# The Paul Ehrlich Foundation

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## Preface

*In honour of the great German doctor and serologist who turned Frankfurt into a medical eldorado at the beginning of the 20th century, the Paul Ehrlich and Ludwig Darmstaedter Prize is awarded to scientists from all over the world who have achieved outstanding results in Paul Ehrlich's fields of work.*

*The prize given by the Paul Ehrlich Foundation is one of Germany's most eminent accolades in recognition of bio-medical research work in Germany. The President of the Federal Republic of Germany is Honorary President of the Paul Ehrlich Foundation. The prize-giving ceremony is traditionally held every year on March 14, Paul Ehrlich's birthday, in Frankfurt's St. Paul's Church, a symbol of German democracy and liberty.*

*The Foundation's Scientific Council, whose members include internationally renowned scientists, has the formidable task of selecting the best of the excellent world-wide. The list of prize winners shows that the Council has lived up to this challenge. Many of the Paul Ehrlich and Ludwig Darmstaedter Prize winners have also received the Nobel Prize. In addition, the Paul Ehrlich Foundation created with the Paul Ehrlich and Ludwig Darmstaedter Prize for Young Researchers, awarded for the first time in 2006, an important device to encourage young gifted scientists.*

*Paul Ehrlich, like all great researchers, was way ahead of his time. His research work laid the cornerstone for the medical standards still valid today.*

*In awarding the Paul Ehrlich and Ludwig Darmstaedter Prize, the Foundation wishes to encourage young scientists to do what Paul Ehrlich did throughout his entire life: extend medical know-how and make a contribution to the constant struggle against illness and disease-induced mortality.*

*Prof. Dr. Wilhelm Bender*
*Chairman of the Scientific Council*
*of the Paul Ehrlich Foundation*

# Paul Ehrlich: His life and Achievements

Paul Ehrlich was born on March 14, 1854, in Strehlen/Silesia (now Strzelin, Poland) into a prosperous family. His father owned a thriving liqueur factory.

Paul Ehrlich had watched liqueurs being coloured in his father's distillery and was so fascinated by the process that he wanted to try it out for himself. Legend has it that, as a seven-year-old boy, he was caught by his mother trying to colour two pigeons by dipping them into a pot of paint. Whether the story is true or not, colouring agents and dyes occupied him throughout his life and a child's experiments developed into a lifelong passion.

Ehrlich attended grammar school in Breslau (now Wrocław, Poland). During this time, he was a frequent visitor to the house of one of his mother's cousins, Carl Weigert (1845–1904), a pathologist at the University of Breslau and later professor in Frankfurt. Weigert was an expert in colouring pathological and anatomical specimens. In this field, he introduced what, at that time, were new synthetic colouring agents: aniline dyes. Ehrlich once watched him producing wafer-thin slices of tissue and carefully staining them. Young Ehrlich saw for the first time a fascinating microcosm under the microscope: bright blue and glowing particles of stained tissue. He also observed that the cells absorbed the dye in different ways: some parts were coloured deep blue, some had only absorbed small amounts of dye and others none at all. From now on, he concentrated entirely on the staining of thin slices of tissue, one of the most important techniques in histology.

Paul Ehrlich finished grammar school in 1872 and then went on to study medicine, first in Breslau, then in Strasbourg. Here, two academic tutors gave all-important impulses to his career. The anatomist Wilhelm von Waldeyer introduced him to the techniques of histological staining. The chemist Adolf von Baeyer encouraged his enthusiasm for chemistry. From his first term onwards, Ehrlich's goal was to understand the basic mechanisms by which toxic compounds and chemical compounds act on the living cell. He believed that staining takes place in a chemical reaction and not in a purely physical way ("Corpora non agunt nisi fixata"). This fundamental notion guided his work throughout his life. After another semester in Freiburg, he passed his State Examination and received his doctorate in 1878 at the University of Leipzig. His doctoral thesis was entitled "Contributions to the Theory and Practice of Histological Staining". In the same year, he moved as Assistant Medical Director to Friedrich Theodor

von Frerichs' Second Medical Clinic at the Charité hospital in Berlin.

Paul Ehrlich in his office at the Royal Institute for Experimental Therapy in Frankfurt.

