Works Cited

Primary Sources

Adams, Jerry. *Jerry Adams on "Jim Watson, 'The Double Helix'" and "Responses to 'The Double Helix'." CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, 15 June 2003. Web. 2 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/james-d-watson/discovering-double-helix/adams-responses-to-the-double-helix/>. This was an oral history with Jerry Adams, a biologist who got his PhD under James Watson, and today, works as a geneticist. Adams worked with Watson when he published his book, "The Double Helix." In these short clips, he discusses James' negative response to the book due to his awful portrayal of Rosalind Franklin. He also says that Watson explains he wrote it this way because as a young man, he did see Rosalind in that way. He did not take her as seriously because she was a woman, and often concentrated on her annoyances and physical appearance. This is primary evidence of her encounter of prejudice, and shows historical context with Watson looking back on these actions.

Adams, Jerry. *Jerry Adams on Women in Science*. *CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, 15 Jan. 2003. Web. 2 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/scientific-experience/women-science/adams-women-in-science/>. This was an oral history from the CSH Collection in which Jerry Adams, a biologist who studied under James Watson and today works as a geneticist, discussed women in science, both before and after Rosalind's time. He agrees that women were disadvantaged, both being plagued with social maternal obligations, and fewer opportunities due to male prejudice in the field-difficulty being hired, getting to go to conferences, and being taken seriously. He also feels that while their position has improved, it hasn't entirely become equal. Thus, we can justify Rosalind indeed encountered gender prejudice, but also experienced an exchange that helped to dissuade it after her work in DNA.

Bernal, J.D. "Dr. Rosalind Franklin." *Unknown* [Unknown] 1958: n. pag. *CSHL Archives Repository*. Web. 16 Feb. 2016. <http://libgallery.cshl.edu/items/show/37189>. This was a newspaper clipping from an unknown newspaper which printed Rosalind Franklin's

obituary, written by J.D. Bernal. The clipping is most fascinating because Bernal solely discusses Rosalind's research in the sciences and her success in doing so, respectfully establishing her as a main player in the sciences and someone who transformed the field of biology. There is no hint of social prejudice whatsoever. In terms of contributing to my research, a man deeming Rosalind important to science publicly in this manner can only demonstrate her significance in the advancement of science at that time-the importance of her exploration, which for some people, outweighed the historical context of gender prejudice.

Bolton, Paul. *Education: Historical Statistics*. Research rept. no. SN/SG/4252. London: House of Commons Library, 2012. PDF file. This is a compilation of data taken from 1920-1990 regarding the breakdown of education in the United Kingdom by gender, race, age and degree that I used in conjunction with data I received from King's College in London to create a visual relationship (a series of graphs on my exhibit) to demonstrate the relationship between gender and education both in participation, vs. men, and by academic field to demonstrate both the historical context Rosalind was working in, how her choice was indeed a minority, like so many others she made, therefore demonstrating her exploration socially, and finally, to demonstrate how that data progressed after her time, to demonstrate how she and other scientists like her (as well as the exchange she didn't purposefully start) influenced the continuing of progress for bringing women equally into the global workforce. The data showed that women were always far below men in college enrollment and often dropped out for social obligations like having a family/caring for the home before graduate studies, and were often encouraged to take up "softer studies", such as the arts instead of science and technology, though that was desperately needed. The data also showed that after Rosalind's time, these numbers started to gradually improve for women, bringing them closer and closer to equality, or at least awareness of the need for it. In terms of my use of it, this is a primary source because I only used the raw data, which was taken directly from the time period of interest. 2012 was simply the last edit of it.

Brenner, Sydney. *Sydney Brenner on The DNA Discovery in Context: Achieving Greatness*. *CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, 10 June 2002. Web. 2 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/james-d-

watson/discovering-double-helix/dna-discovery-context-achieving-greatness/>. This was a particularly fascinating oral history from Sydney Brenner in the CSH Collection, in which he explained the historical significance of the Double Helix theory, in terms of historical context. Being that Brenner was a biologist himself, his perspective allows us to see not only what the rest of the world thought about the development, but the world of science itself. And he agrees, this was the Darwin of the 20th century- creation of celebrities of science, and created a drive in science comparable to the Space Race. This would be the resulting exchange of science from Rosalind's data, as well as the significance of her exploration and encounter.

Brenner, Sydney. *Sydney Brenner on Women in Science: Admitting Women to Cambridge University*. *CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, 10 June 2002. Web. 2 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/james-d-watson/discovering-double-helix/dna-discovery-context-achieving-greatness/>. This was an oral history from the CSH collection from Sydney Brenner, a geneticist today, and biologist at the time of Rosalind's work at King's College. Brenner discusses the point in history that Cambridge University decided to admit women in their university, as well as the position of women in science before Rosalind's time and during, and after her major work into today's work. He confirms that women were treated with a low position, and not allowed into the university whatsoever before Rosalind and during her work at King's, with little reason. When colleges finally did try to rectify this, they had to reform many college laws, and often couldn't get it approved by the fellows. Further, when women were finally admitted, they did fine, often publishing the most celebrated papers. Today, women occupy a much more equal role in science, though it still hasn't caught up entirely. This demonstrates that Rosalind was indeed exploring a new role for women by working at King's, and the prejudice she encountered was very real. However, it also shows the exchange of conversation sparked by actions from women such as her wanting to be accepted led to more women joining the field to the point of approaching equality. This interview helped me understand the social context Rosalind experienced so I could then see it in terms of the theme.

Caspar, Don. *Don Caspar on Jim Watson*. *CSH Oral History Colection: CSHL Digial Archives*. Cold Spring Harbor Laboratory, 1 Jan. 2001. Web. 9 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/james-d-watson/jim-watson-young-man/jim-watson-young-man-i/>. This was a shorter oral history from Don Caspar from the CSH Collection in which he describes Jim Watson as an intelligent man, but a womanizer, particularly around the time he worked with Rosalind, further proving the prejudice she encountered in the workplace; not only the presence of it, but the magnitude of it, which could have made success for women more difficult [made it difficult to be taken seriously as a female].

Caspar, Don. *Don Caspar on Jim Watson's Personal Recollections, on Working with Jim Watson, on Genes, Girls and Garnow, and on The Double Helix*. *CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, 1 Jan. 2001. Web. 9 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/james-d-watson/memories-jim-watson/jim-watsons-personal-recollections/>. This was a series of consecutive oral histories of Don Caspar from the CSH Collection in which Caspar agrees that Jim Watson was an easily, off-put person that tended to blame things on Rosalind, didn't tend to ask her permission for anything, and portrayed her, along with many other colleagues, entirely wrong in his recollections and autobiography. Those portrayals, however, were perfect for understanding his view of Rosalind in terms of his prejudice toward women. Thus, we can see her encounter of it confirmed. However, these interviews also discuss Rosalind's significant exploration of viruses, which gave her the skills not only to dominate any previous research, but take on more difficult research with the question of DNA soon after.

Caspar, Don. *Jim Watson as a Young Man*. *CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, 1 Jan. 2001. Web. 9 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/james-d-watson/jim-watson-young-man/jim-watson-young-man-relationships-women-i/>. Another interview with Don Caspar from the CSH Collection [a friend and colleague of Franklin's], in this clip Don describes the attitude, personality and work ethic not only of Jim Watson as a young man, but all of the men working in Cambridge alongside Franklin. He says that men at that time in that workplace tended to see women as objects, not people. They were often a

point of infatuation, but more of an intellectual construct of the mind, as opposed to their own people. They were certainly not taken seriously, and were always considered of lesser intelligence. Their one and only purpose was to be an opportunity for romance-something to be crafted into what you were looking for. This interview describes first hand, from a man's perspective no less, the prejudice that Franklin, and all other women of the time faced. It develops for those in today's world the social norms that Rosalind was working beyond during her work with viruses and DNA.

Caspar, Don. *Jim Watson on Rosalind Franklin*. *CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, n.d. Web. 9 Jan. 2016. In this interview with Don Caspar, another from the CSH Collection, Caspar (friend and colleague of Franklin) discusses again the fact that Watson never saw Franklin as who she was, but rather, an object of his sexual interest, and difficult to get along with, only because of her gender [encounter of prejudice]

Caspar, Don. *Don Caspar on Rosalind Franklin*. *CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, 1 Jan. 2001. Web. 3 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/scientific-experience/women-science/rosalind-franklin/>. This was an interview from Don Caspar, fellow crystallographer on the outskirts of Rosalind Franklin's work, who knew her well personally from the CSH Collection. Caspar describes Franklin as highly admirable, of a great personality, and real scientific achievement. He discusses how she did not always work in the most desirable of conditions, but rather, very much in a man's world. In relation to my project, the interview helps better connect to the theme of the significance of Rosalind's exploration in the sciences, but also, to the encounters with prejudice she had, and the difficulty that added to succeeding in such a line of work. By seeing these interviews with people that knew her-first hand accounts-I can put this small scale story into historical context and see the significance it really holds-how transforming her work was.

