



# Barbara McClintock's World

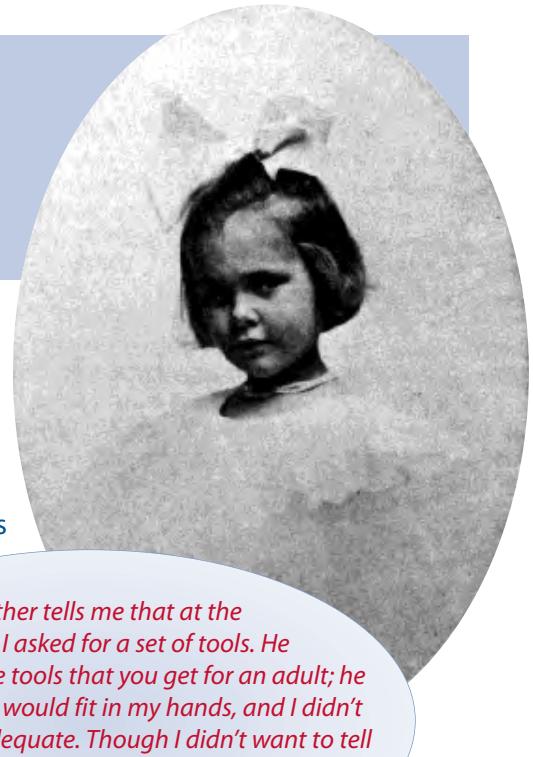
Timeline adapted from Dolan DNA Learning Center exhibition

## 1902-1908

Barbara McClintock is born in Hartford, Connecticut, the third of four children of Sarah and Thomas Henry McClintock, a physician. She spends periods of her childhood in Massachusetts with her paternal aunt and uncle.

Barbara at about age five. This prim and proper picture betrays the fact that she was, in fact, a self-reliant tomboy. Barbara's individualism and self-sufficiency was apparent even in infancy. When Barbara was four months old, her parents changed her birth name, Eleanor, which they considered too delicate and feminine for such a rugged child. In grade school, Barbara persuaded her mother to have matching bloomers (shorts) made for her dresses – so she could more easily join her brother Tom in tree climbing, baseball, volleyball, and football.

*My mother used to put a pillow on the floor and give me one toy and just leave me there. She said I didn't cry, didn't call for anything.*



*My father tells me that at the age of five I asked for a set of tools. He did not get me the tools that you get for an adult; he got me tools that would fit in my hands, and I didn't think they were adequate. Though I didn't want to tell him that, they were not the tools I wanted. I wanted real tools not tools for children.*



## 1908-1918

McClintock's family moves to Brooklyn in 1908, where she attends elementary and secondary school. In 1918, she graduates one semester early from Erasmus Hall High School in Brooklyn. During high school, a growing love of science replaces her passion for sports.

Barbara (center) with her mother (left), brother Tom, and sisters Mignon and Marjorie, about 1918.



### 1918 -1931

McClintock spends her formative years in science at Cornell University. Working in the College of Agriculture, she receives her undergraduate degree in 1923. Although she conducts her graduate research under the cytologist Lester Sharp, she associates most closely with the maize genetics group of Rollins A. Emerson. After receiving her Ph.D. in 1927, she stays on as an instructor until 1931.

*I had good luck  
at Cornell, all the way  
along the line.*



Barbara with the Cornell maize genetics group in 1929: (left-right) Charles Burnham, Marcus Rhoades, Rollins Emerson, and George Beadle (kneeling). As a graduate student, Barbara mastered cytology – techniques for staining and microscopically observing chromosomes. She developed methods that allowed her to identify, for the first time, each of the maize chromosomes by size and shape. She, Rhoades, and Beadle founded the hybrid field of cytogenetics, when they correlated chromosome behavior with the results of breeding experiments in corn.

*We were opening up  
a new field, the three of us were.*

[Referring to her, Beadle, and Rhoades during their years together at Cornell.]

Barbara convinced graduate student Harriet Creighton (at right) to follow up on her observation of a characteristic "knob" at the end of maize chromosome 9 that could be used to follow the exchange of pieces between chromosomes

8 and 9. This research showed that chromosome exchange during the formation of sex cells in parent plants results in the mixing of visible traits in the offspring. This hallmark discovery confirmed the presumed chromosomal basis of the phenomenon of genetic "crossing over" – discovered in 1913 in

Thomas Hunt Morgan's laboratory at Columbia University. After seeing preliminary data during a visit to Cornell in 1931, Morgan intervened to speed the publication of McClintock's and Creighton's research in advance of parallel work done in the fruitfly by Curt Stern.



## 1931-1936

McClintock supports herself with a series of short-term fellowships. First, a two-year National Research Council Fellowship gives her freedom to move between collaborations at the California Institute of Technology, the University of Missouri, and Cornell. Then, in 1933, she receives a Guggenheim Fellowship and spends several difficult months at the Kaiser Wilhelm Institute in Germany. Upon returning "home" to Cornell, she is without any means of support for nearly a year, until the Rockefeller Foundation provides a two-year fellowship for her to work again in Emerson's laboratory.

