

**Barbara McClintock: Jumping Barriers with Jumping Genes**

Vibhaakshayaa Sathish Kumar

Individual Documentary

Junior Division

Process Paper: 447

### **Process Paper**

The topic I chose this year for NHD was on Barbara McClintock's ground breaking discovery of jumping genes. After a consultation with my elder brother, I got the idea of Barbara McClintock. She was a corn geneticist who had discovered genes that could turn other genes "on" and "off". Intrigued by the concept, I began with some brief research.

After reading some sources, I learned that Barbara McClintock was an early pioneer in the study of maize genetics and discovered the revolutionizing concept of jumping genes. These were called transposons, sequences of DNA that can relocate within a genome. I came to realize that her findings and way of thinking were radically different than what was perceived to be the norm, developing a scientific barrier. As a female scientist, McClintock also had to face a gender barrier as her research was dismissed by the male dominated scientific community.

With my topic selected, I began to explore various secondary and primary sources such as books, websites, and journal entries for both the scientific and gender barrier. She began her extensive research at Cold Spring Harbor Laboratory in New York. Unfortunately, no theory at the time could explain her revolutionizing discovery. This scientific barrier was broken by McClintock's perseverance and in the end she created her own successful theory. As for the gender barrier, I read some books that showed different views on this concept. When McClintock presented her ideas at the Cold Spring Harbor Symposium the male scientists in the room responded with criticism and silence, developing a gender barrier. But she broke through this by standing strong on what she knew was right.

With this information, I looked into finding some interviews for my project. Through some research, I contacted Anastasia Nicolov, a researcher at Just Biotherapeutics. I had an online video interview with her on some questions about how research used to work. I found another great person to interview by looking through the Cold Spring Harbor Laboratory's list of current researchers. Professor and Researcher Andrea Schorn caught my eye because she is currently investigating how RNAs use transposable elements and how one could find out ways to silence certain genes during development or disease. I interviewed Professor Schorn through email, as that worked best with her schedule.

I believed that constructing a documentary would be the best way to express my thoughts in a vivid way. By recording myself using a microphone, and using royalty-free music plus sound effects online, I created the audio for my documentary. Using primary source images, interviews, and as well as videos taken both at the time and to better explain certain parts, I developed the video for the documentary.

## Annotated Bibliography

### Primary Sources

#### Documents:

Barbara McClintock to Charles Burnham. 16 Sept. 1940. *U.S National Library of Medicine*, [collections.nlm.nih.gov/ext/document/101584613X225/PDF/101584613X225.pdf](https://collections.nlm.nih.gov/ext/document/101584613X225/PDF/101584613X225.pdf). Accessed 7 Apr. 2020. This letter depicted to the recipient, Charles Burnham, that McClintock wanted to leave her job as assistant professor and do research. It shows that she wanted to do something she wanted to do for the rest of her life, even if it means leaving some money from her salary. Using a section of this letter helps clearly portray to the audience why and how McClintock moved to Cold Spring Harbor Laboratory.

McClintock, Barbara. Activity of Controlling Element in Kernel. *U.S National Library of Medicine*, [profiles.nlm.nih.gov/spotlight/ll/catalog.nlm.nlmuid-101584613X293-doc](https://profiles.nlm.nih.gov/spotlight/ll/catalog.nlm.nlmuid-101584613X293-doc). Typescript. This is a written document made by McClintock which expresses her thoughts clearly. It comes to a reasonable conclusion of a controlling element inside a single maize kernel. I utilized this document to make it clear that McClintock not only used visual evidence but also written explanations.

Different Phases of the Cycle.

[images.ctfassets.net/eqlpemzu8y5/71Nd43xyQMVaQyWF5hWON/cdc035c2753c59b1929a73554ea2acfd/BMcClintock\\_DISCOVERY\\_asset15.jpg?w=453&fm=jpg&fl=progressive&q=90](https://images.ctfassets.net/eqlpemzu8y5/71Nd43xyQMVaQyWF5hWON/cdc035c2753c59b1929a73554ea2acfd/BMcClintock_DISCOVERY_asset15.jpg?w=453&fm=jpg&fl=progressive&q=90). Accessed 7 Apr. 2020. Manuscript. This was a paper that McClintock created to show her work on the revolutionizing discovery of jumping genes. I used this during

the scientific barrier to show the different types of work that McClintock had to perform to get to her conclusion.