During his years at the Charité, Ehrlich made important contributions to hæmatology, the study of the components of blood. Working on the foundations of medical bacteriology developed by Louis Pasteur and Robert Koch, Paul Ehrlich established a new diagnostic technique of staining blood cells. With this method, he succeeded in differentiating lymphocytes and leucocytes and sub-classifying leucocytes according to their stainability. The principles of modern hæmatology are based on Paul Ehrlich's staining methods. He emphasized the significance of vital staining with methylene blue, i.e. staining while upholding cell activity. Another important finding by Ehrlich was the selectivity of dyes in staining cells and tissues. He observed, for example, that methylene blue stained neural tissue only. He also discovered the relative ability of tissue to absorb oxygen, and thereby obtained evidence of oxygen consumption in cells.

Ehrlich summarized the results of his research in 1885 in the monograph: "The organism's need for oxygen: a study based on analysis with dyes", with which he qualified for appointment to a professorial chair in 1887. This study not only had practical value, but also raised intriguing questions for which there were no answers or explanations at that time.

During his nine years at the Charité in Berlin, Ehrlich adopted two habits which stayed with him throughout his life: his private spelling system and a passion for heavy black cigars, of which he smoked up to 50 a day.

In 1882, Paul Ehrlich attended Robert Koch's presentation of his sensational discovery of the tubercle bacillus at the German Physiological Society in Berlin. He was inspired by the lecture and referred to it in retrospect as "my greatest scientific experience", but he noticed at the same time that the staining technique used by Koch was laborious and unreliable. Within a day, he developed an improved and simple staining technique, which Koch acknowledged "without any reservations".

A year later, Paul Ehrlich married Hedwig Pinkus, daughter of one of the most important manufacturers of linen and damask in Silesia.

In 1884, Ehrlich was appointed titular professor. A year later, Friedrich Theodor von Frerichs died and Karl Gerhard, a man with a conservative scientific outlook, became head of the clinic at the Charité. When Ehrlich discovered that he himself was suffering from tuberculosis, and the working conditions at the Charité deteriorated permanently, he stepped down from his position. Paul Ehrlich and his wife moved for two years to Egypt where he

The central laboratory in the Georg-Speyer-Haus in the 1920s.

recovered from his illness and, following his return in 1891, was subsequently cured by Koch's tuberculin. After returning to Berlin, Ehrlich set up a small private laboratory.

In this therapeutic experiments which he performed in 1891 with Paul Guttmann after leaving the Charité, he sought answers to two questions: firstly, is it possible to use dyes not only to stain cells, but also for therapeutic purposes; and secondly, if methylene blue is so effective in staining neural tissue, could it not be equally effective in medication? His test persons were inmates of Moabit Prison suffering from serious neuralgic conditions. Not only did the dye actually reduce their pain, two men with malaria were also successfully treated.

Paul Ehrlich formulated the theory of side chains – the first broad concept of the immunosystem. According to this the specific immune defense develops as a result of impurities, pathogens and their toxins binding at the side chains (receptors) of certain cells. These side chains are then released as "antibodies" into the bloodstream and generate an immune response. This theory was the foundation of the steadily growing field of biomedical science.

In 1891, the Institute for Infectious Diseases was set up near the Charité, and Paul Ehrlich moved there with his laboratory, though without drawing a salary from the Institute. His research showed that by feeding small doses of poison to laboratory animals and then steadily increasing the dose, they gradually became immune to what would otherwise have been lethal doses and eventually developed a 100 to 1,000 times higher toxin tolerance than untreated animals. Against the background of these findings, Ehrlich developed the basic concept of active and passive immunization. Together with Ludwig Brieger, he successfully produced anti-toxic sera from the blood of immunized laboratory animals. In this connection, Ehrlich also made impor-

tant contributions to the development of the diphtheria antitoxin, though Emil von Behring excluded him from its commercial exploitation.

Thanks to the evaluation process he developed for the diphtheria antitoxin, Ehrlich always retained his strong interest in the subject of curative sera. At this time, a testing department was set up under Ehrlich's leadership at the Institute for Infectious Diseases because it had quickly become clear that serum standardization had to be improved. In 1896, the Berlin Institute for Serum Research and Testing was set up with the support of Friedrich Althoff, Director-General at the Prussian Ministry of Culture, and Paul Ehrlich was appointed its first director. Here are the roots of the systematic evaluation and official testing of numerous curative sera that was to become one of the most important tasks of the Frankfurt Institute for Experimental Therapy (today's Paul Ehrlich Institute).