Barbara bought this Model A Ford in 1931, driving first to the University of Missouri to work the summer with Lewis Stadler on the genetic effects of X-rays. She then drove to Pasadena, California, where she spent the winter at Cal Tech as the houseguest of Thomas Hunt Morgan and his wife Lillian. George Beadle was also there, having recently accepted a postdoctoral fellowship in Morgan's lab after leaving Cornell.

*It was a very, very traumatic experience. Had I been politically knowledgeable, I would have taken it in an entirely different way; I would have not been crushed and disturbed and utterly panicked by what I saw going on there.*

[Commenting on time in Nazi Germany.]



Altadena California,  
neighboring town  
to Pasadena.



*I was just so interested in what I was doing I could hardly wait to get up in the morning and get at it. One of my friends, a geneticist, said I was a child, because only children can't wait to get up in the morning and get at what they want to do.*

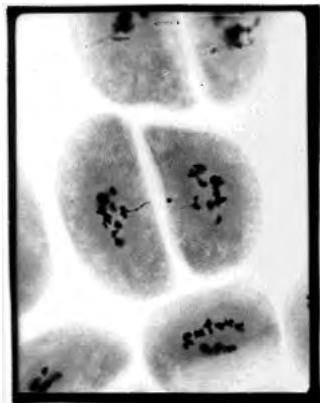
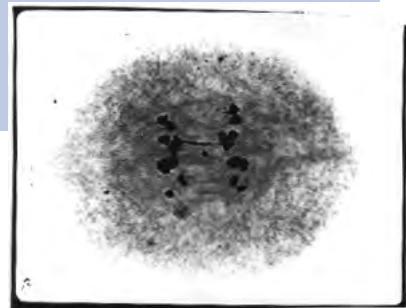
[Commenting on her National Research Council fellowship.]

## 1936-1941

In 1936, longtime friend and supporter, Lewis Stadler, secures McClintock an assistant professorship at the University of Missouri. Although it pays little more than her fellowships, this is her first real faculty position. She takes a leave of absence in 1941 and never returns.

In 1938 Barbara discovers that X-ray treatment can produce chromosomes with two centromeres. During cell division, these dicentric chromosomes form a “bridge” as they attempt to separate. The bridging stress eventually causes the chromosomes to break, and the broken ends refuse to one another in the new daughter cells. This Breakage-Fusion-Bridge cycle repeats through plant development, resulting in variegated (multicolored) leaves and kernels.

*I realized after I'd been there a couple of months that this was no place I could ever really stay. I had that disability that I was always alone. I had no chance of being promoted. I was excluded from faculty meetings and things like that. I had no real part.*



## 1941-1992

In the summer of 1941, McClintock joins Marcus Rhoades in planting a corn crop at the Carnegie Department of Genetics at Cold Spring Harbor. In December, new Carnegie director Milislav Demerec offers Barbara a one-year appointment – a full-time appointment is provided in the spring of 1942. Although she is initially wary of making a long-term commitment, she spends the rest of her life at Cold Spring Harbor.



Milislav Demerec (left) and Edward Tatum.

Barbara originally planted her maize in a field next to the main Carnegie building (now Carnegie Library). This was the same field in which George Shull had grown maize to demonstrate the phenomenon of hybrid vigor. By 1953, she was overwhelmed by years of performing all aspects of growing and harvesting her research crop. Barbara threatened to resign her position, until it was arranged for her to plant at Brookhaven National Laboratory, about 30 miles east of here, where her crop would be a small fraction of a large maize project. At the end of her career, she used fields at the new Uplands Farm Experiment Station on Lawrence Hill Road.

## 1944

1944 is a signal year. McClintock becomes only the third woman elected to the National Academy of Sciences and the first female president of the Genetics Society of America. During a visit with George Beadle at Stanford, she identifies the seven chromosomes of the red bread mold *Neurospora* and describes their movements during meiosis. Beadle remarked that

"Barbara, in two months at Stanford, did more to clean up the cytology of *Neurospora* than all other cytological geneticists had done in all previous time on all forms of mold." (Beadle and his collaborator Edward Tatum shared a Nobel Prize for their earlier work with *Neurospora* that showed the job of a gene is to make a specific protein.)

You know, when I look at a cell, I get down in that cell and look around. I found that the more I worked with them, the bigger and bigger [the *Neurospora* chromosomes] got. And when I was working with them, I wasn't outside, I was down there. I was part of the system. I was right down there and everything got big. I was even able to see the integral parts of the chromosomes – actually, everything was there. It surprised me, because I actually felt as if I were right down there and these things were my friends.