Two Corn Kernel Groupings. *U.S National Library of Medicine*,

[profiles.nlm.nih.gov/spotlight/ll/catalog/nlm:nlmuid-101584613X312-img](https://profiles.nlm.nih.gov/spotlight/ll/catalog/nlm:nlmuid-101584613X312-img). Accessed 7 Apr. 2020. Working paper. This is an unpublished paper that has notes and images by McClintock herself. The U.S National Library of Medicine released her work to the public. I used this document in a lay-over to show that McClintock worked hard to overcome the scientific barrier.

Two Specified Kernels. *U.S. National Library of Medicine*,

[profiles.nlm.nih.gov/spotlight/ll/catalog/nlm:nlmuid-101584613X294-img](https://profiles.nlm.nih.gov/spotlight/ll/catalog/nlm:nlmuid-101584613X294-img). Accessed 7 Apr. 2020. Manuscript. This paper was unpublished, but was created by Barbara McClintock during her research on transposable elements. It shows two enlarged images of kernels and has notes to the side of it. I used this specific work in my documentary since it shows an example of how her work looked like.

"Mutable Loci in Maize." *Sophia: Rare Books*,

[www.sophiararebooks.com/pages/books/3910/barbara-mcclintock/mutable-loci-in-maize-offered-with-some-parallels-between-gene-control-systems-in-maize-and-in](http://www.sophiararebooks.com/pages/books/3910/barbara-mcclintock/mutable-loci-in-maize-offered-with-some-parallels-between-gene-control-systems-in-maize-and-in). I used this website to get an image of 2 documents made by McClintock. Both papers show that McClintock believed her controlling elements were like "on" and "off" switches for genes. This source would be considered as a primary source because the documents were written by McClintock from the time given to the public.

**Images:**

*Anastasia Nicolov. Soundbio,*

[2018.igem.org/wiki/images/d/d1/T--iTesla-Soundbio--Ana%27s\\_profile.jpeg](https://2018.igem.org/wiki/images/d/d1/T--iTesla-Soundbio--Ana%27s_profile.jpeg). I used this image of my interviewee, Anastasia Nicolov, to introduce her before the clip from our interview came in.

*Andrea Schorn.*

[media-exp1.licdn.com/dms/image/C5603AQGisV8WoYK4uw/profile-displayphoto-shrink\\_200\\_200/0?e=1589414400&v=beta&t=IotFMGKOOyFIYZMkkH1-2e98MWXHeEOaGK0mBCL-imw](https://media-exp1.licdn.com/dms/image/C5603AQGisV8WoYK4uw/profile-displayphoto-shrink_200_200/0?e=1589414400&v=beta&t=IotFMGKOOyFIYZMkkH1-2e98MWXHeEOaGK0mBCL-imw). I used this image when I introduced my interviewee, Professor Schorn. It helps transition into the quote that I used from our email interview.

*Annual Cold Spring Harbor Symposium. CSHL Edu,*

[labdish.cshl.edu/wp-content/themes/sociallyviral/discoveries/images/era2/CSHL-23\\_NicholsLab.jpg](https://labdish.cshl.edu/wp-content/themes/sociallyviral/discoveries/images/era2/CSHL-23_NicholsLab.jpg). This picture shows scientists talking in front of the Cold Spring Harbor Laboratory entrance right before an annual symposium. It helps the viewer see what the symposium looks like.

*Barbara McClintock Botany. 1933.*

[www.gf.org/wp-content/uploads/2014/07/Barbara-McClintock-Botany-1933\\_250x250.jpg](https://www.gf.org/wp-content/uploads/2014/07/Barbara-McClintock-Botany-1933_250x250.jpg). I used this image as a transition into Barbara McClintock as a young adult.

*Barbara McClintock Covering Her Face, While the Men Look Away.*

[www.estherlederberg.com/EImages/Cold%20Spring%20Harbor/frames%20McClintockB%20Hershey%20Davis%20McClintock.html](https://www.estherlederberg.com/EImages/Cold%20Spring%20Harbor/frames%20McClintockB%20Hershey%20Davis%20McClintock.html). Accessed 14 Mar. 2020. I use this image to

show in the intro that McClintock's findings were ignored by the male-dominated scientific community because they had been discovered by a woman.

