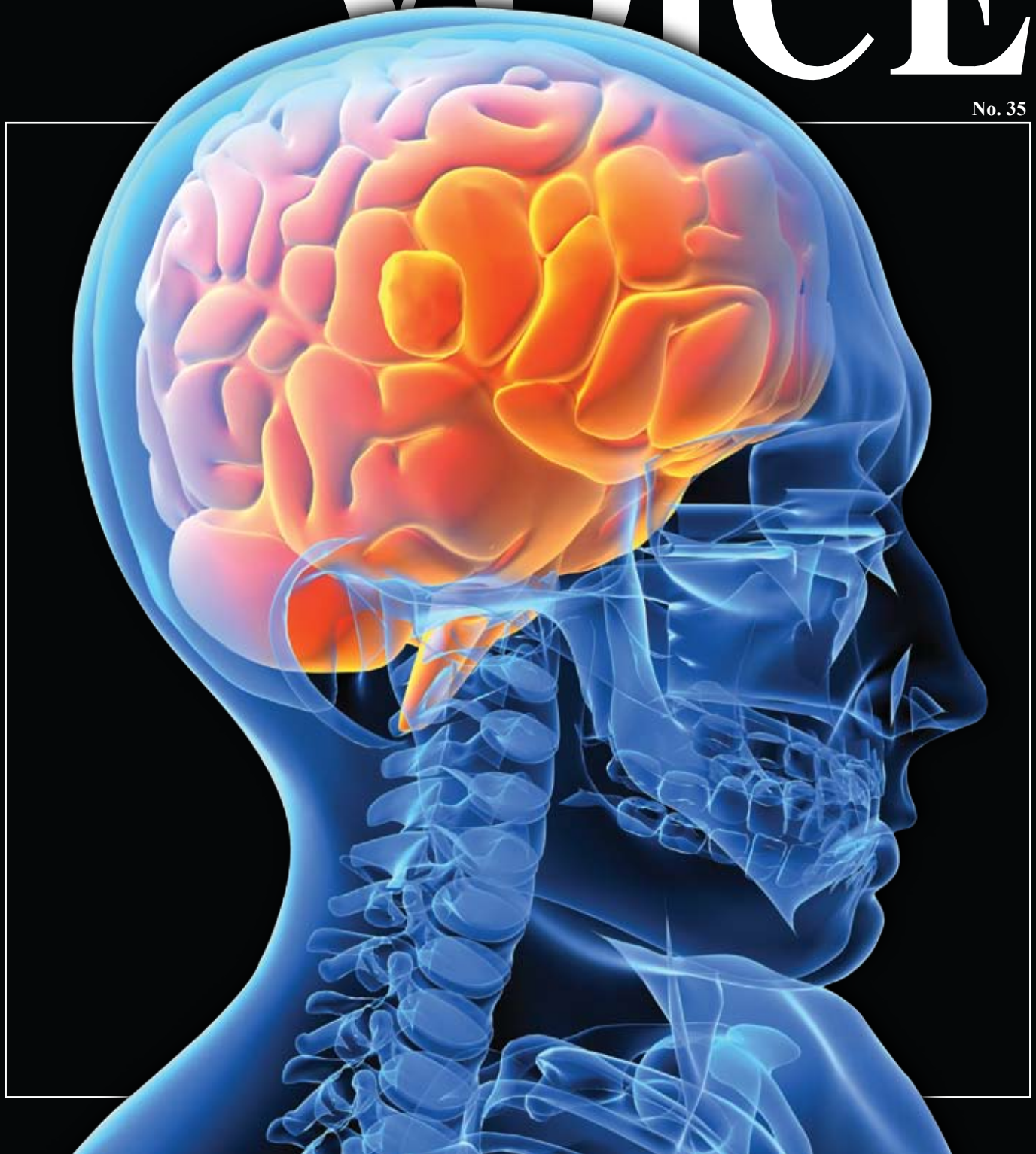
THE POLISH SCIENCE VOICE

No. 35



From the Publisher

Can a cat's eye and a rat's whisker help explain the mysteries of the human brain? For scientists, this sounds like a routine research question. For a layman it promises a journey into the fascinating world of scientific research and discoveries that have become possible thanks to new experiments and state-of-the-art equipment.

A new discipline called neuroinformatics is expected to speed up research on the physiological mechanisms of mental processes, according to Prof. Andrzej Wróbel, Neurophysiology Department head at the Nencki Institute of Experimental Biology in Warsaw. Scientists created this discipline by combining medicine, psychology and neurosciences with robotics, mathematics and computer science, says Wróbel, who is the special guest of this issue of *The Polish Science Voice*. He adds, "The modeling and analysis of these processes requires high-performance computers and Poland has such computers. We also have excellent computer scientists and mathematicians who ensure neuroinformatics can thrive here. Last but not least, we have good experimental labs that produce data for neurophysiology."

Poland also has, of course, creative people like Wróbel who take part in major international research programs. According to Wróbel, neuroinformatics has been a priority in OECD member countries since the mid-1990s after it became evident that increased spending on neurobiological research during the 1990-2000 Decade of the Brain in the United States, Japan and Europe, would fail to produce the expected results.

Wróbel also discusses the medical and economic aspects of neuroinformatics research, no less fascinating than research into the secrets of the human brain itself.

If for Prof. Wróbel, a cat's eye and a rat's whisker may be the keys to unlocking the secrets of science, for Prof. Robert Hasterok, a cytogeneticist at the University of Silesia's Faculty of Biology and Environmental Protection in Katowice, such a key is *Brachypodium distachyon*, commonly called purple false brome, a model grass that enables researchers to more easily and thoroughly study temperate cereals, such as wheat, barley, rye and oats.

Hasterok, together with his Ph.D. student Dominika Idziak, were among over 100 researchers from 45 research centers across the world who formed an international consortium to study the *Brachypodium distachyon* genome. The project produced results, as reported by the prestigious international science journal *Nature*. One of the most important results will be better varieties of grains, in addition to stronger ties between Polish scientists and their colleagues in other countries.

Prof. Hasterok started out this adventure as the only Pole in a British research team, and he and Idziak were also the only Poles in the international team of some 100 researchers. Hopefully, Polish scientists will play a bigger role in such ventures in the future.

Meanwhile, another creative mind in Poland has designed a machine to help people build dikes in a flood emergency. This sandbag-filling machine is among the most efficient designs of its kind in the world today, according to the inventor. The invention has won praise at home and abroad.

In this issue of *The Polish Science Voice*, we also report on the Pomeranian Medical University (PAM) in the northwestern city of Szczecin, which is known internationally for its research on stem cells, genetics, biochemistry and pharmacology, in addition to training medical students. We also focus on some of the latest achievements of Polish medicine.

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Published by Warsaw Voice S.A.

Publisher: Andrzej Jonas
Editors in Charge: Danuta Górecka, Witold Żygulski
Layout: Magdalena Jonas
Address: Warsaw Voice S.A.
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A publication co-financed by THE MINISTRY OF SCIENCE AND HIGHER EDUCATION

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PROBING the Mysteries of the Human BRAIN

Prof. Andrzej Wróbel, Neurophysiology Department head at the Nencki Institute of Experimental Biology in Warsaw, talks to Julia Pawłowska.

■ Your work as a neurophysiologist covers a range of mysterious-sounding disciplines such as neurobiology and neuroinformatics. What do these terms mean exactly?

Neurophysiology is the study of the functions of the nervous system. Neuroinformatics is a mathematical attempt at formulating the rules that govern certain neuronal phenomena. In other words, neuroinformatics seeks to turn neurobiology into a quantitative science like physics and chemistry, which, having described the processes that occur in the inanimate world, are capable of modeling these processes as computer programs. As far as neurobiology is concerned, the goal became attainable only after computers developed sufficient computing power, because biological processes are far more complicated than physical and chemical ones.

Neuroinformatics comprises three things: the development of new data analysis methods, the processing and unification of incredibly large databases, and computational modeling. As a theoretical science, neuroinformatics only employs computers to process data from complex devices at neurophysiology labs and neurological clinics. As such, it is a relatively cheap science.

Scientists created the new discipline by combining medicine, psychology and neurosciences with robotics, mathematics and computer science. That laid the groundwork for neuroinformatics, which, along with neurocognitive science, is expected to speed up research on the physiological mechanisms of mental processes. The modeling and analysis of these processes requires high-performance computers and Poland has such computers. We also have excellent computer scientists and mathematicians who make sure neuroinformatics can thrive here. Last but not least, we have good experimental labs that produce data for neurophysiology.

■ Why are researchers so keen on fathoming the mysteries of the human brain?

The human brain is one of the mysteries of nature that people are still unable to account for, and there is no standardized hypothesis in this area. The origins of life and the unknown laws of physics which governed the beginnings of the universe are similar mysteries.

The brain is the most complicated structure in the universe as we know it. The progress of medicine has significantly increased average life expectancy and, consequently, the frequency of age-related neurodegenerative diseases. At the same time, the world we live in, with all the pollution, stress and so on, constitutes a heavy burden on the human nervous system. As a result, it is estimated that by 2020 the social cost of treating diseases of the nervous system will top the list as far as spending on medical care in developed countries is concerned. Developed countries are aware of the need to foster neuroscience and are investing substantial funds in research in this area, because prevention is cheaper than cure.

Despite increased spending on neurobiological research, the 1990-2000 Decade of the Brain in the United States, Japan

FACTFILE

Andrzej Wróbel graduated in biophysics from the University of Warsaw in 1970. He obtained his doctoral degree in 1974 and followed up with a postdoctoral qualification in 1984. He became a professor in 1996. He spent around three years doing research in the United States and Sweden.

Wróbel has been head of the Neurophysiology Department at the Nencki Institute of Experimental Biology in Warsaw since 2002. He also manages the institute's Visual System Laboratory. Moreover, he is deputy chairman of the institute's Scientific Council and of the Neurobiology Committee of the Polish Academy of Sciences.

Wróbel is a member of numerous scientific associations and has held a number of key posts in these organizations. For example, he was a member of the executive committees of the European Federation of Neuroscience Societies (FENS) and the European Brain and Behavior Society (EBBS). He also presided over the Polish Neuroscience Society, the Dana Alliance for Brain Initiatives, and the Neurobiology Committee of the Polish Academy of Sciences. Wróbel represents Poland in the International Neuroinformatics Coordination Facility and is an editor of science journals such as *Acta Neurobiologiae Experimentalis, Neuroinformatics* and *Kognitywistyka i Media w Edukacji*.

