

**Thanks for using *Dignifying Science: Stories About Women Scientists* in your classroom. The following are some ideas for generating discussion, critical thinking, and further learning based on what your students just read.**

### **Content questions**

*Marie Curie (prologue)*

What is Marie Curie doing here?! Do you really think that will keep her warmer? (Try it.)

*Hedy Lamarr*

In the 1940s Hedy Lamarr tried to be both a movie star and an inventor. She succeeded at one, but not at the other. Which do you think she would rather have been famous for, her movies (and her beauty) or her inventions (and her brains)?

Can you name other people who do two jobs, but don't get recognized for the work in both of them? [I'm thinking of working moms/dads here.]

*Lise Meitner*

Lise Meitner and her nephew work out an important question while skiing. Do you ever have good ideas about something while doing something completely different?

What is the liquid drop model?

Lise Meitner had a good job and many friends in Germany. Why did she leave?

*Rosalind Franklin*

Two labs were competing to make a discovery. Do you think Maurice Wilkins should have shared Rosalind Franklin's data with Watson and Crick? Why do you think he did it?

Was Rosalind Franklin close to discovering the structure of DNA on her own? Why do you think she didn't do it?

The Nobel Committee only awards the Prize to people who are alive. Should Rosalind Franklin have received the Nobel Prize if she hadn't died young?

*Barbara McClintock*

Although some scientists—typically theorists—work alone, these days it's the exception, rather than the rule, especially for people who do experiments. Barbara McClintock was an experimentalist, but she rarely collaborated with others. Why do you think she preferred to work alone?

If she had worked with partners, do you think her (correct) ideas would have been accepted sooner? Why?

*Biruté Galdikas*

Some problems in science are harder than others, and primate research provides a great example. Why do you think the research Biruté Galdikas does is so much harder than the work done by Dian Fossey or Jane Goodall?

More generally, there are many types of research. What Biruté Galdikas (and Dian Fossey and Jane Goodall) does is called "field work," which is a term typically used in contrast with "lab work." Which type of research do you think is typically harder, field work or research done in a laboratory? Why?

*Marie Curie (epilogue)*

Why do you think Madame Curie seems less hopeful here than in the very first story?

*General*

What story or stories did you find most effective? Why? Be as specific as you can.

How would you describe the tone of the book? Cite specific pages and/or panels as examples.

Which character do you find most memorable? Why? Again, be as specific as you can.

Which characters do you find to be the most interesting and engaging? That may be different than most memorable! Why? [For example, which character would you like to go on a vacation with? Which character(s) would you want to invite over for dinner?]

How would you describe Carla Speed McNeil's artistic style? What is its most striking feature? How do you compare it to artist Stephanie Gladden's style?

Before reading this book, what were your attitudes about these scientists? About women in science? In what ways has the book changed your mind about these topics?

If you could ask the artist(s) any questions, what would they be?

If you could ask the writer any questions, what would they be?

### **Storytelling questions**

Why do you think page 103 was done in that particular way? How about pages 106-107?

Why do you think page 88, panels 2, 4, 6, and 8 are done that way? [Why do they get bigger, but also emptier?]

In the Rosalind Franklin story you see the work of a number of different artists, depending on which character's point-of-view you're getting. Describe the style of each artist and the characters they depicted. Would you have done the same thing?

On page 24, what happened between each panel? How much time passed? What do you think happened between page 26 and page 27?

Pay close attention to backgrounds throughout these stories. How do the writer and artist establish and treat setting and environment?

Why did the book start with Hedy Lamarr's story? Why does the book end with Biruté Galdikas' story? [Lamarr was the least able to realize her intellectual potential on her own terms; Biruté Galdikas is the most able.]

### **Ask the characters! Ask yourself!**

Now that you've read the book, try answering some questions as if you were one of the characters. Then, pretend like you were in the character's situation. How would you answer it for yourself?

"Ms. Lamarr, if you had to do it all over again, do you think you would go into the movies, or would you try to be a full time inventor?"

