



# Pioneering Black African American Women Chemists and Pharmacists

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## 1. Introduction

It is assumed that the history of modern science in Africa began between the last two decades of the 19th century and the first two or three of the 20th century. It is true that in our days there are important female figures who were born on the continent, such as the Ph.D. in Chemistry Fatma Hamad, from Tanzania, or the Egyptian Shendy Nada, Ph.D. in Physics, the Ugandan Florence Mutonyi D'ujanga, Ph.D. in Mathematics and the Mozambique Sarifa Abdul Magide Fagild or Kenyan MaryAbukutsa-Onyango, Ph.D. in Sciences, but the global development of science in Africa, from scientific, health, or literature points of view referring to women date back to the 19th century. However, the people of African descent, both men and women, who promoted the development of this modern science in Africa were, in the main, born in the United States, within families of strong African descent, what has come to be called Black families, and another general characteristic of these people is that they all belonged to the Black race.

This article shows the biographies of four women of these characteristics, who achieved important milestones in the fields of Chemistry and Pharmacy and who contributed in a notable way, with their knowledge and their work, to the development of African science. They are Alice Ball, chemist and pharmacist, and Patricia Bath, Mary Elliott Hill and Marie Mainard Daly, graduated in Chemist, who made remarkable discoveries throughout their professional lives.

The objective of the article is to highlight the contributions of these four women and show them as a models and examples for the rest of the women who want to follow in their footsteps.

Finally, some brief brushstrokes on the lives and work of several other Black women of Black descent, also of Black race and born in the United States, like the previous ones, are also indicated, who in a similar way contributed greatly to the development of the current African science.

## 2. Materials and Methods

For the elaboration of the article, information has been sought on the women who are quoted in it, with the objective of highlighting all their remarkable aspects of their lives that are ignored in the scarce existing biographies about them already made.

## 3. Results

In this section, we show the biographies of several women of African descent, although not born on the continent but in the United States, who reached great scientific achievements and discoveries in Chemistry and Pharmacy but at present are not well known by society, both because of the lack of knowledge about the African continent in general and because of the dismissive attitude toward the work of women that still persists in many countries.



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### 3.1. Alice Ball. Her Biography

Alice Augusta Ball, born in the United States, although of African descent, had the honor of becoming the first woman graduated in Chemistry from the College of Hawaii (nowadays known as the University of Hawaii) and also become the first female Chemistry professor of that college. She also introduced the first useful treatment for people diagnosed with Hansen's disease (leprosy): an oil extract under an injectable way very effective for treating leprosy until the advent of antibiotics in 1940 [1]. However, unfortunately, she could not obtain the merit that her discovery deserved in life, as she passed away very young, at the age of 24, not being recognized until years after her death for such an important achievement. In fact, other people other people put their name to her work and she was largely forgotten, but recently she has received proper recognition for her work on leprosy and overcoming racial and gender barriers in science [2,3].

Alice Augusta Ball was born on 24 July 1892 in Seattle (Washington, WA, USA), into a wealthy middle-class family. Her parents were James Presley Ball, Jr., a newspaper editor, photographer, and lawyer, and Laura Louise (Howard) Ball. The couple had 4 children: Robert, William, Alice, and Addie. Her paternal grandfather, James Ball Sr., famous Black photographer, also stood out for using the daguerreotype technique in United States for the first time.

In 1903, as the grandfather suffered great pain due to arthritis, the family decided to move to Honolulu (Hawaii), trying to look for a place with a warmer climate and therefore more suitable to alleviate those pains. However, unfortunately the grandfather died the year after his arrival and that made the family return to Seattle in 1905 [4].

Once in Seattle, Alice Ball attended high school and graduated with honors in Science in 1910. She later entered the University of Washington, where she obtained undergraduate degrees in pharmaceutical Chemistry (in 1912) and Pharmacy (in 1914). She also published a 10-page article, entitled "Benzoylations in Ether Solution", written joint with her professor of Pharmacy, in the accredited *Journal of the American Chemical Society* [5].

After graduating, Alice Ball (Figure 1) received two scholarships, one to study at the University of Berkeley, in California, and another to study at the University of Hawaii. She chose to move to Hawaii to study a master's in chemistry. In 1915, she was the first woman and the first African American to get a master's degree from the University of Hawaii [1].