Wróbel has authored around 60 articles published in English-language science journals. He has also written around 30 textbook publications and book chapters. In 1993, he became the Ministry of Science and Higher Education's pointman on neuroinformatics, a new field of research in Poland at the time.

and Europe failed to bring the expected results and so in the mid-1990s OECD member states prioritized neuroinformatics instead. They established an organization called the International Neuroinformatics Coordination Facility (INCF) to coordinate neuroinformatics research worldwide. The result are specialized institutes in the United States, Germany, Britain and Israel which conduct research of this kind. I used to represent the Polish Ministry of Science and Higher Education in the INCF.

■ How well developed is neuroinformatics research in Poland?

Several research centers in Poland have dealt with neuroinformatics since the 1990s. At the beginning of this decade, the Neurophysiology Department at the Nencki Institute of Experimental Biology obtained a grant to launch a news website with links to many people in Poland with an interest in this field of research. The website is www.neuroinf.pl.

A special task force has been established at the Institute of Experimental Biology as a separate laboratory to study neuroinformatics. The lab is managed by Daniel Wójcik, Ph.D.

■ What have you been researching lately?

My current research focuses on issues studied by the institute's Visual System Laboratory, which I manage. The name of the laboratory dates back to the days when I investigated the processing of data by the visual systems of cats and humans. We also have a team that studies the somatosensory system using the whiskers of rats as a model example. In our research, we use electrophysiology, which is a method of recording electric potentials from individual nerve cells, or neurons, and groups of those. We primarily seek to identify the brain mechanisms of perception in alert animals. Our method is known as chronic recordings of the electrical activity of the brain. We are particularly interested in determining the mechanisms of visual attention in cats and contextual changes in the tactile perception of rats.

■ What exactly are you trying to find out?

Among other things, we want to understand how the brain encodes data and identify the dynamic properties of neural networks, that is the modulation of the electrical activity of the brain when data on visual or tactile stimuli is being processed.

Neuroscientists often base their research on animals. Since you cannot put electrodes and probes in the human brain for experimental research, when you want to understand its mechanisms you need to find a good animal model. In rich countries, research on visual data processing, for example, is conducted on monkeys, while in Poland we use cats, because in both monkeys and cats these mechanisms are similar to those in humans. When you study plasticity processes in the brain, you use rat and mice as models.

We have been conducting several parallel research projects with Sweden, Norway, the Netherlands, Hungary and Australia.

All our papers are published in international science journals, many of which have a high impact factor (IF), which testifies to the prestige and importance of these publications. We have several articles printed every year in journals such as *Neuroinformatics, the Journal of Neuroscience, the European Journal of Neuroscience, Experimental Neurology, the Journal of Integrative Neuroscience,* and *the Journal of Computational Neuroscience*. We had our work published five times in the first few months of this year alone and all these articles received the highest ratings from the Polish Ministry of Science and Higher Education, at 24 points, as well as high IFs ranging from 2.5 to up to 7.5.

■ You are tied to the Warsaw School of Social Sciences and Humanities (SWPS). What does a neurobiologist have to do with social sciences?

I am a physicist by training, while my career in neurophysiology started after I began to study the activity of individual cells. I then developed an interest in neural networks and the functions they performed in the brain. The older I get, the more interested I become in the integrative functions of the human brain, hence my interest in psychophysiological research and work with my psychologist colleagues. I started giving lectures at the University of Warsaw's Psychology Department back in the 1970s and for the past nine years I have taught at the Warsaw School of Social Sciences and Humanities. It was there that I teamed up with Aneta Brzezicka, Ph.D., four years ago to launch Poland's first neuropsychology specialization. We called it neurocognitive science, which is a science that combines neurobiology with cognitive psychology to account for the neurophysiological mechanisms of cognitive processes. Our first students complained they could not even remember the name, but then more such majors cropped up across the country. At present, they are available at universities in Toruń, Poznań and Gdańsk.

■ How do you obtain funding for these projects?

Our basic research relies on grants from the Ministry of Science and Higher Education, which are basically sufficient to pay for what we need in this area. We also often get extra funding for large projects as part of European grants. We obtain some financial aid from producers of biomedical equipment and pharmaceuticals. The only program at the Neurophysiology Department to use private funds is one sponsored by a Western company.

Sadly, we are unable to compete in experimental neurobiological sciences on equal terms with the best and wealthiest research centers in Western Europe or other countries such as the United States, Japan, and Israel. But we are beginning to catch up with the global average as far as the results of our research are concerned.

On the other hand, we could spread our wings in some niche areas of neurophysiology, such as the study of behavior. Research in these areas is labor-intensive and simply too expensive for many leading centers because of the high labor costs involved and the pressure to obtain results fast. The problem is that, in its appraisal of the work of research teams, the Polish Ministry of Science and Higher Education is guided by the impact factor, which

depends on the average number of citations. The IF is the highest in the trendiest fields of study, while being low in niche areas. This rating system leaves us with no option but to follow global trends.

■ How well known is Polish neurobiology research internationally?

The Nencki Institute of Experimental Biology is an internationally famous center for neurophysiology. In the past, many of the institute's researchers won worldwide recognition after World War II. These included Prof. Jerzy Konorski, who researched integrative brain activity and instrumental reflexes; Prof. Liliana Lubińska, who led the way in neuronal transport; and Stella Niemerko, who specialized in neurochemistry. Today the international science community is familiar with brain plasticity research conducted by professors Małgorzata Kossut and Leszek Kaczmarek and with papers on neurorehabilitation written by professors Urszula Sławińska and Julita Czarkowska.

Kossut and Kaczmarek along with their teams have been investigating the molecular foundations of learning and memory formation and the molecular mechanisms of post-stroke neuroplasticity in adult and aging brains. The researchers have developed methods to induce model brain plasticity changes to determine how genetic modification and diseases impact the functions of the cortex.

Sławińska and Czarkowska, in turn, are widely known for their research on mechanisms governing locomotion control and recovery of motor functions in rodents after damage to the brain, spinal cord and peripheral nervous system. In particular, the professors' work focuses on the mechanisms and course of apoptosis, the response of proteins which regulate cell death in neurodegeneration, the role of neurotrophins and cell adhesion proteins and the regulation of the expression of neurotrophin receptors in neuron regeneration and growth. The team led by Sławińska and Czarkowska has also won acclaim for developing a method to stimulate special protein pools involved in neuron regeneration. Moreover, Sławińska and Czarkowska are studying the combined effect and efficiency of pharmaceuticals known as spinal cord implants and physical training as a method to stimulate repair processes after spinal injuries and a severe disease known as amyotrophic lateral sclerosis (ALS).

■ What kind of impact does this research have on medicine?

Most of the research at the institute is aimed at solving fundamental questions, but the institutions which grant funds, mainly those in Europe, increasingly require the research to gravitate towards practical application so that it can be used in medicine and psychology. This explains why we are checking new tests for Alzheimer's disease and dyslexia, for example.

Prof. Elżbieta Szeląg at the Laboratory of Neuropsychology is doing research on the perception of time, speech and language, the functional asymmetry of the brain, biological aging, neurodegenerative diseases and neurodevelopmental disorders, and the recognition and spatial memory of different breeds of rats. Thanks to close work with an audiology and neurology clinic, the findings of this research have helped understand the mechanisms that occur in human patients with brain damage, hearing deficiencies and neurodegenerative diseases.

Apart from our institute, neurophysiological research in Poland is pursued by the Polish Academy of Sciences' Institute of Experimental and Clinical Medicine in Warsaw, the Zoology Institute of the Jagiellonian University in Cracow, the Institute of Pharmacology of the Polish Academy of Sciences in Cracow, and the universities in Lublin, Gdańsk, Wrocław, Toruń, and Poznań.

■ To what extent have the mysteries of the human brain been explored? How many brain diseases can be treated at present?

For the most part, the brain remains a secret, unfortunately. It is the least explored and the most complicated structure in the universe. Even though it is responsible for all the processes that take place in our bodies, there is still no coherent concept of how the brain really works. Even though we know how it is built and which parts are in charge of what, there is no general theory of how the brain works, just as there is no rational theory to explain the origins of life or the first moments after the Big Bang.

However, the etiology of many diseases has been determined and so there has been extensive research to find the appropriate preventive measures.

■ The general public is puzzled and fascinated by terms such as artificial intelligence, neurofeedback, brain-machine interface, or neural networks. Are these terms science or are they still science fiction?

Most of them are pure science. After all, the brain is a neural network, especially when it comes to its functioning, and so quite naturally, neural networks are what our work is mainly about.

The brain-machine interface (BMI) is a superb tool that uses what we know about the brain to help people with all kinds of paralysis, such as paraplegia. For example, the brain-machine interface can provide a blind person with information on the visible world or record a paralyzed person's brainwaves to enable the person to communicate with others.

Neurofeedback, in turn, is an important property that is part of hypotheses concerning neural networks. In Poland, the name is used interchangeably with biofeedback.

Artificial intelligence is a somewhat different story. For the time being, it is still more of a catch phrase than the future of mankind, because we are incapable of building an artificial brain equipped with emotions and a sense of purpose.

Polish SPACE ROBOT Makes Podium

A Martian robotic vehicle designed and built by a group of Polish students took third place in the annual University Rover Challenge, an international competition for space exploration vehicles that was held in the U.S. state of Utah in early June.

The Polish rover, called Magma, was the only robotic vehicle from Europe; it beat rival vehicles from the United States and Canada after a tight contest.

A simulated mission to Mars took place in the harsh surroundings of a Utah desert June 3-5. A total of 12 rovers were submitted for the competition, all designed and built by university and college students from different countries around the world.

The first challenge for the teams was to have their robots officially entered in the competition. The judges checked the weight of the rovers, the quality of the materials they were built from and the workmanship. Only seven rovers were selected for the final stage of the competition, and Magma turned out to be the lightest rover in its category, at 53 kilograms.

