Science as a public duty. Following the ideas and work of Maria Skłodowska-Curie

Nauka - jako powinność wobec społeczeństwa. Śladami idei i dziedzictwa Marii Skłodowskiej-Curie

During the 11th International Congress of Radiation Research in Brisbane, Australia, (2003) Professor Masao S. Sasaki from the Radiation Biology Center, Kyoto University in Japan, the President of the International Association of Radiation Research (IARR), announced at the reception held for the Board of IARR Council that their next meeting would take place in the year 2005, in Denver, USA and that it would finalize the contest and choose the winner-country which would be entitled to organize the 14th Congress in the year 2011. Co-author of this article, who partook in this event, resolved then that she would never rest until she used the opportunity to arrange this big event in Poland, 100 years after the second Nobel Prize was awarded to our great compatriot Maria Skłodowska-Curie for the discovery of polonium and radium, and 110 years after she isolated radium chloride for the first time [1,12]. In 1903 Maria Skłodowska-Curie became the first woman to win the Nobel Prize. She still remains the only woman to receive this prize, the highest scientific award, twice [1,2,10]. Clearly, the Nobel Prize was not the only reason for the fascination with Maria Skłodowska-Curie, a two-time laureate of the prize; it was also fuelled by her outstanding personality.

It is understandable that Maria Skłodowska-Curie is a winner of many ranking lists for the most famous female scientist [11,14]. Through her outstanding discovery of polonium and radium Maria Skłodowska-Curie not only coined the word "radioactivity," but above all she opened the door to a better understanding of the nature of matter and energy for both scientists and the public. Her achievements and discoveries, so extremely important to the scientific world, were not the sole reason for her enormous popularity. Her complete uniqueness and trailblazing activities in so many fields played an enormous role here too. Her scientific actions, feats and services for the public paved the way not only for women in science, but above all for the radiation research and therapy, also in Poland [1,11].

Since she was young, Maria was extremely talented, hardworking, beautiful and emotional. She was a great patriot and a responsible, persevering, and modest person [1,10,12]. It is difficult to find new words to describe her other than those already used for more than one hundred years. Maria Skłodowska-Curie’s fascinating personality was most accurately captured by Albert Einstein, who said that: "Marie Curie is, of all celebrated beings the only one whom fame has not corrupted" [3]. Again, late in his life, one of the greatest physicists of the 20th century thus wrote in his biography: "It was my good fortune to be linked with Madame Curie through twenty years of sublime and unclouded friendship. I came to admire her human grandeur to an ever growing degree. Her strength, her purity of will, her austerity toward herself, her objectivity, her incorruptible judgment - all these were of a kind seldom found joined in a single individual" [3,10]. One should not be surprised that even our great compatriot John Paul II devoted his precious attention to her fame (Figure 1) [8].

Life and passions

Maria Skłodowska, born on November 7, 1867, in Warsaw had many passions, which were drivers and guiding principles in her life and creative discoveries. Her parents, Marianna Bronisława Boguska and Władysław Skłodowski, both came from local, deeply patriotic nobility, hence it is no surprise that Maria’s prime passion was patriotism. It found its expression in her book, where she wrote: "I wished, like many other young people of my country, to contribute my effort toward the conservation of our national spirit." Until the end of her life, however, she proved that she sincerely adopted France as her step motherland, and yet, she never betrayed Poland as her beloved motherland [1,10,12].

She last visited Poland in the year 1932, two years before her death. During her visit in Warsaw on the occasion of opening of the Radium Institute, she wrote these words: "I went for a lonely walk to the Vistula. There is a song from Kraków, which says, that the magic of the Polish waters is so great, that who has fallen in love with them once, will not forget them until death. This river holds a charm for me, the essence of which I cannot even grasp" [1,7,12]. There is little doubt that the song Maria Skłodowska-Curie remembered since her childhood till almost the end of her life, was one of the most patriotic songs children used to learn in the previous times.

Maria Skłodowska’s second and deep passion was research. At the age of 16, she won a gold medal for graduating from secondary school, and then started working as a teacher to help support her family. When she was 18, she worked as a governess and financed her sister through medical school in Paris with the money she earned. The fi-
financial difficulties that her family experienced never stopped her from following her vision and dreams. Her genius and passion for exploration was reflected in her brilliant advancement on the scientific ladder, starting from self-made experimental evening studies in a small chemistry lab in Warsaw run by Mendeleev's former assistant, which she thus commented later: "I was taught there that the way of progress is neither swift nor easy," to a world-famous scientist. She once said that "nothing in life is to be feared. It is only to be understood."