Barbara McClintock Graduation. 1919.

[downloads.ctfassets.net/eqlypemzu8y5/1aK1HBuvUubCA8T0Dwtoz6/474719f0240cfdbb962678a1f630787f/BMcClintock\\_LIFE\\_asset14.png?w=453&fm=png&q=90](https://downloads.ctfassets.net/eqlypemzu8y5/1aK1HBuvUubCA8T0Dwtoz6/474719f0240cfdbb962678a1f630787f/BMcClintock_LIFE_asset14.png?w=453&fm=png&q=90). This is an image of McClintock's high school graduation. It shows in my documentary that after graduating in 1919 McClintock got into maize genetics.

*BMcClintock. Educational Synthesis,*

[www.educationalsynthesis.org/files/images/ppl/famamer/BMcClintock-1960.jpg](http://www.educationalsynthesis.org/files/images/ppl/famamer/BMcClintock-1960.jpg). This is an image of McClintock 20 years after college. It helps transition into the scientific barrier since it shows that McClintock was very sophisticated when her discoveries really started making sense to her.

Cancer Research Lab.

[cancer.psu.edu/documents/11750805/11767895/Research+Landing+Image+2/d304b7f2-2729-4afa-10c3-b98105c3bcd9?t=1515767109945](http://cancer.psu.edu/documents/11750805/11767895/Research+Landing+Image+2/d304b7f2-2729-4afa-10c3-b98105c3bcd9?t=1515767109945). This image shows the cancer researchers of today working in a lab.

*Charles Burnham. Slideserve,* [www.slideserve.com/vance/our-mission](http://www.slideserve.com/vance/our-mission). This is an image of Charles Burnham once he got older. I use this photo after showing the letter McClintock wrote to him.

Cold Spring Harbor Laboratory. *Science Photo,* [www.sciencephoto.com/media/1056187/view](http://www.sciencephoto.com/media/1056187/view).

This is an image of Cold Spring Harbor Laboratory which I used in my documentary when I told the viewers that McClintock moved there to focus only on her research.

Cold Spring Harbor Symposium. *CSHL Edu*,

[library.cshl.edu/Buildings/popup.html?images/black/black5.jpg](http://library.cshl.edu/Buildings/popup.html?images/black/black5.jpg). I used this image to portray how the audience looked like after McClintock finished presenting her findings.

*CSHL-13\_MacDowellLab. CSHL Edu*,

[dpb.carnegiescience.edu/sites/dpb/files/styles/vertical\\_portrait/public/ARCHHQ\\_GEN\\_1963\\_McClintock\\_03.jpg?itok=UdfzcsQ7](http://dpb.carnegiescience.edu/sites/dpb/files/styles/vertical_portrait/public/ARCHHQ_GEN_1963_McClintock_03.jpg?itok=UdfzcsQ7). This image has different scientists from the Cold Spring Harbor Laboratory working on their future discovery. I used it for elaborating that other scientists also have scientific barriers.

CSHL Scientists Jumping. *CSHL Edu*,

[www.cshl.edu/wp-content/uploads/2018/01/DavidHaas-Crystallography-Roswell-Park-Buffalo-1964.jpg](http://www.cshl.edu/wp-content/uploads/2018/01/DavidHaas-Crystallography-Roswell-Park-Buffalo-1964.jpg). This image shows many men and women jumping together in unison. It helps me portray that women were being more and more accepted in the scientific field.

Gregor Mendel. *Britannica*,

[cdn.britannica.com/96/118096-050-BAC1CD4A/Gregor-Mendel-1865.jpg](http://cdn.britannica.com/96/118096-050-BAC1CD4A/Gregor-Mendel-1865.jpg). I used this picture to show what Gregor Mendel, the father of genetics, looked like.

*Gregor Mendel Working with His Pea Plants. Genoma*,

[i0.wp.com/genoma.com/blog/wp-content/uploads/2015/09/gregor-mendel.jpg?fit=750%2C500&ssl=1](http://i0.wp.com/genoma.com/blog/wp-content/uploads/2015/09/gregor-mendel.jpg?fit=750%2C500&ssl=1). Accessed 13 Mar. 2020. This picture shows how Mendel came to conclusion with his findings, using pea plants.

