Life and Work of Marie Skłodowska-Curie and her Family

Anna Gasińska

From the Centre of Oncology, M. Skłodowska-Curie Memorial Institute, Kraków Branch, Poland

Correspondence to: Anna Gasińska, PhD, D, Centre of Oncology, Garncarska 11, 31–115 Kraków, Poland. Tel: + 48 12 423 1073. Fax: + 48 12 422 6680. E-mail: z5gasins@cyf-kr.edu.p

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(…) *And yet it is the 'celebrated scientist' who is strangest to me—probably because the idea that she was a 'celebrated' scientist' did not occupy the mind of Marie Curie. It seems to me rather, that I have always lived near the poor student, hunted by dreams, who was Marie Skłodowska-Curie long before I came into the world.* (…)
Eve Curie—Biography of Marie Curie (1).

Marie Skłodowska-Curie was born in Warsaw on 7 November 1867, at 16 Freta Street, as the fifth and the youngest child of the Skłodowska family (Fig. 1). She was brought up in a well-educated family; her mother taught languages and was headmistress in a school for girls and her father was a professor of mathematics and physics. They made a wonderful family, where playing was educational, where the children learned while playing and played while learning. Father read novels or poetry to the children every day, not forgetting about physical exercise. Marie was small, timid, nervous and beloved of her brother Józef and her sisters Zosia, Bronisława and Helena. She was remarkable for her prodigious memory. At the age of four years she could read with great fluency, and at the age of sixteen she won a gold medal on her graduation from the Russian Lyceum. This was the time when Poland was under foreign subjugation and the state existed only in the hearts of the Polish people.

Fig. 1. Maria Skłodowska-Curie 1867–1934.

From her mother, Marie inherited kindness and an uncompromising sense of duty; from her father, she acquired introspection, preciseness and an addiction to self-education. Marie's youth was marked by dramatic events, which influenced her future. Her older sister died when Marie was nine years old and her beloved and beautiful mother passed away after a long-lasting tuberculosis when Marie was eleven. Unable to cope with these tragedies, Marie abandoned the Catholic Church before she was twenty years old. Even so, these sad events strengthened her and taught her to face up to difficulties in life. When her father lost all his savings through a bad investment, Marie earned money as a teacher, to support the family. At the same time, she took courses in anatomy, biology and sociology, clandestinely in Polish. She also obtained informal training in chemical analysis in the laboratories of the Museum of Industry and Agriculture in Warsaw, where her uncle worked and where she became acquainted with research work.

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Marie and her older sister Bronisława were absolutely determined to get higher education, but women were not allowed to study at Polish universities under foreign occupation, so they had to go abroad. Financial problems prevented both sisters from going to Paris at the same time. It was Bronisława who went to Paris first to study medicine. To support her sister financially, Marie took a post as a governess in the country and in this way she was able to pay for her sister's studies at the Sorbonne. Unfortunately, at that time she fell in love with her employer's son. However, a poor governess could never be accepted as a member of this 'noble' family, and this caused her considerable unhappiness and misery for a long time (1). After three years she returned to Warsaw, to her family, friends, her job as a teacher, to the 'flying university' and to her chemical studies in the laboratory where her uncle worked. There she was taught how to carry out experiments and gained fundamental experience as a research worker (Fig. 2).

