



# research

The Bayer Scientific Magazine

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## Mobile monitoring

High tech for drug development

## The power of alpha

Fighting cancer with radioimmunotherapy

## Safety for pollinators

Harmonizing crop and bee protection

## Global nutrition

# Fitness strategy for crop plants

Higher harvest yields with Crop Efficiency

**Bayer Foundations**

see page 24

# Bayer stands for real Life Science innovations



Dr. Marijn Dekkers, Chairman of the Board of Management of Bayer AG

*Dear reader,*

*The challenges facing our society are many and varied. More than ever before, our steadily growing and aging global population needs new and better medicines and an adequate supply of high-quality food. Without real Life Science innovations, we will not be able to deliver solutions for healthcare and agriculture.*

*Our business portfolio is now aligned exclusively to the Life Sciences – from Pharmaceuticals via Consumer Health and Animal Health through to Crop Science, from physicians via consumers and veterinarians through to farmers. No other comparable company is in a similar position.*

*Bayer is the owner of a globally recognized brand, and the realigned areas of the company are focused on a broad portfolio of innovative products. What's more, the different areas in the company have much in common. In research and development in particular, we want to benefit even more strongly from the fact that, on a cellular level, the biochemical processes are remarkably similar in all living organisms.*

*Our research and the resulting innovations will improve people's lives all over the world, in line with our mission – Bayer: Science For A Better Life. That is our job – every day.*

Best regards,

Point of view	2
News in brief	4
Masthead	49

## AGRICULTURE

### Cover story:

<b>Fitness strategy for crop plants</b> Systematically optimizing the yield potential of wheat and other crops	10
-------------------------------------------------------------------------------------------------------------------	----

## MEDICINE

<b>The power of alpha</b> Fighting refractory tumors with radioimmunotherapy	6
---------------------------------------------------------------------------------	---

<b>High-potency active ingredients</b> Manufacturing highly potent drug compounds	20
--------------------------------------------------------------------------------------	----

<b>A new factor</b> Genome research into thrombosis	28
--------------------------------------------------------	----

<b>Mobile monitoring</b> Sensor technology for optimized drug development	34
------------------------------------------------------------------------------	----

<b>Cells with a future</b> Induced pluripotent stem cells in medical research	42
----------------------------------------------------------------------------------	----

<b>The secret of the gene switch</b> Research networks for epigenetic therapies	46
------------------------------------------------------------------------------------	----

<b>Balsam for the stomach</b> The natural power of medicinal plants	48
------------------------------------------------------------------------	----

## VETERINARY MEDICINE

<b>No chance for parasites</b> Innovative collar protects companion animals against parasites	22
--------------------------------------------------------------------------------------------------	----

## DOSSIER

<b>Partners for bee safety</b> Combining crop and bee protection	36
---------------------------------------------------------------------	----

## FOUNDATIONS

Bayer foundations promote science, medicine and social innovation	24
-------------------------------------------------------------------	----

# Cover story

Strategy for strong harvests



When exposed to stress, plants switch into emergency mode, putting the harvest at risk. Researchers like Dr. Jan Dittgen (photo above) and Dr. Gitta Erdmann (inset) help wheat and other crops safeguard yields even under unfavorable conditions to help ensure the supply of food for a growing global population.

10

## Targeted alpha radiation 6



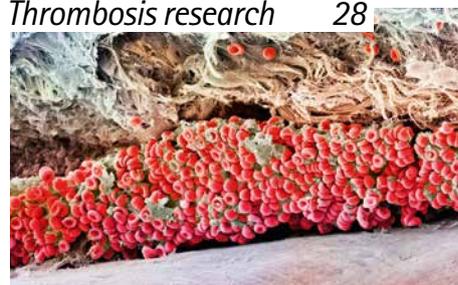
Bayer researchers like Hong Thanh Nguyen are developing radioimmunotherapies to treat patients with refractory cancer. Antibodies transport the radioisotopes through the body directly to the tumors.

## High-tech healthcare 34



State-of-the-art sensor technologies allow the collation of valuable patient data which scientists can use to improve the development of new drug products – for example, when conducting clinical trials.

## Thrombosis research 28



The formation of blood clots can be life-threatening. Bayer scientists are conducting genome research to discover new targets for future therapies. One possibility: blood coagulation factor XI.

## Bayer foundations 24



The Bayer Cares Foundation invests in social innovations. The Bayer Science & Education Foundation promotes life science projects, and has honored the achievements of molecular biologist Professor Emmanuelle Charpentier.

## Dossier: bee safety 36



Neonicotinoids are suspected of being harmful to beneficial insects. In one of the world's largest ever bee monitoring studies, bee and plant protection experts investigated the impact that the active ingredient clothianidin has on bees. The results show that crop and bee protection can and must coexist in harmony.

HANSEN FAMILY AWARD FOR PROFESSOR EMMANUELLE CHARPENTIER

# Gene scissors to combat hereditary diseases

*As one of the most innovative scientists in the field of molecular biology, Professor Emmanuelle Charpentier has developed a kind of molecular scissors that enables targeted editing of the genome. In recognition of this achievement, she was awarded the 2015 Hansen Family Award.*



Revolutionizing biology: Professor Emmanuelle Charpentier has developed a method that is now used in laboratories all over the world.