Over the days that followed, the teams faced four complicated tasks during which they were expected to run a site survey, deliver a medical kit to an injured astronaut, perform remote equipment servicing and search for "signs of life." Points were awarded to the teams for quick completion of the tasks, techniques and imaginative ideas. The rovers and their designers had to cope with extreme conditions such as bumpy terrain and sandy soil that caused many rovers to get stuck; scorching heat disturbed the work of some devices. Some teams failed at individual tasks.

The Polish team impressed the judges in the final event in which the rovers were required to take a soil sample of a specific weight and return it to base for examination.

"We are very happy with our success and would like to thank everybody for their support," said Wojciech Głażewski, one of the Magma designers.

The team behind the project

Magma is a remotely controlled Mars exploration vehicle fitted with a camera that employs the RODM algorithm designed by Polish mathematician Jan Kotlarz. A thoroughly innovative device, the rover was designed especially to endure the extreme conditions at the University Rover Challenge, the designers say.

Magma was built by mechanical engineering students from the Białystok University of Technology aided by colleagues from the Faculty of Physics, Astronomy and Applied Computer Science of the Nicolaus Copernicus University in Toruń.

The students were assisted by the Polish branch of the Mars Society, an international organization that aims to promote the idea of a manned mission to Mars and Mars research. The organization brings together scientists; aerospace engineers such as Robert Zubrin, who has mapped out a plan for the colonization of Mars; astronauts like Buzz Aldrin, who took part in the first landing on the Moon; filmmakers like James Cameron; writers and other enthusiasts—all those who share the vision of human presence on Mars.

Historic

Cracow's Jagiellonian University (UJ), the oldest institution of higher education in Poland, has renovated and reopened its historic gardens after a hiatus of more than two centuries.

The facility, dubbed the Professors' Garden, opened in early May following a two-year renovation project.

The gardens were used for over 350 years in the past until they fell into ruin at the end of the 18th century.

Designed as a place for university professors and students to relax, the gardens, not far from the city's Main Market Square, are also accessible to the general public.

In the past, herbs, vegetables and fruit trees grew in the gardens, which closed to visitors after the university underwent a reform more than two centuries ago. From the early 20th century onward, the site was used for warehousing and logistics purposes. Two years ago, a redevelopment project got under way to restore the gardens to their former splendor.

While the erstwhile fruit frees and other vegetation are no longer there, the renovated gardens have plenty of new plant life. For fire security reasons, instead of narrow alleyways, there are wide walkways with lawns and trees in between them. There are also some herbs and wild strawberries. The whole is made complete by renovated statues from the 19th century. Three of them depict professors wearing gowns and caps, but the identity of the individuals immortalized in the statues is unknown.

The gardens feature five interactive models of scientific instruments. Each refers to a different era, showing the history of the Jagiellonian University in a nutshell. The 15th and 16th

Gardens

centuries, the golden age of the Cracow Academy, as it was called at the time, are represented by models of two early mathematical and astronomical instruments, a sun dial and an armillary sphere. The latter is an astronomical model of the celestial sphere that was popular in the 15th and 16th centuries. The Age of Enlightenment, when the first physics laboratories opened at the university, is symbolized by the Magdeburg hemispheres, which physicists used to demonstrate the phenomena of vacuum and air pressure. In the 19th century, the university started regular meteorological observations, hence the inclusion of the model of a 19th-century Stevenson screen, which used to measure air temperature, pressure and humidity. Finally, the 20th century is represented by an original part of the first cyclotron built by Jagiellonian University staff and a scintillation counter used to survey cosmic rays.

The gardens are open from May until October, from 8 a.m. until dusk. After dusk, visitors can admire the gardens and their spectacular illumination through an openwork gate guarded by two stone halberdiers.

Ewa Dereń

photos: Anna Wojnar, Promotion and Information Department of the UJ

The True Secrets of the Purple False Brome

Prof. Robert Hasterok, a cytogeneticist at the University of Silesia's Faculty of Biology and Environmental Protection in Katowice, talks to Ewa Dereń.

In February, the international science journal *Nature* reported that researchers had sequenced the genome of *Brachypodium distachyon*, a model grass species used for genetic research. You are one of the authors of the paper and were in charge of a stage of the sequencing process that was of key importance to the project's success. Your work made it possible to match individual parts of the nuclear DNA of *Brachypodium distachyon* with specific regions in the plant's chromosomes. You and your Ph.D. student Dominika Idziak were the only Poles among over 100 researchers from 45 research centers who formed an international consortium to study the *Brachypodium distachyon* genome. What makes this rather unimpressive grass species draw so much attention among scientists around the world?

Master and student: Hasterok with Dominika Idziak

Brachypodium distachyon, commonly called purple false brome, is a model grass that enables researchers to more easily and thoroughly study temperate cereals, such as wheat, barley, rye and oats. These grasses are one of the most important groups of domesticated plants.

The sequencing of the nuclear genome of *Brachypodium* is a big step towards intensified research on cereal grain species with improved immunity to infections, better adaptation to tough climate and higher yields. The research described in *Nature* may have a substantial impact on global science, especially when it comes to the question of what humankind will eat in the future.

■ **Why do scientists need model grasses instead of just doing research directly on cereals such as wheat?**

All the cereals I listed are very difficult as subjects of genetic research. Their genomes are big and their nuclei contain vast quantities of DNA, most of which are non-coding sequences that carry little or no information of significance to the economic value of cereal species. We are only interested in relatively short sequences, or genes, which encode for certain qualities of plants, such as flowering time, size of harvest, composition of nutrients in caryopses, which constitute the bulk of human food, tolerance of poor soil quality, resistance to drought and pathogens and so on. If we were to try and track down the genes in huge, complex genomes with many repeated sequences, the genes would be much more difficult to identify. It was thus vital to find a model organism related to cultivated grasses closely enough to make sure the repertoire and arrangement of genes was similar to that of temperate cereals. Apart from having a small nuclear genome with a low number of repeated DNA sequences and few chromosomes, the model plant would need to display a number of other characteristics such as small physical stature, a short life cycle, self-fertility, and uncomplicated growth requirements; and, most importantly, it should grow in the temperate climate. *Brachypodium distachyon* is native to the Mediterranean region and areas north of it, up to the southern border of Poland. It is a common plant species in Iran, Iraq and Turkey. It reaches a height of 20-30 centimeters, is easy to grow and its life cycle takes only three to four months, so that it produces a new generation of seeds within just a quarter of a year from sowing.

■ ***Brachypodium* was first proposed as a model grass by Prof. John Draper at Aberystwyth University in Britain. You started researching the plant in his team, being the first and only Polish scientist to do so. How do you remember that experience?**

When I first came to Aberystwyth University on a scholarship, I did not even know that *Brachypodium distachyon* existed. I had been analyzing the chromosomes of species of the *Brassica* (cabbage) genus and completing my doctoral thesis at the University of Silesia when I got the opportunity to go to a European academic center as part of the EU's Tempus program, which enabled researchers to undertake short-term fellowships. I chose Aberystwyth because their field of research was closest to what I was doing at the time. My fellowship went well so I was invited to come on a 12-month scholarship, and needless to say, I accepted the offer. Aberystwyth was my first encounter with research on grasses. When my year at the university was coming to a close, I got an invitation from Prof. Draper's research group and so began my adventure with *Brachypodium*.

■ **You were the first team member to see the chromosomes of *Brachypodium*. Is that correct?**

Several of my colleagues had been trying to spot them, but since the chromosomes were small and quite difficult to see, as we found out later, all attempts indeed failed for a long time. Since my earlier research focused on plant species with tiny chromosomes as well, in the end I succeeded in spotting *Brachypodium* chromosomes and then counting and measuring them. That happened midway through 2000. In the following year, the journal Plant Physiology printed our first significant publication with a full description of *Brachypodium distachyon*.

We then gradually tackled the *Brachypodium* chromosomes. In the meantime, I returned to the University of Silesia and, as a young Ph.D. degree holder without a research team, I studied *Brachypodium* on my own. I also continued to work with the research group at Aberystwyth University and things went on like that until January 2006, when a conference took place in San Diego, California, that became another turning point in the research on *Brachypodium distachyon*. It was there that the idea to sequence the *Brachypodium distachyon* genome came about. Every year, the Plant and Animal Genome conference in San Diego draws around 2,000 scientists who deal with genetics and molecular biology. In 2006, the conference became a meeting point for a wide group of people from different countries who worked on *Brachypodium*, but never worked together until that point, and each one of them was doing something different. The research lacked a common direction and coordination. We decided to do something together and one of the most obvious ideas was to sequence the genome.

■ **What exactly did your team do to help make the sequencing of the *Brachypodium distachyon* genome a success?**

The consortium reached a point where the researchers had developed sequence maps of the *Brachypodium* genome and, to cut a long story short, the maps now had to be assigned to individual chromosomes. However, in all the many teams which did the sequencing there was not a single expert capable of doing just that. In the meantime, my team had designed a set of special markers enabling us to precisely identify each of the five chromosomes and particular chromosome regions in the *Brachypodium distachyon* genome. Figuratively speaking, we had come up with a set of colorful tacks we could push into any chromosome to locate it. Those sequence maps needed such tacks and so our contribution to the research and the publication in *Nature* was the integration of maps developed through *Brachypodium distachyon* genome sequencing with individual chromosomes. Our method made it possible to determine the physical location of large regions of the *Brachypodium* genome assembled into so-called supercontigs in the chromosomes. The makers of the maps arranged the supercontigs according to certain criteria, but sometimes these arrangements contained various errors and our tacks helped eliminate at least some of those. In other words, our contribution was small but pivotal at that particular stage of research.

■ **What else can be investigated when it comes to *Brachypodium distachyon*?**

For the time being, the research community is only familiar with the sequence of the genome. This can be compared to knowing just the letters of the alphabet, which is far from being able to read and understand a whole book. We still know very little about the functional contents of the genome; we do not know what many of the *Brachypodium* genes are responsible for and how they interact with other genes and non-coding sequences. My team is actually less interested in these questions, because we work on chromosomes and not individual genes. The successful sequencing of the genome has clearly expanded research possibilities at the chromosome level as well. For example, we now have access to libraries of DNA sequences which we use to obtain sets of sequences that will enable us to literally "paint" entire chromosomes, assign-

The *Brachypodium* research may have a substantial impact on global science, especially when it comes to the question of what humankind will eat in the future.

ing a different color to each chromosome and visualizing it by employing fluorescent microscopy. The technique makes it possible to visualize a number of key processes that occur in *Brachypodium distachyon* cell nuclei. Such visualization was for a long time completely unobtainable for plant chromosomes. Our "chromosome painting" is the second time the technique has ever been used in plant research. Unlike human or animal chromosomes, those in plants cannot be easily painted and the only plant for which it became possible a couple of years ago was Arabidopsis thaliana, a model species as well. *Brachypodium distachyon* is the second plant and the first one as far as grasses are concerned.