Figure 1. Alice Ball in 1915. Source: [3].

Later, when she was 23 years old, she started to work in a teaching and research position in that institution and became the very first woman chemistry instructor in it [6].

Regarding her research, Alice Ball worked very hard in the laboratory to develop a successful treatment for people who have been diagnosed with a Hansen's disease (leprosy). In her graduate studies at the University of Hawaii, she took as the subject of her doctoral thesis the research on the chemical composition and active substance of "Piper methysticum" (kava) [5]. At that stage, Dr. Harry T. Hollmann, who worked as an attending physician at Kalihi Hospital in Hawaii, asked her to help him design a method to isolate the active chemical components in chaulmoogra oil [2]. That oil had already been used in Chinese and Indian medicine and had also been used to treat leprosy with mixed results. However, most patients did not like to take it for long periods of time as it was bitter and tended to upset the stomach. Alice Ball (in the Figure 2 working in the lab) developed a process to isolate fatty acid ethyl esters from oil into fatty acid components of different molecular weights, which allowed her to manipulate the oil into a water soluble injectable form. Her method, which was highly successful and alleviate leprosy symptoms, later known as the "Ball Method", was used on thousands of infected individuals for over thirty years until the discovery of sulfone drugs.



**Figure 2.** Alice Ball working in the lab with chaulmoogra oil. Source: [7].

However, she could not publish her results because she passed away before. The chemist Arthur L. Dean, from the University of Hawaii, took over her work and started producing large quantities of injectable chaulmoogra extract. In the American Medical Association Journal was published in 1918 by a Hawaiian physician that 78 patients in Kalihi Hospital had healed after being treated with those injections. Isolated ethyl ester was the most recommended treatment for leprosy until the use of sulfone-based drugs in the 1940s [5].

Alice Ball died on 31 December 1916, when she was only 24 after complications resulting from inhaling chlorine gas in a lab teaching accident. Few months before, she had returned to Seattle for being treated. In 1917, the Pacific Commercial Advertiser newspaper published a collaboration suggesting that her death could have been caused by chlorine poisoning while she was working. However, the real cause of her death is still unknown because her initial death certificate was modified in the sense of indicating that the cause of her death was tuberculosis [4].

During her life, she did not get to see the full impact of her discovery. What's more, following her death, the president of the College of Hawaii, Dr. Arthur Dean, continued Alice Ball's research without naming her. Dean even called "Dean Method" Ball Method. As can be seen, one more case in which a woman suffers from the so-called "Matilda Effect" (see Appendix A).

The University of Hawaii ignored Alice Ball's work for almost 90 years, until it recognized it in 2000 and paid honor to her by dedicating a plaque with her name, located on the unique chaulmoogra tree on campus (Figure 3). On the same day, the Lieutenant Governor declared 29 February as "Alice Ball Day", which is celebrated every 4 years. In 2007 the University of Hawaii again awarded her the Medal of Distinction [3].



**Figure 3.** The chaulmoogra tree and the plaque at its feet in honor of Alice Ball. Source: University of Hawaii.

Several publications have appeared in recent years, by different authors, glossing both her figure and her work (Figure 4).



**Figure 4.** A book on the Ball Method. Source: [7].

### 3.2. Patricia Era Bath. Her Biography

Born on 4 November 1942 in Harlem, Manhattan, New York, Patricia Era Bath, graduated in Chemistry, was the first female member of the Jules Stein Eye Institute, the first woman responsible for a graduate program in Ophthalmology, the first woman Honorary worker of the UCLA Medical Center (a distinction that was granted to her after her retirement), the first Black woman to work as resident in ophthalmology at New York University and also the first Black woman to practice as a surgeon at UCLA Medical Center. She was also the first Black doctor to receive a patent for a medical purpose. In fact, she held four patents. She also was one of the founders of the non-profit American Institute for the Prevention of Blindness in Washington D.C. She can also be classified as an inventor: she created the Laserphaco Probe, an instrument for the laser treatment of cataracts [8].

