Heroes For Our Students

Tobie Brandriss

I have been teaching biology for the last 24 years at Hunter College High School in New York City, a school for intellectually gifted students who are motivated to do well and who are challenging. Yet, while they are gifted in numerous areas, they may or may not be particularly tuned in to science. Even those who are often see science as a collection of facts and understandings totally divorced from its rich history. They learn about how insulin works and about nerve structure, fertilization, and development; and much of it interests them a great deal. But they have no idea of the the day to day work that went into making these discoveries. And most cannot imagine themselves making a personal contribution to the field of biology.

I have found that one instructional technique which does capture their imaginations in more personal way is having them gaze into the lives of scientists whose discoveries we study. They love reading Leewenboek’s letters describing the “animalcules” swimming around in his saliva, and hearing about Pasteur’s trek up to the Alps with his flasks of nutrient broth (Dubos 1976).

So, I set myself a mission: I decided to search for biographies and autobiographies of biologists and physicians whose stories could inspire the students with examples of obstacles overcome, show them what motivated these scientists, and how the scientific mind operates. I wanted them to learn how scientists come to formulate unique and important problems—something we would like our students to do themselves—and to ask themselves: What allowed the scientist to approach a problem and solve it in a way no one had previously? How was the scientist able to persevere against obstacles? How was the scientist affected by his/her time in history?

I found six books I felt were well suited to my goal. They were by or about scientists who could be models students look to as they shape their own goals and values, scientists whom the students can see as both heroes and humans. I chose books that would reflect the multicultural and gender differences in my classroom. So, among them I included a book about an African American scientist, Hispanic scientist, and two women scientists. These books are appropriate for use in a highly motivated high school biology class taught either at the honors or advanced placement level. In addition, I have included books in the reference section that could be used in the General Biology class. Below, I will:

1. Give a synopsis of each of these books.
2. Describe for whom each is appropriate.
3. Quote some of the students’ reactions to the books and the scientists.
4. Explain how I structured the unit.

Before I start, I do want to mention that one problem I faced is that our biology course is already very packed and time is at a premium. As a result, I felt two constraints in introducing this unit. One was to integrate it into the course in a way that would not take away too much class time and yet would allow the students to get the most out of it. The other was not to swamp the students with a great deal of extra work, causing them to view the project as a burden and a chore. The idea was to uplift and inspire them, not drag them down with too much work.

As I went through auto/biographies to find appropriate ones and settled on these six, a unifying theme began to become clear to me: They were all about scientists who worked in the latter half of the 19th and first half of the 20th century and persevered against existing preconceptions in science or society at three levels: prevailing mainstream scientific ideas; gender; nationality or race.

Auto/Biographies Used in the Unit


Synopsis

This is a vividly told story of how insulin was discovered during the period 1921-23 in Canada. It is well documented, yet reads like an exciting novel. It describes the day-to-day work in a medical research lab, the frustrations of working with live animals, and the need to work out problems that have nothing to do with the particular question one is trying to solve. For example: how to keep dogs from dying of infections after surgery.

The book describes how Fred Banting’s belief in his idea for isolating insulin kept him going once others had stopped, and how his lack of both research experience and scientific knowledge were hindrances.
The book also awakens the reader to what a miracle the discovery of insulin was. There are gripping accounts of children and of adults who were living on the terrible starvation diet which was the only known treatment for diabetes. This treatment often resulted in death from starvation, if not from diabetes.

In addition, students are exposed in full force to the competition and politics involved in scientific discovery—not something the scientific community can be proud of, yet part of the process that does often exist; this provides added fruit for discussion.

**Appropriate Audience**

This book is a good one for most bright biology students. It would be of special interest to aspiring surgeons and aspiring chemists.

**Student Reaction**

Most students loved this book. Many were surprised how little Banting knew about experimental science and how careless he seemed to be in his research. I never knew which students would take whose side in terms of who should receive the credit for the discovery of insulin—each protagonist had his supporter.

One student wrote:

> The amount of patience needed to do so many tests and explore every facet of the subject is amazing... Michael Blake made what could have been a very boring scientific book into both a fun book as well as a learning experience. He made the book scientific enough so I could understand the specifics of what went on, while adding almost a sense of mystery as if this was a fictional story. Ramon Casanova


**Synopsis**

This most inspiring and readable book is written by the fourth woman in history to win a Nobel Prize in Medicine (1986) for her discovery of the Nerve Growth Factor (NGF). It is interesting to read precisely because it is an autobiography—we read of this scientist’s own thoughts as she progressed through her work, not the speculation of a biographer about what she must have been thinking, as in the biographies of Banting and others.

