty space. All hands are behind backs or in pockets, as if Watson and Crick are oblivious to the convention that the proper mode of unifying such photographs is to drape arms around shoulders.

The fact is that Watson's model of a perfect sexual couple seems to include one submissive member, if his attitude towards Rosalind Franklin is any indication, as perhaps does Crick's, if the permissiveness of his wife is a clue. Which is to say that Watson and Crick, insofar as they are a successful scientific team, cannot function on the sexual model. Crick chides Watson for taking time off; Watson is disappointed that Crick does not respond to a brainstorm; both move in and out of the partnership with apparently equal independence. However, neither can solve the problem alone.Watson is quite frank about his need for Crick: "Several times I carried on alone for a half hour or so, but without Francis' reassuring chatter my inability to think in three dimensions became all too apparent."

The nature of their complementarity can be summarized as follows: Crick is voluble, Watson apparently rather inarticulate. Watson seems more facile with new ideas, Crick faster to see the consequences of Watson's ideas and what their shared discovery implies. Watson's worldly drives complement Crick's more purely intellectual aspirations. Even intellectually, Watson is more practical, Crick more theoretical. When Watson makes fun of muddled biologists who waste time "on useless polemics about the origin of life," he is mocking one of Crick's future preoccupations. The book's intermittent treatment of the complementary pair America-England is focused by the Watson-Crick team, though the issue is muted by the fact that Crick is himself a sort of enfant terrible, in some ways himself a Lucky Jim. Lucky Jim is the English hero most apt to appeal to an American reader; perhaps Crick's similar appeal explains Watson's bonding with him.

I am arguing that the idea of base pairs is, as Watson says, so ' 'pretty" that it can function as the basis of not only Watson's science but of his novel as well. The prettiness of the scientific discovery is partly as follows: The strands of the DNA molecule spiral around each other. Between the spirals are the four bases, adenine, cytosine, guanine, and thymine. Inward from one strand can come any of the four; but adenine (A) always joins with thymine (T) coming out of the other strand, thymine with adenine, guanine (G) with cytosine (C), cytosine with guanine. The point is that each base locks with only one other base, by means of hydrogen bonds. One of the benefits

of the symmetry is that it explains the way the gene can break in half and duplicate itself. The two strands break apart, but every A attracts a complementary T, every T an A, every G a C, and every C a G, until a duplicate double helix is reformed.

And what is so lovely and moving about the novel is the way Watson and Crick come together, split apart, and by means of the novel unite again. Despite rumors that Crick was planning a lawsuit over the book, it is not too sentimental to assert that the book exists to recreate the Watson-Crick bond. In the section between the preface and chapter 1, Watson first tells the ' 'Honest Jim" story, then adds a final introductory paragraph:

Later as I trudged upward [away from Willy Seeds, toward the restaurant], I thought again about our earlier meetings in London. Then DNA was still a mystery, up for grabs, and no one was sure who would get it and whether he would deserve it if it proved as exciting as we semisecretly believed. But now the race was over and, as one of the winners, I knew the tale was not simple and certainly not as the newspapers reported. Chiefly it was a matter of five people: Maurice Wilkins, Rosalind Franklin, Linus Pauling, Francis Crick, and me. And as Francis was the dominant force in shaping my part, I will start the story with him.

Watson, egotist, phrases it thus: ' 'Francis was the dominant force in shaping my part." Watson is, to give him the benefit of the doubt, conscious that the genesis of the story is parallel to the genesis of the DNA molecule: Crick was a template for the forming of his complement, Watson. Then Watson begins the story proper with the sentence: ' 'I have never seen Francis Crick in a modest mood." And by 1974, Crick, well beyond the sort of anger that could have caused legal action in 1968, sees the humor of his relationship with Watson and considers beginning his own memoir: "Jim was always clumsy with his hands. One had only to see him peel an orange." Watson's memoir recreates Crick who created him, and Crick's hypothesized memoir recreates Watson: each is destined to go on remanufacturing the other. Watson, in 1968, knows half of what he knows about base pairing from Kingsley Amis, half from the gene.

But it needs to be reiterated that, despite the genetic model, we are not considering sexual bonding: the attraction of A for T, and C for G, has nothing to do with animal magnetism. Following some of the steps of the discovery, we can see how oddly the base pairing is suggested by sexual pairing, and how oddly the suggestion is undermined. While working on the DNA model, Watson and Crick are both occasionally working on other things. Watson becomes interested in the sexuality of bacteria, and stays with it in the face of his disappointment that "the discovery that bacteria were divided into male and female sexes amused but did not arouse [Crick]." Crick is in fact unhappy that Watson is distracted from DNA; nevertheless, the diversion seems to pay off, for around the same time (though curiously just after being nearly assaulted by Rosalind Franklin, an event that creates a new bond with Wilkins), Watson once and for all decides to give up the transatlantic pursuit of a three-strand DNA molecule. ' 'Thus by the time I had cycled back to collegeand climbed over the back gate, I had decided to build two-chain models. Francis would have to agree. Even though he was a physicist, he knew that important biological objects come in pairs."