Crick, Francis. *What Mad Pursuit*. N.p.: Basic Books, 2008. Print. This is the autobiography Francis Crick wrote about his experiences in discovering the double helix. In it, he not only admits he and Watson often adopted a patronizing attitude towards Franklin, but that

they never told her they used her data, and know how important she was to their discovery. I quote this book a few times in my exhibit.

Franklin, Rosalind. Letter to J. T. Randall. 24 Nov. 1950. Profiles of Science: Rosalind Franklin Papers. National Library of Medicine. PDF file. This was correspondence between Rosalind Franklin and J.T. Randall shortly after he requested her coming to King's in which Rosalind demonstrates her out of the ordinary (for a woman) personality by making detailed, stern demands for equipment she will need in the lab, not disrespectfully, but not any less than forceful either. Along with setting the tone for her coming to King's it conveyed to me Rosalind's typical professional attitude, which was important in understanding her social exploration.

Franklin, Rosalind, and Raymond Gosling. DNA X-Ray Images. 1952. James D. Watson Collection. CSHL. JDW/1/6/8. *CSHL Archives Repository*. Web. 14 Feb. 2016. <http://libgallery.cshl.edu/items/show/51231>. This was a collection of "various photographic prints of DNA X-ray images (A and B-form) including the famous "Photograph 51" (B-form), which was taken by Raymond Gosling while working under Rosalind Franklin. The A-form photograph includes handwritten notation by Watson on the verso and may have been used in his lecture at the 1953 CSH Symposium." I intend to use them visually in my exhibit as examples of the fine photographs Rosalind captured of DNA, and example of her experimental skill.

Franklin, Rosalind, and Raymond G. Gosling. *Crystallographic photo of Sodium Thymonucleate, Type B. "Photo 51."* May 1952. Ava Helen and Linus Pauling Papers. Sci9.001.5. *Oregon State University: Linus Pauling and The Race for DNA*. Web. 25 Jan. 2016. <http://scarc.library.oregonstate.edu/coll/pauling/dna/pictures/sci9.001.5.html>. This is the original image of Photograph 51, attached to a sheet from Franklin's lab notes, which basically was the significant encounter that led to the final clarity in the understanding of DNA structure in the exploration of Franklin and others in biology. This was the photo that was exchanged with Watson and Crick without Rosalind's knowledge, allowing them to publish their famous theory in Nature, without crediting her.

Franklin, Rosalind E. *Location of the Ribonucleic Acid in the Tobacco Mosaic Virus Particle*. London: Birkbeck College, University of London W.C.L., 1955. *CSHL Archives Repository*. Web. 8 Feb. 2016. <http://libgallery.cshl.edu/items/show/73982>. This was

Rosalind Franklin's original paper on the structure of the TMV. This paper demonstrates a couple of things. First, it further concludes that Rosalind continued her scientific structural biology exploration beyond DNA, keeping up important exchanges in that field. Second, it shows the depth of impact that DNA's structure made on biology. Not only did the discovery lead to new findings like genetics, it also led to the understanding of the structure of similar molecules, like RNA, which made up parts of high interest molecules like the TMV, which eventually aided in the development of the polio virus. Rosalind's encounter of Photo 51 led to exchanges that meant everything to the exploration of structural biology, both immediately and through later research, like this paper.

Franklin, Rosalind E., D. L.D. Caspar, and Aaron Klug. *The Structure of Viruses as Determined by X-Ray Diffraction*. N.p.: n.p., 1959. *CSHL Archives Repository*. Web. 8 Feb. 2016. <http://libgallery.cshl.edu/items/show/73984>. This was the paper published by Franklin, Caspar, and Klug on their findings of the structure of viruses, particularly TMV, resulting from Franklin's crystallography work at Birkbeck following her departure from DNA and King's. This is the paper that all of the scientists in biology were talking about, because it showed extreme advancements in the field of structural biology, and was very important to future developments, such as the polio vaccine. This demonstrates that Rosalind's scientific and social exploration did not end with DNA, but rather, her exchanges of data with other scientists continued to reform biology until she died.

Franklin, Rosalind E., and Barry Commoner. *X-Ray Diffraction by an Abnormal Protein (B8) Associated Tobacco Mosaic Virus*. N.p.: n.p., 1956. *CSHL Archives Repository*. Web. 8 Feb. 2016. <http://libgallery.cshl.edu/items/show/73983>. This was another paper published by Franklin in conjunction with a fellow biologist after her departure from Kings on her work on the Tobacco Mosaic Virus. This paper gave me two points to add to my research. First, because of its advanced nature and a handwritten note on the paper from Francis Crick asking Rosalind for the paper back, we can see that Rosalind's work after DNA continued to be very influential in science, and promote collaboration or exchanges with other scientists to advance the exploration of biological structures. Second, we can see through the bibliography where Rosalind cites work from both Watson and Crick, Rosalind held nothing against them, but continued to exchange data

with them for the sake of scientific exploration, so her encounter of gender prejudice was likely not due to personal spite, so much as the social climate of the 1950s.

Franklin, Rosalind E., and Raymond G. Gosling. "A Note on Molecular Configuration in Sodium Thymonucleate." 1953. Special Collections & Archives Research Center. Oregon State University. Sci9.001.20. *Linus Pauling and the Race for DNA*. Web. 29 Jan. 2016. <http://scarc.library.oregonstate.edu/coll/pauling/dna/notes/sci9.001.20-01.html>. This was Rosalind Franklin and Raymond Gosling's draft of their publication of the structure of DNA, which reached the *Acta Crystallographica* just one day before Watson and Crick got the model from the last piece of her data, thanks to Wilkins, photo 51. This manuscript contains all of the data of the Double Helix Theory except the replication method and anti-parallel base-pairing direction. After Watson and Crick sent in their paper to nature, this ended up as an addendum or proof to their theory. In other words, she got the structure first, but the exchange provided the other two pieces of the theory. This demonstrates just how fundamental Rosalind's data was in forming the experimental foundation of the Double Helix Theory.

Fraser, R. D.B. "The Structure of Deoxyribose Nucleic Acid." 17 Mar. 1953. Special Collections & Archives Research Center. Oregon State University. Fraser-structure. *Linus Pauling and the Race for DNA*. Web. 29 Jan. 2016. <http://scarc.library.oregonstate.edu/coll/pauling/dna/notes/fraser-structure-01.html>. This paper was essentially an official scientific benchmark, in which all of the scientists working at or around King's College, including Wilkins, Franklin, Price and Randall all gave a consensus on what they had agreed on in terms of the structure of DNA. With that, they discuss their ideas on other proposed theories, such as the Paulings', and Rosalind's disagreement with it. While this was a very early synthesis of ideas, it was presented in the beginning of 1953, the same year as the infamous *Nature* article of the Double Helix Theory, and thus, demonstrates how far ahead the scientists working at King's were in terms of their research, particularly Franklin. It also shows how their exchanges with other scientists led to the betterment of the whole field of biology, not just the tiny part in their own university.

Gosling, Raymond. *Raymond Gosling on Becoming a Scientist: Working at King's College*. *CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, 3 Mar.

2003. Web. 2 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/scientific-experience/becoming-scientist/golsing-becoming-scientist-working-kings-college/>. This was another oral history from the CSH Oral History Collection in which Raymond Gosling, longtime friend and colleague of Rosalind Franklin, discusses his work at King's College, where he did most of his work with Franklin. He reveals that while King's college was created in part to provide a university education to both women and religious minorities, it still held some prejudice against women, as all fields of science did, leaving me to interpret that Rosalind, was indeed, exploring a new major field for women and encountering prejudice. He also discusses how the work of DNA came to Wilkins, and how his shy experimental lack of skill worked with it, which leads to the confirmed conclusion that it was Rosalind's exploration that reformed the research.

Gosling, Raymond. *Raymond Gosling on Continued Relationship with Rosalind Franklin*. *CSH Oral History Collection: CSHL Digital Archives*. Cold Srping Harbor Laboratory, 3 Mar. 2003. Web. 2 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/james-d-watson/discovering-double-helix/continued-relationship-rosalind-franklin/>. This was another oral history with Raymond Gosling, friend and colleague of Rosalind Franklin, of the CSH Collection. In this short clip, Gosling discusses Rosalind's departure from King's, and how she was banned from studying DNA in order to leave to Birkbeck College. He also discusses how she never honored the ban, but instead, continued to work on DNA and help him finish his thesis. This demonstrates her dedication to her exploration, and also her continued encounters scientifically. Finally, he discusses the fun he had working with Rosalind, her personality, and the struggles regarding gender prejudice she faced during her work as a scientist.