Henry, Matthew. Adult and Child Holding Hands. *Stocksnap*, [stocksnap.io/photo/BC5XIXIIPP](http://stocksnap.io/photo/BC5XIXIIPP).

Accessed 13 Mar. 2020. I used this picture to start off my documentary because it shows

the hands of an adult and a child. Both of them have DNA and genes, which I zoom into for effect.

Images of Professor Nathaniel Comfort. *Hopkins History of Medicine*,

[www.hopkinshistoryofmedicine.org/sites/default/files/Schmidt\\_dissertation](http://www.hopkinshistoryofmedicine.org/sites/default/files/Schmidt_dissertation). I used a couple of these images to introduce Professor Nathaniel Comfort's quotes in his book, "The Tangled Field".

Male Scientists. *PBS*, [pbs.twimg.com/media/CdmspXCUUAAGsMK.jpg](http://pbs.twimg.com/media/CdmspXCUUAAGsMK.jpg). I used this image to depict some of the male scientists from that time period to the viewers.

McClintock's Nobel Prize. *CSHL Edu*,

[library.cshl.edu/images/archives/Barbara%20McClintock-0097.jpg](http://library.cshl.edu/images/archives/Barbara%20McClintock-0097.jpg). I used this image, an actual photograph of McClintock's Nobel Prize, to let the viewers see what it looks like.

McClintock and a Group of Colleagues Standing. *Cornell EDU*,

[plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/images/ithaca.gif](http://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/images/ithaca.gif).

During McClintock's time at Cornell, she made some friends. This included Charles Burnham, who helped McClintock get into CSHL. This has both of them, plus some others, to show who Burnham was to the viewers.

McClintock and Other Male Scientists.

[archives-dc.library.caltech.edu/islandora/object/ct1%3A7691](http://archives-dc.library.caltech.edu/islandora/object/ct1%3A7691). In this photograph McClintock is collaborating with some scientists about her research on controlling elements. The men look like they are laughing in disbelief. It helps with the connection that McClintock tried her best to convince the scientists.

McClintock Reading. *CSHL Archives*, [www.pnas.org/content/pnas/109/50/20198/F1.large.jpg](http://www.pnas.org/content/pnas/109/50/20198/F1.large.jpg).

This shows McClintock looking over her publications. I used this image to end the scientific barrier and transition into the connection for the gender barrier.

McClintock's Corn.

[images.ctfassets.net/eqlypemzu8y5/1dg4xUB8Q7YuhfbMIzHmk5/6120616363b603af68446c4bc3d9dd47/BMcClintock\\_DISCOVERY\\_asset4.jpg?w=1042&fm=jpg&fl=progressive&q=90](https://images.ctfassets.net/eqlypemzu8y5/1dg4xUB8Q7YuhfbMIzHmk5/6120616363b603af68446c4bc3d9dd47/BMcClintock_DISCOVERY_asset4.jpg?w=1042&fm=jpg&fl=progressive&q=90). Accessed 14 Mar. 2020. This image shows corn that has kernels in a variety of colors. It helps to present the type of maize looked at, to perform her experiments.

McClintock Sitting Down.

[cdn.the-scientist.com/assets/articleNo/41546/iImg/24895/75f8cf91-d228-494b-b1ac-c5ea35110813-foundations.jpg](https://cdn.the-scientist.com/assets/articleNo/41546/iImg/24895/75f8cf91-d228-494b-b1ac-c5ea35110813-foundations.jpg). I use this image while telling the viewers that nothing went like McClintock thought it would. I inserted this image because McClintock looks concerned in the image and that went well with the context of what I was saying.

McClintock with Another Professor. *Genetics*,

[www.genetics.org/content/genetics/164/4/1251/F1.large.jpg](http://www.genetics.org/content/genetics/164/4/1251/F1.large.jpg). This photograph has McClintock and another professor at the University of Missouri. I used it when I explained how McClintock worked as an assistant professor.

McClintock Working in Cornfield. *Science Photo*,

[media.sciencephoto.com/image/c0375903/800wm](https://media.sciencephoto.com/image/c0375903/800wm). This picture was used to show McClintock working in her cornfield. It helped prove that McClintock only began to present her findings when she believed to have a good amount of evidence.