In 1891 it was Marie's turn, and Marie Skłodowska went to the Sorbonne to attend the lectures given by Paul Appel, Gabriel Lippman and Edmond Bouty. There she met physicists who were already well known, Jean Perrin and Charles Maurain. In Paris she first stayed with her sister Bronisława and her husband. Then she moved into student lodgings, usually on the top floor in rooms normally occupied by servants, where she lived in abject poverty, forgetting about her basic physical needs. Marie devoted herself and all her time to hard work, which finally bore fruit. In 1893 she graduated from the Sorbonne ranking first on the licentiate list of physical sciences and she returned to Warsaw. She searched for a job at the universities in Warsaw and Kraków, but without success. At that time, universities in Europe rarely considered employing female graduates. Then she won an Aleksandrowicz family scholarship, which was usually awarded to outstanding students abroad. With this scholarship Marie was able to go to Paris again to study mathematics at the Sorbonne. In 1894 she was ranked second on the licentiate list of mathematical sciences. While studying magnetism with Professor Lippman, she was looking for a laboratory in which to carry out her experiments, when she was introduced to a French physicist, Pierre Curie. The first meeting was very memorable for both scientists. Pierre was then 35 years old and had a good position in science. He was tall, slender, with an undefinable, careless elegance. He had serene eyes, a soft voice and a kind smile. Neither Pierre nor Marie, both having experienced painful episodes in their lives, were thinking about love. Still, they were both amazed at the similarities in their personalities and they enjoyed every minute of their conversations together. Pierre's family was well-to-do. His father was a doctor and was anticlergy; his two sons had never been baptized. Pierre grew up in admiration of the surrounding world. He was educated at home, because, as he himself said, he was a slow thinker. He gained his BSc degree at the age of eighteen and became a licentiate in science and was employed by Sorbonne University as a junior lecturer. He worked with his brother Jacob on piezoelectricity. At the time he met Marie he was working at the Municipal School for Industrial Physics and Chemistry. Pierre said he had found a soul-mate and, with some hesitation on Marie's part, they decided to get married. He wrote to Marie:

> *How wonderful it would be … if we could spend our lives together, following our ideals. Your patriotic ideals, and our common ideals of humanity and scientific research.*

Their marriage (25 July 1895) marked the beginning of a partnership that was soon to achieve results of world significance. Marie's marriage to Pierre Curie was a civil ceremony, as neither Pierre nor Marie belonged to any particular religion. They were given bicycles as a wedding present and after work they spent time cycling around Normandy, walking, and observing animals and plants (Fig. 3).

The birth of their daughter Irene in 1897 did not interfere with Marie's intensive scientific work. In the autumn of 1897, looking for a subject for her thesis, Marie Curie decided to investigate whether the property discovered in uranium could be found in other matter. She followed

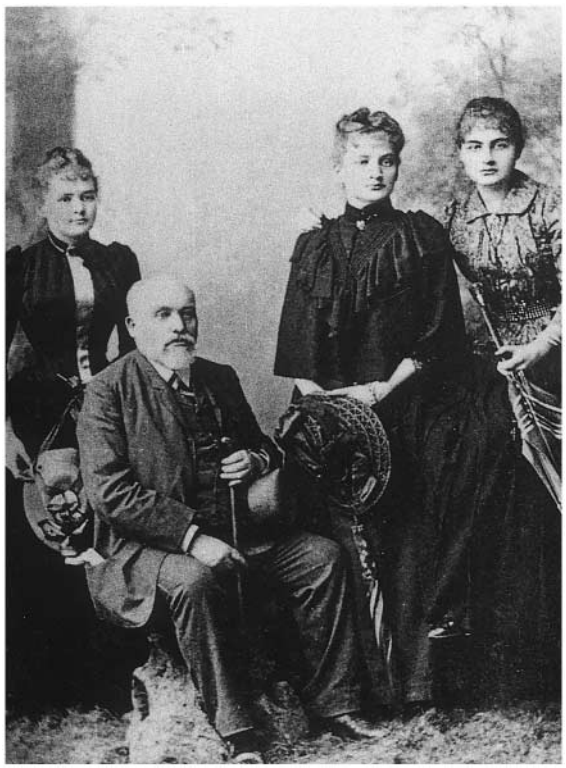

Fig. 2. Maria, Bronisława and Helena with their father Władysław Skłodowski (1890).

Fig. 3. Marie and Pierre Curie (1895).

Henri Becqerel's discovery (1896) of a new phenomenon, which she later called radioactivity. Marie thus began studying uranium radiation. Using techniques and an apparatus devised by Jacob and Pierre Curie, she carefully measured the radiation in pitchblend and ores containing uranium. When she found out that the radiation from the ore was more intense than that from uranium itself, she realized that there must exist an unknown element, even more radioactive than uranium. On 12 April 1898, Professor Lippman announced her findings to the French Academy of Science. But the existence of this new element needed to be proven by isolating it from other elements. It was then that Pierre Curie joined her in the work. They worked in an old shed, formerly the prosectorium of a medical school. Pierre concentrated on physics, Maria on chemistry. She was mainly responsible for isolating uranium salts from tonnes of ore. Their cooperation led to the discovery of polonium (so called by Marie in honour of Poland) in the summer of 1898, and that of radium a few months later. Their friend Paul Langevin wrote:

> *This discovery will probably have an impact on the future of our civilization comparable with that of the discoveries that allowed man to subdue the power of fire.*

In 1900 Marie was appointed lecturer in physics at the Ecole Normale Superieure for girls in Sevres, where she introduced a method of teaching based on experimental demonstrations (Fig. 4).