Her father, Rupert Bath, was an immigrant from Trinidad, passionate about culture, who worked first as a columnist and a merchant marine, and who at one point became the first Black man to work for the New York Subway as a train driver. Her mother, Gladys Bath, who was descended from African slaves, was a housewife while her children were young, and later she became a domestic servant, in order to help them pay for their studies. Both of them greatly influenced her vocation: her father, teaching her about the wonders of travel and the importance of discovering new cultures. Her mother piqued her interest in science when giving away her a chemistry set. It is not surprising, therefore, that Patricia Bath was passionate about science from a very young age, especially Chemistry and Mathematics, being lucky that her parents had saved enough money to send the two brothers to Charles Evans High School [9]. She carried out her first studies at the Charles Evans Hughes Institute, where she obtained brilliant qualifications, needing just two and a half years to obtain her diploma.

During her stay at the Institute, Patricia Bath got a National Science Foundation Fellowship for her in-depth study of the medical works of Ludwig Philipp Albert Schweitzer (1875–1965), Nobel Peace Prize winner in 1952. This scholarship allowed her to researching at Yeshiva University and at the Central Hospital in Harlem, in which she tried to study the relationships between cancer, nutrition and stress. The program head, Dr. Robert Bernard, impressed with Patricia Bath's discoveries, incorporated her discoveries in a scientific paper he presented at a conference. In 1960, while still a teenager, Patricia Bath won *Mademoiselle* magazine's "Award of Merit" for her contribution to the project [10].

Later, Patricia Bath obtained a Bachelor of Arts in Chemistry from Hunter College in Manhattan in 1964. She moved to Washington D.C. to study in Howard College Medical University, where she received a Ph.D. in 1968. During her first months in the North American capital, the enactment of the 1964 Civil Rights Act took place.

About that experience, Patricia Bath would say years later [9]

*Dr. Martin Luther King told us that we should forget hate, segregation, racism. Our duty was to ignore all that noise and focus on our goals and that's what I did. I had a few obstacles, but I freed myself from them.*

In Howard, she was president of the National Student Medical Association and collaborator of the National Institute of Health and the National Institute of Mental Health [11].

Patricia Bath was hired as an intern at Harlem Central Hospital and shortly after graduating as an ophthalmologist, and after completing a one-year fellowship at Columbia University, Patricia Bath took her family and moved to the West Coast of the United States. The "Jules Stein" Ocular Institute, attached to the University of Los Angeles (UCLA) received her to continue her research on corneal transplants and degenerative eye diseases [10].

She moved to Yugoslavia in 1966. There, she could study child health, seeing that the practice of eye care was not the same between racial minorities and the poor population. Later she also perceived lots of cases of blindness among her Black and poor patients. She decided to address this issue and persuaded her Columbia professors to operate free of charge on blind patients at Harlem Central Hospital, where eye surgery was not previously

offered [9]. Patricia Bath was one of the pioneers in the volunteer-led discipline of “community ophthalmology” worldwide, providing needed eye care to disadvantaged populations.

Between 1970 and 1973, she worked at New York University as a resident in Ophthalmology, being the first African-American woman to hold this role. She married in the early 1970s and her daughter Eraka was born in 1972 [9].

In those years, she also briefly worked as an assistant professor at the Jules Stein Eye Institute at UCLA and at the Charles R. Drew University of Medicine and Science. In 1976, Patricia Bath co-founded the American Institute for the Prevention of Blindness, which established that “eyesight is a basic human right.” By 1983, Patricia Bath helped create the Ophthalmology Residency Training program at UCLA-Drew, which she also chaired, becoming, in addition to her other firsts milestones, the first woman in the nation to hold that position. In 1983, she became the head of a department at Charles R. Drew, the first woman to hold that position. In 1993, she retired from UCLA, which subsequently named her the first woman on its honorary staff.

She served as Professor of Ophthalmology at Howard University School of Medicine and Professor of Telemedicine and Ophthalmology at St. Georges University [10] and was one of the founders of the ophthalmology training program at King-Drew Medical Center [9].

Patricia Bath (Figure 5) gave many international conferences and was the author of more than 100 scientific articles.