In 1899, the Berlin Institute moved to Frankfurt am Main. At that time, the city's Lord Mayor, Franz Adickes, was trying to attract eminent scientists to Frankfurt. He planned to establish teaching institutions for the training of scientists. On November 8, 1899, and again with Friedrich Althoff's support, Ehrlich became the first director of the Royal Institute for Experimental Therapy (today's Paul Ehrlich Institute). The well-equipped chemicals firms located in and around Frankfurt were keenly interested in serum research. Paul Ehrlich cooperated with Farbwerke Hoechst, which supplied him with dyes, with Arthur von Weinberg, co-proprietor of Cassella, and with Ludwig Darmstaedter. With Darmstaedter's support the Chemotherapeutic Research Institute Georg-Speyer-Haus was established in 1906, immediately adjoining the Royal Institute for Experimental Therapy. Paul Ehrlich was also appointed Director of his new institution.

Paul Ehrlich developed the idea of combatting pathogens in the human body and the toxins produced by them using a chemical substance that binds with the pathogens and toxins. The concentration of this chemical substance was to be effective, but not harmful to the body. Ehrlich, who had a gift for formulating complex matters in simple language, coined the phrases "dosis tolerata" and "dosis curativa" for these two concepts. Against the background of his idea of resistance to medication, he searched for a substance that could destroy all pathogens at one blow, the "therapia sterilisans magna". He called this selectively applied medication the "magic bullet".

Ehrlich's years of research in Frankfurt mark the beginning of experimental chemotherapy. He discovered the effectivity of trypan red, a dye, in the treatment of trypanosome infections in mice related to human sleeping sickness. In cooperation with Robert Koch, he researched into the use of atoxyl, an arseno-benzene derivative, and in

1907 described the development of trypanosome resistance to continued exposure to atoxyl.

For Ehrlich, the discovery of atoxyl was a breakthrough for his future research work. Based on his research findings until then, he recognized the great potential in atoxyl. He synthesized hundreds of derivatives by substitution of the amino groups attached to benzene. He was firmly convinced that some homologues would have the desired specificity with less toxicity, which could be important for selective chemotherapy. On this basis, Ehrlich and his assistant Sahachiro Hata developed the famous compound 606 (Salvarsan). His co-worker, the chemist Dr. Alfred Bertheim, was closely involved in this work. It was he who conducted the synthesis and his name is on the patent together with that of Ehrlich, while Hata demonstrated the effectiveness of Salvarsan. This proved to be the first drug effective in destroying *Spirochaeta pallida*, the cause of syphilis. In November 1910, the production of diaminodioxy-arseno-benzole, known as Salvarsan, was started by Farbwerke Hoechst. Soon after that, Ehrlich discovered an even more effective modification, Neo-salvarsan. As the first ever antimicrobial chemotherapeutic agent, Salvarsan not only allowed an effective therapy of syphilis, but also opened up a new direction in research which led, a generation later, to the sulfonamides and the antibiotics.

Paul Ehrlich and his Japanese co-worker, Sahachiro Hata, with whom he discovered the preparation 606 (Salvarsan).

In 1908, Paul Ehrlich and Ilya Ilyich Mechnikov together received the Nobel Prize for Medicine "for invaluable services to medical and biological research, namely the evaluation and control of sera". Ehrlich emphasized in his Nobel Prize lecture that "we are approaching the limits of what the microscope could do and has done for us and the use of optical … instruments cannot master the challenge of penetrating further into the all-important problem of cell life. But the time has now come to venture into the finest chemism of cell life and to break down the concept of cell into a large number of separate partial functions. But since what happens in the cell is largely of a chemical nature and since the composition of chemical structures is largely beyond the boundaries of visibility, we shall have to look for different research methods. This direction is not only important for a real understanding of the mechanisms of life itself, but is also the basis for a truly rational use of active ingredients." Today, a century later, we recognize how right he was. His pioneering research laid the foundations for hæmotology and clinical cytology. He made Frankfurt the birth-

Paul Ehrlich with his co-workers in the garden of the Royal Institute for Experimental Therapy in Frankfurt.

place of chemotherapy, went forward with serum therapy and made valuable contributions to immunology and cancer research.