Men Watching a Presentation. *Genetics*,

[genetics.wisc.edu/wp-content/uploads/sites/90/2017/02/BannerBk1\\_Pg29\\_GenSeminary\\_June1917\\_GenPicnic\\_21Jul1918-copy.jpg](http://genetics.wisc.edu/wp-content/uploads/sites/90/2017/02/BannerBk1_Pg29_GenSeminary_June1917_GenPicnic_21Jul1918-copy.jpg). This image helped display what the room where McClintock presented her findings looked like. This particular image has male-scientists looking up at a presentation done on the blackboard.

Modern Scientist Working. *Synpromics*,

[www.synpromics.com/sites/default/files/styles/720px\\_wide\\_16\\_9/public/images/synthetic-promoter-library-construction.jpg?itok=0k5s7Hta](http://www.synpromics.com/sites/default/files/styles/720px_wide_16_9/public/images/synthetic-promoter-library-construction.jpg?itok=0k5s7Hta). I used a royalty-free image of a scientist working with a petri dish, to show that it was similar work that my interviewee, Ms. Nicolov, does.

A Portrait of Barbara McClintock. *Nobel Prize*,

[www.nobelprize.org/images/mcclintock-13355-portrait-mini-2x.jpg](http://www.nobelprize.org/images/mcclintock-13355-portrait-mini-2x.jpg). It is the first picture of McClintock that the viewers will see.

Professor and Researcher Schorn. *Cold Spring Harbor Laboratory*,

[www.cshl.edu/wp-content/uploads/2019/05/Andrea-Schorn.jpg](http://www.cshl.edu/wp-content/uploads/2019/05/Andrea-Schorn.jpg)  
<https://www.pnas.org/content/pnas/109/50/20198/F1.large.jpg>. I used this image of Professor and Researcher Schorn to the side of the quote from our interview. This makes the documentary a little interesting, while I am reading the quote.

Scientists That Approved Watson and Crick's Discovery.

[images2.minutemediacdn.com/image/upload/c\\_fill,g\\_auto,h\\_1248,w\\_2220/f\\_auto,q\\_auto,w\\_1100/v1555920807/shape/mentalfloss/3281382.jpg](http://images2.minutemediacdn.com/image/upload/c_fill,g_auto,h_1248,w_2220/f_auto,q_auto,w_1100/v1555920807/shape/mentalfloss/3281382.jpg). I used this image of the men who

denied McClintock's work but accepted Watson and Crick's work to show the viewers all the gender bias from that time

Sewall Wright. [www.nap.edu/openbook/0309049784/xhtml/images/img00019.jpg](http://www.nap.edu/openbook/0309049784/xhtml/images/img00019.jpg). This image introduces Sewall Wright, a popular male geneticist, that turned down McClintock's presentation on jumping genes.

Sewall Wright at a Blackboard.

[encrypted-tbn0.gstatic.com/images?q=tbn%3AANd9GcTopwfcNw7so7KT8ZOtwFL7TJVAB7eeiVFFfGZd7BO974lGvByr](https://encrypted-tbn0.gstatic.com/images?q=tbn%3AANd9GcTopwfcNw7so7KT8ZOtwFL7TJVAB7eeiVFFfGZd7BO974lGvByr). In this image, Sewall Wright is drawing a common view of genes being fixed on the blackboard. It goes with what I am saying, as that is what he does during a conference with McClintock.

Students Working Together.

[api.hub.jhu.edu/factory/sites/default/files/styles/landscape/public/1\\_Frontiers\\_103117.jpg?itok=OzKYgQ1O](https://api.hub.jhu.edu/factory/sites/default/files/styles/landscape/public/1_Frontiers_103117.jpg?itok=OzKYgQ1O) :. Accessed 14 Mar. 2020. I used this image to end my documentary because it shows young students, both male and female, doing a science experiment.

University of Wisconsin.

[d9mfr5qxp4i37.cloudfront.net/wp-content/uploads/sites/132/2017/12/ladies-hall-historical-1-1600x499.jpg](https://d9mfr5qxp4i37.cloudfront.net/wp-content/uploads/sites/132/2017/12/ladies-hall-historical-1-1600x499.jpg). I used this image to display the place where the 1958 conference, in which McClintock presented her findings again, occurred

Watson and Crick.