**Figure 5.** Patricia Bath in 1994. Source: [9].

Regarding her inventions, Patricia Bath held four patents in the United States. The year 1981 would mark a before and after in her life. At that time she began to work on her most recognized invention: the Laserphaco ultrasound (Laser PHotoAblative Cataract surgery). For more than five years, she immersed herself in the construction of a tool that would make it possible to weaken, in a less painful way, the rough and outer layer of the cataracts. This allowed the procedure to be much more precise and accelerated. Indeed, in that year, she conceived the Laserphaco probe, a medical instrument that improves the use of lasers for cataract removal, and “for cataract lens ablation and removal.” That device was completed in 1986, after Patricia Bath researched lasers in Berlin, and patented it in 1988, making her the first African American to receive a patent for medical use. The device, which dissolves cataracts with a laser quickly and almost painlessly, irrigates and cleans the eye and allows easy insertion of a new lens, is used internationally to treat this condition [10].

Three of the four Patricia Bath patents are related to the Laserphaco probe. In 2000, she was awarded a patent for a method devised to use ultrasound technology in the treatment of cataracts.

In early 1993, Patricia Bath (Figure 6) decided to retire. In the following decades, Patricia dedicated many efforts to humanitarian work. She visited several African countries, especially Kenya and Tanzania, where she promoted various initiatives to prevent

childhood blindness, as well as promote new information and communication technologies (ICTs) among poor students.



Figure 6. Patricia Bath. Source: [9].

With her health deteriorating, she decided to move to San Francisco to be closer to her daughter Eraka and granddaughter. On one occasion, shortly before her death, Eraka and Patricia sat down to talk. Both discussed the life of the ophthalmologist and exchanged concerns about the work that she still felt pending. On that occasion, the daughter wasted no time in offering a revelation to her mother: *“Even if you did not seek to be a role model, you became one”* [9].

Thanks to the work carried out throughout her life, her effort and her dedication to Ophthalmology, Patricia Bath received honors from two of her universities. In 1998, Hunter College gave tribute her by placing her in their “Hall of Fame” and Howard University named her a “Howard University Pioneer in Academic Medicine” in 1993. An illustrated book about her life and work (Figure 7, left) was also published in 2017. Both the National Association of Science Teachers and the Chicago Public Library considered that book as one of the best books for children of the year. Specifically, that library named it “the best of the best selection” [12]. Another book on her was titled “Women on Science”, by Rachel Ignatofsky (Figure 7, right).



Figure 7. Covers of two books on Patricia Bath. Source: [9].

Patricia Bath (Figure 8) passed away on 30 May 2019, after suffering for months from lung cancer that finally ended her life. Her daughter Eraka was in charge of communicating that her mother had died, answering the questions that some of the media asked her after the sad event. Eraka, instead of highlighting the merits, the numerous publications or the five patents for inventions that her mother managed to register in the United States, preferred to focus more on offering another point of view, a more personal, more human, lesser-known side. Among the phrases she dedicated to her mother, the following can be highlighted [9]:



**Figure 8.** Patricia Bath. Source: [9].

*My mother was an exceptional woman, as well as simple. She used to wear sneakers and blue jeans all the time ([ . . . ] Mom liked to look casual, not pretentious. She came from very humble roots. It could be said that she had a second career as a humanitarian. Her attitude was always vigorous, tireless.*

### 3.3. Mary Elliott Hill. Her Biography

There is not much precise data in the literature about Mary Elliott Hill. In fact, although that information is not officially confirmed, it is thought that she is the first Black woman to earn a bachelor's degree in Chemistry, [13]

Hill was born in South Mills, North Carolina, on 5 January 1907 and had two brothers. Her parents were Robert Elliott, fireman, and Frances Bass [1].

She began her university studies in 1925, at the Virginia State College for Negroes (now Virginia State University) and got her bachelor's degree in Chemistry in 1929.

When she finished her degree, she began her teaching work in 1930 at the Laboratory Secondary School of her University. In 1932 she served as a part-time Professor of Chemistry at the Hampton Institute and became a full professor in 1937 [1]. Later, between 1938 and 1942, she worked as a professor at her University [14].

Mary Elliott Hill took advantage of summers of her working years to go after graduate studies at the University of Pennsylvania, becoming the first Black woman to earn a master in Chemistry, in 1941 [14].