His experimental observations, his ability to draw scientific conclusions, his talents in the theoretical and, last but not least, rhetorical field, Ehrlich proved his exceptional far-sightedness and his gift for effectively analyzing scientific data. His revolutionary approach consisted in the idea that biological processes are based on chemical reactions and thus open to quantitative analysis. In the whole history of medicine, few achievements can match those of Paul Ehrlich.

In 1911, Paul Ehrlich was honoured with the highest award the Prussian state could make: he was appointed Wirklicher Geheimrat or Real Privy Councillor with the title "Excellency". In 1912 the city of Frankfurt made him an honorary citizen. Frankfurt University was founded in 1914 and Paul Ehrlich was to become its first rector. Owing to his failing health, however, he turned down this office. Paul Ehrlich died in Bad Homburg on August 20, 1915. He was buried at the Old Jewish Cemetery in Rat-Beil-Straße. Emil von Behring wrote in his obituary: "With you, Paul Ehrlich, a man from the heroic age of experimental therapeutic research has left us, a man who was a king in the realm of the science which you yourself established and a teacher to countless researchers throughout the world."

# Ludwig Darmstaedter: Scientist and Friend

The radical change in medicine at the beginning of the 20th century in Germany can be credited not only to Paul Ehrlich, but also to Ludwig Darmstaedter. He was a man with a wide range of interests and a pronounced sense of social responsibility.

He was born on August 9, 1846 in Mannheim as the tenth and youngest child of a wealthy merchant. After losing both parents at an early age, he was raised by a stepbrother many years his elder.

In his early youth, he had already shown an interest in geology and mineralogy. At the age of 18, he studied mineralogy and chemistry at the University of Heidelberg, where he received his doctorate four years later. During his studies, he was influenced by Robert Bunsen, Emil Erlenmeyer and Gustav Kirchhoff. In the following years he lived in Leipzig, Berlin and Paris. He researched intensively on questions that were of interest to the burgeoning chemicals industry at that time and published studies on naphthol, dinitronaphthalin and lanoline. Having spent several years in England, Belgium and Spain, he returned to Germany and became a partner in Benno Jaffé's ammonia and glycerol business in Berlin. The firm, Jaffé & Darmstaedter, became very important as a result of acquiring the patent for the production of lanoline, which was used in the manufacture of skin care products, cosmetics and pharmaceuticals. In 1900, the company was converted into a joint stock corporation and Ludwig Darmstaedter became a member of the advisory board. In 1904, Darmstaedter, who had always had a great interest in the history of chemistry, published jointly with René Du Bois-Reymond "4000 Years of Pioneering Work in the Exact Sciences", which he expanded in the following years. In 1908, he reissued it under his name as "Handbook on the History of the Natural Sciences and Technology".

Throughout his life, Darmstaedter was a passionate collector. At the age of 60, he retired from the board of directors in order to devote himself entirely to his scientific studies and collections. The outcome was an unparalleled collection of autographs by important natural scientists and medical researchers as well as politicians, artists and intellectuals. It is known today as the "Darmstaedter Collection of the State Library of the Prussian Cultural Heritage Foundation in Berlin". In 1907, he donated the collection to the state and enlarged it until his death in 1927. At that time it consisted of 190,000 manuscripts. Starting with minerals and crystals as a young man, he also began to collect porcelain in 1879. At the age of 78, three years

before his death, he began to buy stamps and had soon built up a large and valuable collection.

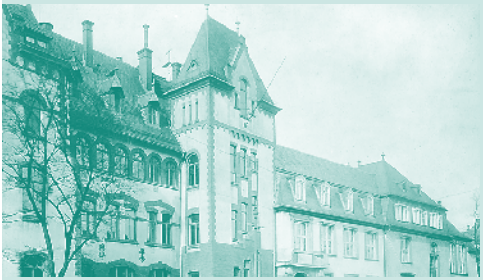
October 17, 1927, Ludwig Darmstaedter died of angina pectoris in Berlin.

The Royal Institute for Experimental Therapy in Frankfurt around 1900.

In 1872, Darmstaedter married Marie Gumbert, the sister of Franziska Speyer, wife of Frankfurt banker Georg Speyer. Darmstaedter encouraged his sister-in-law to support Paul Ehrlich's research work. In 1904, Franziska Speyer set up a foundation and donated one million marks for the establishment of an institute. In memory of her deceased husband, it was named the Chemotherapeutic Research Institute Georg-Speyer-Haus. After her death in 1909, further funds out of her estate were donated to the Institute, which was directly adjacent to the Royal Institute for Experimental Therapy and of which Paul Ehrlich was Director.