At the beginning of this year, the Ministry of Science and Higher Education provided us with a substantial research grant to further analyze the *Brachypodium distachyon* genome, chromosome painting in particular. As part of the grant, we have been working with British scientists at research centers in Norwich and Aberystwyth and new publications are under way. There is a total of perhaps a few hundred people around the world who research *Brachypodium distachyon*, but the number is growing rapidly. Around 150 people are credited as the authors of the project which led to the publication in *Nature*.

■ **What is the practical side of *Brachypodium distachyon* genome sequencing?**

Research of this kind builds a certain body of knowledge that seemingly has no practical application, but in science you can never tell what will find practical application and when. Sometimes one discovery can supply the missing piece of the puzzle, and all of a sudden it creates a whole new quality that nobody else would have thought of before. That way, looking at scientific research solely in terms of immediate practical applications is taking things far too simply. For example, many people ask us if *Brachypodium distachyon* is a cereal species. Well, it is a weed that cannot be utilized directly like wheat, maize or rice. However, the plant can be very useful when it becomes a model to enable faster and easier understanding of important cereals. So, as far as direct, practical applications of the *Brachypodium* research are concerned, there are none to speak of, but some research centers are working on this direct aspect. For example, my colleagues at Aberystwyth are researching the resistance of *Brachypodium distachyon* to different fungal infections. Many pathogens which are dangerous to rice and wheat can also infect *Brachypodium*, but some *Brachypodium distachyon* ecotypes are resistant to them. The research seeks to establish the differences between the susceptible and resistant ecotypes, aiming to understand what differences in the genome organization and the arrangement of genes are responsible for the susceptibility and resistance to a given pathogen and what defense mechanisms the plant activates to contain infections. Last but not least, the researchers want to see how their studies of the model organism's susceptibility and resistance can translate into a real-life situation on a wheat field or other.

This kind of research is just one of several directions. Another investigates how *Brachypodium distachyon* could be used in biofuel production. The plant itself is not really useful as an energy plant, because it is too small, incomparably smaller than, for example, Miscanthus, also known as "elephant grass." But as a model organism, it can be used to study certain metabolic routes that trigger faster and more efficient enzymatic hydrolysis of cellulose. Plants abound in cellulose, as it is a major component of the plant cell wall. It would not be easy to do, but theoretically, cellulose could be used to produce ethanol and other biofuels. Research on the process is under way and some of it involves *Brachypodium*.

■ **What other fields of research does your department pursue?**

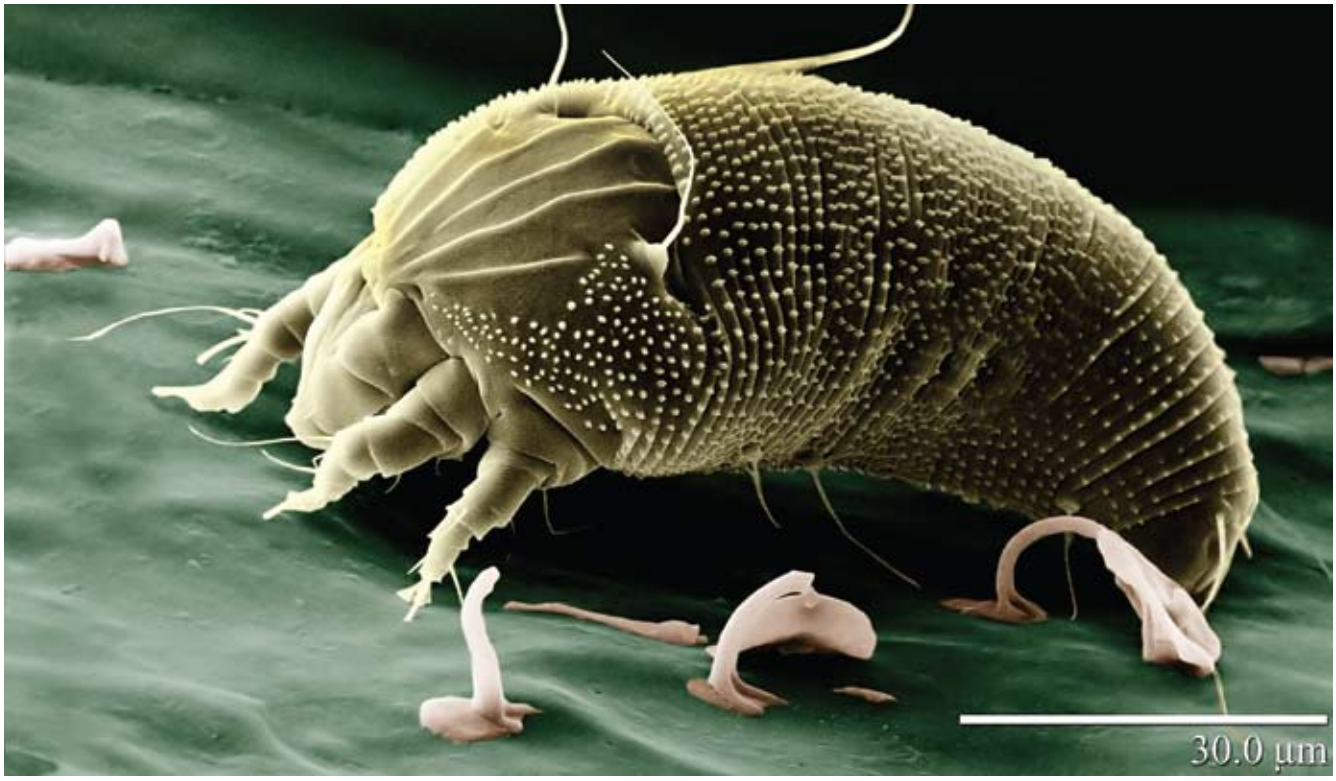
Our staff also deal with the molecular cytogenetics of plants, a science that studies plant genomes at the chromosomal level. It combines cytology, genetics, molecular biology and, to a growing extent, digital image analysis and processing, because state-of-the-art processing of microscopic images is very important to ensure appropriate presentation and quantification of the findings.

My department researches several areas. Some of my colleagues analyze the structure of nuclear genome in plants in the context of physical mapping of diverse DNA sequences that make up the genome. This is what my research team does as well. Others assess the stability of genomes exposed to different mutagens. For example, they irradiate the seeds of a given plant species or expose it to all kinds of chemical agents. Then, they watch its chromosomes and their behavior during cell division, so as to identify any possible rearrangements such as translocation when a fragment of one chromosome "jumps" to another one.

The third major field of research at the department are analyses of epigenetic regulation in the genome, as it is called. Taking a step beyond studying just DNA sequences, this kind of research focuses on various chemical modifications of the chromatin that have an impact on the structure of the chromatin and, consequently, its functions.

For several years now, my team has conducting research thanks to continuing financial support from the Polish Ministry of Science and Higher Education.

Photos: Agnieszka Szymala, University of Silesia



Mite Is Not RIGHT

Scientists at the Textile Research Institute in Łódź have created a carpet that keeps house dust mites at bay. The invention promises to ease the lives of many people allergic to these tiny creatures.

Depending on their type, house dust mites measure from a few hundred micrometers to a millimeter. They live mainly in household dust and are invisible to the naked eye. They feed on other microorganisms and the minute scraps of dead skin shed by humans and animals. They infest bedclothes, mattresses, carpets and upholstery and particularly enjoy warm and moist places.

"House dust mites, or more precisely their excrement, is one of the most potent allergenic substances," says Małgorzata Cieślak, Ph.D., at the Textile Research Institute.

According to doctors, allergic reactions can range from coughing and sneezing to asthma. Most doctors counsel those affected to remove carpets and other textiles from their homes.

Research conducted by Swedish scientists has shown that more airborne allergens can be found at breathing height in rooms that have textile floor carpeting, than in those that do not. This is mainly because even a slight airflow sends the allergen-bearing dust up in the air.

According to Cieślak, a properly designed carpet should act like an air filter, grabbing house dust mites and their excrement out of the circulating dust clouds and preventing them from becoming airborne again. The carpet should also inhibit the reproduction of house dust mites, Cieślak says.

The carpet designed by the Łódź scientists is made from fibers coated in a special substance that inhibits the feeding habits of house dust mites, making them starve to death. The substance is safe for humans and domestic animals, according to the researchers.

The carpet also contains specially selected fibers that limit adhesion. The fiber design prevents mite excrement and other particles from adhering to its surface during normal, everyday use, making it easier to keep the carpet clean.

The Łódź carpet has won many international awards, including a special prize and silver medal at last year's International Women's Invention Exhibition in Seoul, South Korea, and a gold medal at the 3rd International Warsaw Invention & Innovation Show last year.

The Łódź scientists worked on the project in collaboration with researchers from the Department of Parasitology at the Medical University of Silesia in Katowice. Krzysztof Solarz, Ph.D., led the research team. MB

Battling Inoperable Liver Cancer

A group of doctors in Warsaw are testing a pioneering method to treat patients with "incurable" liver cancer. Thanks to precisely targeted radiation therapy, the doctors say they have been able to achieve the impossible—extend the lives of patients who have failed to respond to any other treatment methods known to contemporary medicine.

This innovative therapy was developed more than 18 months ago by doctors at the Radiology and Imaging Diagnostics Unit of the Ministry of Internal Affairs and Administration's Central Research Hospital in Warsaw.

The hospital is managed by Prof. Jerzy Walecki, and the research team involved in the project is led by Dr. Jarosław Ćwikła, a nuclear medicine specialist. The group also includes Dr. Mirosław Nowicki, an interventional radiologist, Dr. Artur Sankowski, an imaging assessment radiologist, as well as several other doctors who prepare patients for the therapy, treat them and provide post-treatment care. The project is being developed in association with several other cancer and surgery clinics across the country.