The unavoidable inference is that Watson has the unexpected heterosexuality of bacteria in mind even though returning from hopeless Rosy and Maurice to Francis. At any rate, following a digression on the subject of Bertrand Fourcade,' 'the most beautiful male, if not person, in Cambridge," Watson excitedly passes on to Crick his inspiration about paired biological objects. "Francis, however, drew the line against accepting my assertion that the repeated finding of twoness in biological systems told us to build two-chain models." This is the second time that Crick is "not aroused" by an enthusiasm of Watson's. But Watson goes on to build double helices anyway, which are eventually justified by the base pairing. On the one hand, then, the sexual metaphor has its role in leading to the double helix, but on the other hand it is never taken very seriously. When Watson says that' 'important biological objects come in pairs," he would have to be thinking less of such pairs as Wilkins-Franklin, and more of such pairs as Watson-Crick. During Watson's digression on the subject of Bertrand Fourcade's asexual or transsexual beauty he is, with Watson's sister, about the only thing in the book more attractive than a DNA molecule he mentions "Bertrand s perfectly' proportioned face." On Bertrand's asexual or transsexual face, Watson implies, are paired biological organs in perfect asexual symmetry and mutual adjustment.

By two males a child is born the DNA model, which contains the "secret of life" and exhibits its capacity for dividing into what are always called "daughter" DNA molecules. The reader who is looking for a novelistic taxonomy will inevitably think of another male chemist who discovers the "secret," the "principle of life," by ignoring "the tranquillity of his domestic affections" and building a contraption.

Yet what *Frankenstein* gives us is not an analogue but a perfect contrast: pretty model, ugly monster; comic triumph, catastrophe. This is not the moment for a full explication of Mary Shelley's novel, but perhaps Sandra Gilbert and Susan Gubar can help us quickly to seize the essential distinction. What Gilbert and Gubar show in *The Madwoman in the Attic* is that *Frankenstein* is not, in fact, about the masculine creation of life: "Though it has been disguised, buried, or miniaturized, femaleness the gender definition of mothers and daughters, orphans and beggars, monsters and false creators is at the heart of this apparently masculine book." Mothers *and* daughters, monsters *and* false creators Frankenstein and his monster are both women. Thus the birth scene (in which Frankenstein first of all discovers that he is not Adam but Eve) enacts "Eve's discovery not that she must fall but that, having been created female, she is fallen, femaleness and fallenness being essentially synonymous." *Frankenstein* is ' 'a Coleridgean and Miltonic nightmare of filthy creation" and "filthy femaleness."

Conversely, if there is one thing *The Double Helix* does not have, it is any sense of sin. Further, the lab in which Watson and Crick work is relatively sanitized they build up their model as if with tinker toys and all they give birth to is an idea of a pretty molecule that can split into equally pretty twin daughters. The contrast, then, is as follows: *Frankenstein* appears to be about a man giving birth to a male monster, but is really about a woman giving birth to a female monster. *The Double Helix* seems to be about men giving birth to the gene that splits into daughters, but really is about the asexual creation of a model of asexual genes that can split into more asexual genes. The opposition can be put more neatly: *Frankenstein* is a novel by a woman that appears to

be about asexual birth, but sex is omnipresent and dirty; *The Double Helix* is by a sexist man with sex on his mind, but sex is eliminate from the central plot, and all is cleanliness.

Evelyn Fox Keller has written about scientists as if they were all Watsons: in her essay. "Gender and Science," she explores the popular conception that scientists are paradoxically both masculine and asexual, and finds evidence that it is true and reasons why it might be. (Lwoff s summary of Watson□"cold logic, hypersensitivity, lack of affectivity"□recalls Keller's language.) My only point here is that from the idea that the prettiest symmetries in the world are masculine and asexual (quasi-sexual, let us say), from Bertrand Fourcade's face to Watson-Crick, Watson found the inspiration for both his DNA model and his novel. Base pairing is thus the local connection of science and literature; but Watson's use of the concept is so comprehensive that it can unite science and literature in general, with the surprising result that a literary triumph after a scientific one does not represent a feminization.