In 1942, she worked at Bennett College in Greensboro, North Carolina as a professor, and also as an assistant professor of Chemistry at Tennessee A & I State College (a Black college now known as Tennessee State University). The following year she went to Kentucky State University, where her husband, Carl McClellan Hill, was the head of the Chemistry department. Carl Hill, who had been the dean of the School of Arts and Sciences at Tennessee A & I, had accepted the position as president of Kentucky State College (now Kentucky State University) in Frankfort, Kentucky and Mary Elliott Hill followed him. The marriage had three children. Between 1951 and 1952 she was named associate professor and became interim head of that department [1].



Mary Elliott Hill (Figure 9) and Carl Hill worked together, and they specialized in the use of ketenes [15]. Together with other people of the research team guided by her husband and with himself, she co-authored more than 40 publications on these topics, although she was never cited as the senior author [1]. She published two textbooks: the first, *General College Chemistry*, in 1944, written with Myron B. Towns and her husband. The second, the laboratory manual “*Experiments in Organic Chemistry*”, in 1954, which was made into four editions [15].



**Figure 9.** Mary Elliott Hill working in the lab. Source: [16].

Several of the student taught by her in Black colleges and universities in which she taught became Chemistry professors (Figure 10). She was a member of several institutions: the Tennessee Academy of Science, the National Institute of Science, Alpha Kappa Alpha National Honor Society, and Beta Kappa Chi [1].



**Figure 10.** Mary Elliott Hill. Source: [17].

Regarding her personal life, it is known that Mary Elliott Hill married Carl McClellan Hill (the date is unknown). The newspaper “*The Courier-Journal*” (Louisville, Kentucky), of 13 February 1969 affirmed that they were married two years after a classmate introduced them at the age of 16, while in another source is indicated that the marriage took place during their second year at Virginia State College, suggesting sometime between 1925 and 1927 [18].

In the interview with the newspaper “The Courier-Journal” cited above, Mary Elliott Hill herself revealed that her hobbies were enjoying flowers arranging, reading, studying German and Russian, and watching football matches. She and her husband were very involved in their Presbyterian Churches in Nashville, Tennessee [1].

The marriage had just returned from a travel to England, when she died due to “a heart condition” she had “for some time”, in King’s Daughters Hospital in Frankfort, Kentucky, on 12 February 1969, news that it was announced by the aforementioned newspaper “The Courier-Journal” [1].

### 3.4. Marie Maynard Daly. Her Biography

Marie Maynard Daly was the first Black woman to earn a Ph.D. in Chemistry in the United States, from Columbia University in 1947 [19].

Her parents were Ivan C. Daly, who had emigrated from the British West Indies and worked as a postal clerk, and Helen Page, a native of Washington, DC. The marriage went on to live in New York, where she was born on 16 April 1921, in Corona, a neighborhood in Queens. The family used to visit the maternal grandparents in Washington, where she took the opportunity to read with relish about scientific researchers and their discoveries in her grandfather’s extensive library, which obviously influenced her later decision to become a scientist. In fact, she was especially marked by the work “The Microbe Hunters”, by Paul de Kruif [1]. Her father also had a decisive role in his daughter’s decision to study Chemistry, since he had also wanted to be a chemist and, in fact, he even started studying that discipline at Cornell University, although he had to abandon them due to lack of financial means [20]

Marie Daly studied in Hunter College High School, an all-girls school attended by Hunter College teachers, who encouraged her to study Chemistry, and later enrolled at Queens College, a newly established small school in Flushing, New York, where she earned her bachelor’s degree magna cum laude in Chemistry in 1942 [1]. Concerning graduation, she was named a Queens College Scholar [deBask], an honor that was only awarded to the top 2.5% of the graduating class [20].

The fact that World War II produced a great labor shortage in the country and that, on the other hand, scientists were needed to help with the problems arising from that war, was taken advantage of by Marie Daly (in Figure 11), as well as by several other women, to get scholarships to study. She got two of them, one at New York University and the other at Columbia University. Both scholarships allowed her to obtain her master’s degree and her doctorate, respectively [19].



Figure 11. Marie Daly. Source: [20].