Gosling, Raymond. *Raymond Gosling on Francis Crick*. *CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, 3 Mar. 2003. Web. 2 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/scientific-experience/molecular-biologists/gosling-francis-crick/>. This was another oral history from the CSH Oral History Collection, in which Raymond Gosling, longtime friend and colleague of Rosalind Franklin, made a brief note on scientist Francis Crick. Basically, the significance of this statement is that Gosling does confirm the great intellect of both Watson and Crick, saying he is not surprised that they solved the structure, however,

Crick was very much a flighty scientist, hopping from flower to flower, being slow to finish anything, and if it hadn't been for Rosalind's exploration, uncovering the hard data which was exchanged to Watson and Crick, they couldn't have finished or proved their theory.

Gosling, Raymond. *Raymond Gosling on Seeing the Watson-Crick Double Helix Model*. *CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, 3 Mar. 2003. Web. 2 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/james-d-watson/discovering-double-helix/seeing-watson-crick-double-helix-model/>. This was another oral history from the CSH Collection in which Raymond Gosling, friend and colleague of Rosalind Franklin, discussed the moment when Rosalind first saw the model and theory of Watson and Crick's Double Helix. He says that she was hardly upset, but rather, felt that the scientists involved, including herself, and all of the scientists before her, were all standing on one another's shoulders-that this was the product of years of work from all of them, and they should all be proud. This was the beginning of a burst for biology, when scientists were now discussing they never thought they would. Rosalind's wish was never that she had done it first-she looked at it in terms of science-it was an accomplishment of the field. Thus, Rosalind's exploration and encounter of Photograph 51, which allowed the exchange of data to Watson and Crick, helped to create the foundation to the theory which changed the entire field of biology.

Gosling, Raymond. *Raymond Gosling on The DNA Race*. *CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, 3 Mar. 2003. Web. 2 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/james-d-watson/discovering-double-helix/race-double-helix/>. This was an oral history from the CSH Collection in which Raymond Gosling, friend and colleague of Rosalind Franklin, discussed the "race to discover DNA's structure". Gosling explains that to Rosalind, it was never a race, only to Maurice Wilkins. When Watson and Crick made their publication, and the model was released, Franklin had already begun writing her paper on the helical B form of DNA. However, she didn't believe in building models-she wanted to have the math to prove her theory. So, as she was finishing this, Watson and Crick released theirs, and Franklin and Gosling were offered an opportunity to add to their publication-a supplemental article. Randall demanded they do it, and so they quickly finished their paper and added it to

Nature. This yet again confirms that it was Rosalind's exploration that provided the raw data to prove the Watson and Crick theory, leading to the biological explosion of exchanges among scientists.

Gosling, Raymond. *Raymond Gosling on Working on DNA with Rosalind Franklin*. *CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, 3 Mar. 2003. Web. 1 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/scientific-experience/molecular-biologists/working-dna-rosalind-franklin/>. This was yet another oral history from the CSH Digital Collection where Raymond Gosling, longtime friend and colleague of Rosalind Franklin, gave a personal account of his work with her at King's College. He discusses Franklin's incredible laboratory skill, her significance in redefining experimental work and providing the data not only to uncover the structure of DNA, but also to gain an international reputation for her work in coal and later, RNA. It was for this reputation she was headhunted to work at King's in the first place. He also discusses her personality and work ethic, both in regards to her scientific exploration and in conjunction with her conflicts with Maurice Wilkins. He explains how much of the feudal conflict was the fault of a misunderstanding caused by a lack of information given by Randall upon hiring Franklin, and makes note that Watson's account of her personality was very far off. Finally, he specifically talks about the significance of her accomplishing all of this as a woman in this field. All in all, Gosling's account allows us to see firsthand the significance of Rosalind's career and its context, in terms of exploration, encounter, and exchange.

Holton, Gerald James. "Robert Olby. Interview with Gerald James Holton. Plenary Sessions of the Conference on Transforming Conceptions of Modern Science, Bellagio Italy. September 1969." Interview by Robert Olby. *Linus Pauling and the Race for DNA*. Ed. Oregon State University Library. Special Collections & Archives Research Center, Oregon State University Libraries, 2015. Web. 5 Feb. 2016. <http://scarc.library.oregonstate.edu/coll/pauling/dna/people/franklin.html>. This was an excerpt from an interview of Gerald James Holton conducted by Robert Olby during the Plenary Sessions of the Conference on Transforming Conceptions of Modern Science, held in Bellagio Italy in September of 1969. In it, Holton comments that, "[Franklin] came very much closer to the discovery of the double helix than she has usually been

credited with doing." This demonstrates that the encounter of gender prejudice was, in fact, a factor in determining Rosalind's credit for the Double Helix, and that the exchange between male scientists and their prejudice, after receiving her data without her consent, led to a misconception that Rosalind had little to do with the Double Helix theory. Holton was an American physics professor during the time of Rosalind's research, working at Harvard University.

Houghton, Kathleen. Letter to James D. Watson. 16 Feb. 1990. James D. Watson Collection. CSHL. JDW/2/2/765a/42. *CSHL Archives Repository*. Web. 16 Feb. 2016. <http://libgallery.cshl.edu/items/show/39141>. This was a letter from a high school senior in New York who had just studied the work of James Watson writing to James Watson in the years following his publication of the Double Helix. In the letter, Houghton says that when they studied Watson, they also learned about Rosalind Franklin, which demonstrates that outside the social context of the 1950s, Rosalind's work was significant enough to become a standard in high school biology. Also, it demonstrates the impact of her encounter on Watson's publication. The letter mainly was the best example I have uncovered of exchanges resulting from Watson's prejudicial view of Franklin in his autobiography and the prejudice Rosalind encountered as a whole. Houghton accuses Watson of disgusting behavior, and asks him why it can't ever be women that are commended for important work. The letter is very scornfully written, and leaves no room for argument. This shows two things; one, Watson's views of Rosalind were without a doubt, prejudicial, and two, that Rosalind's exploration in a new field for women led to a major influence in changing gender prejudice by influencing exchanges on the treatment of her during her work at King's long after her death. At first, women that read her story regarded it as normal. But, as time went on and the exchanges reconsidered the story, by this point in history, we can see that the view has shifted entirely, and now prejudice is considered inexcusable.

Klug, Aaron. *Aaron Klug on Francis Crick. CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, 17 June 2005. Web. 1 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/scientific-experience/molecular-biologists/aaron-francis-crick/>. This interview is a personal statement of Aaron Klug, close friend and colleague of Rosalind Franklin, on his work with copublisher of the

Double Helix theory, Francis Crick. In it, he confirms that Watson and Crick never had much raw data to support their theories. Rather, the data came from Franklin, and they functioned as creative visionaries. Many of their initial theories were wrong, but they never knew because of the lack of data. This is a further confirmation that Rosalind was well on the road to discovery-she just wanted to be sure. This fact tells us the significance of her scientific exploration and encounter, as well as the exchange of her data to Watson and Crick, though she wasn't responsible for it initially. They were the fast route for her data- her contribution compounded with their vision led to the final theory of the DNA structure.

Klug, Aaron. *Aaron Klug on Jim Watson: Writer*. *CSH Oral History Collection: CSHL Digital Archives*. Cold Spring Harbor Laboratory, 17 June 2005. Web. 1 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/james-d-watson/writer/aaton-jim-watson-writer/>. In this short interview, Aaron Klug makes a brief review of James Watson's book, "The Double Helix," which became such a controversial conversation piece due to its rude patriarchal presentation of Rosalind Franklin's work on DNA. According to Klug, Jim was a great writer, but not subtle or terribly accurate. He tended to leave many things out in order to make his writing entertaining and powerful. Reading between the lines, this source confirmed that the scientists that worked most closely to Franklin were upset with Jim's portrayal of her, and felt that her contributions were not given enough significance. This is yet another example of Franklin's encounter of social prejudice and the exchange sparked from this realization. Aaron's admission that the book was powerful is also yet another confirmation of the importance of Rosalind's scientific exploration.

Klug, Aaron. "From Macromolecules to Biological Assemblies." Nobel Lecture. MRC Laboratory of Molecular Biology, Cambridge CB2 2QH, U.K. 8 Dec. 1982. Print. Lecture transcript. This was Aaron Klug's lecture which he gave for his Nobel Prize on RNA and virus structural models. In it, he credits Rosalind Franklin with the beginning data to his work. Rosalind Franklin did a good deal of exploration in RNA after she was banned from working on DNA due to its similar structure. This is yet another historically significant of her exploration sparking exchanges, both socially and scientifically. It helped me understand the true depth of her work-the span it covered, across biology.