The project involves the use of radioactive isotopes for treating patients with advanced inoperable primary or metastatic liver cancer. At first, the doctors only used the [^{90}Y] yttrium isotope, but now—with the consent of the hospital's bioethics board—they also apply [^{188}Re] rhenium. The rhenium therapy method is their own research project financed by the Ministry of Science and Higher Education and the Association of Patients and Supporters of Patients with Neuroendocrine Tumors.

Radioisotope therapy

"Our field is treating cancer with radioisotopes," says Ćwikła. "This involves diseases that are either forms of primary advanced liver cancer or other popular tumors that have metastasized to the liver, such as cancer of the large intestine, breast cancer or neuroendocrine tumors, which do not respond to other treatment methods."

Specifically, the method used by the researchers is called radioembolization. The idea is to supply radioactive material via blood vessels (the hepatic artery) directly to the vessels supplying the tumor, to expose the tumor to radiation and destroy it without harming healthy tissue. The aim of this therapy is not so much curing the patient—because this is usually impossible due to the advanced state of the disease—as reducing the tumor's mass in an attempt to extend the patient's life and make it more comfortable, Ćwikła says. In some cases the tumor can shrink so much that it can be removed surgically or chemically, which could in fact be tantamount to a cure, according to Ćwikła.

FACTFILE

Jarosław B. Ćwikła, M.D., specializes in nuclear medicine and radiology. He heads the Nuclear Medicine Laboratory at the Ministry of Internal Affairs and Administration's Central Research Hospital in Warsaw. He is also chairman of the Association of Patients and Supporters of Patients with Neuroendocrine Tumors.
He has published more than 40 research papers in both Polish and international periodicals. In addition to isotope radiotherapy and radioembolization, his work involves diagnosis of neuroendocrine tumors, improving the quality of life for patients with such tumors, and the use of radioisotope methods for treating cancer and arthritis.

Hepatocellular carcinoma

Hepatocellular carcinoma, or liver cancer, is a disease that most often ends in death. It can develop over a long time without causing any symptoms, which is dangerous in that the patient's chances of survival depend on how early the disease is diagnosed. Early symptoms, meanwhile, like minor pain in the abdomen, flatulence and loss of appetite, are easy to confuse with less serious diseases. Once a patient has intense pain, fever, jaundice or ascites, the disease is usually very advanced and has spread, which makes it harder to treat.

Liver cancer is the fifth most frequent cancer in the world, and third in terms of death rate. The average survival rate from diagnosis is six months. If the disease is restricted to one lobe, just 10 percent of patients survive five years.

Treatment consists primarily of surgical procedures (excision of the whole tumor), a liver transplant or thermal ablation, and in more advanced states—chemoembolization or chemotherapy. In many cases, however, the disease is too advanced for any of these methods to be effective. These are the kind of patients who are treated by Ćwikła's team.

Radioembolization

"When other kinds of treatment end and the patient cannot be helped, surgery proves impossible, chemotherapy doesn't work or has stopped working, the tumor cannot be removed by thermal ablation and the patient has exhausted all the standard methods, that's where we step in," says Ćwikła. "We try to help with a nonstandard method."

The procedure is called radioembolization. It involves the occlusion of blood vessels with various materials, most often resin or glass spheres.

"Apart from commercial [^{90}Y] yttrium-labeled substances, we use [^{188}Re] rhenium-labeled human serum albumin microspheres," says Ćwikła. These microspheres are specially prepared first and coated with the radioactive isotope. The radioembolic material is then introduced into the vessel which supplies the tumor; in most cases this is the hepatic artery or a branch of the hepatic artery.

To be accurate and safe, the procedure has to be carried out by an experienced interventional radiologist with excellent intuition and precision in identifying the visceral vessels in the abdominal cavity. The tumor has to be exposed to radiation selectively, only in the area where the microspheres are deposited. Embolization anchors the spheres in the target site in the liver—the tumor.

This technique uses extremely large doses of radiation, from a few dozen to several hundred grays (Gy). To compare, a single exposition of the whole body to radiation exceeding 5 Gy usually leads to death within 14 days, while a single dose of traditional radiotherapy ranges from 1.5 to 2.5 Gy.

The doctors can use such high doses only because these are precisely targeted and do not affect any healthy tissue. Radioembolization allows patients to avoid external radiation sources which, if they were to reach the tumor with the same kind of energy, would be lethal for the body as a whole.

The element that destroys the tumor and makes the patient respond to the treatment are fast electrons radiated from the nucleus of the [^{188}Re] isotope as a result of its decay. Irradiation of the cancer cells starts a whole cascade of events ultimately leading to the cancer's eradication, for example by inducing programmed cell death (apoptosis) or at least halting the cancer cells' further development.

Rhenium makes the difference

Specialist medical centers around the world have provided similar therapy for over 10 years, using commercially made yttrium-labeled resin (SIR-Spheres, Sirtex Medical) or glass (TheraSpheres, MDS Nordion) microspheres.

"Data from research reports confirm the effectiveness of this kind of therapy," says Ćwikła. "At present, two large, multiple-center clinical trials are under way that aim to provide further proof. One of them involves patients with colorectal cancer that has metastasized to the liver, the other is treating advanced hepatocellular carcinoma. We intend to join both projects soon."

The Polish scientists have decided to use the [^{188}Re] rhenium isotope instead of yttrium isotopes. Why? The [^{90}Y] yttrium isotope in the commercially made preparations used elsewhere in the world is expensive, according to Ćwikła. "The cost per unit is zl.38,000-zl.42,000, to which you have to add the cost of the procedure itself, so a single treatment costs from zl.55,000 to zl.60,000," he says. "The procedure needs to be performed just once—with the response to the treatment usually spanning a year or more—so even despite the high cost it is still more economical than chemotherapy, which costs up to zl.100,000 per month and requires constant administration as long as the disease progresses."

According to Ćwikła, the use of yttrium leads to difficulties with imaging, while this is an essential part of the treatment—accurately determining the location of the isotope in the organs 24 hours after the procedure. This is necessary to establish where the medication is, whether it has reached the site it was supposed to or not, Ćwikła says.

"The blood flow in a liver with tumors is extremely complex, which is why it is

always necessary to assess where and in what amount the isotope is located," says Ćwikła. "It is only after imaging has been performed that it becomes clear that some sites have the ideal accumulation of the medication, meaning that a response to the treatment is highly likely, while in other areas it has not collected at all—then the treatment is ineffective. It is of key importance to monitor what goes on inside the patient's body. If the medication has not accumulated in the right place, the procedure has to be repeated."

Liver cancer is the fifth most frequent cancer in the world, and third in terms of death rate.

Thanks to the nature of its radiation, rhenium enables doctors to determine where the medication is located with greater accuracy. Rhenium is simpler to use in imaging, but also simpler to obtain. The preparations with yttrium have to be ordered from manufacturers in Australia or Canada. Deliveries take place once a week. In the case of rhenium, Polish-made equipment is available that can produce the required amount of the isotope at any time. The cost of treatment per unit is half that in the case of yttrium, no more than about zl.30,000, according to Ćwikła.

The equipment for making rhenium 188 is also a Polish invention. It is a tungsten/rhenium [$^{88}W/^{188}Re$] generator developed at the Polatom Institute of Atomic Energy in Świerk near Warsaw.

Yet another advantage of rhenium 188 is that the microspheres coated with it, unlike in the case of resin or glass microspheres with yttrium, are completely natural, made from human albumin, Ćwikła says.

Work on radioembolization involving rhenium began at the Warsaw hospital a year ago; the method started being used routinely six months ago. First, due to the complexity of the therapeutic process, the doctors from the hospital's radiology unit gathered experience in radioembolization by using commercial yttrium-labeled preparations. They went through an intensive training course at the Clinic of Radiology and Nuclear Medicine in Magdeburg, Germany. Today the Warsaw hospital is one of two medical centers in Poland that have a certificate for performing radioembolization using [^{90}Y] SIR-Spheres.

Treatment program

Before being admitted to the treatment program, patients sent to the Warsaw hospital from cancer treatment centers all over Poland have to undergo numerous tests. The doctors determine how advanced the disease is and what the possibilities are for carrying out the procedure. The patients have to meet certain criteria—clinical, imaging-related, and physiological. Another important criterion is the lack of any hepatopulmonary leakage and the physical viability of administering the radioembolic material. The issue is whether there is any danger that the medication might leak from the liver to the lungs, which could cause toxic, post-radiation pneumonia, and whether the blood vessels are sufficiently patent and have no unique anatomical features precluding the procedure.

Once a patient is admitted, the doctors start the procedure, which involves two stages. In the first, preparatory, stage, they perform an angiography, which is like an ordinary diagnostic procedure, to assess the tumor vasculature and plug some of the visceral blood vessels—for example, the gastric artery, the gastroduodenal artery, or the cystic artery. This is a non-invasive procedure in which a catheter is introduced through the femoral artery and special guides help locate the vasculature of the liver and other visceral structures. These vessels have to be closed when the radioisotope is being introduced so that the radioactive material does not go any farther—to the gall bladder, duodenum or pancreas—and irradiate healthy tissue, which would be dangerous for the patient.

The second stage takes place a few weeks after the preparatory procedure. The radiologist introduces the radioisotope into the left or right hepatic artery, depending on which side the tumor is. This takes 45 minutes to two hours. After a whole day has passed, the doctors perform an imaging procedure to see if the medication has collected in the tumor. If everything is fine, the patient can go home the next day and, depending on how they feel, return to their usual activities. This is a safe technique benefiting patients, well tolerated and significantly improving the quality of life for patients with chronic progressive cancer.

So far, the hospital's Radiology and Imaging Diagnostics Unit has carried out a dozen or so procedures using [^{188}Re] rhenium and a comparable number with [^{90}Y] yttrium. The preliminary results are being analyzed and a scientific publication is in preparation.

Julia Pawłowska

Holy Grail of Thoracic Surgery

Physicians from across the world flock to the Polish mountain resort of Zakopane to learn an innovative lung cancer staging method developed by Dr. Marcin Zieliński, a surgeon and director of the town's Specialist Pulmonary Hospital.

