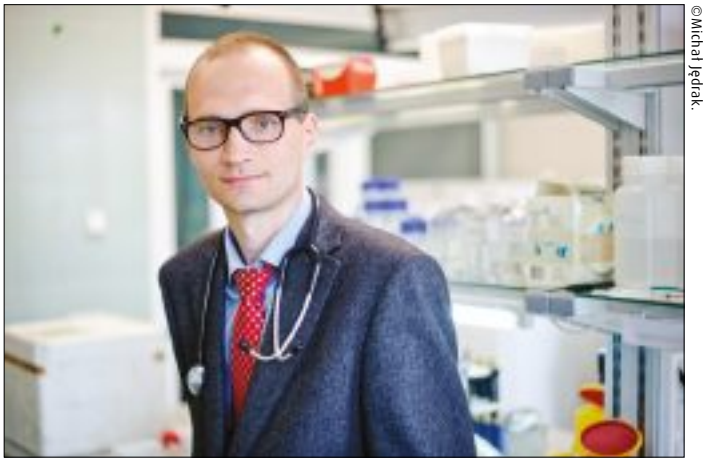
Polish Science Aims High

Foundation for Polish Science

"We would never have this in the States," said researchers from an American cancer institute visiting the Centre of New Technologies at the University of Warsaw in the Polish capital. Here Polish researchers developed a groundbreaking method for diagnosing thyroid cancer. It was possible thanks to the superb scientific standards of the Polish researchers as well as the excellent infrastructure built and delivered to researchers in recent years, making Poland one of the more attractive places to pursue science.



Prof. Krystian Jażdżewski

The American researchers came to Poland at the invitation of Prof. Krystian Jażdżewski, a geneticist researching the role of microRNA-146a in thyroid cancer whose works in prestigious scientific journals have been cited over 1,300 times. They would probably have an equally positive impression if they visited the International Institute of Molecular and Cell Biology in Warsaw—a unique scientific institution operating under the same principles as the finest research institutions in the world. Here at the institute, where the famous zebrafish are raised—a model species for laboratory tests on cancer, heart disease, and neurodegeneration—Prof. Agnieszka Chacińska inquires into "cell powerhouses"—mitochondria. Defects in mitochondria cause fatal illnesses in children and the elderly. Meanwhile, at the University of Warsaw's Faculty of Chemistry, Prof. Ewa Górecka seeks new applications for liquid crystals in one of the best-equipped laboratories in the world. The specialized apparatus draws students to Poland from universities in numerous countries to learn new X-ray methods here. Students and researchers from abroad also want to cooperate with Polish astronomers whose research is winning great recognition in the international scientific community. One of them, Prof. Grzegorz Pietrzyński from the Polish Academy of Sciences, has calibrated the "cosmic yardstick"—the unit for measuring distances in the Universe—to record-breaking precision.

Prof. Agnieszka Chacińska

Professors Jażdżewski, Chacińska, Górecka and Pietrzyński are all winners of grants in programmes of the Foundation for Polish Science, the largest non-governmental institution supporting science in Poland for over 25 years. With their dedication and achievements, these distinguished scientists show that world-class research can be done in Poland. Now all researchers, regardless of nationality, have the opportunity to win Polish grants. Anyone who has earned a doctorate or higher can apply for new competitions announced by the Foundation for Polish Science, win a grant, and conduct innovative research, create a research team, and even head up a new centre of scientific excellence.

It's an option worth considering, as Poland—the largest country in Central & Eastern Europe—with its growing economy and huge plans for investment in science, is becoming an increasingly attractive location for conducting research. In the past 8 years, about EUR 5 billion in EU funds have been invested in Poland in state-of-the-art infrastructure for universities, research, and growth of the R&D sector. New laboratories, multimedia lecture halls, campuses, and modern centres with equipment previously available only at the leading scientific institutions of Western Europe, have all been built.

Positive changes continue. Through 2020 Poland will receive EU funds of over EUR 82.5 billion, EUR 11 billion of which will go to researchers and entrepreneurs for the development of innovative products, services and technologies, creation of prototypes and pilot production lines, and commercialization of these innovations. Factoring into this the growing support for R&D from the state budget and the private sector, it is clear that Polish research will receive a huge financial injection.

Measuring the immeasurable

Poles are leaders in astronomy, conducting precise observations of millions of stars, discovering planets, studying pulsating stars and binary stars.

At one of the best sites in the world for observing space, the American observatory in Chile, one of the telescopes belongs to the University of Warsaw Astronomical Observatory. Since 1996 it has supplied the highest quality data for millions of objects. Every night it observes about 20 million stars in the sky. No one has managed to generate such a high-quality picture of such a large number of stars as the team of Polish astronomers.

Poland recently became a member of the European Northern Observatory. This guarantees Poles access to these instruments—they can apply for time and conduct observations. The same is true for the Southern African Large Telescope, where Poland is a member of the SALT research consortium. This all contributes to groundbreaking scientific publications and important research results. Poland's star shines brightly in the firmament of world astronomy.