In 1891, at the age of 24, she went to Paris, where she started her studies in physics at Sorbonne. She was the first female student to graduate holding the first position in the class ranking. Her thirst for knowledge led her to shortly thereafter undertake and successfully complete studies in mathematics. While on vacation with her family, Maria tried to get a job in Kraków, at the Jagiellonian University. Her efforts, however, proved to be in vain so she returned again to Paris, where she met and married Pierre Curie in July 1895 and started her PhD studies (Figure 2).

During only twenty years since the start of her studies at Sorbonne in 1891, Maria graduated in physics and math, carried out research on magnetism, discovered polonium and radium, received her PhD degree, at the same time bringing up her two daughters. She also succeeded in her grueling and tedious work on radium chloride and radium's isolation, until she became the first human awarded twice with a Nobel Prize - first on November 12, 1903, with Pierre Curie and Henry Becquerel in physics, and second on December 10, 1911 in chemistry.

Maria Skłodowska-Curie’s creativity and passions were a crucial inspiration in many scientific fields. In the year 1898 not only does she discover polonium and later radium, but more importantly, she correctly describes uranium deriving its power from the atom itself. Such a belief at that point was truly revolutionary. Despite the endlessly hard and tedious process of separation and isolation, Maria and Pierre discovered joy and beauty in the results, what was expressed on the world-famous picture of postcard visible in the light emitted by radium bromide (Figure 3).

Richard Feynman, a great theoretical physicist and Nobel laureate of 1965, when asked what scientific discovery he considered the most important of all, replied that it is learning the truth that all things are made of atoms. ["... If, in some cataclysm, all of scientific knowledge were to be destroyed, and only one sentence passed on to the next generations of creatures, what statement would contain the most information in the fewest words? I believe it is atomic hypothesis (or the atomic fact, or however you wish to call it) that all things are made of atoms - little particles that move around in perpetual motion, attracting each other when they are a little distance apart, but repelling upon being squeezed into one another. In that one sentence, you will see, there is an enormous amount of information about the world, if just a little imagination and thinking are applied"].
The end of the 19th century brought about a breakthrough in the understanding of the structure of matter. In 1897 a British physicist Joseph John Thomson (1856-1940) discovered an electron in a series of experiments exploring the nature of electric discharge in a high-vacuum cathode-ray tube, an area being investigated by numerous scientists at the time. Thomson interpreted the deflection of the rays by electrically charged plates and magnets as evidence of existence of "bodies much smaller than atoms" that he calculated as having a very large value for the charge-to-mass ratio. He proclaimed that electrons are constituents of all atoms. The idea that atom is indivisible was dropped. Indivisibility proved to be divisible. The first elementary particle was discovered. In 1896, few months after the discovery of Roentgen radiation, and somewhat in consequence of it, Henri Becquerel discovered the phenomenon of radioactivity. The significance of the finding was radically changed by Maria Skłodowska-Curie and Pierre Curie’s discovery of polonium and radium in 1898. It showed that the radioactivity of uranium and thorium is an atomic and not a molecular property. The progress of work in the field resulting in learning the structure of an atom and, most importantly, its nucleus, as well as the development of quantum physics. Humankind entered the atomic age.

Joseph James Thomson, one of the greatest physicists of that time, and a discoverer of an electron, whose name was already mentioned, concluded the very fruitful period in the development of knowledge on the structure of matter with the following words: "The new discoveries made in physics in the last few years, and the ideas and potentialities suggested by them, have had an effect upon the workers in that subject akin to that produced in literature by the Renaissance[...]. In the distance tower still higher peaks, which will yield to those who ascend them still wider prospects, and deeper the feeling, whose truth is emphasized by every advance in science, that "Get thee the Works of the Lord".

Scientific discoveries are of various importance, scope and duration of influence, and these are the measures of their magnitude. A particularly important criterion of magnitude of a scientific finding is its civilization-al upshot. On this scale the discovery of polonium and radium places Maria Skłodowska-Curie and Pierre Curie among the greatest discoverers in the history of science.