Klug, Aaron. "Letter from Aaron Klug to Philip Siekevitz." Letter to Philip Siekevitz. 14 Apr. 1976. Profiles in Science: Rosalind Franklin Papers. The National Library of Medicine. PDF file. In this letter, Aaron Klug responds with a statement of his agreement of Rosalind Franklin's importance in the discovery of the structure of DNA, which he demonstrated in two articles in *Nature* in 1974 and 1976. However, he states she should not be honored for her role as a "woman of science" as she was not an active feminist or competitive about her work, but rather, key in developing the idea of the A and B forms of DNA. He explains that he feels Franklin's non-feminist attitude would have found such an honor "distasteful," and though she may have presented the DNA structure theory on her own, she probably wouldn't have done so "with the same flourish as Watson and Crick." For this reason, he concludes by refusing the award, saying if she had lived, she would have received many honors.

Klug, Aaron. "The Nobel Prize in Chemistry 1982: Aaron Klug." *Nobelprize.org: The Official Web Site of the Nobel Prize*. Ed. Nobel Media. Nobel Media, n.d. Web. 15 Jan. 2016. <http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1982/klug-interview-transcript.html>. This was an interview from the Nobel Prize Committee with Aaron Klug, friend and colleague of Rosalind Franklin, in which he talks about her exploration in biomedical science, both with viruses and DNA. He demonstrates how her work with viruses encountered structural theories which became the experimental foundation for later accomplishments such as the development of the polio vaccine, even shortly after her death. Further, he discusses how her experimental work, which encountered Photograph 51, among other breakthroughs, served as key information to the Watson and Crick theory, partly known and partly not known to her. Her development of an X-ray diffraction method new to crystallographers allowed her to discover 2 forms of DNA initially, and in the end, allow DNA to be structurally discovered all at once, not in stages. Klug says he admired her personality and work ethic, and learned a lot from it, which was important for me to understand, as he was a man. He also discusses her personal struggles, such as working with Wilkins, and the challenges her encounter of prejudice presented with her exploration. Overall, it further helped me understand the overlap between Rosalind's social and scientific exploration, and their consequent encounters/exchanges.

Klug, Aaron. *Oral History: Aaron Klug on Rosalind Franklin*. *CSH Oral History Collection: CSHL Online Archives*. Cold Spring Harbour Labratory, 17 June 2005. Web. 1 Jan. 2016. <http://library.cshl.edu/oralhistory/interview/scientific-experience/women-science/aaron-rosalind-franklin/>. In this short review of his work with longtime friend and colleague, Aaron Klug, another scientist who worked alongside Rosalind, gives a personal view of her work ethic and relationships with key figures such as Maurice Wilkins. He confirms that Rosalind, would, indeed have been able to decode the structure of DNA on her own, in time, however, he felt that her imagination was not as great as that of Watson and Crick, and therefore, her presentation of it wouldn't have held the same finesse. Still, he credits her for her extreme intellect and lab skills, her importance in the discovery of the structure and pioneering crystallography, and finally, her importance in pioneering a new area of opportunity for women.

Linus Pauling gesturing toward a model of the alpha-helix. Aug. 1954. Photograph. Special Collections and Archives Research Center: Linus Pauling and the Race for DNA. Oregon State University Libraries. 1954i.38. This was a photo of Linus Pauling and his triple helix DNA model, which Rosalind Franklin would disprove. I used it visually in my exhibit.

"Linus Pauling's Triple Helix." *Yale Scientific*. Yale, 21 Dec. 2013. Web. 7 Apr. 2016. <http://www.yalescientific.org/2013/12/brilliant-blunders-from-darwin-to-einstein-colossal-mistakes-by-great-scientists-that-changed-our-understanding-of-life-and-the-universe/>. This was a diagram of Linus Pauling's triple helix DNA model, which Rosalind Franklin would quickly disprove. I used it visually on my exhibit.

Madrid Crystallographic Meeting. 1 Apr. 1956. James D. Watson Collection. CSHL. JDW/1/16/3. *CSHL Archives Repository*. Web. 14 Feb. 2016. <http://libgallery.cshl.edu/items/show/51763>. This was a photo of Rosalind Franklin, John Kendrew, Francis Crick and others at the Madrid Crystallographic Meeting in 1956, the prime of Rosalind's scientific career. I intend to use it as a visual component on my board. It is important to note that Rosalind is the only person in the photo that is female and a scientist, not a wife. She is also the only person not smiling, but serious. It provides an interesting view of her career, as she was never taken seriously, but seemed to be the only serious one. It certainly demonstrates science as being "a Man's World."

Nature 302 (1983). Print. This was a later publication of James Watson in *Nature* where he goes over the events leading up to his publication of the double helix theory in 1953. He says that he discovered Franklin and Gosling were working together on the structure of DNA, but not in collaboration with Wilkins. He admits they had the best DNA preparation. However, he credits the crystallographic experimental successes to Wilkins and Gosling, instead of Franklin, even though they were her successes. Thus, we see that he was aware of her talent and importance, but refused to admit it where it counted-further gender prejudice, and demonstration of Franklin's importance to the scientific exploration.

"1962 Nobel Prize." *Academy of Acheivement*. American Academy of Acheivement, 1996. Web. 7 Apr. 2016. <http://www.achievement.org/autodoc/page/wat0bio-1>. This photo depicts Wilkins, Watson and Crick receiving the Nobel Prize of 1962. I displayed it visually on my exhibit.

"The original DNA demonstration model." *Linus Pauling and the Race for DNA*. Oregon State University Libraries, 2015. Web. 7 Apr. 2016. <http://scarc.library.oregonstate.edu/coll/pauling/dna/pictures/picture-dnamodel.html>. This was a photo of Watson and Crick's double helix model, which I used visually on my exhibit.

Pauling, Ava Helen. Interview by Lee Herzenberg. Sept. 1977. This was an interview with Ava Helen Pauling, who was in constant correspondence with Linus and Peter Pauling, two fellow DNA researchers to Rosalind Franklin, about Franklin's work with DNA. In this interview, Pauling agrees with the other scientists in their exchanges on Franklin's experimental data, that Photograph 51 was the clearest crystallographic image in structural biology history, and it screamed "helix." This is just further evidence of the importance Franklin's experimental data had on the discovery of the structural theory of DNA, and consequently, the field of biology.

Pauling, Linus. Letter to Peter Pauling. 10 Mar. 1953. *Linus Pauling and the Race for DNA*. Web. 15 Jan. 2016. <http://scarc.library.oregonstate.edu/coll/pauling/dna/corr/sci9.001.29-lp-peterpauling-19530310-transcript.html>. This was a letter from Linus Pauling to Peter Pauling around the time Rosalind's Photograph 51 was given to Watson and Crick and she moved to Birkbeck College. The Paulings had created a theory of DNA's structure as well,

however, as stated in this letter, Rosalind proved it wrong, and explained her research, not yet published but given to Randall, dictated that the phosphate groups of DNA occurred on the outside, as in the Double Helix structure. At this point, the Paulings had not yet met Rosalind, but found her theory hard to prove. This was part of the exchange sparked by Rosalind's exploration which would lead to the most significant exchange at all-the exchange of Rosalind's data and Photograph 51 to Watson and Crick without her knowledge, resulting in their publication. This source demonstrates Rosalind's research/exploration was indeed at the forefront of discovering DNA, and thus, substantially responsible for its eventual structure discovery.

Pauling, Linus. Letter to Peter Pauling. 27 Mar. 1953. *Linus Pauling and the Race for DNA*. Web. 15 Jan. 2016. <http://scarc.library.oregonstate.edu/coll/pauling/dna/corr/sci9.001.33-lp-peterpauling-19530327-transcript.html>. This was another letter from Linus Pauling to Peter Pauling. The Paulings were another pair of theorists on the structure of DNA working alongside Franklin, Watson, Crick and Wilkins during the "race" to the structure of DNA. This letter in particular was written immediately after Watson and Crick made their official publication in nature on the double helix theory. They mention that Rosalind has gone off to Birkbeck College, and follow that by explaining what they saw from the Watson and Crick theory and the significance they found in it, as they believed it was a viable theory. The part that was most important to my research was the fact that Pauling describes the verifying data to be *Wilkins'* photographs, though Rosalind Franklin was the one that took them. This is just one more example of the significance of Rosalind's experimental work, and the social prejudice which kept her from controlling it.

Pauling, Linus. Letter to Peter Pauling. 18 Feb. 1953. TS. This was another letter from Linus Pauling to Peter Pauling, the isolated duo in the race to discover DNA structure, working alongside Franklin, published while Rosalind and Watson and Crick were exchanging thoughts on the DNA structure and Rosalind was being forced to leave Cambridge to go to Birkbeck. This letter was being written shortly after the "Cambridge people" shot down Paulings' theory. Paulings says that he doesn't have a good opinion of Rosalind, but does Maurice, though he has never met either one of them. This is a blatant example of social prejudice exuded toward Franklin.