[labdish.cshl.edu/wp-content/themes/sociallyviral/discoveries/images/era3/CSHL-35\\_WatsonCrick](http://labdish.cshl.edu/wp-content/themes/sociallyviral/discoveries/images/era3/CSHL-35_WatsonCrick). I used this image to show viewers who Watson and Crick was and that they

were accepted by the scientific community much sooner than McClintock. The website had many primary source images of them that I used in my documentary.

Working with Maize. *Carnegie Science*,

[dpb.carnegiescience.edu/sites/dpb/files/styles/vertical\\_portrait/public/ARCHHQ\\_GEN\\_1963\\_McClintock\\_03.jpg?itok=UdfzcsQ7](http://dpb.carnegiescience.edu/sites/dpb/files/styles/vertical_portrait/public/ARCHHQ_GEN_1963_McClintock_03.jpg?itok=UdfzcsQ7). I use two images from this website to show McClintock doing tedious work with the maize. It helps the viewers see that she had to work long hours just to prepare her kernels to look under the microscope.

Young Barbara McClintock. *Wikimedia*,

[upload.wikimedia.org/wikipedia/commons/1/1e/Barbara\\_McClintock.jpeg](http://upload.wikimedia.org/wikipedia/commons/1/1e/Barbara_McClintock.jpeg). I used this image to show Barbara McClintock during her teenage years in the introduction

### **Interviews:**

Nicolov, Anastasia. Videoconference interview. 23 Jan. 2020. Anastasia Nicolov is a current researcher at Just Biotherapeutics. My brother gave me her contact information and I emailed her with some questions on how research used to work and how it works today. Together we set up a short online video call/interview. A clip from the interview was screen recorded and used for the documentary.

Schorn, Andrea. E-mail interview. 28 Jan. 2020. While looking through the Cold Spring Harbor website, I found Professor and Researcher Andrea Schorn. She is currently investigating how to silence certain genes using transposons in RNA during development or disease. I contacted her and had a brief email interview with her. She answered many questions on Barbara McClintock and the barriers she faced. A snippet of what she wrote in the email was used in my documentary.

**Newspapers:**

"Dr. Barbara McClintock, 90, Gene Research Pioneer, Dies." *The New York Times*, 4 Sept. 1992, sec. A, p. 1, [s1.nytimes.com/timesmachine/pages/1/1992/09/04/3312592\\_360W.png?quality=75&auto=webp&disable=upscale](https://www.nytimes.com/1992/09/04/3312592_360W.png?quality=75&auto=webp&disable=upscale). Accessed 14 Mar. 2020. This primary source newspaper elaborates on Barbara McClintock's death. It also talks about her life's work and how influential she was as a person. I used this as an image in my documentary when I told the viewers that McClintock has now passed away.

"Long Island Biologist Wins Nobel in Medicine." *New York Times*, 11 Oct. 1983, sec. A, p. 1, [s1.nytimes.com/timesmachine/pages/1/1983/10/11/224255\\_360W.png?quality=75&auto=webp&disable=upscale](https://www.nytimes.com/1983/10/11/224255_360W.png?quality=75&auto=webp&disable=upscale). Accessed 14 Mar. 2020. This newspaper talked about Barbara McClintock winning the Nobel Prize in Physiology or Medicine. It would be a primary source; it was published the same year when McClintock won the Nobel Prize. I used this newspaper towards the end of the documentary where I talk about her long-lasting legacy.

**Videos:**

"Barbara McClintock Tribute Film." *Youtube*, uploaded by Connecticut Women's Hall of Fame, [www.youtube.com/watch?v=5-1yXo5zp1I](https://www.youtube.com/watch?v=5-1yXo5zp1I). I used about 20 second of this video for my documentary. This clip was an interview that was conducted with McClintock. McClintock says that she knew that her discovery was correct and that nobody could hurt her by arguing it wasn't. This would be a primary source because I am only using the archival footage from the video, which was taken when McClintock's discovery had first been accepted.

**Websites:**

"Barbara McClintock's World." *Weed to Wonder*,

old.weedtowonder.org/mcclintock/gallery/gallery9.html. I used this website "Image Gallery" for my documentary. I used photographs 1, 2, 4, 7, 8, 10, 12, and 13 given from this website in different parts of my documentary. This would be considered a primary source because the images provided are taken by someone at the time. The website is also supported by the Cold Spring Harbor Laboratory Organization.