Zieliński says his method, developed six years ago, is the least invasive of all methods of this kind developed so far. It is also the most accurate one, according to the surgeon. It makes it possible to determine if a patient would actually benefit from having a lung tumor removed surgically.

The method has attracted interest from other medical centers in Poland—in the cities of Cracow, Szczecin and Rzeszów—but first physicians from abroad started to come to Zakopane to learn how to use it, Zieliński says. He has performed a series of diagnostic procedures using his method abroad. Called Transcervical Extended Mediastinal Lymphadenectomy (TEMLA), the method involves removing lymph nodes from the chest through a small incision in the neck.

The lymph nodes are essential in diagnosing the stage of lung cancer because they are usually the first place to which the cancer spreads. By examining the removed organs under a microscope, one is able to determine whether or not they contain cancer cells. This helps make a decision about further treatment. If the cancer has already spread to the lymph nodes an operation to remove the lung tumor will not be very helpful, Zieliński says; it might even result in a deterioration of the patient's health. But if the cancer has not spread to the nodes an operation offers a chance for the patient to recover.

TEMLA vs. mediastinoscopy

What is innovative about the TEMLA method is that it involves dissecting whole lymph nodes rather than only small portions of them as is done when the conventional diagnostic method called mediastinoscopy is used. Mediastinoscopy is not always reliable because the dissected lymph node fragments may be free from cancer cells, although the cancer has already spread to the nodes. The results of other methods used to diagnose cancer—CAT scans and endoscopic ultrasound—are equally inaccurate. With Zieliński's method, if no cancer cells are found in the removed lymph nodes there is 98 percent certainty that the cancer has not metastasized and that an operation can benefit the patient. The method can also be used to check the results of previous medical examinations if they indicate that the cancer has not spread.

The method was developed by Zieliński as he treated patients with myasthenia, a disease triggered by a thymus disorder. The treatment included the removal of the thymus, an organ located in the mediastinum. Zieliński accessed the organ through the neck and this is how he hit upon the idea that lymph nodes could be removed in the same way. But to do so he needed a suitable instrument, which only had to be developed. The prototype, designed by Zieliński, was made at the Zakopane hospital. Instruments based on this prototype are now manufactured by an international company specialized in the production of surgical instruments.

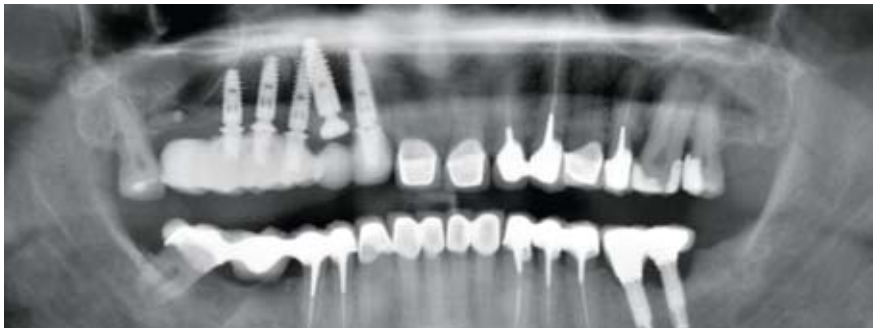
Gold standard

A growing number of surgeons are eager to use the TEMLA method, according to Zieliński. Dozens of specialists from across the world, including those from reputable American teaching hospitals, have come to Zakopane to learn the technique. Zieliński was invited to deliver a lecture about TEMLA at a convention of the American Association for Thoracic Surgery. In March, he spent two weeks with his team in Sao Paulo, Brazil, where he taught his method to more than 80 surgeons from South America. He is still receiving invitations from other medical centers, mainly in Europe and America, but also from countries such as Jordan.

The method has been widely described in medical journals. Outstanding Belgian thoracic surgeon Paul E. van Schil has written that TEMLA is the most accurate method for evaluating mediastinum and should be regarded as the "gold standard" in the field. Van Schil has called Zieliński's discovery "the Holy Grail of thoracic surgery."

Ewa Dereń

BREAKTHROUGH IN DENTISTRY AND ORTHOPEDICS?



Scientists at the Medical University of Lublin in eastern Poland have developed a new composite biomaterial to regenerate bone tissue. Clinical trials on animals show that the material may mark a breakthrough in dentistry and orthopedics, the scientists say.

Work on the project is still in progress and it is too early to announce a worldwide success, the scientists say. But the material may prove to be a milestone in dental surgery and orthopedics.

The composite is already protected by a patent in Poland and an application for an international patent has been filed. Several pharmaceutical corporations are interested in the invention, the scientists say.

The inventors

The inventors are a team of scientists from the Biochemistry and Biotechnology Department at the Medical University of Lublin working under the guidance of Prof. Grażyna Ginalska. They have conducted research on artificial bones for 10 years now and spent two years alone to produce the composite. They have been helped by researchers from the Faculty of Materials Engineering and Ceramics of the AGH University of Technology in Cracow. The research project has been partially funded from European Union funds under the Innovative Economy Operational Program.

Marrying organic with inorganic

The composite is a combination of sugar polymer, an organic material, and hydroxyapatite, an inorganic mineral. Hydroxyapatite has been used in medicine for years. What is new is that it has been combined with a polymer to produce a material with much greater plasticity, the scientists say.

When dry, the composite is hard but becomes soft when saturated with a special substance or even the patient's blood. Then the composite may be cut with a scalpel or shaped by hand. These properties are important, the scientists say, because they make it possible to treat accident patients by inserting a piece of the composite into the empty space where bone is missing and shaping it appropriately in order to fully fill the gap. The composite grows into the bone. It is important that it does not contain any irritants or allergenic substances, the scientists say. As a result, the patient is not prone to complications and the reconstructed area heals well. The organic sugar polymer is broken down within the body and replaced with osteoblasts, or cells responsible for bone formation.

Clinical trials on animals show that the composite easily merges with bone tissue, according to the scientists.

The trials have been conducted by a team led by Izabela Polkowska, Ph.D., from the Faculty of Veterinary Medicine at the University of Life Sciences in Lublin. The composite has been used in dental surgery on animals treated at the clinic.

Dogs' teeth, rabbit bones

Polkowska has used the composite, impregnated with an anti-bacterial drug, to close oronasal fistulas in dogs. The material has turned out to be effective—the effect of bone tissue regeneration became apparent after four months, according to Polkowska.

Additionally, the composite has been used to substitute for missing bone fragments in dogs' skulls and teeth. Orthopedic tests have also been made—the composite has been used in place of missing thigh bone fragments in rabbits. The effect is excellent, according to Polkowska: the rabbits can jump and do not show any health problems.

If the trials on animals end in success, the researchers say they will be able to start clinical trials on people. They plan to apply for official permission to conduct such trials later this year. The researchers want to conduct the trials at the dentistry clinic of the Medical University of Lublin. The composite could be used to substitute for bone fragments missing due to cancer or it could be put into the tooth socket to support tooth implants.

The mechanical properties of the composite resemble those of spongy bone, the scientists say, and its compression strength is the same as that of human cartilage. The composite is easy to sterilize and can be impregnated with anti-bacterial agents, such as antibiotics and protein growth factors.

The scientists say they want their invention to enter production as soon as possible. Talks between the university and pharmaceutical companies are well advanced, according to the researchers. If any of these companies decides to invest in the invention, mass production of the artificial bone could start in two or three years, according to the researchers.

Ewa Dereń

Going with the Flow

Predicting floods and preventing flood damage are among the aims of a research project launched in January by a group of institutions in the southern Silesia region.

The project is being coordinated by the University of Silesia in Katowice, and other members of the research consortium include the Cracow University of Technology, the Institute for Ecology of Industrial Areas in Katowice, and the Polish Academy of Sciences' Institute of Environmental Engineering in Zabrze. Their strategic business partner is water supply company Górnośląskie Przedsiębiorstwo Wodociągów.

The project focuses on the Goczałkowicki Reservoir, a manmade lake built on the Vistula River in 1955. The lake supplies water to Katowice and other cities in Silesia province.

As part of the project, over the next four years, an interdisciplinary team of experts will monitor and analyze the hydrological, hydro-geological, chemical and physical properties of the reservoir as well as the surrounding plant and animal life. The analyzed data will be collected into an integrated database. Researchers will use this data to build a numerical model of the reservoir, which will enable them to determine its condition and functionality as well as run simulations and predict changes.

In practice, the model will enable scientists to predict changes in the level and quality of the water, experts say.

Deforestation, regulation, retention

Researchers taking part in the project want to solve the problem of the reduced functionality of Poland's manmade lakes due to aging and excessive exploitation of surrounding areas. A further aim is to better predict the risks of flooding, because even though the main cause is usually intensive rainfall, many other factors such as deforestation—which causes rain water to reach rivers faster—regulation of rivers, and the creation of retention reservoirs, also contribute to the effect.

Based on depth measurements of the Goczałkowicki Reservoir, scientists will model its bed, which will enable them to have an accurate idea of its capacity to contain water, especially in the event of sudden surges. The studies of deforestation, on the other hand, will enable them to predict the rate of water flow to rivers after rainfall and the associated risks. The project will last until March 2014 and the procedures will then be transferred to other reservoirs around Poland as well as other European countries with a similar climate and geology.

Under its Water Framework Directive, the European Union aims to intensify efforts to enable better management of water resources by 2015. This especially applies to reservoirs subject to strong human pressure.

The project meets the requirements of international treaties on the conservation and management of water resources, such as the Bern Convention on the Conservation of European Wildlife and Natural Habitats of 1979, the Bonn Convention on Migratory Species of that same year, and the EU Habitat Directive of 1992.

The project is expected to help facilitate decision making on the management and maintenance of water reservoirs, keeping in mind both environmental protection requirements and the need to supply high quality water.

The researchers want to upgrade the Goczałkowicki Reservoir as a source of drinkable water for the Silesia region, in addition to contributing to flood prevention, maintaining the reservoir's role in times of drought and preserving its natural values and fishing potential. Also examined will be possible recreational uses of the reservoir.

New laboratory equipment will be bought as part of the project and many new jobs will be created for students and doctoral candidates.

The project is partially financed by the European Regional Development Fund under the EU's Innovative Economy Operational Program.