When Watson's nonfiction novel was finally published, it was modestly called *The Double Helix;* the metamorphosis we have observed is from literary title *(Honest Jim),* to scientific-literary title *(Base Pairs),* to scientific title. The decision to give what turned out to be a literary "classic" a scientific name may be a sign of insecurities such as Keller might diagnose□a retreat to entrenched masculinity. The oddity, however, is that Watson should have tried something literary in the first place, if literature is more sexy but less masculine than science. But the oddity is eliminated if science and literature can be considered in terms of the same base-pair model as genes and friendships. *(Base* would take on a third meaning in expanding its territory in this way: from ' 'base" as the opposite of acid, to ' 'base" as a term of opprobrium, to ' 'base" as the foundation of a structure.) In a Baconian esthetic, literature can be the basis of a masculine intellectual conquest as well as science: science and literature can bond in complementary masculinity. If this is so, perhaps we can eke a pun out of the apparently untroping, apparently scientific title to justify the union of troping and science: the double he-lix.

Keller argues that science is presumed to be masculine because it is presumed to be objective; the desire for objectivity, she thinks, grows from the destruction of the child's unity with the mother, on which all identity depends but, in addition, on which only the *male's* gender identity (culturally defined, at least in part) depends. But love, Keller tells us, relies on the trespassing of strict subject-object divisions. Whatever its origin, the cultural stereotype of the masculine scientist exists, and is predictably registered in Mailer's *Of a Fire on the Moon,* in which WASP science-technology and Mailer compete for the love of the virgin moon; Mailer wins.

That the stereotype exists not only among the general public but also among scientists and litterateurs is not surprising. What is more surprising is the role sex plays in intellectual history, the interdisciplinary impulse of which might have been expected to undermine patterns of domination among the disciplines. In classical intellectual history, however, such as Lovejoy's or Nicolson's, philosophy and science, respectively, play the masculine role and literature always the female role, at least insofar as literature is

fertilized by science/ philosophy, and never the reverse. Lovejoy says that philosophy is the "seed-plot" of intellectual history; in Nicolson or Popper it is science, but I believe the implicit metaphor is the same. No wonder that Foucault, in decrying intellectual history of the Lovejoy-Nicolson variety, in asserting that the boundaries of disciplines may be ignored when one demarcates archaeological territories, will write an introduction to a book by a hermaphrodite, saying the same things about sexual divisions that he had said about disciplinary ones. If Lovejoy's project is heterosexual and interdisciplinary, then Foucault's is antisexual, in the sense that he does not take the boundary between sexes to be impermeable, and antidisciplinary.

And Watson's is quasi-sexual and quasi-disciplinary: just as *The Double Helix* seems more erotic than it is, the boundary between disciplines look more formidable than it is. Watson's book itself is a quasi-disciplinary intellectual history, in which fifties science bonds with fifties literature; the resultant nonfiction novel finds a comfortable home in the 1960s, a decade in which disciplinary frontiers were being crossed in many directions. It is not that science of the fifties fecundates literature of the sixties; literature and science are complimentary and templates for each other.

First of all, it is easy to show that *The Double Helix,* as a work of literature, requires the Watson and Crick papers that the Norton edition provides as a context. As Lwoff rightly says,' 'the most thrilling page of [Watson's] book" contains the following two sentences: "Suddenly I became aware that an adenine-thymine pair held together by two hydrogen bonds was identical in shape to a guanine-cytosine pair held together by at least two hydrogen bonds. All the hydrogen bonds seemed to form naturally; no fudging was required to make the two types of base pairs identical in shape." This is, however, only thrilling if one has read the semitechnical introduction by Stent, or the papers at the end of the book first, or the book once before. The word "suddenly," which seems designed to signal a breakthrough to the nonscientific reader, had been misleading to the nonscientific reader only a few pages back: "Suddenly I realized the potentially profound implications of a DNA structure in which the adenine residue formed hydrogen bonds similar to those found in crystals of pure adenine. If DNA was like this, each adenine residue would form two hydrogen bonds to an adenine residue related to it by a 180-degree rotation." But this is the beginning of a scheme of like-with-like pairing (A-A, for example, not A-T), and it is wrong. The literature is dependent at its very center on the complementary science.

Less obviously, but just as profoundly, the DNA scientific papers may be considered as a sort of template for the manufacture of this novel. They also have an insufficiency impossible to rectify within disciplinary bounds, or rather two: they lack human life, and they lack sufficient style.

As for life: one senses, reading the papers, that a remarkable claim is being constantly suppressed. The first paper (25 April 1953) contains the famous isolated sentence: "It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material." That intimation in the April paper generates the paper of 30 May 1953. But the sequel also has lacunae: ' 'Our model suggests possible explanations for a number of other phenomena. For example,

spontaneous mutation may be due to a base occasionally occurring in one of its less likely tautomeric forms. Again, the pairing between homologous chromosomes at meiosis may depend on pairing between specific bases. We shall discuss these ideas in detail elsewhere." Inevitably, a mortise in one paper finds a tenon in the next; always the scientific claims grow, but extended to their grandiose conclusion, they surpass the ability of science to demonstrate them.