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Prof. Grzegorz Pietrzyński

One of the most important discoveries in astronomy was the expansion of the Universe observed by Edwin Hubble. The winners of the 2011 Nobel Prize in Physics discovered that the expansion has recently accelerated significantly. Why? The explanation should be sought in the nature of dark energy. To discover its secret, it is necessary to precisely measure the value of the Hubble Constant. To determine this value, distances to very faraway objects must be measured. For this purpose, astronomers use supernovas and cepheids—types of pulsating stars. Prof. Grzegorz Pietrzyński's team has measured the distance to the nearest galaxies with unmatched precision. This is the most important step in measuring the Universe.

"Our project seeks to calibrate cepheids with the highest possible precision," Pietrzyński explains. His team creates "yardsticks" for very precise measurement. The work is conducted on the basis of observations made in Chile, Hawaii, the Canary Islands, and South Africa. The core of the international team is a 10-person group formed thanks to the TEAM programme, implemented by the Foundation for Polish Science in 2007–2015 using European funds from the Innovative Economy Operational Programme. Now the work will continue pursuant to an ERC Advanced Grant of EUR 2.4 million which Pietrzyński has just received. This is the fourth such prestigious grant for a Pole, and the second for an astronomer.

"The conditions for conducting research in Poland are good," says Pietrzyński, "and in many aspects they are no different from those abroad. There is great competition in the rivalry for grants, because many scientific teams have been created pursuing research at the highest global level. Many Polish researchers are returning from abroad, and there are many programmes encouraging their return, such as the Foundation for Polish Science HOMING programme, or the WELCOME programme implemented by the foundation in previous years."

Genetics vs. cancer

According to Prof. Krystian Jażdżewski, "In Poland you can find world-class working conditions, obtain funding, and achieve research successes. Many scientists who gained experience abroad have decided to return to Poland." For over a decade the Polish geneticist conducted research at Ohio State University under the direction of Prof. Albert de la Chapelle. Now he works at the Medical University of Warsaw and the Centre of New Technologies at the University of Warsaw, where theoreticians and empirical scientists from nearly every field of knowledge operate on exactly the same equipment as their colleagues at American and Western European laboratories.

"Poland offers good working conditions for the youngest researchers," Jażdżewski says. "The most care has been extended to this group in recent years. They can win the same stipends and grants and join the best teams, which guarantees good publications in the future." Jażdżewski created the team that is developing next-generation sequencing techniques and getting better and better at recognizing new genes—micro RNA—whose quantity changes together with growing tumours.

The risk that we will be attacked by a hereditary form of cancer is inscribed in our genes. However, we can learn about it in time and monitor our health. In a single experiment, genome tests can examine dozens of genes whose mutations can disrupt processes within the cell. As Jażdżewski explains, it may be unknown whether the patient's tumour is primary or metastasized, or perhaps an entirely benign tumour and not cause for worry. The answer is provided by measuring the quantity of mRNA in the circulatory blood. This method can be applied at a very early stage of growth of the tumour, and even before patients are aware they are sick. "If the disease cannot be avoided, rigorous tests enable discovery at an early phase, when treatment is still not very burdensome," Jażdżewski says.

His team has developed tests targeted to colon, breast and thyroid cancer. He argues that there is no reason not to test all of the genes known to scientists to be responsible for an inherited risk of cancer. Such tests have been available on the American and European market for several years. In Poland they are conducted at the University of Warsaw, among other locations, at a cost just 1/10th of the commercial price abroad.

According to Jażdżewski, "Multi-gene tests identify the risk of falling ill with cancer, but we apply the same methods to diagnose genetic diseases in children. The cost of such an examination is EUR 280–420 here, whereas in the West the same tests cost EUR 2,000–4,000. This is a huge success for Polish researchers, who think about applications also in the context of price."

Mitochondria—power plants for cells

Thousands of brightly coloured fish in various stages of development dart about the aquariums of the International Institute of Molecular and Cell Biology. For the first few days of its life, a newborn zebrafish is transparent—scientists can see specific cells in the fish's body and observe the processes occurring in the cells. Ninety percent of the fish's genes are similar to human genes. Mutations found or induced in zebrafish can be helpful in solving the puzzle of genetic human illnesses, Alzheimer's, Parkinson's, and senile dementia.

The researchers have equipment at their disposal for biochemical and cell biology analysis, such as fluorescent microscopes. Prof. Agnieszka Chacińska's team studies the biogenesis and function of mitochondria. This is the part of the cell where cellular respiration occurs. Mitochondrial diseases are very rare. They progress rapidly and lead to death during childhood. It is still impossible to treat these illnesses because there is too much that is not yet understood. Scientists are only now examining how mitochondria function at the level of the cell, tissues, and the entire organism.