On the occasion of Darmstaedter's 80th birthday in 1926 and in his honour, the Chemotherapeutic Research Institute Georg-Speyer-Haus Foundation created the Ludwig Darmstaedter Prize in recognition of his support for Paul Ehrlich. The prize was to be awarded once every three years for outstanding work in the fields of chemotherapy and biology. On

The Georg-Speyer-Haus soon after its construction.



In the 1920s, the Royal Institute for Experimental Therapy and the Georg-Speyer-Haus were joined by a common entrance.

Both buildings are now situated in Paul-Ehrlich-Strasse 42–44 in Frankfurt.

# The Foundation, the Prize and the Role of Hedwig Ehrlich

Paul Ehrlich's widow, Hedwig Ehrlich, donated the sum of 90,000 marks to the Association of Friends and Patrons of Frankfurt University for a Paul Ehrlich Fund. On July 13, 1929, fourteen years after Paul Ehrlich's death, the fund was transferred to the Paul Ehrlich Foundation. Since then, the foundation's assets have been administered on a trust basis by the Association of Friends and Patrons of the Johann Wolfgang Goethe University Frankfurt am Main e.V. The Paul Ehrlich Prize was first awarded in 1930 to scientists from Germany and abroad for their valuable contributions in Paul Ehrlich's fields of work.

When National Socialism came to power in 1933, the Paul Ehrlich Foundation could not continue to function, and in 1934 the Paul Ehrlich Prize also ceased to be awarded – temporarily. All of the Jewish employees of the Georg-Speyer-Haus were dismissed in 1935, and all papers and studies that bore the name of Paul Ehrlich were removed from the Institute. Paul-Ehrlich-Straße was renamed Ludwig-Rehn-Straße in 1938 and was only changed back to Paul-Ehrlich-Straße in 1945. Hedwig Ehrlich first emigrated to Switzerland and subsequently to the United States of America. She died in a hospital in New York City on December 20, 1948 and is buried in Westchester in the State of New York.

Thanks to the efforts of Günter K. Schwerin, grandson of Hedwig and Paul Ehrlich and long-time honorary member of the Paul Ehrlich Foundation, the former Royal Institute for Experimental Therapy was renamed after its founder, Paul Ehrlich, in 1947. Günter K. Schwerin died on May 19, 1997 at the age of 87 in Munich and is buried in Mount Pleasant Cemetery in Hawthorne, New York.

The Paul Ehrlich Foundation resumed its work in 1952. The Scientific Council of the Paul Ehrlich Foundation and the Board of Directors of the Foundation Georg-Speyer-Haus Institute for Biomedical Research as it was now called resolved in 1952 to unite the Paul Ehrlich Prize and the Ludwig Darmstaedter Prize. According to the agreement, the new prize is awarded in accordance with the Articles of Association of the Paul Ehrlich Foundation.

Since 1960, the Federal Ministery of Health has made an annual contribution of currently € 50,000 (March 2012) in recognition of Paul Ehrlich's work and his great services to mankind.

The Honorary President, the Scientific Council and the Board of Trustees comprise the Paul Ehrlich Foundation.

The President of the Federal Republic of Germany is by tradition the Honorary President of the Foundation.

The Scientific Council of the Paul Ehrlich Foundation has 14 members from six countries. The Chairman is Prof. Dr. Wilhelm Bender, who is also Chairman of the Association of Friends and Patrons of the Johann Wolfgang Goethe University Frankfurt am Main e.V. Choosing the winners of the Paul Ehrlich and Ludwig Darmstaedter Prize is the most important task of the Scientific Council.

Holiday in the mountains: the young couple Hedwig and Paul Ehrlich.

The Board of Trustees has 18 members. The Chairman of the Board of Trustees is presently Dr. Rolf-E. Breuer, Chairman of the Board of Directors of the Foundation Georg-Speyer-Haus Institute for Biomedical Research, Frankfurt am Main (March 2012). According to the Articles of Association of the Foundation, the Board of Trustees is obliged to initiate all measures appropriate to achieving the objectives of the Foundation, in particular to preserve and increase the assets of the Foundation.