Ewa Dereń, photos: Andrzej Siudy

Medical Training and More

As well as training medical students, the Pomeranian Medical University (PAM) in the northwestern city of Szczecin is known internationally for its research on stem cells, genetics, biochemistry and pharmacology.

The university's genetics professor Jan Lubiński and his team have revolutionized clinical research into the treatment of breast and ovarian cancer patients. Prof. Mariusz Ratajczak, head of the university's Physiology Department, has gained world acclaim for discovering a new type of stem cells in mouse bone marrow and human umbilical-cord blood.

14 courses in four faculties

Launched in 1948, the university today provides bachelor's and master's degree courses to students in four faculties: Medicine, Dentistry, Biotechnology and Laboratory Medicine, and Health Science. Students have a choice of 14 courses and three majors. New courses include cosmetology, physiotherapy, and medical biotechnology. Dental hygiene was added in 2008, followed by dietetics this academic year.

"All the courses are very popular and on average four to eight people compete for a place," says the university's spokeswoman Kinga Brandys. "We have also started a English-language course in dentistry. Previously English-speaking students were only able to study medicine. We have no plans to introduce more new courses in the near future but are aware that many young people are interested in pharmacy and psychology."

Altogether 3,723 students are currently enrolled on courses, up from 3,208 last year, according to the university's statistics.

The Pomeranian Medical University has more than 500 faculty members and almost 200 other staff. Among the academic staff are 43 professors and 54 lecturers with postdoctoral qualifications.

Since it opened after World War II, the university says it has trained 8,060 physicians and 3,314 dentists. A total of 1,113 researchers have obtained doctoral degrees and 196 have obtained postdoctoral qualifications. Fifteen scientists have received honorary doctorates.

Courses in English

The university also runs English-language courses that attracted over 500 foreign students this academic year. The students come from Norway, Denmark, Germany, Sweden, Canada, and the United States. Since 1996, when the university launched English-language courses, it has trained over 120 foreign students.

Before foreign students can start their courses, they must take extra classes in Polish, biology, chemistry and physics.

Prof. Tomasz Urasiński, dean of the English-language courses program, says that the university's English-language courses are targeted at students from countries such as Norway and Sweden, whose governments financially support students who want to obtain medical training abroad.

"The university offers a high standard of education, and our degrees are recognized all over the world," says Urasiński. "Before Poland joined the European Union, our graduates had to take qualifying exams abroad, but most passed these with flying colors."

Cancer research...

Many of the university's researchers are well known internationally. For example, Prof. Lubiński and his colleagues at the Department of Genetics and Pathomorphology are known for their clinical research into the treatment of cancer patients with a mutated BRCA1 gene, which, according to the researchers, is the cause of a high predisposition to breast and ovarian cancers.

Lubiński's department has one of the world's largest cancer data banks and recently purchased new state-of-the-art equipment for DNA diagnosis, using almost zl.18 million in funds from European Union coffers. Only a few institutions in the world have such equipment, according to Lubiński.

Prof. Bohdan Górski and Dr. Thierry van de Wetering, members of Lubiński's team, have developed a new, automated

method for diagnosing DNA. Thanks to this method, which replaced a previous manual procedure, genetic analysis can be done faster and more efficiently because the concentration and quality of the samples can be monitored straight away, the researchers say.

...and other discoveries

Prof. Ratajczak, who heads the university's Physiology Department, has discovered a new type of stem cells in mouse bone marrow and human umbilical-cord blood. These cells become differentiated in the same way as embryonic cells, Ratajczak says. Thanks to this discovery it is no longer necessary to source stem cells from embryos, according to the researcher.

The Szczecin university has also made significant clinical inroads in invasive cardiology, surgery of the hand and gastroenterology.

"Our most outstanding graduates who remain to work at the university in their chosen career paths as scientists, teachers or researchers, are our future," says the university's rector, Prof. Przemysław Nowacki. "Today these young people work in our best laboratories. Most of them are researching modern medical issues to do with stem cells, genetics, biochemistry and pharmacology."

Cross-border project

The Pomeranian Medical University is coordinating a 14-million-euro telemedicine project within the Pomerania Euroregion, a region of Europe on the south shore of the Baltic Sea divided between Germany and Poland. Some 35 medical institutions in northwestern Poland and northeastern Germany, 21 German hospitals, 11 Polish hospitals, and the West Pomeranian University of Technology in Szczecin are involved in the project, which focuses on medical diagnostics and therapy for cancer patients as well as those with heart disease and those who have suffered strokes. The project is co-financed by the European Regional Development Fund.

Anna Miszczyk

Stem Cell Research Center Planned in Szczecin

A center for stem cell research will be established in the northwestern city of Szczecin in a project managed by Prof. Mariusz Ratajczak at the Pomeranian Medical University.

Andrzej Szkocki

The center will coordinate stem cell research across Central and Eastern Europe, according to the researchers at the Pomeranian Medical University, who have secured more than zl.45 million in European Union funding for the project.

Stem cells are responsible for the regeneration and rejuvenation of tissues and organs. Their properties come in handy in regenerative medicine. Stem cells have been used for decades in hematopoietic transplants to treat leukemia. Attempts are now being made to use stem cells to regenerate damaged heart muscle, though for the time being such procedures are still in the experimental phase. Neurologists are also pinning a lot of hope on stem cells. They want to use them to regenerate nervous cells damaged by stroke. Doctors specializing in diabetes say stem cells could help regenerate pancreatic islets as well as damaged liver tissue.

The Pomeranian Medical University will carry out the project together with the Jagiellonian University in Cracow, the Medical Center of Postgraduate Education in Warsaw, the Polish Academy of Sciences' Institute of Experimental Biology in Warsaw, and the University of Silesia in Katowice. The Polish partners will work with a stem cell research center in Louisville, Kentucky, in the United States.

A total of 150 jobs will be created for research workers, physicians and biologists as part of the project nationwide. Of this, around 40 people will be employed in Szczecin. A special association of regenerative medicine will also be established to enable the researchers to share their experiences.

No ethical problems involved

"The association will develop standards for stem cell therapies," says Ratajczak. "Since regenerative medicine is a young discipline, these standards have not yet been set. In our work, we will be using exclusively non-embryonic stem cells. So there will be no ethical problem involved and no accusations to the effect that we supposedly destroy human life."

Ratajczak has made a name for himself in the international research community after he discovered adult stem cells in mice bone marrow and human umbilical cord blood, aided by a team of researchers at the University of Louisville. These cells are able to differentiate like embryonic stem cells, Ratajczak says, adding that the discovery enables regenerative medicine to develop without the need to harvest cells from embryos.

Anna Miszczyk

Biotechnology Studies for Katowice

The University of Silesia in Katowice has received zl.4 million in European Union funding to launch undergraduate and graduate studies in biotechnology.

To begin with, 132 first-year students will be enrolled for the bachelor's program and 114 for the master's program, the university said, adding that 40 percent of the best performing students will receive a special scholarship of zl.1,000 per month.

The Department of Biology and Environmental Protection will run both programs.

The biotechnology courses comprise 11 new specialized subjects complete with laboratory work using the latest technology, the university said.

According to the university, students will acquire theoretical knowledge and practical skills in areas such as functional genomics, plant cell cultures, and fluorescent visualization of genes and gene expression products. Another group of students will be taught how to use biotechnology methods to reclaim contaminated land and treat soil contaminated with chemicals and heavy metals.

Students will be able to gain work experience in biotechnology companies as well as laboratories operated by food processing plants, breweries, sewage treatment plants, and cosmetic producers, the university said.

The courses will be co-financed under the European Commission's Human Capital Operational Program.

Ewa Dereń

Sandbag Filling Machine

In a flood emergency, it takes four men and an agonizing 12 hours of work to fill enough sandbags to build a 100 meter long and half meter high dike. A machine built by Sopot-based inventor Lech Michalczewski can do the same in one hour.

This sandbag filling machine is among the most efficient designs of its kind in the world today, according to the inventor, who designed and patented the machine three years ago. In 2007, Michalczewski's machine won a gold medal at the World Invention Fair in Brussels. In 2008, the invention was named a Polish Ecology Leader and grabbed a gold medal at the 15th Polish Invention Fair in Warsaw. Most recently the machine was among designs nominated for the European Business Awards for the Environment, a Europe-wide contest held by the European Commission to reward the most ecologically innovative companies.

Michalczewski's invention is a rotating three-armed machine in which each arm has a spoon-like end. One person, using a shovel, loads these spoons up with sand as they rotate by and a second person attaches specially profiled bags, which are then filled automatically. All that is left to do is to lift the bags off the ground, carry them to the intended spot and build the dike, Michalczewski says. The electrically powered machine can fill up to 900 bags an hour, according to the inventor.

The machine can be easily and quickly assembled and dismantled. Its relatively modest weight of 120 kg and its small dimensions allow it to be easily transported in a pickup truck or even carried over short distances, according to Michalczewski. It takes only a few minutes to assemble the machine and three people are needed to operate it.

The machine is fitted with a power generator and floodlights, enabling it to be used at night.

The invention has caught the attention of both Polish and foreign institutions, including the Hungarian ministry of defense, according to Michalczewski.

The inventor says he is interested in various aspects of flood prevention and in minimizing damage done by floods. Apart from his passion for flood protection machinery, Michalczewski has amassed a wealth of information on flood control methods, which he discusses at seminars and workshops in areas vulnerable to flooding.

His sandbag filling machine has proven its value in flood defense operations, including those mounted after the latest spate of floods that hit Poland in May.

Ewa Dereń

Science and Technology Parks Thrive: Report

A growing number of science and technology parks are springing up across Poland to benefit from a wealth of European Union funds set aside for innovation and new technology.

At the end of last year, there were 47 science and technology parks in Poland, with a total of 583 businesses and a combined work force of more than 17,000; compared with 2007, the number of businesses grew by 61 percent, and employment soared by 86 percent, according to the *Business and Innovation Centers in Poland* report published by the Polish Business and Innovation Centers Association in conjunction with the Polish Agency for Enterprise Development.

Some zl.650 million was invested in the development of science and technology parks nationwide through the end of last year, with most of the funds coming from EU coffers, according to the report.

Bridging science and business

According to experts, science and technology parks are designed to support the establishment of new innovative technology firms and stimulate the transfer of technology to small and medium-sized businesses. These projects also aim to improve the use of EU funds and promote research projects through fostering ties between science and business.