In it, Levi-Montalcini writes personally about growing up in a “free-thinking” Jewish family in Italy before and during World War II. She describes her desire, from childhood, to pursue scholarly work, and the perceived incompatibility between family life and the life of a researcher that led her to reject the former for the latter. She recalls incidents from as early as age 8 that led to her decision to forgo marriage to pursue a career. One reads how she floundered for a vocation until, when her governess died of stomach cancer, she chose to study medicine. She was one of seven women in a medical class of 300.

One reads about the rise of Mussolini and Fascism and how the encroaching anti-Semitism and Nazism put restrictions on her ability to do research and the lengths to which she went to find space to continue her study of brain cells. She writes of what gave her the courage while she was in hiding during the war to set up a small laboratory in her bedroom to continue her work.

Rita Levi-Montalcini includes a number of excellent chapters explaining experimental neurobiology—how the field developed and how she moved from question to question in her particular area of research. She does it in a way that exposes the reader to the mind of a scientist on an everyday level: the questions asked, the techniques used, the patience involved in collecting results and observing nerve growth, the setbacks and the breakthroughs. One gets a sense of the role of intuition in discovery and of the role of accident.

Rita Levi-Montalcini emerges a sensitive, reflective, understated and brilliant scientist who overcame extant attitudes about women, and survived anti-Semitism to lead a productive life professionally and personally.

**Appropriate Audience**

This book is excellent for bright, motivated biology students. The book is also a valuable one to use in conjunction with Social Studies and English classes because it exposes students to the effect of social conventions and political movements on an individual. From a scientific point of view, it is very challenging reading—students will have to work hard at understanding. When they do, they find it a most inspirational book—a powerful look into the mind and heart of a scientist.

**Student Reactions**

The personal tone of this book engendered very personal reactions from the students. The quote which follows was written by a young Asian American woman. Her paper symbolized to me what true multicultural education is. Here an Asian girl writes about a young woman in Italy from a “free-thinking” Jewish family, who went into hiding from the Nazis to pursue her research. The universal themes in RLM’s life spoke to this student and transcended all the differences in time and background between them.

I found that even as a young girl she was very sensitive to the roles of the sexes in society... She was never happy with the thought of being a traditional submissive wife.

There was always an inner instinct to pursue scholarly work. A desire to take control of her life. Eun Hwa Nam


**Synopsis**

This book presents a detailed account of the life of E.E. Just, an eminent African American biologist
who studied fertilization and development and wrote and published impressively in the 1920s and 1930s. It is not only a biography but a social history documenting the difficulties facing a brilliant black man, whose work was highly regarded, in being accepted personally and professionally in the scientific and academic community.

Just was born in South Carolina in 1883 into a family that had lived in a certain kind of limbo, "halfway between freedom and slavery" (Manning 1983). Just's mother was a strong optimistic woman, a leader in her community and a strong believer in education. Just himself left South Carolina to study in an all white high school in New Hampshire and then went on to graduate from Dartmouth, the only black student in his class. He excelled in all of his studies, graduated with many honors and was the only one in his class to graduate magna cum laude. Even so, he was not selected to speak at graduation, perhaps because "...it would be a faux pas to allow the only black in the graduating class to address the crowd of parents, alumni, and benefactors" (Manning 1983). Yet, Just was full of hope about life's possibilities.

At the time, there were only two choices open to a black college graduate, even from prestigious Dartmouth—to teach or to preach—and only among blacks. Because of his race, Just would not be offered a teaching position except at a black university. Just took a job teaching English at Howard University despite the fact that his field was Biology. Eventually he established a Department of Zoology at Howard, pursued his own research, and earned a Ph.D. from the University of Chicago.

We read descriptions of the attitudes towards blacks in society, in academia, and even in scientific literature. One is confronted with the discrimination against him even among those who consider themselves his mentors. He was the first black in the United States to receive foundation support for research in pure science. He faced constant frustration in trying to get research funds, as the question kept arising throughout his life to plague him: Is he "really good. ... first class ... compared with any standard?" or is he "simply unusual for a Negro?" (Manning 1983).

After a number of years, Just arranged to go to Europe to pursue his research. There he felt much more accepted and at peace although the struggle for funds continued throughout his life. Eventually he had to return to the U.S. because of Nazism: he barely escaped in 1940.