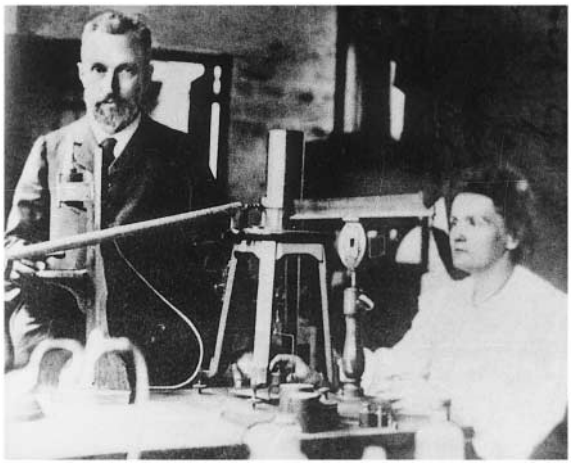

Fig. 4. Pierre and Marie Curie by their piezoelectric balance, used for radioactivity measurements.

While Pierre Curie devoted himself to the physical study of a new radiation, he was also the first person to publish the results of research on the radiobiology of radium, performed on his own skin, which formed the basis for curietherapy, Marie struggled to obtain pure radium in the metallic state. Even though their achievements were unique, in 1902 the Curies idealistically relinquished their right to patent the radium isolate. They published all the results of their study along with the detailed manufacturing processes and they offered free information on the subject. Marie Curie wrote: '*Radium is a chemical element, a property of all humans*' (2).

For her work, Marie received a doctorate in science in June 1903 and on 10 December that same year, Marie and Pierre shared with Henri Becquerel the Nobel prize in physics, for their discovery of radioactivity.

In 1904 Pierre Curie was appointed Professor of Physics at the University of Paris. It was then that their second daughter, Eva, was born. It was also in December 1904 that Marie Curie was appointed to her first research post as chief assistant in the laboratory directed by Pierre. On 5 July 1905 Pierre Curie was finally, after his third attempt, elected a member of the French Academy.

Marie and Pierre spent their free time going on trips. Unfortunately, this happy period of their life ended abruptly.

On 19 April 1906 Pierre died in a street accident, under the wheels of a horse-waggon. When his father learnt of his death, he said: '*Whatever was he thinking about this time*' (2). The sudden death of Pierre Curie was not only a bitter experience but also a decisive turning-point in Marie Curie's career and life. Her father-in-law helped her to bring up her daughters. He had a particular influence over Irene. He read tales to her and made her sensitive to the

beauty of nature. When he died, soon afterwards, Marie had only governesses to help her (Fig. 5).

After Pierre Curie's death, Marie devoted all her energy to completing the scientific work that they had carried out and to build the laboratory of the Radium Institute. In 1909 the Institute of Radium was founded in Paris, for the study of radioactivity and the biological effects of ionizing radiation. This Institute was composed of two laboratories: the Curie Pavillion, directed by Madame Curie, and the Pasteur Pavillion, directed by Claudius Regaud, a professor of histology and pathology, who devoted himself passionately to the study of the biological effects of radiation.

In 1908 Marie Curie became a titular professor, and in 1910 her fundamental thesis on radioactivity was published. In 1911 she participated in the First Council of Solvay's Physics Conference in Brussels. She was the only woman among such scientists as Rutherford, Einstein, Langevin, Perrin, and Max Planck. She took part in six further meetings of the group (Fig. 6).

In 1922 she was appointed a member of the International Commission of Intellectual Cooperation by the Council of the League of Nations. Moreover, while not regretting her earlier attitude to resist patenting her own ideas, she became an advocate of scientists' right to patent

Fig. 5. Marie with her daughters Irene and Eva in 1908, one year after Pierre's death.