Thus, Marie Daly was simultaneously her work as a laboratory assistant at Queens College with her studies at New York University to obtain her bachelor's degree in Chemistry in 1942, and completed her master's degree at New York University in only one year. She became a Chemistry tutor at Queens College and enrolled in the Ph.D. program at Columbia University. Her supervisor was María Leticia Caldwell, Ph.D. in nutrition, who helped Marie Daly discover the way in which chemicals produced in the body aid in the digestion of food. Marie Daly obtained her Ph.D. in Chemistry in 1947, with a thesis entitled "A study of the products formed by the action of pancreatic amylase on corn starch", thus becoming the first person to earn a Ph.D. from Columbia University and the first African-American woman to obtain a Ph.D. in Chemistry in the United States [19]. Years later, while devoting her time to research and as a sign of gratitude, Marie Daly created in 1988 a scholarship fund at Queens College with the objective of helping African-American science graduates and minority students in Chemistry or Physics [1].

Her postdoctoral research at the Rockefeller Institute centered on the composition of the cell's nucleus and the procedure in which proteins are metabolized.

Marie Daly was Professor of Physics at Howard University from 1947 to 1948 while simultaneously carrying on new research under the guidance of Herman Branson. she also worked at the Faculty of Physics and Surgeons at Columbia University in 1955, where she studied arterial metabolism in collaboration with Dr. Quentin B. Deming.

When she received a grant from the American Cancer Society, she decided to join Dr. Un. E. Mirsky at the Rockefeller Institute to study the cell nucleus and its constituents [21]. Later, she and Deming moved in 1960 to the Albert Einstein College of Medicine at Yeshiva University, where. she continued her work as an assistant professor of Biochemistry and Medicine. There, Marie Daly tried to increase the number of minority students enrolling in medical schools. In 1971 she was promoted to associate professor [22]. From 1958 to 1963, she was also researching in the American Heart Association.

In 1975, she was one of 30 women participants in a conference dealing with the challenges facing minority women in fields now called STEM (an acronym made up of the initials of the words Science, Technology, Engineering and Mathematics). That event was organized by the American Association for the Advancement of Science and, as a result an inform entitled "The Double Bind: The Price of Being a Minority Woman in Science (1976)" was published. In it, some recommendations on the hiring and retention of minority women scientists were included [20].

During her research period, her contributions focused on four different lines of research: histone chemistry, protein synthesis, the relationship between cholesterol and hypertension, and creatine uptake by muscle cells [23].

With reference to histones, proteins found in the nucleus of cells, Marie Daly was particularly interested in nuclear proteins. She suggested that histones were a mixture of building blocks like lysine and argenine and concluded that the only bases present in appreciable amounts were adenine, guanine, thymine, and cytosine. Since then, histones have been considered really important in gene expression [23].

Marie Daly also investigated protein synthesis, including the role of cytoplasmic ribonucleoprotein in protein synthesis [21].

In 1953, Watson and Crick described the structure of DNA. When in 1962, Watson received Nobel Prize, he cited, in the acceptance ceremony, Marie Daly's research on "The role of ribonucleoprotein in protein synthesis" as contributing to her work [21].

Marie Daly and her colleagues also researched on cholesterol and hypertension. She was the first person to consider hypertension as a precursor to atherosclerosis, and also the first to identify the relationship between cholesterol and clogged arteries [21]. She was also one of the first investigators of the effects of cigarette smoke on the lungs and hypertension [24].

Finally, in the 1970s, Marie Daly began studying creatine uptake by muscle cells, an important research topic in the energy recycling systems of muscles. Her publication

“Creatine uptake by cultured cells”, in 1980, describes the conditions under which muscle tissues better absorb creatine [25].

During her research career, Marie Daly belonged to many scientific societies. She was one of the governors of the New York Academy of Sciences for two years. She belonged to the American Cancer Society, American Association for the Advancement of Science, New York Academy of Sciences, and Council on Atherosclerosis of the American Heart Association. The New York City Health Search Council designated her as a career scientist [22].

Marie Daly retired in 1986, from the Albert Einstein College of Medicine, and in 1988 she created a fellowship for African-American chemists and physicists at Queens College in memory of her father [Grinstein]. In 1999, she was recognized by the National Technical Association as one of the Top 50 Women in Science, Engineering, and Technology [26].

Marie Daly passed away on 28 October 2003 [deBask]. On 26 February 2016, Founding Director of P.S.360Q Elementary School, Emmanuel-Cooke, announced that the school would be named the “Dr. Marie M. Daly Academy of Excellence” in her honor [27].