In fact, these ultimate claims were being made before the DNA papers were written, before even Watson was ready for them: during the interim between the final theory and the building of the final model, Watson is "slightly queasy when at lunch Francis winged into the Eagle to tell everyone within hearing distance that we had found the secret of life." From Frankenstein to Francis. Nevertheless, despite his temporary nervousness, Watson had agreed all along that' 'to understand what life is, we must know how genes act." The reader may at first assume that the scientists must mean something very limited by ' 'life." But Watson is not modest: if genes are composed of DNA□such is the original premise□then "DNA would have to provide the key to enable us to find out how the genes determined, among other characteristics, the color of our hair, our eyes, most likely our comparative intelligence, and maybe even our potential to amuse others." Our potential to amuse others? Watson's DNA investigation pursues the secret of *Lucky Jim.* Certainly no paper Watson and Crick wrote on the DNA molecule comes close to explaining how DNA made *Lucky Jim* an amusing book. So the scientific papers call for, and are a template for the creation of, *The Double Helix,* itself a very amusing book. And much of the amusement is in the baseness of the base pairing: the novel is necessary to show how the DNA model does in a fashion give us the secret of Amis's wit.

Style is the second desideratum that the literature fulfills for the science. Watson is painfully conscious of stylistic questions□in fact, his ambitions are essentially concerned with such questions. For in the arsenal of the redoubtable enemy, Linus Pauling, style is as deadly a weapon as content.

By the time I was back in Copenhagen, the journal containing Linus' article had arrived from the States. I quickly read it and immediately reread it. Most of the language was above me, and so I could only get a general impression of his argument. I had no way of judging whether it made sense. The only thing I was sure of was that it was written with style. A few days later the next issue of the journal arrived, this time containing seven more Pauling articles. Again the language was full of rhetorical tricks. One article started with the phrase, "Collagen is a very interesting protein." It inspired me to compose opening lines of the paper I would write about DNA, if I solved its structure. A sentence like "Genes are interesting to geneticists" would distinguish my way of thought from Pauling's.

When Watson does in fact solve the structure, he remembers his stylistic intention. The first article (25 April 1953) begins: "We wish to suggest a structure for the salt of deoxyribose nucleic acid (D.N.A.). This structure has novel features which are of considerable biological interest." The coy understatement of the Pauling sentence on collagen is somewhat ineptly imitated□a lack of faith in understatement is manifested by

the too impressive adjective "considerable"□but the attempt is still evident. Watson's point, however, had been to distinguish his style from Pauling's, not mimic it, and in this I believe he failed. What is the stylistic distinction implicit in Watson's never-used sentence "Genes are interesting to geneticists"? First of all, the literariness of the statement is more pronounced than Pauling's, by virtue of its symmetry□its complementary doubling. But the sentence is not merely symmetrical; it is tautological. And in the tautology, I think, is a real clue to Watson's style. If I am right, what the tautology suggests is this: genes are only interesting to geneticists□by definition□but DNA is important to everyone by virtue of its intrinsic explanatory force. The translation from genes to DNA is from effects to causes; from the beginning Watson had sided with those who thought that the behavior of the gene could not be understood by ' 'purely genetic tricks," and so had learned as much chemistry as the case required. What is understated in ' 'genes are interesting to geneticists," in the nice symmetry, is not merely the grandeur of Watson's anticipated discovery, but also self-promotion at the expense of less adaptive scientists.

The novel, then, is required to satisfy the stylistic demands that Watson had hoped to satisfy in his scientific papers, but did not. Interestingly enough, the whole question of the importance of the scientific style of the DNA science came up immediately in the aftermath of the publication of *The Double Helix.* Medawar is on the side of its importance:

The great thing about the discovery was its completeness, its air of finality. If Watson and Crick had been seen groping toward an answer; if they had published a partly right solution and had been obliged to follow it up with corrections and glosses, some of them made by other people; if the solution had come out piecemeal instead of in a blaze of understanding; then it would still have been a great episode in biological history but something more in the common run of things; something splendidly well done, but not done in the grand romantic manner.

To this Crick (not Watson) replies:

There is [an argument] recently proposed by Gunther Stent and supported by such a sophisticated thinker as Medawar. This is that if Watson and I had not discovered the structure, instead of being revealed with a flourish it would have trickled out and that its impact would have been far less. For this sort of reason Stent had argued that a scientific discovery is more akin to a work of art than is generally admitted. Style, he argues, is as important as content.I am not completely convinced by this argument, at least in this case. Rather than believe that Watson and Crick made the DNA structure, I would rather stress that the structure made Watson and Crick... [W]hat I think is overlooked in such arguments is the intrinsic beauty of the DNA double helix. It is the molecule which has style, quite as much as the scientists.