Most of Poland's science and technology parks operate as either limited-liability companies (52.2 percent) or public-private joint-stock companies (34.8 percent), the report says. In most cases, the shareholders are municipalities, regional governments and universities. Several parks operate in the form of foundations or local government agencies. A few others are parts of universities.

According to the Polish Business and Innovation Centers Association, the average Polish science and technology park is 56 hectares in area and has an annual budget of zl.4.7 million.

Many science and technology parks run business incubators that offer preferential treatment to start-ups in modern business sectors. Each business incubator contributed to starting up seven businesses on average last year, according to the report. Many of the businesses were set up by graduate and postgraduate students.

Some of the businesses and institutions operating as part of science and technology parks have patented their work domestically and Europe-wide. Ten businesses have won awards at international trade fairs and competitions and 43 have grabbed prizes at exhibitions and competitions in Poland, the report says.

Innovation disparities

The report shows that science and technology parks are developing the fastest in large cities in regions such as Silesia, Mazovia, Wielkopolska and Małopolska. There are few innovation centers in rural areas and small towns, a trend that may lead to wider disparities in development between local areas, according to the report. Another potential threat, the report says, is that some of the parks are only interested in developing infrastructure for the needs of businesses operating there, while neglecting technology transfer and ties with the science sector.

In addition to science and technology parks, there are also other kinds of business and innovation centers in Poland, the report says. These include academic business incubators, technology transfer centers, seed capital funds, business angel networks, local and regional loan funds, credit guarantee funds, and training, advisory and information centers. Training and advisory centers account for around 45 percent of the total number of business and innovation centers nationwide, according to the report. This is because such centers are the easiest to launch, with relatively low financial outlays required, the report says.

Bright future

Poland's science and technology parks can expect to receive more funds to develop their operations in the next few years, according to the report. The European Union has set aside a total of 150 million euros for investment in such projects by 2013 under its Innovative Economy Operational Program. Most of the money will be spent on infrastructure such as buildings, roads and utilities, according to experts. Additionally, hundreds of millions of euros will be invested in each of Poland's 16 provinces to establish new science and technology parks and business incubators and expand existing facilities under Regional Operational Programs.

Another available source of funding is the EU's Human Capital Operational Program for 2007-2013. Funds from this source will be used to develop training services offered by science and technology parks and to support the launch of innovative businesses, the report says.

Ewa Dereń

Unusual Burial Mound in Sudan

Researchers from the Poznań Archeological Museum, led by Marek Chłodnicki, Ph.D., have completed investigations on a large Meroitic burial mound at Hagar el-Beida in Sudan.

Each part of the richly furnished burial chamber, including the vault, was built of sun-dried mud bricks and it is the first mound of this kind discovered in the area of the fourth cataract of the Nile, according to the archeologists.

The researchers believe the person buried in the mound could have come to the area from a distant place where this burial tradition was practiced. The excavations have shown that the mound was built in the second half of the fourth century AD.

The structure is 30 meters in diameter and six meters high. The lower part of the mound was surrounded by a two-meter-high stone circle. The central part is a vertical shaft leading to the burial chamber. The archeologists found several large ceramic beer vessels at the bottom of the shaft. They also discovered five other vessels—bowls of different sizes and a ladle—made of copper alloys, some of them richly decorated with ornaments resembling the lotus flower, cobra and frog.

The remains of the person buried in the mound are not well preserved so it is not possible to determine the person's sex using anthropological methods, the archeologists say. But because a set of arrowheads and the remains of a quiver were also found in the burial chamber, the archeologists believe it was a male grave.

Innovative Diode

Scientists from the Laboratory of Physical Chemistry and Nanotechnology in the town of Śrem—a unit of the Faculty of Chemistry of the Adam Mickiewicz University in Poznań—have developed what they say is the world's first polymeric light-emitting diode (LED) that emits light on the basis of non-linear optical effects.

The diode generates mainly white light with an addition of color rays on the surface of the light cone. The rays form characteristic color circles. The effect is unique because it involves an electrically induced nanostructural polymer.

Melamine Detector

Scientists from the Polish Academy of Sciences' Institute of Physical Chemistry in Warsaw have developed an innovative detector that makes it possible to identify products contaminated with melamine. The device has been tested in a laboratory and a patent application has been filed for it.

"Our method to detect and measure melamine concentrations ensures a level of accuracy that until recently could only be achieved in a laboratory," says the institute's Prof. Włodzimierz Kutner. He adds that the detector does not react to nitrogen but directly to melamine.

Until recently accurate tests to detect melamine could only be made in a laboratory. The food industry used indirect methods that measured the content of nitrogen in food product samples. The choice of nitrogen was not accidental because melamine contains a large proportion of this element. Melamine is 66 percent made up of nitrogen by mass.

Melamine is a chemical compound that is used to make polymeric materials for the production of adhesives, kitchen tops and dishes, artificial fertilizers and dyes. Melamine is also added illegally to food products to artificially boost their protein content.

If it gets into the human body, melamine poses a serious health hazard in combination with cyanuric acid, a detergent used to sterilize food packaging. The reason is that it forms yellow deposits in kidneys, which may lead to renal failure and, in extreme cases, death.

Water Pollution Detector

Scientists from the University of Silesia in Katowice are conducting a research project that aims to design an automatic biodetector of general water toxicity. The device is supposed to monitor water quality on a continuous basis and immediately detect low-concentration pollution. The device takes only 1.5 minutes to detect harmful substances.

The biodetector keeps trace of the metabolic activity of nitrifying bacteria by monitoring oxygen content in the water flowing through bioreactors. The device enables continuous monitoring of water quality in natural water bodies and in water sources. The detection system combines the properties of selected microorganisms with electrochemical detectors.

Protecting People Against Nanoparticles

Scientists at the Central Institute for Labor Protection/National Research Institute (CIOP PIB) are working on new polymeric and carbon materials designed to protect people against harmful nanoparticles and specific vapors and gases. In contrast to the filtering and adsorbing materials used so far, the new materials will be able to stop not only vapor and gas but even the smallest particles ranging from 1 to 100 nanometers in size, the scientists say.

Agnieszka Brochocka, D.Sc. Eng., of the institute's Personal Protection Unit in the city of Łódź, who heads the research project, says the scientists are conducting research into non-woven fabrics based on polymers: polypropylene and polycarbonate. They also plan to develop new types of activated carbon as a basic material used in the

design of adsorbents. The non-woven polymeric materials will constitute the basic material for the design of filtering half-masks and filters. The half-masks are built of several layers of materials obtained using different techniques. The layers are attached to each other by means of ultrasound welding or other methods.

Adsorbents protect people against vapors and gases while filtering materials protect them against aerosols: dust, smoke and spray. Depending on their structure, filtering materials first stop large and then small particles. The new materials are designed to stop mainly nanoparticles.

"We are developing polymeric materials that will provide an effective barrier to aerosols containing nanoparticles, which contaminate the air in sectors such as the chemical industry, pharmaceutical production, food processing, electronics, and the metallurgical industry," Brochocka says.

New Sources of Light

Scientists at the Polish Academy of Sciences' Institute of Low Temperatures and Structural Research in the city of Wrocław—in conjunction with the Faculty of Chemistry at the University of Wrocław and the Faculty of Physics at the University of Gdańsk—are developing modern luminophores, or chemical compounds with luminescence properties. Their work is expected to result in the emergence of cheaper and environment-friendly sources of light with properties similar to those of natural sunlight, but without harmful UV components.

Assoc. Prof. Przemysław Dereń, who is coordinating the project, says modern lamps developed by the research consortium will be much cheaper than those currently in use. Thanks to the use of luminophores, it will be possible to reduce the amount of electronics in fluorescent lamps. The electronic components make the lamps more expensive and prone to failure.

The new sources of light will be environment-friendly because they will not contain mercury, which is a standard component of most fluorescent lamps in use today, according to the researchers. As part of the project, the researchers will also work on luminophores for solar concentrators, which concentrate sunlight and convert it into electricity.

Mine Dust Control System

A new coal mine dust control system in the form of water spray curtains has been launched at the Halemba-Wirek mine in Ruda Śląska, Silesia province. The system is capable of reducing dust pollution in coal mines by up to 70 percent, according to the designers.

The system is composed of several mesh curtains installed in a mine wall one after another. The curtains fill almost the entire cross section of the wall, with narrow gaps located alternately to the right and left. As a result, the air flows as if through a labyrinth. Water with the addition of a special substance is sprayed on the curtains at a high pressure producing tiny droplets that absorb dust particles. The droplets with dust settle on the curtains and flow down. The dust taken out of the air can be easily collected in the form of sludge.

Experts from the State Mining Authority (WUG) say the system reduces coal mine dust, which is a health hazard to miners. It also uses less water compared with conventional sprinkling systems, and reduces the amount of rock dust needed to neutralize coal dust.

Doctors warn that the process of mining and transporting coal with the use of mining machines such as shearers, crushers and conveyors, creates continuous clouds of dust, which is a health and safety risk. Coal worker's pneumoconiosis, or black lung disease, accounts for 75 percent of occupational disease cases diagnosed in the coal mining sector.

Breakthrough in Eye Surgery?

Surgeons at the District Railway Hospital in Katowice say they have performed their first five corneal transplantation operations using what is known as Boston keratoprosthesis, an artificial cornea with a plastic optical part. Physicians say the new method marks a breakthrough in eye surgery and offers a chance for those patients who until recently could not be helped.

The operations were performed by a team led by Prof. Edward Wylęgała in consultation with Prof. Uli Jurkunas from the Massachusetts Eye and Ear Infirmary, a hospital of the Harvard Medical School, in Boston, Massachusetts, in the United States.

The Boston keratoprosthesis differs from other corneal prostheses in that it is implanted in a single procedure, which means patients do not need to wait for several months for the second stage of surgery, the doctors say. The keratoprosthesis resembles a rivet—it is composed of a front plate with a stem that houses the optical portion of the device, a back plate and a ring. During the transplant, the device is assembled with a donor corneal graft.

This treatment method is suitable for patients for whom the conventional corneal transplantation procedure is not an option because of a previous graft failure due to either rejection or infection.

Compiled by Tadeusz Belerski