Some of the most significant phrases that she uttered are the following [26]:

*“Courage is like—it’s a habitus, a habit, a virtue: you get it by courageous acts. It’s like you learn to swim by swimming. You learn courage by couraging”.*

*“Courage to be is the key to revelatory power of the feminist revolution”.*

*“I had explained that a woman’s asking for equality in the church would be comparable to a black person’s demanding equality in the Ku Klux Klan”.*

### 3.5. Brief Biographies of Other Pioneering Black Female Scientists

In this last subsection and as a complement to the above, brief biographies of other pioneering African-American women scientists, also Black, are shown (in alphabetical order, with the exception of the last three because they form a group). For further information, the reader can check [28,29]. These women are the following.

**Annie J. Easley**, born in Birmingham, Alabama, in 1933, was a computer scientist, mathematician, and rocket scientist female. Her entire childhood was spent dreaming of becoming a nurse, but once she attended high school, she slowly switched her interest to pharmacy. She was one of the first African-Americans to work as a computer scientist at NASA and led the team that developed the software for the Centaur rocket stage. That work served as the technological basis for the launch of space shuttles and the launch of communications, military, and meteorological satellites, contributing to the 1997 Cassini flight to Saturn. Died in Cleveland in 2011.

**Shirley Ann Jackson**, theoretical physicist and famous Black inventor, received a bachelor and doctoral degree, both in Physics, from the the Massachusetts Institute of Technology (MIT). She became the first African-American female to earn a Ph.D. from that Institute. In 2016, she was awarded by President Barack Obama the National Medal of Science, the highest honor to individuals who made contributions to scientific fields.

The chemist, mathematician, and educator **Angie Lena King** (née Turner) was born in 1905 in Elkhorn, McDowell County, West Virginia. She taught Chemist both to students, in West Virginia State College, and to soldiers in the West Virginia State’s Army Specialized Training Program. She published in the 1970s a contribution entitled “The Status of Women in East Africa” to highlight women who were working at this time. After her retirement she received an honorary Doctor of Laws Degree. She passed away in 2004.

**Ruth Ella Moore** (1903, Columbus, Ohio, 1994) was a bacteriologist who became, in 1933, the first Black woman to obtain a doctorate in Natural Sciences. She was a professor and chair of the bacteriology department at Howard University. She published several papers on tuberculosis, immunology, and dental caries, the response of stomach microorganisms to antibiotics, and the blood type of African-Americans.

**Carolyn Beatrice Parker** (Gainesville, Florida, 1917–1966) was the first Black female to obtain a postgraduate degree in Physics from the MIT. From 1943 to 1947 she was working

on the Dayton Project, the plutonium research and development arm of the Manhattan Project. Later, she became an assistant professor in Physics at Fisk University. According to her family, her work in that project was one of the causes that produced her death aged 48, due to leukemia that she contracted as a direct result of radiation exposure during that work. For that reason, she was also unable to finish her doctoral thesis.

**Marguerite Thomas Williams** (Washington D.C., 1991) was the first Black woman to obtain a Ph.D. in geology. She was a professor of that discipline and of social sciences. She taught in the Geology department at Miner Teacher's College (1923–1933) and was also a professor at Howard University during the 1940s. She retired in 1955.

Finally, the figures of the three Black mathematicians women **Creola Katherine Johnson**, née Coleman (White Sulfur Springs, West Virginia; 1918–Newport News, 2020), also physicist and rocket scientist, **Dorothy Johnson Vaughan** (Kansas City, Missouri, 1910–2008) and **Mary Winston Jackson** (Hampton, 1921–11 February 2005), also an engineer, who worked for the National Advisory Committee for Aeronautics (NACA), which would later become NASA, were depicted in the successful film "Hidden Figures". In that film it is described both the experience and the work of them on Project Mercury and Apollo 11 to discover the equations to put astronaut John Glenn into orbit.

In 2015, President Barack Obama awarded Katherine Johnson the Presidential Medal of Freedom. She died on 2020 at 101 years old. In 1949, Dorothy Vaughan assumed the management of West Area Computers, a segregated work group made up exclusively of African-American women, majoring in mathematics which was initially asked for using separate facilities for lunch or restrooms, so they wouldn't wear the same one as white women. A satellite in the constellation Aephe is named after her. For her part, Mary Jackson also faced the rights of women and people of color throughout her life. She was the incarnation of the Double V idea: the victory of both, people of color and women.