Fig. 6. First Solvay Conference in 1911. Marie was the only woman there, amid a galaxy of brilliant physicists. The young Albert Einstein is seen standing second from the right (3).

their discoveries and inventions. She also campaigned for access to free international scientific literature, for internationally recognized scientific symbols and standards and for free international exchange of scientists.

In 1911 she received an unprecedented second Nobel prize, this time in chemistry, for her work on radium and radium compounds and for the isolation of metallic radium. Despite this academic success, for her this period was not a happy one. A scandal broke out about her relationship with Paul Langevin. The press published her stolen letters to Langevin, a married man and the father of four children. Public opinion turned against her. Marie—the woman, of whom Einstein said, '*She has the soul of an oyster. She is unable to express joy or pain*' fell in love with a man who was not worthy of her feelings. She paid for parting from him with a deep depression.

Marie Curie went back to Poland to spend her vacation with her daughters in the Tatra Mountains in Zakopane. She sought to recover psychological balance but she would never be able to enjoy life again. And it was at that time that she was invited to become an honorary member of the Science Society in Warsaw, and to begin research there. However, Marie Curie stayed in France. She decided to complete the construction of the Radium Institute, which had been Pierre Curie's dream.

In 1913 the Kernbaum Radiological Laboratory was opened in Warsaw and Marie became its honorary head. Later, in 1935, in the same laboratory, Józef Rotblat, with only 300 mg radium in solution, succeeded in producing radioactive cobalt.

In 1913 Marie spent her vacation with Albert Einstein and his family in the Alps. In 1914, when the buildings were completed, Marie became head of the Paris Institute of Radium. During World War I Marie organized a mobile radiographic unit and took it to the battlefront, where she frequently operated it herself, examining the wounded and training radiographic assistants. Irena helped her in this job. At a rough estimate, as a direct result of her activities more than 150 radiologists were trained at her courses; more than 200 x-ray laboratories

(including 20 mobile laboratories) were organized for military hospitals, and more than a million soldiers were helped by radiography before surgery. (Fig. 7)

In 1918 Irene joined the staff of the Radium Institute and this became the world centre for nuclear physics and chemistry. Many foreign scientists, including some from Poland, came to the Institute supported by Marie Curie's grants. She devoted her research to the study of chemistry of radioactive substances and the medical applications of these substances. In 1920, a decision was made to create a Foundation with the generous financial support of Henri de Rothschild, who was a physician himself. A clinic devoted to the treatment of diseases requiring ionizing radiation, in particular various forms of cancer, was established.

In 1921, accompanied by her two daughters, Marie Curie made a triumphant journey to the United States. Her trip was organized by Ms Maloney, a journalist impressed by Marie (Fig. 8). President Warren Harding presented her with a gram of radium that had been bought by American women. The radium was absolutely essential for the continuation and enhancement of the research programme in her laboratory in Paris, as the radium she had isolated herself had been donated to curietherapy.

In 1918 when Poland had newly won its independence, Marie Curie became an active member of the committee organizing the Radium Institute in Warsaw. The aim of this institute was to study and treat cancer. In 1925 Marie travelled to Warsaw to lay the cornestone of the Polish Radium Institute named after her (Fig. 9). Later, on 29 May 1932 she also witnessed the inauguration of the Radium Institute in Warsaw, for which she had requested in the United States, and again received, a second gram of radium. Unfortunately, this was the last visit of Marie Skłodowska-Curie to Poland.

On 9 October 1926, Irene married Frederic Joliot, a physicist, and her mother's co-worker. Irene very much resembled her mother in terms of character and personality. She cared for almost nothing except science. She took no interest in clothes and was not very sociable. Eva was a complete contrast to Irene. Extremely beautiful, smart and flirtatious, she played the piano, showed interest in literature and did not care in the slightest for physics or chemistry. Eva Curie differed from her mother, not only in her interests, but also in her attitude to life and its different problems.