But Watson's style□expressed in the nice, cruel, complementary doubling of "genes" and ' 'geneticists"□demanded expression before the stylish double helix was discovered. What *The Double Helix* seeks to propose, if I have built the correct model of its structure, is that base pairing is so deeply a function of Watson's mind that the pretty

DNA followed from Watson as much as Watson from the pretty DNA. If this is the case, the title *The Double Helix* refers not only to the DNA molecule but also to the style and form of the book. Style, in Mailer's and Wolfe's "scientific" nonfiction novels, is put up against science. But style, in Watson's book, is both cause and effect of the science.

In creating a more truly transgeneric literature than Mailer's or Wolfe's (call *The Double Helix* a factual novel rather than a nonfiction novel, since its basis is not the subtraction of fictionality), Watson implicitly proposes a quasi-disciplinary model for intellectual history at least as interesting as Lovejoy's interdisciplinary and Foucault's antidisciplinary histories of ideas. According to Watson, literature and science are both incomplete, even if literature is factual and science is pretty, and are thus templates for the manufacture of each other. Only in these terms can *The Double Helix* be considered literature at all; though, in these terms it can join the canon.

Source: John Limon, *"The Double Helix* as Literature," in *Raritan,* Vol. 5, No. 3, Winter 1986, pp. 26-47.

Critical Essay #3

In the following review of a new edition of The Double Helix, *the reviewer calls it a "very useful but under-developed book."*

These two books go together very well. There are all kinds of correspondences between them and some illuminating differences in style and content. Anyone seriously interested in the history of molecular biology will think about acquiring the Monod memoir. Anyone whose teaching involves reference to or scrutiny of James Watson's *The Double Helix,* of which Stent has now produced a critical edition, should consider buying this volume. This does not exhaust the kinds of readers, who will, I think, be fascinated by these books.

In the case of the new edition of *The Double Helix,* it is hard to know whether to call the book Watson's or Stent's. James Watson, a Nobel prize-winning molecular biologist, wrote an account of his collaboration with Francis Crick on the molecular structure of DNA, in *The Double Helix.* This was first published in March 1968, in the midst of a developing controversy over the deception, obtuse-ness, competition, plagiarism, and desperate ambition in science that the book describes. But it was Gunther Stent, a bacterial geneticist at Berkeley, lately turned to the extra-curricular production of philosophical books and essays, who suggested to Watson the idea of a new edition. The resulting book also contains reviews from the late 1960's, several contextual and reflective essays, and a selection of the original papers from 1953 and 1954 which put forward the by-now celebrated and seemingly well-established double-helical model of DNA structure. Stent's was a good idea, and it has been realised in a sensible, if somewhat unambitious way. I finished the book with a sense of missed opportunities and surprise at several striking omissions.

The book opens with an accomplished but uninspiring historical essay by Stent. Nothing is said about the early ethos of molecular biology, the 'prematurity' or inappositeness of postulations like the double helix, or the institutional growth of molecular biology. References to historical studies of molecular biology are desultory: At least two major monographs and a score of secondary articles are ignored. There then follows the entire text of *The Double Helix* in an unaltered form. Watson had a chance to write a short piece on how he now sees his book, thirteen years and a million copies after it first appeared; the opportunity was not taken up.

Next Stent offers us three views of *The Double Helix,* one by Crick, which is very good and characteristically incisive, one by Linus Pauling, which is a hymn to structural studies in biology, and a third by the crystallographer, Aaron Klug, showing that the work of his former colleague, Rosalind Franklin, on DNA is sytematically devalued in *The Double Helix.* This issue has itself been the subject of a book by Ann Sayre, *Rosalind Franklin and DNA,* to which no reference is made even in a footnote, nor is the literature engendered by Sayre's book mentioned. This seems to me irresponsible on scholarly grounds and possibly malicious.

After these essays come a selection of twelve reviews of the original edition, prefaced by an excellent review of reviews by Stent. This section also includes three letters from *Science* in 1968, which contest a claim seemingly made by Watson in *The Double Helix* that he and Crick obtained ideas and data from their competitors by improper means. Finally, there are the early papers, which will be opaque to the non-specialist, and which would have benefitted from a brief technical gloss, making clear just what they do and do not show. That would have been interesting given the recent much criticised proposal of an alternative model of DNA structure; indeed Stent himself was once a critic of the double helix. On balance, then, this is a very useful but under-developed book.

Source: Review of *The Double Helix* in *BJHS,* Vol. 16, No. 54, November 1983, pp. 278-79.