Appropriate Audience

I hesitated to recommend this book to most of my Honors Biology students. It is a very scholarly, well documented work which seems too detailed even for our bright students. In addition, I was not sure that reading it would be a positive experience for a young African American high school student because of the extent of the prejudice he/she would read about, the frustration and bitterness Just experienced, and how it affected his life.

The book seemed more appropriate for a highly motivated, older student (Advanced Placement) interested in the role of blacks in American society, particularly (but not exclusively) in science at the turn of the century. I did, however, offer it to the Honors students as a choice because I wanted to present them with a scientist with whom they were probably not familiar, and because there were some students for whom the book might be appropriate.

Student Reactions

Although I told the students of my reservations, in fact, many students chose the book and reacted to it much more positively than I had thought they would. When I asked them if they had found the extent of the racism discouraging, they seemed to feel that it is important for us who live now to know about the way things were.

One student's comments may be of interest:

"It seems to me an extremely sad ending for a person who had worked so hard throughout his life. As I begin to think about it, however, Just's life was a very full one, and he accomplished more than any African-American living in the early 1900's could dream of. Receiving his PhD, publishing 78 articles and working amongst the most famous scientists in both the US and Europe were just some of his many accomplishments. . . . Ernest Everett Just was not only a great scientist but a great man for dealing with (the prejudices) and still succeeding. Natasha Austin"


Synopsis

This is a well-written and documented book by a woman who was a personal friend of Rosalind Franklin. It was through questionable access to Rosalind Franklin's X-ray crystallographic pictures of DNA that Watson and Crick were able to construct their Nobel Prize-winning model of DNA. The book is largely a defense against the description that James Watson paints of Franklin in The Double Helix. It is a description that Sayre feels Watson proposed because of his prejudice against women who are bright and dedicated to science, and perhaps also to defend the fact that he did not give her the credit she deserved for helping him and Crick discover the structure of DNA. The first half of the book is devoted to Franklin's family history and youth. Sayre describes her as a bright, well-educated woman who is honest in her science and totally dedicated to her research. She is impatient with slipshod work and unsubstantiated theories. We get a close-up view of the discrimination that operated against women in
science in England in the 1920s through 1950s (Watson was not the only one who felt that one could not be both a good scientist and a "normal" woman) and what enabled Franklin to decide to enter the field initially. The second half of the book about her work with DNA is strong and gripping.

**Appropriate Audience**

This book would be of interest to those who want to learn more about Franklin's role in discovering the structure of DNA. It would also be a good choice for anyone interested in the difficulties facing intelligent women in scientific research in the first half of the 20th century. The book deals with the social attitudes that discouraged women and how this particular woman overcame these obstacles. Many students are inspired by the Sayre book to then read *The Double Helix* by Watson. Having students do so offers an excellent opportunity for students to compare two accounts of the same events.

**Student Reactions**

Most students liked the book because it tied in to so much they had learned about the DNA molecule and the intrigue involved in discovering its structure. The book is short and easy to read and many students seemed to be convinced by Sayre's arguments. Others felt Sayre was biased by her friendship with Franklin. For many of the girls Franklin was a hero. See Illustration #3 for a letter one student wrote to *The New York Times*.

The final two books I selected to offer to the students were biographies of Louis Pasteur and Ramon Y Cajal.


**Synopsis**

This book, in addition to describing Pasteur and his brilliant scientific accomplishments, also gives one a history of the discovery of the role of microorganisms in fermentation, the history of the belief in Spontaneous Generation and how Pasteur disproved it once and for all, and the history of the germ theory of disease, contagion, and the development of vaccines.

The author does not give a detailed account of Pasteur's personal life although he does give us a feel for him as both a family man and a researcher. He mostly concentrates on Pasteur, the scientist doing his research, and shows the reader how he progressed from solving one problem to the next. In tracing
Pasteur's line of thought in each experimental situation he takes on, Dubos exposes us to the brilliance of his mind, his tremendous powers of concentration, his perseverance, and the showmanship he used in convincing the world that he was right.

**Appropriate Audience**

Some chapters are exciting reading (how Pasteur came up with the rabies vaccine, how he collected crowds—including scientists, diplomats and royalty—in a field at Pouilly le Fort to demonstrate the effectiveness of the Anthrax vaccine). Other chapters go into a great deal of depth and are too technical to hold the interest of most students.

The book would be appropriate for AP Biology students in its entirety. For Honors students, I would require the following chapters: Introduction, 1, 2, 4, 6, 8, 9, 10, 12, and 13, and make the rest optional so that they do not get too bogged down in material that they have not studied or that is more abstract. I have included a much simpler version of the book appropriate for General Biology students, edited by Thomas D. Brock, in the reference section.