At the beginning of the 1930s Marie experienced deep satisfaction in watching the development of the Curie Foundation in Paris, but in 1934 she became seriously ill. It was mainly Eva who devotedly took care of her mother while Irene and Frederic worked very hard in the laboratory. Marie was overjoyed to learn that Irene and Frederic Joliot had discovered artificial radioactivity in 1934. A few months after this discovery, and before her daughter and son-in-law were awarded the Nobel prize in chemistry (1935), Marie Skłodowska-Curie was admitted to a sanatorium in Sancellmoz near Sallanches (France) in the Alps, which was wrongly recommended by doctors, and there she died on 4 July 1934. Marie Skłodowska-Curie died of leukaemia, an illness that was caused by almost 37 years of exposure to radiation. On 6th July she was buried next to her husband Pierre in the cemetery in Sceaux.

Less than a year after Marie's death, Irene and Frederic Joliot-Curie were awarded the Nobel prize. for the discovery of artificial radioactivity, increasing to four, in one family, the number of recipients of this highest of scientific awards.

Marie Skłodowska-Curie left a great legacy to the world. Her work led to the development of nuclear energy and the treatment of cancer. Under Marie Skłodowska-Curie's guidance about 483 scientific papers were pub-

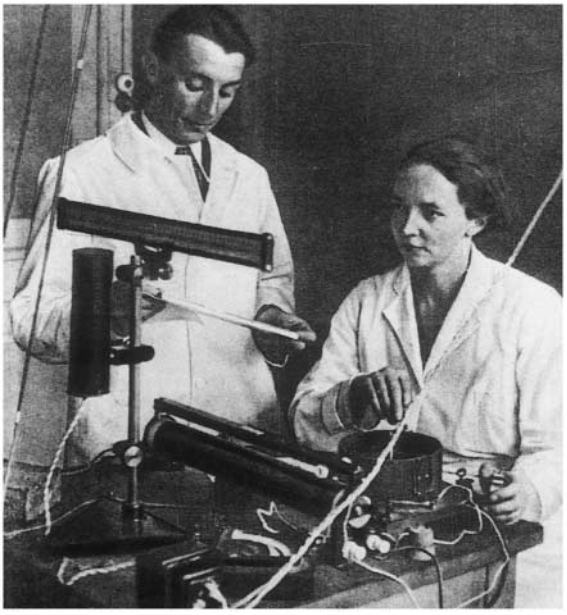

Fig. 7. Irene and Frederic Joliot—Curie in their laboratory in Paris (1934)

Fig. 8. Marie Curie in the company of Ms Maloney (left) and her daughters Irene and Eva after their arrival in the USA (1921).

lished, and 34 doctorates were awarded to her students. In the medical unit, 8319 patients were treated with radium. She was one of the first women scientists to win worldwide fame. Marie Curie, the first woman to obtain the degree of Doctor of Science in Europe, opened the way for women to enter fields that had hitherto been reserved for men. Albert Einstein said that Marie was '*…the only person not corrupted by fame*'. Marie Curie also improved the image of science. As a result of her determination and her love of freedom, she has become a symbol.

After Marie Curie's death, Irene Joliot became head of the Radium Institute. She had two children: Helene and Pierre. Irene died in Paris in 1956. Her daughter, Helene later married a grandson of Paul Langevin, making a happy ending to the unfortunate love affair of Marie Curie and Paul Langevin.

During World War II, Eva Curie was a correspondent for the New York and London press. In 1941 she left New York to find herself at the front lines in Africa and Asia. She described her experience in a book *Journey Among Warriors*, which she dedicated to her mother. Later, she married an American diplomat, Henry Labouisse, who was the US Ambassador in Greece, and then for some considerable time the General Director of UNICEF. In 1995 Eva Curie, in the presence of the Presidents of both France and Poland, took part in the ceremony of transferring the remains of her parents Marie and Pierre Curie to the Pantheon in Paris. Marie was the first woman to be laid to rest in the Pantheon in recognition of her own achievements.

In 1967, the year of the centenary of the birth of Marie Skłodowska, a museum dedicated to her memory was established in her family home in Warsaw. This permanent exhibition shows the life of Marie Curie. We can see some of her personal belongings (a gown, books, furniture), and some of the instruments which she and Pierre used. The exhibition presents Marie Curie as a great patriot and human being who served mankind through science.

Fig. 9. Marie Skłodowska-Curie at the ceremony to lay the cornestone of the Radium Institute in Warsaw (1925) (3).

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