Pauling, Linus. "Linus Pauling, Crusading Scientist." Interview by Robert Richter and NOVA, WGBH-Boston. *Linus Pauling and the Race for DNA*. Ed. Oregon State University Libraries. Special Collections & Archives Research Center, Oregon State University Libraries, 1977. Web. 5 Feb. 2016. <http://scarc.library.oregonstate.edu/coll/pauling/dna/audio/1977v.66-dnawork.html>. This was an interview with Linus Pauling with NOVA where he talks about his own involvement in the race to discover the structure of DNA. He says that he was also trying to beat Watson and Crick and those at Kings to discovering the structure of DNA, but that he lost because he was handicapped to the equipment of Watson and Crick with Franklin's data, which he considered imperative to their success. He also says that The discovery was based solely on her photographs. Thus, we can see that Franklin's experimental data was *known* to be fundamental to the theory from the very beginning, and the exchange of it to Watson and Crick was the only reason biology was advanced in the fashion that it was.

Pauling, Linus. "Linus Pauling note to self concerning Rosalind Franklin's research on tobacco mosaic virus." Memo. 6 Oct. 1954. Special Collections & Archives Research Center. Oregon State University Libraries. Sci3.005.28-Iptoself-19541006. *Linus Pauling and the Race for DNA*. Web. 5 Feb. 2016. <http://scarc.library.oregonstate.edu/coll/pauling/dna/notes/sci3.005.28-lptoself-19541006.html>. This was a memo Linus Pauling, fellow DNA researcher, wrote to him self regarding his thoughts on Rosalind Franklin's research on the Tobacco Mosaic Virus structure. Through this letter, we can see that Linus Pauling found that Rosalind's research was very advanced for her time, but he won't openly concede this because of her gender. Either way, we can see that Rosalind made advances in her scientific exploration in more than just DNA research. Her experimental methods were cutting edge and led to very advanced structural encounters, and the data that she produced she exchanged with other scientists, thus advancing the field of biology.

Pauling, Peter. Letter to Linus Pauling and Ava Helen Pauling. 14 Mar. 1953. *Linus Pauling and the Race for DNA*. Web. 15 Jan. 2016. <http://scarc.library.oregonstate.edu/coll/pauling/dna/corr/bio5.041.6-peterpauling-lp-19530314-transcript.html>. This was a letter from Peter Pauling to Linus Pauling and

another family member. The Paulings were more DNA theorists at the time of Watson, Crick, Wilkins, and Franklin who sort of worked in isolation and on their own terms, but relied on the other scientists for criticism of their work. Rosalind's, as indicated in this letter, was not always welcome as the Paulings did not take her seriously as a female [conclusive evidence of gender prejudice in 1950s]. In this letter, Peter discusses the transfer of his paper to James Watson, whom he considered a more significant scientist. He also mentions that Wilkins and Franklin were to take a look at it, but that Franklin was just a fool sticking her nose in-it was Wilkins that was supposed to be doing the work anyway. Thus, from this source I could conclude that not only was Rosalind the only not-competitive/racing figure in the quest to unravel DNA's structure, but almost all of the men she worked with considered her a difficult female, not a significant scientist, as she was. She most certainly encountered significant prejudice socially.

Piper, Ann. "Light on a Dark Lady." Wimbledon Literary and Scientific Society. Oct. 1995. *CSHL Archives Repository*. Ed. CSHL. CSHL, n.d. Web. 8 Feb. 2016. <http://libgallery.cshl.edu/items/show/52975>. This was a transcript of a speech by Ann Piper, longtime childhood friend of Rosalind Franklin, that she gave after Rosalind died in order to give her due credit for the groundbreaking change she created as a female scientist, both socially and scientifically, through her discoveries, such as the structure of DNA. In the speech, Piper tells the entire Franklin story from her point of view, beginning with their time in school as children, all the way through the work Franklin did at King's college, her lack of anger toward the gender prejudice she faced because of the social climate of the time, and the work she did up until her early death. The entire speech is given in reference to the historical context of the time, and with association of the political and social backgrounds of Rosalind's family. Basically, it gives a non-scientific perspective on Rosalind Franklin's social and scientific explorations, the encounters made through them, and the subsequent exchanges.

Piper, Anne. "Rosalind Franklin: Light on a Dark Lady." *TIBS* 23.268 (1998): 151-54. *CSHL Archives Repository*. Web. 14 Feb. 2016. <http://libgallery.cshl.edu/items/show/52975>. This was an article written by Anne Piper, longtime childhood friend and fellow scientist of Rosalind Franklin, in the TIBS, or "Trends in Biochemical Sciences," journal. It was derived from her lecture at Wimbledon, "Light on a Dark Lady," but being that it was

published in the journal, it contained some additional photographs, side notes, and primary excerpts. It also contained two additional articles at the end. One was by E.C. Friedberg, looking back on the discovery of the double helix, and the other by Sydney Brenner, longtime friend and colleague of Rosalind's, called, "Biology's enfant terrible." Like the lecture, it discussed both Rosalind's scientific contributions and the social prejudice she faced as a woman. The fact that it was published in such a prestigious journal so late shows that exchanges about Rosalind's impact carried on well past her death, demonstrating the significance and influential impact of her explorations and encounters.

Randall, J. T., and King's College London. Letter to Rosalind Franklin. 4 Dec. 1950. Profiles in Science: Rosalind Franklin Papers. National Library of Medicine. PDF file. In this letter, Randall is explaining to Rosalind Franklin what he wants her to work on in her research at King's College in London. Instead of following the original intended solution of the research, he states that he wants Franklin to focus on investigating the structure of certain biological fibers using both low and high angle diffraction. He wants to focus on theoretical problems of the future, which are likely to use all microscopy, not just X-ray optics. It will just be her and Gosling with a graduate student Mrs. Heller. It is in this letter that he informs her of Wilkin's work in DNA, which Gosling worked in conjunction with. Basically, in summary, this letter is the request by Randall for Franklin to focus on investigating the structure of DNA in her time at King's College. This request for exploration is what would lead to her encounter of Photograph 51, Wilkins, prejudice and more, and also the fateful exchange between Franklin's work and Watson and Crick.

Rosalind Franklin. Mar. 1956. Novartis Foundation. Portrait-franklin. *Linus Pauling and The Race for DNA: Oregon State University Libraries Special Collections and Archives Research Center*. Web. 25 Jan. 2016. <http://scarc.library.oregonstate.edu/coll/pauling/dna/pictures/portrait-franklin.html>. This was a photographic portrait of Rosalind Franklin, which I used visually in my exhibit

Sayre, Anne. Letter to James D. Watson. 26 Aug. 1970. James D. Watson Collection. CSHL. JDW/2/2/618/78. *CSHL Archives Repository*. Web. 16 Feb. 2016. <http://libgallery.cshl.edu/items/show/37190>. This was a letter from Anne Sayre to

James D. Watson in which she shared a lot of information about Rosalind's relationship with her family, regarding both her work in science and her political views. This gave me insight into not only Rosalind's childhood and personal background, but how prejudice was a factor in the social structure of her family, and what sort of social environment she would have been used to before coming to King's. This was mainly a contributing source to the social side of my research.

Schramm, G. Letter to James D. Watson. 25 Feb. 1956. James D. Watson Collection: Personal Papers: Correspondence. CSHL. JDW/2/2/1620/1. *CSHL Archives Repository*. Web. 7 Feb. 2016. <http://libgallery.cshl.edu/items/show/86327>. This letter was written from scientist G. Schramm, from the Max Planck Institute for Viruses to James Watson in the years following the discovery of the double helix when most of the scientists who had previously been working on DNA had turned to small viruses, the same subject Rosalind had taken up upon moving to Birkbeck. This letter is significant because Schramm mentions he would like to meet with Watson and Franklin about their work on viruses, which demonstrates that Rosalind's scientific exploration continued to be very important in exchanges among scientists, which were greatly increased because of her work in the DNA question.

Siekevitz, Philip. "Letter from Philip Siekevitz to Aaron Klug." Letter to Aaron Klug. 26 Mar. 1976. Profiles in Science: The Rosalind Franklin Papers. The National Library of Medicine. PDF file. In this letter, the President of the New York Academy of Sciences requests the Awards Committee honor Rosalind Franklin for her work in science, which he feels has been too lightly credited. It demonstrates the prejudice/unfair crediting Rosalind Franklin encountered, and the exchange later caused over controversy over this conflict.