As Chacińska explains, "Mitochondria work like power plants. When power plants don't function, cities and countries cannot grow. This is what happens in the organism when defects in the mitochondria lead to very serious consequences connected with energy deficiencies and their secondary effects. Mitochondrial diseases affect the tissues that are the most dependent on the production of energy: our muscles, heart and brain." Recently she succeeded in observing how mitochondria eliminate unnecessary proteins. This step helps understand, for example, why we age. This work has been described among other places in *PNAS* and *Nature*.

New applications for liquid crystals

Liquid-crystal displays are widely used in televisions, computers and phones. Prof. Ewa Górecka is conducting research that may open up new paths for practical use of liquid crystals. She is intrigued by the nematic—the simplest phase of liquid crystals, built from molecules with unusual shapes.

As Górecka explains, "The nematic can be imagined as tossing matchsticks into water and compressing them. Then the matchsticks will begin to align themselves in a single direction. But sometimes even completely symmetrical molecules begin to form spiral structures. Then the structure becomes non-superimposable on its mirror image, that is, chiral. We are interested in why this happens."

Górecka has worked in Japan, the United States, and France. But for 20 years she has been in Poland, where she established a research team at the University of Warsaw Faculty of Chemistry. In her view at a good institution it is easier to obtain apparatus, and good results by researchers attract students and money for research—that is how strong research centres are created around the world.

"In Poland it is easier to obtain funds for research," Górecka says. "The success rate in many Polish programmes is about 20%, but in European programmes it is less than 10%. In many European grants, a lot of excellent projects are rejected." In two major grants from the Foundation for Polish Science—TEAM and MASTER—her team published 24 scientific papers in widely read international journals.

EU structural funds have allowed Polish research centres to purchase state-of-the-art instruments. "Just a decade ago we conducted X-ray research at friendly foreign laboratories because we could not conduct such advanced work in Poland," Górecka explains. "Now the Faculty of Chemistry at the University of Warsaw boasts world-class X-ray apparatus, including a low-angle diffractometer."

Prof. Ewa Górecka

Operation "Smart Growth"— almost 270 million euro in Foundation for Polish Science programmes

The Foundation for Polish Science is a non-governmental, non-political, non-profit organization pursuing the mission of supporting science. For 25 years the foundation has operated in compliance with its motto "Supporting the best, so that they can become even better," helping the most talented scientists in development of their research careers and pursuing innovative research projects. The foundation's activity consists of awarding grants, stipends, subsidies and prizes, supporting initiatives for the advancement of science and the society, and stimulating international scientific cooperation.

In late 2015 and early 2016, the foundation launched a new range of programmes financed from EU structural funds under the Smart Growth Operational Programme.

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Prof. Krystian Jażdżewski and his research group.

For the first time in its history, the foundation is involved in creation of new scientific institutions in Poland. In the INTERNATIONAL RESEARCH AGENDAS programme, wielding a total budget of EUR 126 million, about 10 such units will be established. They will be formed by the most distinguished scientists from Poland and abroad. The first competition to select the directors of the new units has already been completed. The next two competitions will be announced in mid-2016 and mid-2017. Some 500 researchers from Poland and abroad will be hired at the newly established units to work in over 50 teams pursuing interdisciplinary research.

Continuing its efforts to support the finest scientists, the foundation will also conduct five programmes in which individual researchers can apply for grants. The combined budget of the TEAM, TEAM-TECH, FIRST TEAM, REINTEGRATION and HOMING programmes is EUR 143 million. Depending on the programme, researchers can win several hundred thousand to several million zlotys (from EUR 180,000 to more than EUR 800,000) to pursue innovative projects in Poland that fall within the scope of National Smart Specializations—identified fields of the economy where Poland seeks to expand its potential to compete on a global scale.

Funding may be sought by scientists of any nationality holding at least a doctorate. Projects may be pursued in a research unit, an enterprise, or in some programmes in a scientific/industrial consortium. Projects may be implemented with a flexible timeframe, with a minimum commitment of 20% of the researcher's working time.

The most funds will be earmarked for creation of research teams. These funds will be available to experienced researchers planning to conduct groundbreaking research in Poland of global importance (the TEAM programme), as well as postdocs seeking support for creation of their first research team (the FIRST TEAM programme). A special offer is targeted to persons with great experience implementing the results of scientific research. The TEAM-TECH programme was created with them in mind, providing funding for group projects aimed at development of technologies, processes and innovative products in cooperation with a commercial partner. As part of this programme, in the future it will also be possible to fund teams developing research services using existing infrastructure. The foundation is striving to encourage postdocs to return to scientific work after a break for parenthood or work in a non-scientific field (the REINTEGRATION programme). The HOMING programme offers grants for postdoctoral fellowships for researchers wishing to return to Poland or come to Poland from abroad.

Recruitment for these programmes is scheduled to last until the end of 2019, and will be conducted twice a year on average. The foundation anticipates that over 350 grants will be awarded in the TEAM, TEAM-TECH, FIRST TEAM, HOMING and REINTEGRATION programmes, including creation of over 150 research teams. Over 2,100 young researchers (undergraduates, PhD students and postdocs) will be involved in implementation of these projects.