**Secondary Sources****Books:**

Comfort, Nathaniel C. *The Tangled Field*. JSTOR ed., Harvard UP, 2001. This book was very informative and useful to learn about why some people think the gender discrimination was a myth. I used certain parts from this book in my documentary to better explain parts of it. The author wasn't very biased as he showed the common views of the gender discrimination and then explained why that wasn't true.

Keller, Evelyn Fox. *A Feeling for the Organism: The Life and Work of Barbara McClintock*. 18th ed., New York, Freeman, 2001. This book was very useful for my gender barrier research. It clearly displayed that McClintock was ignored by the male-dominated scientific community. Keller also elaborated on how McClintock wanted freedom and stopped publishing to public journals, but she never stopped researching. This author also

isn't biased. She explained why the opposition, who believed McClintock wasn't discriminated against for her gender, is wrong.

Pasachoff, Naomi E. *Barbara McClintock: Genius of Genetics*. Berkeley Heights, Enslow Publishers, 2006. This book was a great use of my time and research. It gave background on McClintock's life and explained her entire maize journey within its pages. The author, Naomi Pasachoff, used primary source letters and images to describe how McClintock performed her research that I used in my documentary. The author is not biased because she only elaborates on real facts, which she supports with evidence. I used many of the images in the documentary.

### **Music:**

"Cinematic Background - Epic Inspirational Cinematic Music / Orchestral Music." *Youtube*, uploaded by AShamaluevMusic, 4 Sept. 2017, [www.youtube.com/watch?v=4CRzJbKs8aM](http://www.youtube.com/watch?v=4CRzJbKs8aM). Accessed 14 Mar. 2020. I used this music when I am showing the opposition's point of view because it has a sincere, collected tone that provides the concept that where they stand is incorrect.

"Emotional Piano Documentary Background Music." *Youtube*, uploaded by AShamaluevMusic, 21 Aug. 2019, [www.youtube.com/watch?v=BBndOuCUGe8](http://www.youtube.com/watch?v=BBndOuCUGe8). Accessed 14 Mar. 2020. This music gives off some serious yet emotional vibes. I used it for the background of the scientific barrier because it is a serious concept and was a mental roadblock. I also used this for when I am telling McClintock's legacy because it helps add a seriousness to it.

Macleod, Kevin. "Dreams Becoming Real." *Youtube*, 21 Apr. 2015, [m.youtube.com/watch?v=XF9IHq8p3AI](http://m.youtube.com/watch?v=XF9IHq8p3AI). I used this composition for the beginning of my documentary

because the music has a sense of suspense, which helps the viewer wonder "what is going to happen next?"

"(No Copyright Music) Dramatic Emotional Background Music." *Youtube*, uploaded by AShamaluevMusic, 27 Oct. 2019, [www.youtube.com/watch?v=il9HGo4hPjI](http://www.youtube.com/watch?v=il9HGo4hPjI). Accessed 14 Mar. 2020. This background music has a very sad tone to it. It helps with the context of the gender barrier by developing major pathos to the documentary. I also used it for the conclusion because the fact that McClintock isn't alive any longer is sad.

### **Videos:**

"DNA Double Helix." *Gfycat*, [thumbs.gfycat.com/AlertWealthyEastsiberianlaika-size\\_restricted.gif](https://thumbs.gfycat.com/AlertWealthyEastsiberianlaika-size_restricted.gif). Accessed 14 Mar. 2020. I used this GIF to show the viewers what the DNA double helix that Watson and Crick discovered looked like.

"Genome Editing with CRISPR-Cas9." *Youtube*, uploaded by McGovern Institute, 2014, [Genome Editing with CRISPR-Cas9](#). I used about 5 seconds of this video for the beginning of the documentary. It was to show an interesting animation of dna/genes in our cells.

"Simple Transposition [HD Animation]." *Youtube*, uploaded by McGraw-Hill Animations, [www.youtube.com/watch?v=Mr9xln6tHF8](http://www.youtube.com/watch?v=Mr9xln6tHF8). I used about 4 seconds of this video to show a simple animation of how transposition works, during the intro.