Another example of passions came from Maria and Pierre’s devotion to bringing up children. They paid careful attention to the education of their children as well as other young people [1,12]. Maria introduced a new teaching method at Sevres, a school for girls; the method was based on demonstrations of experiments. Since the beginning of the 20th century Maria also fought to support students through fellowships, first Curie-Carnegie, and later Pasteur. Service to the public and community as scientists' duties was Maria Skłodowska-Curie's another vision. Although Pierre and Maria Curie intentionally did not file for a patent on radium separation procedure and gave it to American engineers, later, Maria had to struggle to obtain radium for two Institutes (in 1921 - for institute in Paris, and in 1924 - for the institute in Warsaw). This led her to promote the view that scientists' pure devotion ought to be appreciated, and pure scientific research and scientists supported. She wrote: "It seems, however, that a society well organized ought to assure to these workers the means for efficient labor, in a life from which material care is excluded so that this life may be freely devoted to the service of scientific research," also persuading that "we must not forget that when radium was discovered no one knew that it would prove useful in hospitals. The work was one of pure science" [10].

A yet another example of her deep feeling of responsibility and need for the service to the public was shown during the World War I, when Maria, holding a deep personal an inner conviction that radiology had a potential to save lives at the battlefield, put the public and community as scientists’ duties first. She personally and organized the activities to save the public and community as scientists’ duties. She paid careful attention to the education of their children as well as other young people [1,12]. Maria introduced a new teaching method at Sevres, a school for girls; the method was based on demonstrations of experiments. Since the beginning of the 20th century Maria also fought to support students through fellowships, first Curie-Carnegie, and later Pasteur. Service to the public and community as scientists’ duties was Maria Skłodowska-Curie’s another vision. Although Pierre and Maria Curie intentionally did not file for a patent on radium separation procedure and gave it to American engineers, later, Maria had to struggle to obtain radium for two Institutes (in 1921 - for institute in Paris, and in 1924 - for the institute in Warsaw). This led her to promote the view that scientists’ pure devotion ought to be appreciated, and pure scientific research and scientists supported. She wrote: "It seems, however, that a society well organized ought to assure to these workers the means for efficient labor, in a life from which material care is excluded so that this life may be freely devoted to the service of scientific research," also persuading that "we must not forget that when radium was discovered no one knew that it would prove useful in hospitals. The work was one of pure science" [10].

A yet another example of her deep feeling of responsibility and need for the service to the public was shown during the World War I, when Maria, holding a deep personal an inner conviction that radiology had a potential to save lives at the battlefield, put the public and community as scientists’ duties first. She personally and organized the activities to save the public and community as scientists’ duties. She paid careful attention to the education of their children as well as other young people [1,12]. Maria introduced a new teaching method at Sevres, a school for girls; the method was based on demonstrations of experiments. Since the beginning of the 20th century Maria also fought to support students through fellowships, first Curie-Carnegie, and later Pasteur. Service to the public and community as scientists’ duties was Maria Skłodowska-Curie’s another vision. Although Pierre and Maria Curie intentionally did not file for a patent on radium separation procedure and gave it to American engineers, later, Maria had to struggle to obtain radium for two Institutes (in 1921 - for institute in Paris, and in 1924 - for the institute in Warsaw). This led her to promote the view that scientists’ pure devotion ought to be appreciated, and pure scientific research and scientists supported. She wrote: "It seems, however, that a society well organized ought to assure to these workers the means for efficient labor, in a life from which material care is excluded so that this life may be freely devoted to the service of scientific research," also persuading that "we must not forget that when radium was discovered no one knew that it would prove useful in hospitals. The work was one of pure science" [10].