Stanley, Wendell M. Letter to James D. Watson. 8 Feb. 1956. James D. Watson Collection: Personal Papers: Correspondence. CSHL. JDW/2/2/1725/1. *CSHL Archives Repository*. Web. 7 Feb. 2016. <http://libgallery.cshl.edu/items/show/86967>. This was a letter from Wendell Stanley, a scientist working in the virus laboratory at the University of California-Berkley, to James Watson, who at the time, was working with Crick on small viruses at the same time as Franklin, who was working on TMV at Bernal. In the letter, Stanley said that he had heard from Bernal about the results from Franklin's latest work,

and he agreed that her work was becoming of greater and greater interest. This demonstrates that even after Rosalind was banned from her exploration of DNA and forced to leave for Birkbeck, she continued to demonstrate significant scientific exploration, and had several structural encounters that continued exchanges with scientists that advanced the field of structural biology.

Watson, James. "James Watson, 'Succeeding in Science: Some Rules of Thumb.'" *Science* 261.24 (1993): 1812. Print. This was another article from James Watson in the journal *Science* where he discusses the exchanges going on between the scientific community and those witnessing it in regards to the controversy over whether or not he "stole" her data, mainly Photo 51, in order to submit his double helix theory, and whether or not she was credited fairly. He says that he is being accused of theft of her data, but that it simply didn't happen like that. Wilkins showed him the photo and gave him the measurements. He did not physically steal it. He was simply shown it and knew right away that it was a helix. He does concede that the photo was the event that psychologically mobilized him to develop his theory. This means that Watson declared on his own accord that the exchange of data of Franklin's is indeed what created his theory on the double helix, and without her experimental exploration encountering the photo, it wouldn't have been possible. However, he also deems the controversy exchange as not his fault, but does admit that the data was, in a sense, taken from Rosalind, in largest part because of gender prejudicial encounters.

Watson, James D. "Copy of galley proof of letter to Science by James D. Watson regarding Science's review of The Double Helix. Includes handwritten annotations by Watson." Letter to Science. 19 May 1969. James D. Watson Collection: Personal Papers: Correspondence. CSHL. JDW/2/2/1630/10. *CSHL Archives Repository*. Web. 7 Feb. 2016. <http://libgallery.cshl.edu/items/show/86402>. This was a response from Watson to the journal *Science* regarding their review of his autobiography, "The Double Helix." In it, Watson clarifies that though *Science* felt that he was dishonest, he did not steal Franklin's data, and neither did Crick. Both could have copied down her data, but they didn't, further insinuating that it was just *presented* to them, and thus, they could not be negatively held accountable for deceit. Further, Watson says that he did feel Rosalind's A and B form of DNA work was of vital importance, and that the only reason he did not

elaborate on it was because it would have been dry to the average reader. He agrees the Randall letter on the work at King's was of the highest importance. Finally, he says that his not taking notes at Rosy's lecture was not due to not taking her seriously, though he admits to this anyway, it was simply a bad habit. We can see through these exchanges that Watson's treatment of Rosalind in his later publications and early opinions of her were merely a product of the social climate of his time, and that her exchange of data was vital to the discovery of the double helix.

Watson, James D. *The Double Helix: A Personal Account of the Discovery of the Structure of DNA*. 2nd ed. New York: Atbeneum, 1969. Print. This was perhaps one of the most important resources in my research; it is the infamous autobiography of James Watson on his work with DNA. The reason for its importance is it encompasses James Watson's initial thoughts about Rosalind, and basically a lot of reflections of her as a young man, which revealed the true integration of gender prejudice in the social context of that time. It also provided a first-hand account of how Rosalind was credited, how her data was received and used, and the overall importance of her experimental work. This book sparked immense controversy over the "disgusting" view of "Rosy" as being a female out of place and simply in the way of "real science." It was also disputed over its initial discounting of her importance. The version of the book I used was the second edition, which contained an addendum at the end where Watson, in response to the outrage of readers, re-framed his recollection of Rosalind to demonstrate that the book was written to show his thoughts of her as a young man during that social context-as it was, and that now, he understands how the context influenced him, and he now realizes the importance of her contribution to science. This book influenced exchanges on social acceptance of women in various areas of society and the importance of Rosalind's work for years after her death. This book allowed me to directly understand the prejudice affecting Franklin and the importance of her contributions to science.

Watson, James D. Letter to Istvan Hargittai. 2 Sept. 2003. James D. Watson Collection. CSHL. JDW/2/2/781/3. *CSHL Archives Repository*. Web. 14 Feb. 2016. <http://libgallery.cshl.edu/items/show/39287>. This was a piece of correspondence between Watson and Istvan Hargittai, in which for whatever reason, Watson was answering some questions regarding his discovery of the double helix. The reason it was

important to my research was because in this letter, Watson confirms that no one knows for sure whether or not Rosalind Franklin was ever explicitly told that Maurice Wilkins showed her Photo 51 to Watson and Crick. However, while he admits it was very important to his research, Watson defensively says that model building would have brought him to the same conclusion *eventually*. Thus, it is quite possible her data was shared without her knowledge-it was never checked to see if she knew-or perhaps-no one wanted her to.

Watson, James D. Letter to Lillian Molnar. 17 Dec. 1982. TS. James D. Watson Collection. CSHL. JDW/2/2/1113/44. This was another letter in which James Watson had to defend his highly socially prejudice account of Rosalind Franklin in the "Double Helix." In this article, he confirms that what he wrote in his original book was an account of how he thought as a young man in that social context, not how he more "reasonably" remembers Rosalind today. He directs the reader to his second edition of the book, where he made an addendum to address the issue. This shows that Rosalind not only encountered social prejudice, but that it was entirely a byproduct of the historical context, and since has been reformed, mainly through the influence of explorers like her who rewrote the boundaries for women in the workplace.

Watson, James D. Letter to Michael Stoker. 5 Dec. 1979. TS. CSHL Archives Repository. CSHL. JDW/2/2/1744/32. This was a letter from James Watson to a friend, Michael Stoker, shortly after his publication of the Double Helix was released. In it, he claims he is fearful that he will soon be receiving blackmail from the closest friends of Rosalind Franklin. This tells me that not only was Watson aware of the shameful nature of his opinions of Franklin, but he had changed them, which means that most of the social prejudice she encountered was a product of the social climate of the 1950s more than personal opinion.

Watson, James D. Letter to Rebecca Bargon. 22 Oct. 1998. TS. CSHL Archives Repository. CSHL. JDW/2/1759/102. This was the responding letter from James Watson to Rebecca Bargon regarding her request for his opinion on the coincidences that allowed his publication of the double helix theory, and essentially bluntly prompted him to respond on the issue of the Franklin controversy. In his response, Watson deems his greatest piece of luck the failure of Linus Pauling to solve the DNA structure, and deemed the Franklin

photo "unnecessary for success," clearly a defensive response to his own motivating factor of success (photo 51 use). However, in the next sentence. he does admit that if he had not been successful, he would predict that Wilkins or Franklin would have had the right answer by 1954. So, Watson himself admitted that Franklin's exploration was indeed on the road to success, and implies that her exchange of data to him was indeed the motivating factor for his success, so had it not been for the encounter of Photograph 51, the structure would have been a long way off.

Watson, James D. Letter to Rosalind E. Franklin. 9 Apr. 1955. James D. Watson Collection. CSHL. JDW/2/2/618/99. *CSHL Archives Repository*. Web. 16 Feb. 2016. <http://libgallery.cshl.edu/items/show/37197>. This was a letter from James Watson to Rosalind Franklin from 1955, in which Watson thanked Franklin for her latest manuscript on TMV. This letter showed that the two scientists continued to exchange data after the Double Helix Theory was published, which showed that neither thought anything of the social prejudice existing between them, but considered it a social norm, and that Rosalind never stopped her exploration as an elite crystallographer.

Watson, James D., and Francis Crick. "Molecular Structure of Nucleic Acids: A Structure for Deoxyribosenucleic Acid." *Nature* 171.4356 (1953): 737-38. *Oregon State University Libraries Special Collections & Archives Research Center: Linus Pauling and The Race for DNA*. Web. 25 Jan. 2016. <http://scarc.library.oregonstate.edu/coll/pauling/dna/papers/corr68.11-reprint-19530425.html>. This was the official publication of Watson and Crick's theory on DNA structure published in *Nature*, which sparked the period of exchange between scientists on the seemingly endless possibilities of what the double helix structure could mean for the field of biology (essentially, the beginning of modern genetics). This theory was based solely off of the experimental data of Rosalind Franklin (it was the first official publication of her Photograph 51, to which she was not even credited), and her name was stated a mere one time as an associate of Maurice Wilkins, who didn't contribute to the taking of Photograph 51. I used this article visually on my board, as well as linguistically, and this document resides at the focal point of the argument of my research, so it allowed me to see firsthand the presentation of the theory and Franklin's association with it so I

could then better understand the historical arguments of experts who authored my secondary work.