Adaptations

An abridged edition of Watson and Crick's discovery of the structure of DNA is available on audiocassette, read by Watson. Its title is *The Double Helix: The Story Behind the Discovery of DNA,* and it became available in February 2000 from Soundelux.

Topics for Further Study

Write an essay expressing your views on the possibility of cloning human beings. Include fair comments on the opposing viewpoint and tell why you believe the opposition is wrong.

Recall a time when you had to complete a group project at school or for an organization to which you belong. Write a report on how the project was conducted, from start to finish, using the style and information you find most useful to explain the details. Also discuss others' attitudes and views, especially those you worked with closely.

DNA testing has been used in solving violent crimes and paternity suits. Research one particular case, and write a report on why the testing was used and what controversies surrounded it.

Science fiction and futuristic novels have enjoyed a large readership for decades. Write a short story set in the future, and include details about human life based on actual scientific research at the beginning of the twenty-first century.

Compare and Contrast

1950s: Animal scientist C. R. Henderson helps New York dairy cattle breeders become world leaders in applied genetics. The key is artificial insemination, which creates a larger number of milk-producing cows.

1960s: The Green Revolution is a worldwide attempt to increase food production by creating plant varieties more responsive to specific fertilizers. It results in a higher yield of food, but there are concerns over health issues and over political control of which farmers are allowed to grow more crops.

1990s: ' 'FlavrSavr" tomatoes□genetically engineered for a longer shelf life□are introduced into American grocery stores. Few consumers are impressed and some worry that the produce is unhealthy.

1950s: Biologist Arthur Kornberg produces DNA in a test tube.

1960s: Biologists fuse human and mouse cells to create hybrid cells that cast off all but a few of the human chromosomes. Since any human proteins recognized in these hybrid cells must have been produced by genes located on the remaining human chromosomes, scientists are able to assign specific genes to specific chromosomes.

1990s: Dolly the sheep is the first adult animal cloned. Researchers in the Human Genome Project announce the complete sequencing of the DNA in chromosome 22. This is the first human chromosome to be completely sequenced.

What Do I Read Next?

In his 1994 publication of *The Astonishing Hypothesis: The Scientific Search for the Soul,* Francis Crick presents an interesting and controversial theory on the makeup of human life. His general assumption is that a person's "mind" is really just a connection of nerve cells and associated molecules. The "soul," he contends, does not exist.

Genetically Engineered Food: A Self-Defense Guide for Consumers (2000) is an informative look at food production today. Ronnie Cummins and Ben Lilliston argue that genetically engineered food presents health risks to humans and is bad news for the environment.

Physician and lawyer Philip R. Reilly discusses true tales of crime, history, illness, ethics, and human behavior in *Abraham Lincoln's DNA and Other Adventures in Genetics.* Published in 2000, this book illustrates interesting principles of human genetics and broader issues surrounding the more controversial tales.

In the classic novel *Brave New World,* reprinted in 1998 by Perennial Classics, Aldous Huxley describes a future in which rapid advances in science and technology lead to the government's increasing ability to gain control over the population. In the new world, everyone consumes daily grams of "soma" to fight depression, babies are born in laboratories, and the most popular form of entertainment is a "Feelie," a movie that stimulates sight, hearing, and touch.

Further Study

Bishop, Jerry E., and Michael Waldholz, *Genome: The Story of the Most Astonishing Scientific Adventure of Our Time? The Attempt to Map All the Genes in the Human Body,* Simon and Schuster, 1990.

This book highlights the major events leading up to the expansion of the fields of genetics and biotechnology. Its style is very accessible and includes examples of both personal and professional challenges faced during scientific research.

Marinacci, Barbara, ed., *Linus Pauling in His Own Words: Selected Writings, Speeches, and Interviews,* Touchstone Books, 1995.

Though this book may appeal more to the serious student of science, it is still a kind of memoir by James Watson's most formidable competitor in the search for the structure of DNA. Not as controversial as Watson's book, Pauling's collection provides a good balance in discussing research in DNA and many other areas of science.

Watson, James D., and John Tooze, *The DNA Story: A Documentary History of Gene Cloning,* W. H. Freeman, 1981.

This is an interesting look at the history of gene cloning, told through a variety of media□from scientific papers and correspondence to newspaper articles and cartoons.

Bibliography

Amazon.com, www.amazon.com (November 20, 2000).

Bronowski, J., Review, in *Nation,* March 18, 1968, pp. 381-382.

Fremont-Smith, Elliot, Review, *in New York Times,* February 19, 1968.Medawar, P. B., Review, in *New York Review of Books,* March 28, 1968, pp. 3-5.

Sinsheimer, Robert L., *"The Double Helix (1968),"* in *Science and Engineering,* September 1968, pp. 4-6.

U.S. News Online: Double-Teaming the Double Helix, www.usnews.com/usnews/issue/980817/17dna.htm (August 17, 1998).