**Student Reactions**

I suggested to the students that only those very interested in science choose it. Those who did really liked it and learned a great deal. It was as if they took my cautionary words as a challenge.

---


This autobiography is very personally and engagingly written by a Nobel Prize winning scientist who has been called the founder of neuroscience. He came from humble beginnings in one of the poorest regions of Spain. He was the son of a country doctor who refused to let him pursue his interest in art. Instead, after apprenticing for a shoemaker, he was sent off to medical school. He made many discoveries about the nervous system and published extensively. One of the great charms of his autobiography, however, is how much attention he gives to his nonscientific life.

**Appropriate Audience**

Because of its length and its tendency to ramble, I hesitated to recommend this book to most students as part of this biography unit, but would recommend it at the end of the year to students who enjoy reading biographies and enjoy biology.

**Student Reactions**

I bought only three copies to offer students because of its length. To my surprise, all were taken. Some students liked it, others did not like it at all.
The Assignment

In order to integrate the project into the course without making it too burdensome for the students and without encroaching too much on class time, I handled it the following way: After students had gotten into the groove of the course, I brought the books into class, gave the students a little introduction to each and allowed them to choose one. They were given two months to read their book and write a paper, guided by questions I asked them to consider specific to each book. (See Illustration #1 for a sample of questions.) As they read their books at home, we continued the required biology curriculum in class. Because the books were about scientists whose discoveries we study, the students would often enrich our class discussions with insights they had gained from reading the biographies.

Shortly after the papers were handed in, I did a cooperative learning session with the students in which they were grouped with others who had read the same book. I asked each group to discuss:

1. The personal characteristics that were salient in their scientist
2. The obstacles, if any, their scientist had to overcome
3. How they felt about their scientist after they read the book.

I then asked each group to prepare an oral presentation in which one student reported to the rest of the class about the life of its scientist, and another reported the results of their group discussion, addressing the three questions above. I asked the students in the class to note, as they listened to each group's report, if there were common qualities that emerged about the scientists and about the nature of the creative process. During the class discussions we had, the students did identify common themes in the scientists' lives.

Common Themes in the Lives of the Scientists

Common themes in the lives of the scientists emerged from my own reading of the biographies and from class discussions I have had with my students after doing this unit several times. They were:

1. Each of these scientists exhibited a total preoccupation with the problem at hand which fascinated them and resulted in an almost obsessive desire to find the answer, whether it was how to disprove Spontaneous Generation (Pasteur) or to find out what makes neurons grow (Levi-Montalcini). They awoke with it, worked on it all day, and went to bed with it, itching to get up the next morning to work on it some more.
2. They were undaunted by lack of money. If it meant constructing a makeshift laboratory in two rat-infested rooms as Pasteur did, or begging for eggs to study in her research using wartime food ration cards as Levi-Montalcini did, or continuing to apply for money for research that had been granted to no other black man as Just did, they found a way.

3. They had absolute faith in themselves and confidence in their experimental abilities.

4. They had the conviction that there was a solution to the problem and that with persistent work, they would uncover it.

5. There existed an independence of mind that allowed Pasteur, Just, Banting and Levi-Montalcini to take on world-famous scientists, disagree with them, and pursue their independent line of reasoning.

6. The role of intuition was evident. It was intuition that led them to solutions they were sure of even though along the way they did not have proof that they were correct. This intuition gave them the uncanny ability to select the right materials for their work. It was intuition that gave them the ability to disregard results that didn’t make sense and not let those results sidetrack them. They put the results aside with the conviction that someday they would make sense and, without fail, they did.

7. The importance of being able to discard a belief that one held or that was widely held by others and, in Barbara McClintock’s words, “Listen to the material,” (Keller 1985) was clear. The importance of observation and really getting to know the substance or organism they were studying, respecting its integrity and learning what it has to “say” was also a common theme.

8. For each of the women whose lives we studied, the important role of her father in encouraging her studies was evident.

**Conclusion**

The papers the students wrote and the class discussions we had about the scientists convinced me of the power biography can have on our young people. They learned how scientists approach unsolved problems, how they persevere against obstacles, and how they are affected by their historical and social surroundings. Many were deeply inspired by what they read. See Illustration #3 for a letter one of my students wrote to The New York Times—without showing it to me until she got a call that they were going to publish it!