Another example of her deep feeling of responsibility and need for the service to the public was shown during the World War I, when Maria, holding a deep personal an inner conviction that radiology had a potential to save lives at the battlefield, put the public and community as scientists’ duties first. She personally and organized the activities to save the public and community as scientists’ duties. She paid careful attention to the education of their children as well as other young people [1,12]. Maria introduced a new teaching method at Sevres, a school for girls; the method was based on demonstrations of experiments. Since the beginning of the 20th century Maria also fought to support students through fellowships, first Curie-Carnegie, and later Pasteur. Service to the public and community as scientists’ duties was Maria Skłodowska-Curie’s another vision. Although Pierre and Maria Curie intentionally did not file for a patent on radium separation procedure and gave it to American engineers, later, Maria had to struggle to obtain radium for two Institutes (in 1921 - for institute in Paris, and in 1924 - for the institute in Warsaw). This led her to promote the view that scientists’ pure devotion ought to be appreciated, and pure scientific research and scientists supported. She wrote: "It seems, however, that a society well organized ought to assure to these workers the means for efficient labor, in a life from which material care is excluded so that this life may be freely devoted to the service of scientific research," also persuading that "we must not forget that when radium was discovered no one knew that it would prove useful in hospitals. The work was one of pure science" [10].

Another example of her deep feeling of responsibility and need for the service to the public was shown during the World War I, when Maria, holding a deep personal an inner conviction that radiology had a potential to save lives at the battlefield, put the public and community as scientists’ duties first. She personally and organized the activities to save the public and community as scientists’ duties. She paid careful attention to the education of their children as well as other young people [1,12]. Maria introduced a new teaching method at Sevres, a school for girls; the method was based on demonstrations of experiments. Since the beginning of the 20th century Maria also fought to support students through fellowships, first Curie-Carnegie, and later Pasteur. Service to the public and community as scientists’ duties was Maria Skłodowska-Curie’s another vision. Although Pierre and Maria Curie intentionally did not file for a patent on radium separation procedure and gave it to American engineers, later, Maria had to struggle to obtain radium for two Institutes (in 1921 - for institute in Paris, and in 1924 - for the institute in Warsaw). This led her to promote the view that scientists’ pure devotion ought to be appreciated, and pure scientific research and scientists supported. She wrote: "It seems, however, that a society well organized ought to assure to these workers the means for efficient labor, in a life from which material care is excluded so that this life may be freely devoted to the service of scientific research," also persuading that "we must not forget that when radium was discovered no one knew that it would prove useful in hospitals. The work was one of pure science" [10].
Nobel prize: "It can even be thought that of polonium and radium, and expressed by weapon. This aspect of the outcome of the for military purposes, in the form of nuclear technique. With the use of isotopes we are whole field of natural sciences as well as in radiotherapy. Over one hundred years later gave rise to radiochemistry, radiology and the role of her great achievements in medicine, were honoured by the Jagiellonian University with a Honoris Causa Doctorate, which she received in 1924. It is hardly a surprise that Madame Curie and her work is still a source of inspiration for many, and that events like the Science as a Public Duty - Following the ideas and Work of Maria Skłodowska-Curie Symposium, satellite to 14th ICRR, which were held at Collegium Novum and the Col- legium Medicum of the Jagiellonian University, are being dedicated to her.

Heritage to medicine

"The mythical status of Marie Curie among the general public probably has more to do with the medical use of radium than with her role in opening the atomic age." — Helen Langewin

- Maria's granddaughter

The discovery of polonium and radium gave rise to radiochemistry, radiology and radiotherapy. Over one hundred years later they constitute separate branches of science. In modern times application of radioactivity is to certain extent counter-balanced by the over-a-century-long development of brachytherapy, which remains one of the most common approaches in the struggle with cancer. An ever greater progress can also be observed in the development of modern imaging techniques and their broad clinical application. And all began with Maria Skłodowska-Curie and Pierre Curie’s contribution over 100 years ago.

The contemporary division of scientists (set in the context of the modern discussions on "the superiority of fundamental sciences over technical, applied" and vice versa) into intellectuals unrivalled in searching for, and resolving theoretical problems, intellectually ready to take up a challenge to change the structure and image of science, and into brilliant minds in the sphere of technical and applied sciences, is natural. These are two kinds of different talents. The genius of Maria Skłodowska-Curie and Pierre Curie lies above all in the fact that both these talents are present in their scientific work.

The scientific discoveries of the turn of the 19th and 20th centuries played fundamental part in transforming the world. They influenced human life on Earth tremen- dously. They influenced the lives of us all. The discovery of polonium and radium was equal to the con- quering revolution and the order that Newton put the Universe in.