Watson, James D., *The Double Helix: A Personal Account of the Discovery of the Structure of DNA,* Norton Critical Edition, edited by Gunther S. Stent, W. W. Norton and Company, 1980.

-"The Double Helix Revisited," *Time.com,* http:/ www.time.com/time/magazine/articles/0,3266,48104, 00.html (July 3, 2000).

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Introduction

Purpose of the Book

The purpose of Nonfiction Classics for Students (NCfS) is to provide readers with a guide to understanding, enjoying, and studying novels by giving them easy access to information about the work. Part of Gale's□For Students□ Literature line, NCfS is specifically designed to meet the curricular needs of high school and undergraduate college students and their teachers, as well as the interests of general readers and researchers considering specific novels. While each volume contains entries on

□classic□ novels frequently studied in classrooms, there are also entries containing hard-to-find information on contemporary novels, including works by multicultural, international, and women novelists.

The information covered in each entry includes an introduction to the novel and the novel's author; a plot summary, to help readers unravel and understand the events in a novel; descriptions of important characters, including explanation of a given character's role in the novel as well as discussion about that character's relationship to other characters in the novel; analysis of important themes in the novel; and an explanation of important literary techniques and movements as they are demonstrated in the novel.

In addition to this material, which helps the readers analyze the novel itself, students are also provided with important information on the literary and historical background informing each work. This includes a historical context essay, a box comparing the time or place the novel was written to modern Western culture, a critical overview essay, and excerpts from critical essays on the novel. A unique feature of NCfS is a specially commissioned critical essay on each novel, targeted toward the student reader.

To further aid the student in studying and enjoying each novel, information on media adaptations is provided, as well as reading suggestions for works of fiction and nonfiction on similar themes and topics. Classroom aids include ideas for research papers and lists of critical sources that provide additional material on the novel.

Selection Criteria

The titles for each volume of NCfS were selected by surveying numerous sources on teaching literature and analyzing course curricula for various school districts. Some of the sources surveyed included: literature anthologies; Reading Lists for College-Bound Students: The Books Most Recommended by America's Top Colleges; textbooks on teaching the novel; a College Board survey of novels commonly studied in high schools; a National Council of Teachers of English (NCTE) survey of novels commonly studied in high schools; the NCTE's Teaching Literature in High School: The Novel;and the Young Adult Library Services Association (YALSA) list of best books for young adults of the past twenty-five years. Input was also solicited from our advisory board, as well as educators from various areas. From these discussions, it was determined that each volume should have a mix of □classic□ novels (those works commonly taught in literature classes) and contemporary novels for which information is often hard to find. Because of the interest in expanding the canon of literature, an emphasis was also placed on including works by international, multicultural, and women authors. Our advisory board members□educational professionals□ helped pare down the list for each volume. If a work was not selected for the present volume, it was often noted as a possibility for a future volume. As always, the editor welcomes suggestions for titles to be included in future volumes.

How Each Entry Is Organized

Each entry, or chapter, in NCfS focuses on one novel. Each entry heading lists the full name of the novel, the author's name, and the date of the novel's publication. The following elements are contained in each entry:

- Introduction: a brief overview of the novel which provides information about its first appearance, its literary standing, any controversies surrounding the work, and major conflicts or themes within the work.
- Author Biography: this section includes basic facts about the author's life, and focuses on events and times in the author's life that inspired the novel in question.
- Plot Summary: a factual description of the major events in the novel. Lengthy summaries are broken down with subheads.
- Characters: an alphabetical listing of major characters in the novel. Each character name is followed by a brief to an extensive description of the character's role in the novel, as well as discussion of the character's actions, relationships, and possible motivation. Characters are listed alphabetically by last name. If a character is unnamed□for instance, the narrator in Invisible Man-the character is listed as □The Narrator□ and alphabetized as □Narrator.□ If a character's first name is the only one given, the name will appear alphabetically by that name. □ Variant names are also included for each character. Thus, the full name □Jean Louise Finch□ would head the listing for the narrator of To Kill a Mockingbird, but listed in a separate cross-reference would be the nickname □Scout Finch.□
- Themes: a thorough overview of how the major topics, themes, and issues are addressed within the novel. Each theme discussed appears in a separate subhead, and is easily accessed through the boldface entries in the Subject/Theme Index.
- Style: this section addresses important style elements of the novel, such as setting, point of view, and narration; important literary devices used, such as imagery, foreshadowing, symbolism; and, if applicable, genres to which the work might have belonged, such as Gothicism or Romanticism. Literary terms are explained within the entry, but can also be found in the Glossary.
- Historical Context: This section outlines the social, political, and cultural climate in which the author lived and the novel was created. This section may include descriptions of related historical events, pertinent aspects of daily life in the culture, and the artistic and literary sensibilities of the time in which the work was written. If the novel is a historical work, information regarding the time in which the novel is set is also included. Each section is broken down with helpful subheads.
- Critical Overview: this section provides background on the critical reputation of the novel, including bannings or any other public controversies surrounding the work. For older works, this section includes a history of how the novel was first received and how perceptions of it may have changed over the years; for more recent novels, direct quotes from early reviews may also be included.
- Criticism: an essay commissioned by NCfS which specifically deals with the novel and is written specifically for the student audience, as well as excerpts from previously published criticism on the work (if available).