The objective of the Paul Ehrlich Foundation is to preserve Paul Ehrlich's scientific heritage and his memory and to protect the will of its settlor, Hedwig Ehrlich. In that spirit and irrespective of nationality, race, confession, origin or gender, scientists are honoured for their valuable research results in Paul Ehrlich's fields of work, especially in experimental and chemotherapeutic hæmatology, clinical bacteriology, immunology, and cancer research. Moreover, the Foundation also grants scholarships to support the work of young researchers in the disciplines mentioned above.

Today, the Paul Ehrlich and Ludwig

Darmstaedter Prize is one of the most important and distinguished awards in biomedical research in Germany. Each year on March 14, the date of Paul Ehrlich's birthday, the prize-giving ceremony takes place in Frankfurt's historic St. Paul's Church. The prize is presently endowed with € 100,000. The prize winner receives a certificate and a gold copy of the original medal of the Ludwig Darmstaedter Prize carrying the portrait of Paul Ehrlich. Since 1952, the prize has been awarded to more than 100 scientists who have made important contributions to Paul Ehrlich's pioneering work.

St. Paul's Church in Frankfurt, a national symbol of freedom and democracy in Germany.

Many winners of the Paul Ehrlich and Ludwig Darmstaedter Prize have also received the Nobel Prize:

The interior of St. Paul's Church at the award ceremony in 2005. In the foreground is the bust of Paul Ehrlich.

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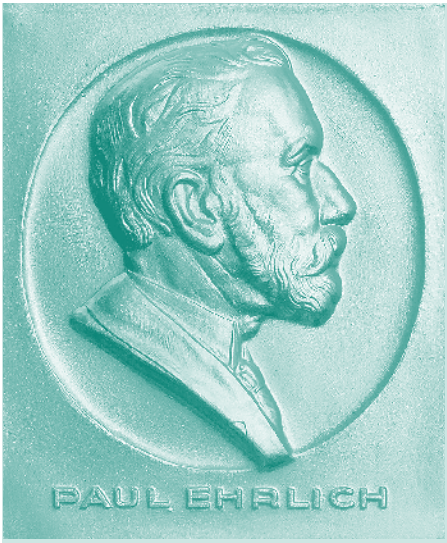
## The Paul Ehrlich and Ludwig Darmstaedter Prize for Young Researchers

The Paul Ehrlich and Ludwig Darmstaedter Prize for Young Researchers has been awarded by the Paul Ehrlich Foundation since 2006. It is awarded annually to a young scientist working at a research institute in Germany for outstanding accomplishments in the field of biomedical research.The prize is worth up to € 60,000 and must be used completely for research purposes. Nominees can be suggested by university lecturers as well as senior scientists of research institutes in Germany.

The junior scientists must be younger than 40 years. Prize winners are selected by the Scientific Council of the Paul Ehrlich Foundation following the suggestions by a selection commission comprising eight German scientists.




Every winner of the Paul Ehrlich and Ludwig Darmstaedter Prize receives a golden medallion with a portrait of Paul Ehrlich.

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Nobel Prize 2008

Tim R. Mosmann
Laureate 2008

Manfred Eigen
Laureate 1992
Nobel Prize 1967

Cesare Montecucco
Laureate 2011

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Andrew Z. Fire, Laureate 2006, Nobel Prize 2006
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Nobel Prize 2005