It is often the case that fundamental theories and experiments seem to have no practical sense at first ("The theory of rela- tivity has no commercial sense. It cannot be said that it pays off"). Application and possible benefits from fundamental discoveries come much later, and almost always in fields and branches that the discoverer him or herself is incapable of foreseeing, and ex- istence of which most often he or she cannot even imagine. An anecdote comes to mind: in the mid-19th century, British Chan- cellor of the Exchequer visits laboratory of Michael Faraday, who shows him his inven- tion - a machine for generating electric cur- rent. Skeptically, the Chancellor asked what it could be used for. "I have no idea, sir," replied Faraday, "but I am sure that you can levy a tax on it one day"[2].

Meanwhile, Maria Skłodowska-Curie and Pierre Curie, by exceptional intuition and almost immediately, pointed to medicine as the field of practical application of radioactivity. In modern parlance, they combined systemic and logical elements with creative and innovative ones. The discovery of polon- nium and radium introduced the phenomenon of radioactivity into medicine. The obtained experimental results were interpreted brilliantly.

Today, over one hundred years after the Curie’s discovery, their first experiments and approach limited to pressing radioactive ra- dium onto patient’s skin (curietherapy), we have a thriving and constantly developing oncological radiotherapy, radioimmuno- diagnostic imaging, as well as nuclear medicine, which are separate basic medical specialties.

Radiotherapy treats patients with cancer with the use of ionizing radiation. Radi- cal radiotherapy aims at destroying the tu- mor, whereas palliative radiotherapy aims at bringing symptomatic relief. If the radia- tion source remains in direct contact with the tumor, we speak of brachytherapy, and a treatment with the use of radiation source placed at a certain distance from tissues is called teletherapy.

The first element to be employed in brachytherapy was radium (Ra 226) discov- ered as already mentioned by the Curies. The treatment with radium was initially em- ployed as contact brachytherapy and was used for treating skin neoplasms, but already a few years later Alexander Bell proposed a treatment in which the isotopes are placed in natural body cavities (intracavitary brachytherapy), and next directly in malignant tumors (interstitial brachytherapy). Launching Radium Institute in Manchester on Maria Skłodowska-Curie’s initiative, which was first such center dedicated to this form of therapy, was also an important event in the development of brachytherapy. Rad- ium was the main element used in brachytherapy until the 1950s.

Teletherapy is another treatment tech- nique in radiotherapy using ionizing radia- tion. In this technique, a specific volume of tissues including the malignant tumor and adequate peripheral tissues, as well as the draining lymph nodes, if necessary, are irradiated with external beams.

1934 proved to be an important date, as this is the year when Irena and Frederic Joliot-Curie discovered artificial radioactiv- ity, which created greater possibility of finding an isotope with desired properties (therapy with radium was not always as effective as expected).

In the mid-20th century radiotherapy began to use cobalt (Co-60) as an ionizing radiation source, and in the last decade of the 20th century the introduction of helium-4 in 1992 was an isotope particularly popular in brachytherapy. Other isotopes used here are: Cs-137, Ta-182, Y-90, Sr-89-I-125, P-32, Ru-106, Pd-103 and Au-198.

Until recently the main form of teleradiotherapy was the use of the so-called "cobalt bomb" that had been successfully applied in cancer treatment due to the high energy gamma radiation of Co-60, more intense than in the case of Ra 226. Hadron therapy is yet another type of teletherapy. Its theoretical background was founded in the 1950s, nearly 30 years after Maria’s death, due to the fundamental works of Robert Rathbun Wilson "Radiological Use of
In the hadron therapy the therapeutic beam is a well collimated beam of heavy ions - mainly protons and carbon ions. With appropriately selected parameters, the computer controlled ion beam can destroy, with one millimeter accuracy, the whole malignant tumor bit by bit, its shape notwithstanding. A characteristic feature of heavy ion therapy is a unique dosage layout in patient's body, far more advantageous than in the case of photon and electron beams used in the traditional radiotherapy. Currently heavy ions therapy is foreseen as the future of radiosurgery, similarly to the presently used gamma or cyber knives. All methods of radiotherapy used until now and still being intensely developed were made possible, since the very moment of their origin and introduction to medicine, by the ingenious discoveries and ideas, as well as very practical concepts initiated by Maria Skłodowska-Curie and Pierre Curie.

Nuclear medicine is currently yet another separate basic medical specialty, which although not linked to great discoveries of Maria and Pierre directly, makes use of radio pharmaceuticals - substances containing radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.