"Professor Meitner, do you think you get enough credit for your role in the discovery of nuclear fission?"

“Dr. Franklin, the same question applies to you: Do you think that you’ve finally received the credit you earned for your part in the discovery of DNA’s structure?”

“Professor McClintock, what do you think of the human genome project?”

“Dr. Galdikas, what do you think is the most significant trait you need to do your work?”

## **Vocabulary**

radioactivity  
frequency hopping  
fission  
“liquid drop” model  
DNA  
helix  
genes  
rain forest  
primate

## **More to explore**

### **Books**

*Madame Curie*, by Eve Curie, translated by Vincent Sheean (NY: Garden City Publishing, 1940).

The letter to her brother used as for the prologue comes from this affectionate biography written by her youngest daughter. Eve Curie’s description of her mother’s early years of deprivation and optimism are particularly inspiring.

*What Little I Remember*, by Otto Frisch (London: Cambridge University Press, 1979).

Frisch actually remembered plenty, and wrote about his work with many famous physicists with verve and humor.

*Lise Meitner: A Life in Physics*, by Ruth Lewin Sime (Berkeley: University of California Press, 1996).

Ruth Lewin Sime has written extensively on Lise Meitner, and her book is excellent. Though her perspective seems to focus on the negative (she is particularly hard on Otto Hahn and his post-war posture), Sime does a thorough and convincing job of presenting the case that Meitner was treated poorly by both Hahn and the Nobel Prize committees.

*The Double Helix*, by James D. Watson (originally published in 1968, but seek out the Norton Critical Edition edited by Gunther Stent, NY: W.W. Norton & Company, 1980).

Start here, but don't stop with what Watson accurately calls "A personal account of the discovery of the structure of DNA." If it were mine to subtitle, I would change that to "A very personal account..." This book caused an uproar in both its draft and published forms, and may have been the main (though inadvertent) reason why many began to pay attention to Franklin's role in the discovery. It's fascinating.

*Rosalind Franklin, the Dark Lady of DNA*, by Brenda Maddox (NY: HarperCollins, 2002).

Maddox presents a balanced account of Rosalind Franklin's life, moreso than any other book to date. If you read only one book about Franklin, make it this one.

*What Mad Pursuit*, by Francis Crick (NY: Basic Books, 1988).

Not at all a reaction to Watson's book (though its subtitle—"A personal view of scientific discovery"—is similar enough to make the idea plausible), this is a more measured and philosophical look at how one scientist approaches science. It's by no means dry, however, and offers lively insights into Crick's views of how science is best done. It also recounts the making of a BBC docudrama (which I've still not seen) called *Life Story*, about the quest for DNA's structure and mentions an unsuccessful attempt at a Hollywood movie, for which the script failed to find a backer.

*A Feeling for the Organism*, by Evelyn Fox Keller (NY: W.H. Freeman, 1983).

Though McClintock stopped cooperating with Keller before she had finished the book, it still reads as an authoritative account of her work.

*Reflections of Eden: My Years with the Orangutans of Borneo*, by Biruté M.F. Galdikas (Boston: Little, Brown and Company, 1995).

Galdikas' book offers accessible prose and I found its personal focus on individual orangutans and stories engrossing and entertaining.

*Watching the Wild Apes*, by Bettyann Kevles (NY: E.P. Dutton, 1976) and *Walking with the Great Apes*, by Sy Montgomery (Boston: Houghton Mifflin, 1991).

Kevles' book planted the seed of the idea for presenting a fictionalized day in the life of a researcher, and provides a fine introduction to all three of Louis Leakey's protégés (Galdikas, Dian Fossey, and Jane Goodall). As for Montgomery, after reading the introduction I was prepared to dislike the rest, anticipating an "Aren't they wonderful because they're women?" tone to mar the book. Fortunately, the conclusion I initially jumped to was wrong. Hers isn't the objective journalism that people (especially scientists) pretend exists, but is instead intelligent advocacy writing.