J. Robin Warren
Laureate 1997
Nobel Prize 2005

Richard A. Lerner
laureate 2003

Peter G. Schultz
Laureate 2003

Harry Noller, Laureate 2007
Ada Yonath, Laureate 2007, Nobel Prize 2009

s earchers 2009

Ian Wilmut
Laureate 2005

Eckhard Lammert
Laureate of the Prize
for Young Researchers
2008

Michael Schindler
Laureate of the Prize
for Young Researchers
2007

# Prize Winners of the Paul Ehrlich and Ludwig Darmstaedter Prize

| | |
|---|---|
| 1952 | Prof. Dr. Gerhard Eißner, Tübingen |
| | Prof. Dr. Wolf-H. Wagner, Nonnenhorn |
| 1953 | Prof. Dr. Dr. h.c. mult. Adolf Butenandt, Munich |
| 1954 | Prof. Dr. Dr. h.c. Sir E. Boris Chain, London |
| 1956 | Prof. Dr. Gerhard Domagk, Elberfeld |
| 1958 | Prof. Dr. Dr. h.c. Richard Kuhn, Heidelberg |
| 1960 | Prof. Dr. Felix Haurowitz, Bloomington |
| 1961 | Prof. Dr. Albert H. Coons, Boston |
| | Prof. Dr. Günther Heymann, Langen |
| | Prof. Dr. Örjan E. Ouchterlony, Göteborg |
| | Prof. Dr. Jacques Oudin, Paris |
| 1962 | Prof. Dr. Dr. h.c. mult. Otto Warburg, Berlin |
| 1963 | Prof. Dr. Helmut Holzer, Freiburg |
| | Dr. Lothar Jaenicke, Cologne |
| | Dr. Detlev Kayser, Berlin |
| | Prof. Dr. Tullio Terranova, Rome |
| 1964 | Prof. Dr. Fritz Kauffmann, Copenhagen |
| 1965 | Prof. Dr. Otto Lüderitz, Freiburg |
| | Prof. Dr. Léon Le Minor, Paris |
| | Dr. Ida Ørskov, Copenhagen |
| | Dr. Fritz Ørskov, Copenhagen |
| | Prof. Dr. B. A. D. Stocker, Stanford |
| 1966 | Prof. Dr. Dr. h.c. mult. F. Peyton Rous, New York |
| 1967 | Prof. Dr. Wilhelm Bernhard, Villejuif |
| | Prof. Dr. Renato Dulbecco, San Diego |
| 1968 | Prof. Dr. Dr. h.c. Walter T. J. Morgan, London |
| | Prof. Dr. Dr. h.c. Otto Westphal, Montreux |
| 1969 | Prof. Dr. Hiroshi Nikaido, Boston |
| | Prof. Dr. Anne-Marie Staub, Paris |
| | Prof. Dr. Winifred M. Watkins, London |

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|---|---|
| 1970 | Prof. Dr. Dr. h.c. Ernst Ruska, Berlin |
| | Prof. Dr. Helmut Ruska, Düsseldorf |
| 1971 | Prof. Dr. Albert Claude, Brussels |
| | Prof. Dr. Keith R. Porter, Boulder |
| | Prof. Dr. Fritiof Sjöstrand, Los Angeles |
| 1972 | Dr. Dr. h.c. Denis P. Burkitt, London/Uganda |
| | Prof. Dr. Dr. h.c. mult. Jan Waldenström, Malmö |
| 1973 | Prof. Dr. Sir Anthony Epstein, Bristol |
| | Prof. Dr. K. Ishizaka, Baltimore |
| | Prof. Dr. D. H. Wright, Southampton |
| 1974 | Prof. Dr. J. L. Gowans, Oxford |
| | Prof. Dr. J. F. A. P. Miller, Melbourne |
| 1975 | Prof. Dr. George B. Mackaness, Saranac Lake |
| | Prof. Dr. Nicholas A. Mitchison, London |
| | Prof. Dr. Morten Simonsen, Copenhagen |
| 1976 | Prof. Dr. Georges Barski, Villejuif |
| | Prof. Dr. Boris Ephrussi, Gif-sur-Yvette |
| 1977 | Prof. Dr. T. Caspersson, Stockholm |
| | Prof. Dr. J. B. Gurdon, Cambridge |
| 1978 | Prof. Dr. Ludwik Gross, New York |
| | Prof. Dr. Dr. h.c. Werner Schäfer, Tübingen |
| 1979 | Prof. Dr. Arnold Graffi, Berlin |
| | Prof. Dr. Otto Mühlbock, Amsterdam |
| | Prof. Dr. Wallace P. Rowe, Bethesda |
| 1980 | Prof. Dr. Tomoichiro Akiba, Saitama |
| | Prof. Dr. Hamao Umezawa, Tokyo |
| 1981 | Prof. Dr. Stanley Falkow, Seattle |
| | Prof. Dr. Susumu Mitsuhashi, Gunma-Ken |
| 1982 | Prof. Dr. Niels Jerne, Castillon du Gard |
| 1983 | Prof. Dr. Peter C. Doherty, Canberra |
| | Dr. Michael Potter, Bethesda |
| | Prof. Dr. Rolf M. Zinkernagel, Zurich |
| 1984 | Prof. Dr. Piet Borst, Amsterdam |
| | Prof. Dr. George A. M. Cross, New York |
| 1985 | Prof. Dr. Ernest Bueding, Baltimore |
| | Dr. Louis H. Miller, Bethesda |
| | Prof. Dr. Ruth Sonntag Nussenzweig, New York |