## 1947-1956

In 1947, McClintock pinpoints a unique source of some of the variegated traits and chromosome rearrangements she had been observing since her graduate studies at Cornell! It was a segment on the short arm of chromosome 9 she termed *Ds*, because it could *dissociate*, or transpose, from one chromosome location to another. However, she found that the movement of *Ds* is controlled by a second genetic element she termed *activator*, or *Ac*. In 1950, McClintock provided a formal description of the *Ac/Ds* system in a peer-reviewed paper in the *Proceedings of the National Academy of Sciences*. The activity of *Ds* could be followed by its interaction with various pigment genes located on chromosome 9. When *Ds* transposes ("jumps") into a pigment gene during development, pigment production is interrupted – resulting in a sector of colorless cells. Pigment production is restored when *Ds* subsequently transposes out of the pigment gene. Thus, the time and frequency of *Ds* transposition – controlled by *Ac* – results in various variegated patterns of colored/colorless sectors in kernels and leaves. *Ds* is her first example of a so called "jumping gene."

Barbara with Harriet Creighton at the 1956 Cold Spring Harbor Symposium. Barbara's presentations on transposition at the 1951 and 1956 Symposia flew over the heads of all but a few of her scientific colleagues. This, and a lack of interest in her published works pushed her into virtual seclusion at Cold Spring Harbor. Barbara continued to collaborate with maize geneticists who appreciated her work, and she meticulously documented her growing understanding of *Ac/Ds* and a second major transposition system *Suppressor/mutator (Spm)*, in the Carnegie Annual Report. However, the 1950 paper on *Ac/Ds* in the *Proceedings of the National Academy of Sciences* was her last journal publication on transposition until her 1984 Nobel Lecture in Science.





Striped leaves resulting from *Spm* transposition.

*It was just a surprise that I couldn't communicate. It was a surprise that I was being ridiculed or being told that I was really mad, and it required a readjustment. Later on, there were years in which I couldn't talk to anybody about this, and I wasn't invited to give seminars either.*

[Commenting on the reception to her talk at the 1951 Cold Spring Harbor Symposium.]

December 12, 1966

Mr. Francesco Salamini  
Istituto di Allevamento Vegetale  
Via di Corticello, 133  
Bologna

Dear Mr. Salamini:

The kernels and anthers that you sent to me have been examined. There is no doubt that the variegation is caused by a "mutable locus." The phenotypes suggest that this locus is *Bg* in the short arm of chromosome 9. I suspect that the plants you examined were homozygous for the recessive, *b*. Had they carried *b* you would have seen variegation for dark pigmentation in the stalk and the leaf tissues as well as in the anthers. Did you examine the exposed roots?

It would be well to test for control of this "mutable locus" by either the *Ag* or the *Spm* system to determine whether one of these may be responsible.

May I wish you success in analysing this case,

Sincerely yours,

Barbara McClintock

## An Active Life

As a youth, Barbara took every chance to ice skate in Prospect Park. While at Cornell, she became an avid tennis player – meeting Harriet Creighton for a 5:00 PM match whenever possible. Labor in the corn field and walking, sometimes even with weights, kept her spry later in life. Each fall, it was her habit to gather black walnuts on the Cold Spring Harbor Laboratory grounds for use in baked goods that she gave to a favored few of her colleagues.

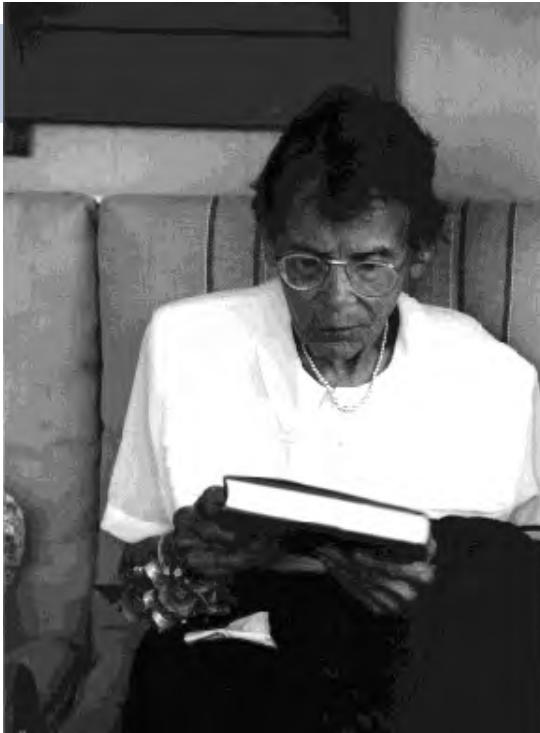
### 1957-1959

McClintock uses chromosome knobs to determine the relationships between the races of maize. Using this information, she examines the dispersal of maize from early centers of cultivation in Central and South America.

Barbara and field hands, Chapengo, Mexico, 1959.



### 1992



Barbara continued her daily laboratory work right up to her 90<sup>th</sup> birthday on June 16, 1992 (pictured here). From this point, she became increasingly frail. She died on September 2<sup>nd</sup> after a brief hospitalization for an acute infection.