Finally, if you like the story's pictures more than its words, have a look at *Orangutan Odyssey* by Biruté Galdikas and Nancy Briggs, with photographs by Karl Ammann (NY: Harry N. Abrams, 1999), *The Nature of Borneo*, by Steven Yates (NY: Facts on File, 1992) or seek out the National Geographic videos *Search for the Great Apes* (Executive Producer Dennis Kane, 1975) and *Creatures of the Mangrove* (Executive Producers Dennis Kane and Thomas Skinner, 1986).

**Articles and other resources**

"A sultry screen star who didn't just act — she invented," by Elizabeth Weise (The Associated Press, March 9, 1997).

This wire service report appeared in dozens of U.S. newspapers, and gives the basic facts on the history of Lamarr's life and patent.

"Advanced weaponry of the stars," by Hans-Joachim Braun, in *American Heritage of Invention & Technology*, vol. 12, no. 4, Spring 1997, 10-17.

If you read only one piece about Lamarr, I would recommend this one. It comes complete with photos, conjecture, narration, and more history than you get from Weise's article. A related article called "Celebrity is the mother of invention" by Travis Brown provides intriguing glimpses of inventors who were famous for things other than their ingenuity. Additional perspectives on Lamarr's invention appear in *Forbes* ("I guess they just take and forget about a person," by Fleming Meeks, vol. 145, no. 10, May 14, 1990, 136-138) and *Scientific American* ("Spread-spectrum radio," by David R. Hughes and Dewayne Hendricks, vol. 278, no. 4, April 1998, 94-96).

"Secret Communication System," U.S. Patent #2,292,387 issued to Hedy Kiesler Markey and George Antheil, August 11, 1942.

Though we've attempted to give the gist of the invention in the story, if you want all the details about how to control torpedoes from a distance without your enemies jamming the signal, start here. Lamarr and Antheil sent their idea in to the National Inventor's Council in December 1940 and chairman Charles F. Kettering (the research director for General Motors) encouraged them to write it up as a patent.

"Looking back," by Lise Meitner, in *Bulletin of the Atomic Scientists*, vol. 20, no. 11, November 1964, 2-7.

Meitner's good-natured recollections in this short article prompted the humorous touches in this story. Though disappointed (and perhaps briefly embittered) by the Nobel Prize committee's decision to award their prize for the discovery of fission only to Hahn and Strassman, she didn't let those feelings dominate her life.

"An interview with Nobel Laureate Maurice Wilkins," by Stephanie Johnson and Thomas R. Merten, in *The American Biology Teacher*, vol. 51, no. 3, March 1989, 151-153.

This interview typifies for me how little Wilkins cares to reveal about himself. Perhaps I didn't look hard enough, but I found very few sources outside of Judson's book (below) that gave a sense of Wilkins either as a flesh-and-blood person or scientist. Interestingly, for all their enmity, Wilkins is the only one of the three Nobel Prize winners who mentioned Franklin in his Nobel lecture. *The World of Physics*, by Jefferson Hane Weaver (Vol. 2, NY: Simon & Schuster, 1987) reprints part of his and Crick's lectures.

"Molecular structure of nucleic acids: A structure for deoxyribose nucleic acid," by James Watson and Francis Crick, in *Nature*, vol. 171, no. 4356, April 25, 1953, 737-738.

A surprisingly accessible paper, even for a lay audience, considering its contents earned the authors a Nobel Prize.

"A naturalist of the genome," by Roger Lewin, in *Science*, vol. 222, no. 4622, October 28, 1983, 402-404; and "Barbara McClintock (June 16, 1902 - September 2, 1992)," by Nina Federoff, in *Genetics*, vol. 136, no. 1, January 1994, 1-10.

The book *The Dynamic Genome* is pretty technical (too much so for me!), so you may want to consult these for summaries of McClintock's accomplishments. One was written soon after her Nobel Prize was announced and the other upon her death.