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|---|---|
| 1986 | Dr. Abner L. Notkins, Bethesda |
| 1987 | Prof. Dr. Jean F. Borel, Basel |
| | Prof. Dr. Hugh O. McDevitt, Stanford |
| | Prof. Dr. Felix Milgrom, Buffalo |
| 1988 | Prof. Dr. Peter K. Vogt, Los Angeles |
| 1989 | Dr. Stuart A. Aaronson, Bethesda |
| | Prof. Dr. Russell F. Doolittle, La Jolla |
| | Prof. Dr. Thomas Graf, Heidelberg |
| 1990 | Prof. Dr. R. John Collier, Boston |
| | Prof. Dr. A. M. Pappenheimer, Jr., Cambridge |
| 1991 | Dr. Rino Rappuoli, Siena |
| | Prof. Dr. Michio Ui, Tokyo |
| 1992 | Prof. Dr. Dr. h.c. mult. Manfred Eigen, Göttingen |
| 1993 | Prof. Philippa Marrack, Ph.D., Denver |
| | Prof. John W. Kappler, Ph.D., Denver |
| | Prof. Dr. Harald von Boehmer, Basel |
| 1994 | Prof. Dr. Peter Howly, Boston |
| | Prof. Dr. Dr. h.c. mult. Harald zur Hausen, Heidelberg |
| 1995 | Prof. Dr. Stanley B. Prusiner, San Francisco |
| 1996 | Prof. Pamela J. Bjorkman, Ph.D., Pasadena |
| | Prof. Dr. Hans-Georg Rammensee, Heidelberg |
| | Prof. Jack L. Strominger, Ph.D., Cambridge |
| 1997 | Prof. Dr. Barry J. Marshall, Charlottesville |
| | Dr. J. Robin Warren, Perth |
| 1998 | Prof. Dr. David P. Lane, Dundee |
| | Prof. Dr. Arnold J. Levine, Princeton |
| | Prof. Dr. Bert Vogelstein, Baltimore |
| 1999 | Prof. Dr. Robert C. Gallo, Baltimore |
| 2000 | Prof. H. Robert Horvitz, Ph.D., Cambridge |
| | Prof. John F. R. Kerr, Ph.D., Hamilton |
| 2001 | Prof. Stephen C. Harrison, Ph.D., Cambridge, USA |
| | Prof. Michael G. Rossmann, Ph.D., West Lafayette |
| 2002 | J. Craig Venter, Ph.D., Rockville |
| 2003 | Prof. Dr. Richard A. Lerner, M.D., La Jolla |
| | Prof. Dr. Peter G. Schultz, Ph.D., La Jolla |
| 2004 | Prof. Mark M. Davis, Ph.D., Stanford |
| | Prof. Tak W. Mak, Ph.D., Toronto |
| 2005 | Prof. Ian Wilmut, O.B.E., F.R.S., F.R.S.E., Roslin |

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|---|---|
| 2006 | Prof. Dr. Andrew Z. Fire, Stanford |
| | Prof. Dr. Craig C. Mello, Worcester |
| 2007 | Prof. Dr. Ada Yonath, Rehovot |
| | Prof. Dr. Harry Noller, Santa Cruz |
| 2008 | Prof. Dr. Tim Mosmann, Ph.D., Rochester |
| 2009 | Prof. Dr. Elizabeth H. Blackburn, San Francisco |
| | Prof. Dr. Carol Greider, Baltimore |
| 2010 | Prof. Dr. Charles Dinarello, Denver |
| 2011 | Prof. Dr. Cesare Montecucco, Padua |
| 2012 | Prof. Dr. Peter Walter, San Francisco |

## Prize Winners of the Paul Ehrlich and Ludwig Darmstaedter Prize for Young Researchers

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|---|---|
| 2006 | Dr. Ana Martin-Villalba, Heidelberg |
| 2007 | Dr. Michael Schindler, Ulm |
| 2008 | PD Dr. Eckhard Lammert, Dresden |
| 2009 | Prof. Dr. Falk Nimmerjahn, Erlangen-Nürnberg |
| 2010 | Prof. Dr. Amparo Acker-Palmer, Frankfurt |
| 2011 | Dr. Stephan Grill, Dresden |
| 2012 | Prof. Dr. Kathrin Maedler, Bremen |

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pp. 16 and 17: Uwe Dettmar,
Frankfurt am Main

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