### **Websites:**

"Barbara McClintock: Breaking 'Illogical Barriers,' American (1902-1992)." *Nasty Women Writers*, 27 Feb. 2019,

[www.nastywomenwriters.com/barbara-mcclintock-breaking-illogical-barriers-american-1902-1992/](http://www.nastywomenwriters.com/barbara-mcclintock-breaking-illogical-barriers-american-1902-1992/). This source is the first one I looked at to understand McClintock and her discovery. The title states, "Breaking Illogical Barriers" and the source really delves deep about the barrier's McClintock had to overcome. They used evidence from different books, letting the reader know the author did take time to create the article. The author of this also seems well-rounded on McClintock's barriers as they are explained with great detail and language.

"Concept 32 Some DNA Can Jump." *McClintock: Jumping Genes, Transposons :: DNA from the Beginning*, [www.dnaftb.org/32/animation.html](http://www.dnaftb.org/32/animation.html) This interactive website really helped me understand Barbara McClintock's discovery of transposons and how they really work. The animations were helpful to physically be able to see what these transposons' effect was on the corn kernels. I used some of these animations to clearly and concisely describe McClintock's findings in the documentary. The creators of the site really made sure the information made sense to the viewers.

Friedlander, Blaine. "Gender-Discrimination Legends Surrounding Nobelist Barbara McClintock and DNA Pioneer Rosalind Franklin to Be Aired at AAAS Convention on Feb. 15, 2002." *Cornell Chronicle*, 15 Feb. 2002, [news.cornell.edu/stories/2002/02/aaas-airs-mcclintock-and-franklin-discrimination-legends](http://news.cornell.edu/stories/2002/02/aaas-airs-mcclintock-and-franklin-discrimination-legends) I used this source to get a brief background on how McClintock was discriminated against because she was a female scientist. This website is very well rounded because it talks about the gender discrimination and then shows evidence for why some people

think it is a legend. It allowed me to see that one story can have two different points of views, which I tried to incorporate in my documentary.

"Gender Discrimination: Barbara McClintock ." *Esther M. Zimmer Lederberg: Gender Discrimination,*

[www.estherlederberg.com/Censorship/Gender%20Discrimination%202.html](http://www.estherlederberg.com/Censorship/Gender%20Discrimination%202.html). This website was very helpful to focus on events that really proved that McClintock was discriminated against for her gender. It also showed that certain male scientists, including Sewall Wright, helped shape the idea that her work was completely wrong because it didn't follow their views. This website might be slightly biased since it never talked about the opposition as much as it should have.

"History of Scientific Women." *Barbara MCCLINTOCK,*

[scientificwomen.net/women/mcclintock-barbara-65](http://scientificwomen.net/women/mcclintock-barbara-65). This website showed me an overview of McClintock's entire life. It elaborated on her childhood, education, and a brief description on her journey with the discovery of jumping genes. This is a credible source because it is a website meant for students to learn accurate information about certain scientific fields and important people.

Jane, Beverley. "Science as a Way of Knowing: A Narrative about Community and Connectedness." *Monash University,*

[www.aare.edu.au/data/publications/2008/jan08135.pdf](http://www.aare.edu.au/data/publications/2008/jan08135.pdf). Accessed 12 Mar. 2020. This was an online PDF file of the author's presentation at Monash University. The author, Beverley Jane, goes over McClintock's life work and analyzes certain occurrences in her research and other events that show how her ways were ineffective. It is a credible source

because it has been reviewed and checked by the professors at the university before being released to the public.

"The Nobel Prize: Women Who Changed Science: Barbara McClintock." *The Official Website of the Nobel Prize - NobelPrize.org*,

[www.nobelprize.org/womenwhochangedscience/stories/barbara-mcclintock](http://www.nobelprize.org/womenwhochangedscience/stories/barbara-mcclintock) I used this secondary source to learn about what Barbara McClintock studied and the paths she took to get into Cold Spring Harbor Laboratory. I used many images from this website as well as a video of her getting a Nobel prize, for my documentary.. This source would be credible because it was on the actual Nobel Prize webpage.

Pearse, Yewande. "Meet Barbara McClintock, Who Used Corn to Decipher 'Jumping Genes.'" *Massive Science*, 11 May 2018,

[massivesci.com/articles/barbara-mcclintock-nobel-corn/](http://massivesci.com/articles/barbara-mcclintock-nobel-corn/) This website used the two books, "A Feeling for An Organism" and "The Tangled Field" to compare and contrast the views of Barbara McClintock's gender discrimination. It was this secondary source that made me checkout the listed books for more research. The author isn't biased because they are using straight facts to show the opposing views.