Wilkins, Maurice. Letter to Francis Crick. Jan. 1953. Cold Spring Harbor Laboratory Archives. Sydney Brenner Collection. *CSHL Archives*. Web. 2 Jan. 2016. <http://cshlarchives.blogspot.com/2013/03/dna-letters-1951-1953.html>. This was a letter from Maurice Wilkins to Francis Crick in 1953, which led to the publication of Watson and Crick's double helix theory. In it, Wilkins talks about an upcoming talk by Franklin, whose Photograph 51 Maurice had shown Watson on his last visit to London when he and Crick had come to show Franklin and Wilkins the incorrect triple helix theory of Linus Pauling. After receiving this letter they would go to King's arriving two days after the talk, which external visitors were barred to, and after Franklin had gone to Birkbeck to join Bernal's group. At this point, Watson and Crick saw the famous X-ray diffraction "Photograph 51" of B-form DNA which demonstrated clearly a helical structure, and would allow them to soon publish their theory. It allowed me to see that Wilkins was indeed in contact with the two without Franklin's knowledge, and her data was indeed imperative to their theory. Thus, it was her exploration that allowed for the accurate biological success.

"Women Protesting." *History Workshop Online*. History Workshop Journal, 2016. Web. 7 Apr. 2016. <http://www.historyworkshop.org.uk/category/archive/>. This was another image of the Women's Liberation Movement, which I used visually on my exhibit.

"Women's Liberation Movement." *The Economist*. The Economist, n.d. Web. 7 Apr. 2016. <http://www.economist.com/blogs/prospero/2013/03/women%E2%80%99s-liberation-britain>. This was a photo of women protesting in the British Women's Liberation Movement, which I included visually in my exhibit.

Secondary Sources

A., C. "Women in the Sciences: Rosalind Franklin." *Avenue* Tribute Issue: Women in the Sciences (2000-2001): 12. *CSHL Archives Repository*. Web. 14 Sept. 2015. <http://libgallery.cshl.edu/items/show/52641>. This was a special tribute article produced in the Avenue journal in 2000-2001 where Rosalind Franklin was recognized as an important woman in the sciences who faced immense social prejudice. Having an article

like this as late as 2001 further shows that exchanges on Rosalind's exploration and looking back on her encounter of prejudice continued to be influential long after her death in influencing the appreciation of women, especially in science related fields. It also provided a brief biography on Franklin in historical context to help jumpstart my research.

Bargon, Rebecca. Letter to James D. Watson. 30 Sept. 1998. James D. Watson Collection: Personal Papers: Correspondence: Student Letters. CSHL. JDW/2/1759/103. *CSHL Archives Repository*. Web. 7 Feb. 2016. <http://libgallery.cshl.edu/items/show/87578>. This was a letter from Rebecca Bargon, a student writing her Ph.D. dissertation, to James Watson, regarding the coincidences that allowed him and Dr. Crick to discover the structure of DNA before anyone else. She asks point blank who he believes would have discovered DNA before anyone else if he hadn't been around, and what information it was that allowed the discovery, very bluntly alluding to the Rosalind Franklin controversy. This demonstrates two ideas; first, exchanges continued far beyond Rosalind's death over whether she received due credit, and two; her involvement was so significant, people later on in history often regarded the discovery of the double helix as a mere series of coincidences, headed by Rosalind's exploration and encounter of Photo 51.

British Women's Liberation Movement, ed. "Timeline of the Women's Liberation Movement." *Women's Liberation Movement*. Ed. British Library. British Library, n.d. Web. 7 Apr. 2016. <http://www.bl.uk/sisterhood/timeline>. This website gave an overview of the events of the Women's Liberation Movement in Britain, which was aggrandized, in part, through the influence of Rosalind's story as a feminist icon. I used the dates not only to confirm at what point the movement emerged and if that had correlation with the Rosalind legend formation, but also for context on my timeline in my exhibit.

Castelow, Ellen. "The 1950s Housewife." *Historic UK*. N.p., n.d. Web. 7 Apr. 2016. <http://www.historic-uk.com/CultureUK/The-1950s-Housewife/>. This was a brief description of what 1950s British women mainly did in the home, how they were educated, and how they were culturally identified. It discusses the chores they were responsible for, the stereotypical identity as weak and soft, etc. I used it for further evidence of Rosalind's redefining social boundaries on my exhibit, and to further understand the context of women in Britain in her time.

Childs, David. *Britian Since 1945: A Political History*. N.p.: Routledge, 2001. Print. This book provided data on what percent of women vs. men attended college from 1920-1980, as well as what percent of women studied each field of science, which, combined with other data, I used to create historical context graphs in my exhibits. I received the book excerpts from Dr. Pat Thane, a professor at King's College, London. The study of women in education also included a study on how gender prejudice effected women's education and employment. I used a couple of these facts in quotations on my exhibit.

Cold Spring Harbor Laboratory. "DNA Timeline." *DNA Learning Center*. Ed. CSHL. HHMI, 2003. Web. 7 Apr. 2016. <http://www.dnai.org/timeline/index.html>. This was a simple, online timeline of advancements in research concerning DNA and genetics from their discovery to modern times. I used this to establish some basic "landmark dates" on my timeline, to give readers a scientific context of Rosalind's work.

Elkin, Lynne Osman. Interview by NOVA. 22 Apr. 2003. This was an interview conducted with Lynne Osman Elkin after the NOVA special on Rosalind Franklin aired in 2003. Elkin, who as I've said, does contain some feminist bias, explains that Rosalind was very close to having the structure solved herself, that she did not receive fair credit, and discusses what she thinks may have happened if she had not died and had had full control over her data.

Elkin, Lynne Osman. "Rosalind Franklin and the Double Helix." *Physics Today* March (2003): 42-48. PDF file. Lynne Elkin was one of the feminists largely impacted by the introduction of Rosalind as a feminist icon who continued to write feminist-biased biographies of her in modern times, stemming from earlier writers in the Women's Liberation Movement of the 1960s-1980s. It was one of the sources I encountered early on that contradicted more objective accounts. However, once I figured out why it was written in this way, it served as an example of the aftermath of the feminist movement. I quoted it on my exhibit to show the bias often seen in these publications, and also presented it as an image for an example of continued feminist writings on Franklin.

Gibbons, Michelle G. "Reassessing Discovery: Rosalind Franklin, Scientific Visualization, and the Structure of DNA." *Philosophy of Science* 79.1 (2012): 63-80. PDF file. Like Maddox's article in *Physics Today*, Gibbons' paper agrees that sexism and deceit did play a role in Franklin's discovery, however, continued exchange in response to *The Double*

Helix caused by the feminist movement has led to oversimplification, and therefore, loss of accuracy in her story, which has become a symbol of sexism in science. However, being interested in the philosophy of science, it goes on to analyze the fundamental value Rosalind's data had on the DNA structure research, deeming it the foundation, as I had been trying to prove, of the Double Helix Theory. This document is quoted to demonstrate these points in my exhibit.

Judson, Horace Freeland. *The Eighth Day of Creation*. N.p.: Simon & Schuster, 1979. Print. This was a secondary, historical account of the transformation of the field of biology resulting from the discovery of the double helix theory. In it, Judson discusses the importance of Franklin's experimental work in providing the only data a.) to uncover the idea of a double helix and b.) to support it. He states that her exchanges with other scientists gave them no indication that DNA was going to hold the importance that it did, but was a very intelligent woman, despite social prejudice encounters with the men she collaborated with at King's and neighboring research institutions. This is said to be one of the most influential historical accounts of the development of the field of biology, and it successfully accounts for Franklin's involvement in its advancements around DNA, as well as the challenges she faced along the way.

Maddox, Brenda. "The double helix and the 'wronged heroine.'" *Nature* 421.1 (2003): 407-08. PDF file. Like her other works on Rosalind, Brenda Maddox's article looks back on the life of Franklin and her impact on science. However, this article was particularly important in my research as Maddox backs up my initial ideas on Rosalind's social significance, and having this confirmation allowed me to continue successful research. Maddox agrees that while Rosalind was not herself a feminist, her story of exploring new social boundaries occurred at a time when women in Britain were thinking about fighting for equality, but hadn't yet begun a full movement, as they needed a leader to get started, and consequently, Rosalind's story was chosen to serve this purpose. Being that Rosalind was already gone, she never knew about this, but James Watson's *The Double Helix* sparked waiting feminist writers to start using Rosalind Franklin's story as a platform to preach women's rights, leading to more writing, more exchange about her, and even hate mail to Watson forcing him to amend his statements. In the end, as the myth of

victimized Rosalind continued to flourish, she not only helped to create change for women, but also inspired them in modern times, and continues to do so today.