**Acknowledgments**

I would like to thank Maura Flannery for reading my manuscript and for her most helpful comments and advice. The initial study which led me to design this biography unit, was made possible by a Sci-Mat Fellowship I was awarded by the Council for Basic Education in conjunction with the National Science Foundation.

**References**


**Interdisciplinary Use of the Project**

While the biography unit can be done quite successfully solely within the Biology course, I have also found it to be an excellent unit to do in an interdisciplinary way. Last year I worked with my Biology students’ Social Studies and English teachers. We were able to delve more deeply into the question of what impact political events and social conditions have on a scientist’s work and also to look at the role of the biographer, the “teller of the story,” in our reactions to a scientist’s life. See Illustration #2 for the more open-ended questions we asked students to address in this unit.

**Other Books That Could Be Used in This Biography Unit:**


Illustration #1

Sample Biography Question Sheet

The Discovery of Insulin by Michael Bliss, University of Chicago Press, 1982.

In writing your paper, please address the following questions:

1. What success had been achieved in obtaining pancreatic extracts before Banting began his work? Why were the extracts NOT used to treat diabetes?

2. What did you learn about experimental surgery and research from Chapters 3 and 4? Be specific and explain.

3. Why was the summer of 1921 a difficult one for Banting personally?

4. There were many problems Banting and Best had to work out in order to be able to get at the pancreatic extract. What were these technical difficulties? Why was there a problem isolating the extract and how was the difficulty overcome? What bits of knowledge did Banting put together to come up with the solution?

5. What important advance in their research occurred when they tried preparing the extract using alcohol? Why was this so important? Who had suggested it?

6. What is the first recorded case of trying the extract on a human?

7. What dilemma arose about the patenting of insulin? Why was a patent taken out in the name of Collip and Best?

8. What personal qualities led to Banting’s success? What qualities held him back? Why did Banting succeed when so many others came close but failed?

9. Banting was frustrated by his poor presentation of his research at the American Physiological Society conference at Yale (page 104), and by the fact that MacLeod rescued the presentation so well. Do you think he was correct in feeling that MacLeod was trying to take credit not due him?

10. One question that keeps coming up in the book is who should get the credit, the one who does the nitty gritty work or the one who contributes ideas and advice but does not do the hands-on work. How do you feel about who should get the credit for the discovery of insulin? Defend your answer with specific reasons.

11. What part of the insulin story made the biggest impression on you? Why?

Illustration #2

Open-Ended Questions for Use in the Biography Unit

Integrated Biography Project

The paper you write should be an integrated essay with a thesis that answers all three questions below. (If doing an Interdisciplinary Unit, one could add: This paper will be graded jointly by your Biology, English and Social Studies teachers and the grade will count in all three courses.)

A. What is your scientist’s major scientific contribution? What scientific obstacles did your scientist overcome? How did his/her contribution alter the course of science or medicine?

B. How did the historical context faced by your scientist affect his/her life and work? What social and political obstacles did this person overcome in his/her life and work? Be sure to consider factors such as race, ethnicity, gender, religion, and political events.

C. Does the manner in which the story is told affect your reactions to the person’s life and his/her achievement? What techniques does the writer use to persuade the reader? Were you persuaded?

Illustration #3

The New York Times, Letters to the Editor of the Long Island Weekly, Sunday, April 11, 1993 (Excerpted)

Unheralded Scientist Behind Nobel for DNA

In reading “Watson Relinquishes Major Role at Lab” (March 21), I realized that, once again, a grave injustice has been done to Rosalind Franklin. Her name was omitted from this article, as it has been for years by textbooks, nonfictional publications, Watson and Crick’s scientific manuscripts and, ironically enough, “The Double Helix: A Personal Account of the Discovery of the Structure of DNA” by James Watson.

Rosalind Franklin was a dedicated scientist working at the King’s College laboratory in London in the 1950s, along with Maurice Wilkins, recipient of the 1962 Nobel Prize for medicine and physiology... Without asking her permission, Wilkins agreed to show him Franklin’s X-ray film patterns, and it was this secret information that aided Watson and Crick in their discovery of DNA’s structure. To the day of her death, Rosalind never knew that her patterns were revealed to Watson and that this was the reason they won the “competition” for DNA’s discovery. This information appears in “Rosalind Franklin and DNA” by Anne Sayre, published in 1975.

As a female high school student, I feel that increased awareness of the unpublicized accomplishments of women scientists will inspire a new generation. Perhaps it is time for Rosalind Franklin to receive recognition for her years of work and discoveries.

Nadia Sawicki, Holliswood.
The writer is a student at Hunter College High School.