Radioactive substances are mainly employed in therapy of thyroid gland conditions: hyperthyroidism and cancer, in which cases one of the synthetic iodine isotopes I-131 has been used for many years now, as well as in treating malignant metastases in bones, where isotopes such as: P-32, Sr-89, Re-186, Re-188, and Sm-153 are employed.

Radioimmunotherapy is an interesting and relatively novel method of treatment. It is a therapeutic application of monoclonal antibodies - labelled with isotopes emitting beta radiation - directed against cancer cells. Most advanced research is the work on radioimmunotherapy of ovarian, lymphoma and colorectal carcinomas dissemination. The mechanism substantiating the use of ionizing radiation in treating neoplastic cells is the action of free radicals - generating radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.

Radioimmunotherapy is an interesting and relatively novel method of treatment. It is a therapeutic application of monoclonal antibodies - labelled with isotopes emitting beta radiation - directed against cancer cells. Most advanced research is the work on radioimmunotherapy of ovarian, lymphoma and colorectal carcinomas dissemination. The mechanism substantiating the use of ionizing radiation in treating neoplastic cells is the action of free radicals - generating radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.

Radioactive substances are mainly employed in therapy of thyroid gland conditions: hyperthyroidism and cancer, in which cases one of the synthetic iodine isotopes I-131 has been used for many years now, as well as in treating malignant metastases in bones, where isotopes such as: P-32, Sr-89, Re-186, Re-188, and Sm-153 are employed.

Radioimmunotherapy is an interesting and relatively novel method of treatment. It is a therapeutic application of monoclonal antibodies - labelled with isotopes emitting beta radiation - directed against cancer cells. Most advanced research is the work on radioimmunotherapy of ovarian, lymphoma and colorectal carcinomas dissemination. The mechanism substantiating the use of ionizing radiation in treating neoplastic cells is the action of free radicals - generating radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.

Radioactive substances are mainly employed in therapy of thyroid gland conditions: hyperthyroidism and cancer, in which cases one of the synthetic iodine isotopes I-131 has been used for many years now, as well as in treating malignant metastases in bones, where isotopes such as: P-32, Sr-89, Re-186, Re-188, and Sm-153 are employed.

Radioimmunotherapy is an interesting and relatively novel method of treatment. It is a therapeutic application of monoclonal antibodies - labelled with isotopes emitting beta radiation - directed against cancer cells. Most advanced research is the work on radioimmunotherapy of ovarian, lymphoma and colorectal carcinomas dissemination. The mechanism substantiating the use of ionizing radiation in treating neoplastic cells is the action of free radicals - generating radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.

Radioactive substances are mainly employed in therapy of thyroid gland conditions: hyperthyroidism and cancer, in which cases one of the synthetic iodine isotopes I-131 has been used for many years now, as well as in treating malignant metastases in bones, where isotopes such as: P-32, Sr-89, Re-186, Re-188, and Sm-153 are employed.

Radioimmunotherapy is an interesting and relatively novel method of treatment. It is a therapeutic application of monoclonal antibodies - labelled with isotopes emitting beta radiation - directed against cancer cells. Most advanced research is the work on radioimmunotherapy of ovarian, lymphoma and colorectal carcinomas dissemination. The mechanism substantiating the use of ionizing radiation in treating neoplastic cells is the action of free radicals - generating radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.

Radioimmune therapy is a method employing and searching for functional imaging techniques in order to make possible, since the very moment of their origin and introduction to medicine, by the ingenious discoveries and ideas, as well as very practical concepts initiated by Maria Skłodowska-Curie and Pierre Curie. Nuclear medicine is currently yet another separate basic medical specialty, which although not linked to great discoveries of Maria and Pierre directly, makes use of radio pharmaceuticals - substances containing radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.

Radioimmune therapy is a method employing and searching for functional imaging techniques in order to make possible, since the very moment of their origin and introduction to medicine, by the ingenious discoveries and ideas, as well as very practical concepts initiated by Maria Skłodowska-Curie and Pierre Curie. Nuclear medicine is currently yet another separate basic medical specialty, which although not linked to great discoveries of Maria and Pierre directly, makes use of radio pharmaceuticals - substances containing radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.