#### 4. Discussion

This article is dedicated to reveal the lives of some Black women who were pioneers of science, specifically of Pharmacy and Chemistry, with the objective of putting them as references to the society. Not surprisingly, they could first face and then overcome all the obstacles related to their gender imposed on them to study a university career and make use of their professions in a completely comparable way to that of men.

The women discussed in this article have been mainly Alice Ball, chemist and pharmacist, and the chemist Patricia Bath, Mary Elliott Hill and Marie Maynard Daly, all of whom made remarkable discoveries throughout their professional lives.

Although Alice Ball tragically died very young due to leukemia produced by the dangers present in her work, the importance of her first successful treatment for people with leprosy deserves all the recognition of society. She was the first woman graduated with an M.S. degree in Chemistry from the College of Hawaii.

Patricia Bath, graduated in Chemistry, is more known for inventing the Laserphaco Probe, a tool used in cataract surgery. She obtained a medical degree from Howard University, attended Columbia University and was the first Black to finish an ophthalmology residency program, in 1973. She was also the first woman to lead an ophthalmology residency program ten years later. In 1988, she became the first Black female doctor to receive a medical patent, when receiving one for the Laserphaco Probe.

Mary Elliott Hill, organic and analytical chemist, was one of the first Black women with a master's degree in Chemistry, in 1941. Joint her husband Carl McClellan Hill, she collaborated in researching ketene synthesis, useful in the development of plastics.

Marie Daly was the first Black woman to earn a doctorate in Chemistry in the United States. While she was researching, she also helped develop programs aimed at increasing minority enrollment in medical school and graduate programs. In 1988, she sponsored a scholarship fund at Queens College destined to Black science graduates.

Apart from these four women and in a less extensive way, this article also deals with the figures of other these exceptional women, also Black and contemporary with them, who

can also be considered pioneers of science due to the great relevance of their discoveries. Allow us, therefore, to finish this contribution by showing our admiration and respect towards all of them.

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## Appendix A

The Matilda Effect is the discrimination and prejudice that occurs against the achievements of women scientists whose contributions are usually attributed to men.

This effect has its origin in the Matthew effect that the sociologist Robert King Merton previously defined as the lack of consideration received by the research of young scientists, or little known, by the scientific community. It was later recognized that Matthew effect was based on the doctoral thesis of the researcher Harriet Zuckerman during the 1960s. In his article, Merton only cited such as researcher in the footnotes, without giving her more credit.

It was not until 1993 when the suffragist and abolitionist Matilda Joslyn Gage (1826–98) in her essay entitled “Woman as Inventor” (firstly appeared as a tract in 1870 and in the North American Review in 1883) brought this fact to light to denounce this situation suffered by thousands of women scientists and that served as an example to define what she called the Matilda/Harriet Effect in honor of Matilda Joslyn Gage, first activist who fought for women’s rights. The term “Matilda effect” was minted in 1993 by science historian Margaret W. Rossiter.

Rossiter provides several examples of this effect. By antiquity, it can be said that the first woman to suffer from it was Trotula of Salerno (1110–1160), an Italian physician who throughout her life wrote very important works with great contributions to medicine in the 12th century, books which were attributed to men, after her death. Furthermore, Salerno was denied its very existence due to society’s rejection of women who decided to pursue scientific research. Other relatively well-known women who suffered from it were Nettie Stevens, Lise Meitner, Marietta Blau, Rosalind Franklin and Jocelyn Bell Burnell. Some of them were clearly deserving of the Nobel Prize, which was only awarded to their male research colleagues.

This subject has been widely investigated in the last years. According to a recent U.S. study, “although overt gender discrimination generally continues to decline in American society, women continue to be disadvantaged with respect to the receipt of scientific awards and prizes, particularly for research.”

Currently, most of the non-governmental organizations that dedicate their efforts to combating gender inequalities affirm that several measures are necessary to fight against this effect, among which the following three stand out: favor education in equality, make visible the role of women in science and guarantee equality for women in STEM careers (and in all the others, the author would add).

The reader interested can check further information on this effect in several contributions ([30,31], for instance).

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