- Sources: an alphabetical list of critical material quoted in the entry, with full bibliographical information.
- Further Reading: an alphabetical list of other critical sources which may prove useful for the student. Includes full bibliographical information and a brief annotation.

In addition, each entry contains the following highlighted sections, set apart from the main text as sidebars:

- Media Adaptations: a list of important film and television adaptations of the novel, including source information. The list also includes stage adaptations, audio recordings, musical adaptations, etc.
- Topics for Further Study: a list of potential study questions or research topics dealing with the novel. This section includes questions related to other disciplines the student may be studying, such as American history, world history, science, math, government, business, geography, economics, psychology, etc.
- Compare and Contrast Box: an □at-a-glance□ comparison of the cultural and historical differences between the author's time and culture and late twentieth century/early twenty-first century Western culture. This box includes pertinent parallels between the major scientific, political, and cultural movements of the time or place the novel was written, the time or place the novel was set (if a historical work), and modern Western culture. Works written after 1990 may not have this box.
- What Do I Read Next?: a list of works that might complement the featured novel or serve as a contrast to it. This includes works by the same author and others, works of fiction and nonfiction, and works from various genres, cultures, and eras.

Other Features

NCfS includes □The Informed Dialogue: Interacting with Literature,□ a foreword by Anne Devereaux Jordan, Senior Editor for Teaching and Learning Literature (TALL), and a founder of the Children's Literature Association. This essay provides an enlightening look at how readers interact with literature and how Nonfiction Classics for Students can help teachers show students how to enrich their own reading experiences.

A Cumulative Author/Title Index lists the authors and titles covered in each volume of the NCfS series.

A Cumulative Nationality/Ethnicity Index breaks down the authors and titles covered in each volume of the NCfS series by nationality and ethnicity.

A Subject/Theme Index, specific to each volume, provides easy reference for users who may be studying a particular subject or theme rather than a single work. Significant subjects from events to broad themes are included, and the entries pointing to the specific theme discussions in each entry are indicated in boldface.

Each entry has several illustrations, including photos of the author, stills from film adaptations (if available), maps, and/or photos of key historical events.

Citing Nonfiction Classics for Students

When writing papers, students who quote directly from any volume of Nonfiction Classics for Students may use the following general forms. These examples are based on MLA style; teachers may request that students adhere to a different style, so the following examples may be adapted as needed. When citing text from NCfS that is not attributed to a particular author (i.e., the Themes, Style, Historical Context sections, etc.), the following format should be used in the bibliography section:

□Night.□ Nonfiction Classics for Students. Ed. Marie Rose Napierkowski. Vol. 4. Detroit: Gale, 1998. 234-35.

When quoting the specially commissioned essay from NCfS (usually the first piece under the □Criticism□ subhead), the following format should be used:

Miller, Tyrus. Critical Essay on □Winesburg, Ohio.□ Nonfiction Classics for Students. Ed. Marie Rose Napierkowski. Vol. 4. Detroit: Gale, 1998. 335-39.

When quoting a journal or newspaper essay that is reprinted in a volume of NCfS, the following form may be used:

Malak, Amin. □Margaret Atwood's □The Handmaid's Tale and the Dystopian Tradition,□ Canadian Literature No. 112 (Spring, 1987), 9-16; excerpted and reprinted in Nonfiction Classics for Students, Vol. 4, ed. Marie Rose Napierkowski (Detroit: Gale, 1998), pp. 133-36.

When quoting material reprinted from a book that appears in a volume of NCfS, the following form may be used:

Adams, Timothy Dow. □Richard Wright: □Wearing the Mask,□ in Telling Lies in Modern American Autobiography (University of North Carolina Press, 1990), 69-83; excerpted and reprinted in Novels for Students, Vol. 1, ed. Diane Telgen (Detroit: Gale, 1997), pp. 59-61.

We Welcome Your Suggestions

The editor of Nonfiction Classics for Students welcomes your comments and ideas. Readers who wish to suggest novels to appear in future volumes, or who have other suggestions, are cordially invited to contact the editor. You may contact the editor via email at: ForStudentsEditors@gale.com. Or write to the editor at:

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