Radioimmune therapy is a method employing and searching for functional imaging techniques in order to make possible, since the very moment of their origin and introduction to medicine, by the ingenious discoveries and ideas, as well as very practical concepts initiated by Maria Skłodowska-Curie and Pierre Curie. Nuclear medicine is currently yet another separate basic medical specialty, which although not linked to great discoveries of Maria and Pierre directly, makes use of radio pharmaceuticals - substances containing radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.

Radioimmune therapy is a method employing and searching for functional imaging techniques in order to make possible, since the very moment of their origin and introduction to medicine, by the ingenious discoveries and ideas, as well as very practical concepts initiated by Maria Skłodowska-Curie and Pierre Curie. Nuclear medicine is currently yet another separate basic medical specialty, which although not linked to great discoveries of Maria and Pierre directly, makes use of radio pharmaceuticals - substances containing radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.

Radioimmune therapy is a method employing and searching for functional imaging techniques in order to make possible, since the very moment of their origin and introduction to medicine, by the ingenious discoveries and ideas, as well as very practical concepts initiated by Maria Skłodowska-Curie and Pierre Curie. Nuclear medicine is currently yet another separate basic medical specialty, which although not linked to great discoveries of Maria and Pierre directly, makes use of radio pharmaceuticals - substances containing radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.

Radioimmune therapy is a method employing and searching for functional imaging techniques in order to make possible, since the very moment of their origin and introduction to medicine, by the ingenious discoveries and ideas, as well as very practical concepts initiated by Maria Skłodowska-Curie and Pierre Curie. Nuclear medicine is currently yet another separate basic medical specialty, which although not linked to great discoveries of Maria and Pierre directly, makes use of radio pharmaceuticals - substances containing radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.

Radioimmune therapy is a method employing and searching for functional imaging techniques in order to make possible, since the very moment of their origin and introduction to medicine, by the ingenious discoveries and ideas, as well as very practical concepts initiated by Maria Skłodowska-Curie and Pierre Curie. Nuclear medicine is currently yet another separate basic medical specialty, which although not linked to great discoveries of Maria and Pierre directly, makes use of radio pharmaceuticals - substances containing radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.

Radioimmune therapy is a method employing and searching for functional imaging techniques in order to make possible, since the very moment of their origin and introduction to medicine, by the ingenious discoveries and ideas, as well as very practical concepts initiated by Maria Skłodowska-Curie and Pierre Curie. Nuclear medicine is currently yet another separate basic medical specialty, which although not linked to great discoveries of Maria and Pierre directly, makes use of radio pharmaceuticals - substances containing radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.

Radioimmune therapy is a method employing and searching for functional imaging techniques in order to make possible, since the very moment of their origin and introduction to medicine, by the ingenious discoveries and ideas, as well as very practical concepts initiated by Maria Skłodowska-Curie and Pierre Curie. Nuclear medicine is currently yet another separate basic medical specialty, which although not linked to great discoveries of Maria and Pierre directly, makes use of radio pharmaceuticals - substances containing radioactive isotope - to treat and diagnose diseases. Thus it also utilizes the phenomenon of radiation which was understood and harnessed to the service to humankind thanks to the Curies.
Maria Skłodowska-Curie Institute of Oncology; Polish: Centrum Onkologii-Instytut im. Marii Skłodowskiej-Curie w Warszawie).

Her fervent and committed activity in every single field of her work was probably fueled by the spirit of times she lived and worked in. It was the age of a romantic vision of science, of fascination with science and inventions, the source of which was the belief that humans can make their lives easier and better with the use of their minds. Remedies to all maladies of the world, nature, humankind and society were sought after in inventions and progress of civilization. Maria repeatedly claimed that “science is at the base of every progress that facilitates human life and reduces suffering”.

Acknowledgements:
The authors would like to kindly thank Dr Andrzej Szlachcic from Department of Biophysics, Chair of Physiology, Jagiellonian University Medical College for the consul-
tation regarding the biophysical details of discussed methods and Ms Monika Kolek from The Office of School of Medicine, Jagiellonian University Medical College for linguistic revision of the article.

Literatura cytowana
11. Petelenz B., Kulakowski A.: Programs and Institutions Bearing Maria Skłodowska-Curie’s (or Marie Curie’s) Name, Chemistry Int. 2011, 33, 42.

Literatura ogólna