Maddox, Brenda. "Mother of DNA." *New Humanist* (2002): 24-25. *CSHL Archives Repository*. Web. 7 Feb. 2016. <http://libgallery.cshl.edu/items/show/85477>. This was an article in the journal *New Humanist* by Brenda Maddox regarding the work of Rosalind Franklin in DNA and her belief in the lack of due credit given to Franklin. It was basically a brief follow-up of her publication of her official biography on Franklin, "Rosalind Franklin: The Dark Lady of DNA." This follow-up provided a short biography of Franklin's family relationships in conjunction with her work in science, social prejudice she faced both at home and work, an overview of her personality, and most of all, a study of how and why Franklin did not receive appropriate credit for her work. The article established a subjective point of view of the Franklin controversy which allowed me to see how exchanges about the social climate Rosalind was working in led to exchanges among historians on whether she received due credit. It also offered one theory on how the exchange of Franklin's data to Watson and Crick not only established the double helix theory, but basically created the field of structural biology itself.

Maddox, Brenda. *Rosalind Franklin: The Dark Lady of DNA*. New York: Perennial, 2002. Print. This was Brenda Maddox's most famous and comprehensive biography of Rosalind Franklin, which is still said to be the best perspective of her story today. From it, I not only clearly gained comprehension of Rosalind's story for the first time, but received primary information about her family, personal life, personality, and details about her career. I quote this book many times on my exhibit, and it led me to many new sources, particularly primary papers. Further, I took several photos from the book and used them visually on my exhibit.

Mahanti, Dr. Subodh. "Rosalind Elise Franklin: The Great Experimentalist Scientist." *Vigyan Prasar Science Portal: For anything and everything on science from India*. Ed. Vigyan Prasar. Vigyan Prasar, 2003. Web. 6 Feb. 2016. <http://www.vigyanprasar.gov.in/scientists/REFranklin.htm>. This is a secondary historical perspective of a scientific historian who is looking back on the work of Rosalind Franklin in honor of the 50th anniversary of the discovery of the double helix, marked by the publication of Watson and Crick in *Nature* in 1953. It provided to me an

objective perspective on the issue of due credit being given to Rosalind for her work in the experimental foundation of the double helix, discussing both Brenda Maddox's opinion that Rosalind's death was simply unfortunately timed, and if it hadn't occurred, she likely would have one the Nobel, in contrast with Anne Sayre's opinion that Rosalind was solely cheated due to gender discrimination. In either case, the article concludes the true scientific and social significance of Rosalind's exploration of DNA, and goes on to say that her experimental skill was also very important in other fields of structural biology. It further provided some objective information on Rosalind's early life, education, and establishment in biology, which the heavily opinionated accounts of Maddox and Sayre could not do. At the conclusion of the brief biography, it provided further readings that led me to the direction of some social background sources, such as Janeway's study of Social Mythology, and some primary accounts involved in the presentation of the double helix theory.

Maisel, Merry, and Laura Smart. "Science Women: Rosalind Elise Franklin." Ed. 1997 San Diego Supercomputer Center. *San Diego Supercomputer Center*. Ed. San Diego Supercomputer Center. SDSC, 1997. Web. 2 Nov. 2015. <http://sdsc.edu/ScienceWomen/franklin.html>. At first, I used this source as a background provider in my preliminary research. However, as my research progressed, I came to realize the creation of this modern, short website about Rosalind's story with a very feminist-biased tone was simply further demonstration of ongoing inspiration of Rosalind's story on the modern world, and the extent to which Rosalind's significance as a fabricated feminist icon has impacted the world.

McGrayne, Sharon Bertsch. *Nobel Prize Women In Science: Their Lives, Struggles, and Momentus Discoveries*. New York: Carol Publishing Group, 1993. Print. This book contained a section on the life and work of Rosalind Franklin, describing in high detail and a very feministic light her experiences and discoveries of both DNA's structure and prejudice in the world of science. It worked to give more information on the personal side of Franklin than can be seen in many other accounts, however, its highly feminist views can be attributed to the author's perspective, and may not be *entirely* historically accurate. In any case, the book also contained reference to many other primary accounts involved in Franklin's work, which furthered my research.

"Nicole Kidman as Rosalind Franklin." *BBC News*. BBC, 14 Sept. 2015. Web. 7 Apr. 2016. <http://www.bbc.com/news/entertainment-arts-34238537>. This was a picture of Rosalind Franklin being portrayed in the BBC play about her. I used it visually in my exhibit as an example of her continued influence as a feminist icon.

PBS, ed. "Rosalind Franklin (1920-1958)." *A Science Odyssey: People and Discoveries*. PBS, 1998. Web. 2 Nov. 2015. <http://www.pbs.org/wgbh/aso/databank/entries/bofran.html>. This article provided a brief look at some basic bibliographic information about Rosalind Franklin, discussed her major scientific achievements, and gave a light account of some social prejudice she encountered, both through her relationship with Maurice Wilkins and her father upon her announcement of choosing a career in science. It was a short preliminary source, but acted as a portal for me to look further into the Wilkins relationship and conflict with Franklin's father.

Rutherford, Adam. "DNA double helix: discovery that led to 60 years of biological revolution." *The Guardian*. Ed. The Guardian. The Guardian, 25 Apr. 2013. Web. 7 Apr. 2016. <https://www.theguardian.com/science/2013/apr/25/dna-double-helix-60-years-biological-revolution>. This modern article focused on describing what advancements in biological research were made because of the Double Helix Theory, thus showing what an important theory Rosalind's data supported, and caused in the end. Rutherford not only discusses the impact on science, but also medicine, culture, and life in general. I quote this in the significance panel of my exhibit. I also used an included photo of Watson and Crick visually on my exhibit.

Sayre, Anne. *Rosalind Franklin and DNA*. New York: W.W. Norton, 1975. Print. This was a book written by longtime friend of Rosalind Franklin and reporter Anne Sayre, who made a life out of trying to bring Franklin the credit she deserved for her work in the field of DNA. She discusses all of the social prejudice encountered by Franklin, the scientific/social exploration she was involved in, consequent encounters, such as the structure of both viruses and DNA, and most importantly, the exchange of scientific data among scientists and its impact on biology, and the exchange of social values between scientists that both kept Rosalind isolated in her work, and eventually, came to see her as the prodigy she was, after many years of reconsideration and the influence of people like Anne Sayre. I use many quotations of Sayre in my work, as her perspective is an

important one of a historian, who can give a hindsight view of what contributed to Franklin's story working out the way it did.

Schindler, Samuel. "Model, Theory, and Evidence in the Discovery of the DNA Structure." *British Journal for the Philosophy of Science* (2008): 619-58. PDF file. This paper gave scientific explanation behind each of the methods used to determine the structure of DNA during the "race for DNA" by Franklin, Wilkins, Watson, Crick, Pauling and more. It not only demonstrated the importance of Rosalind's data, the context of science she was operating in, and why her data was superior-it also provided primary quotations from the scientists themselves about the work of those around them, some of which were displayed on my exhibit. Specifically, this paper was instrumental in explaining the crystallographic methods Rosalind pioneered scientifically speaking.

Schmelz, Joan. "Rosalind Franklin and the Double Helix." *AAS Committee on the Status of Women*. AAS, Jan. 2002. Web. 7 Apr. 2016. <http://www.aas.org/cswa/status/2002/JANUARY2002/Franklin.html>. Yet another publication with a feminist bias from continued influence of Rosalind as a fabricated feminist icon in modern times, Joan Schmelz's article, despite having a bias in some respects, made some interesting points about Rosalind's data, and most importantly, flat out deemed it the experimental foundation of the Double Helix Theory. A clear cut statement such as this was very helpful for presenting that idea on my exhibit. Other statements exhibiting her bias were also clear for presentation on the social side.

Watts, Ruth. Rev. of *Gender, Work and Education in Britain in the 1950s*, by Stephanie Spencer. *Reviews in History*. Ed. University of London School of Advanced Study. Institute of Historical Research, Oct. 2008. Web. 7 Apr. 2016. <http://www.history.ac.uk/reviews/review/689>. This review gave a lot of historical context of what was socially normal and acceptable for 1950s British Women in terms of culture, work, education, etc. I used this to confirm my ideas of the context, and further to compare to the way Rosalind lived in the Social Exploration section to show how Rosalind was setting new boundaries for women. Overall, it talks about how women were home-revolving, in marriage, in work, in personality-in everything. Women were subordinate to their husbands, chained to family needs, and expected to conform everything in their lives to this purpose.

Tertiary Sources

"Secret of Photo 51." By Gary Glassman. *NOVA*. Prod. Gary Glassman. PBS. 22 Apr. 2003. Print. Transcript. This transcript of a NOVA episode about Rosalind Franklin, on its own, demonstrates the impact Rosalind's story has had on the world since becoming a feminist icon, and how her story continues to be of fascination today. I specifically used it for primary materials, as scientists who worked with Franklin, biographers of her, and others who knew her, including her sister, all discussed Rosalind's story scientifically and socially speaking. While nothing terribly new was presented, I used many of these quotes as evidence in my exhibit.