Bacteria take an uncompromising approach to intruders – they simply shred the threat. If foreign viruses introduce their genome into the bacteria, for example, their genetic scissors get straight to work, snipping the unwanted genome back out and cutting it into pieces to render it harmless. This defense mechanism developed by the bacteria, known as the

CRISPR-Cas9 system, intrigued French biologist Professor Emmanuelle Charpentier (46), who ultimately unraveled the details of the mechanism. “My team and I are researching the mechanisms of infections from the perspective of bacteria. How they survive, how they adapt, protect themselves, multiply and, ultimately, cause diseases.” The microorgan-

isms intentionally integrate parts of the viruses' DNA into their own genome, thus strengthening their immunity against other attackers.

Charpentier recognized the potential this tool used by bacteria could offer molecular biology right from an early stage. She and her team therefore decoded the bacterial protection system. Together

with the group led by Professor Jennifer Doudna, a researcher and teacher at the University of California, she also demonstrated that the cutting mechanism could be reproduced and used in different ways, including genome editing. This process is of particular interest to many other researchers around the world who are working to separate genome strands at specific points, remove certain gene sections or add new ones, and make corrections or replacements in order to, for example, add new traits to certain plant types or develop gene therapies. Until recently, this was truly a Sisyphean task, requiring months of effort on the scientists' part. "I wanted to turn the bacteria's genetic scissors into a universal tool as a means of simplifying and speeding up my fellow scientists' work," says the biologist.

### Bacteria the models for genetic engineers worldwide

And, together with Doudna's team, she sensationally managed to find a way of getting the CRISPR-Cas9 system to work in the lab as an RNA programmable genetic editing tool. These achievements originating from basic science earned Charpentier the 2015 Hansen Family Award worth EUR 75,000, which is awarded by the Bayer Science & Education Foundation for pioneering research in innovative fields of biology and medicine. Using the same method as the bacteria, the CRISPR-Cas9 system enables the DNA strand to be cut at precisely defined points – allowing scientists to repair

genes, for example. Every gene contains a blueprint for protein molecules, each of which performs a specific function. However, if the genetic code contains a fault, this produces a defective protein – and can cause hereditary diseases. But the new technology developed by Charpentier now enables researchers to precisely cut out the defective genes and replace them with the correct elements. "It's comparable with swapping one word for another in a text on a computer," explains Charpentier, who foresees applications for this tool in medicine and other fields of research. "The greatest potential surely lies in using this technology to treat hereditary diseases, such as cystic fibrosis or sickle-cell anemia," she believes.

Charpentier developed a keen interest in biology early on, and it was already her favorite subject at school. She went on to study biochemistry and microbiology at the Université Pierre & Marie Curie in Paris and has conducted research at a number of universities in the United States. She qualified as a professor of microbiology in 2006. Today, Charpentier is well known as a pioneer and one of the most innovative researchers in the field of molecular-biological infection research. Following teaching posts at the Helmholtz Center for Infection Research in Braunschweig and Hannover Medical School, Charpentier was appointed Director of the Berlin-based Max Planck Institute for Infection Biology in October 2015. She is also Visiting Professor at Umeå University where she developed the CRISPR-Cas9 research.



Prize-winning: Kemal Malik, member of the Bayer AG Board of Management responsible for innovation, congratulates Professor Emmanuelle Charpentier on her successful research.

The CRISPR-Cas9 system developed by Charpentier and her team now provides researchers with a tool to locate defective gene sequences, remove them and insert healthy sections.

### Hope for new therapeutic approaches for hereditary diseases

"What's special about CRISPR-Cas9 is that it is so simple," Charpentier explains. "You could call it a pair of target-seeking molecular scissors. The technology is already being used worldwide as a molecular biology tool for developing new therapies for hereditary and chronic diseases."

## The Bayer foundations – committed to progress since 1897

*Bayer foundations have been promoting education, science and social innovation all over the world since 1897. As part of the innovation company Bayer, the foundations see themselves above all as initiators, promoters and partners for progress at the interface between industry, science and the social sector. Their programs are focused on pioneers – their commitment to public welfare, their wealth of ideas in resolving social tasks, and their creativity in the fields of science and medicine. The Bayer Science & Education Foundation, for example, grants scholarships and awards which encourage young talents and top researchers alike to deliver outstanding achievements in their field. The Bayer foundations also support efforts to resolve social issues. For example, the Bayer Cares Foundation focuses on citizens' projects and resolving issues in the field of social medicine. The objective of the foundations is always to improve human life through innovation and initiatives.*



[www.bayer-foundations.com](http://www.bayer-foundations.com)

Visit this site to apply or to obtain more information (see back cover flap).

## BAYER SCIENCE TEENS: SCIENCE CAMP IN THE UNITED STATES

# Vacation researchers at 3,000 meters

*The Bayer Science & Education Foundation arranged a visit to Summer Camp in Colorado for young science enthusiasts.*

Dissecting sheep may not appeal to everyone, but performing experiments in the mountains is a different story. Both of these activities featured on the program at the Summer Camp in Colorado, United States, where 20 young science fans from Germany, India and the United States were able to give free rein to their thirst for knowledge. For instance, they had an intensive look at the anatomy of the body. "I didn't feel great when we did that, but it was interesting to see what the heart, lungs and eyes actually look like," said 14-year-old Rebecca Thielemann from Germany. The aspiring researchers also built their own human. "We modeled the muscles of the spinal column and legs with clay on human skeletons made of plastic, and learned a lot about evolution and anatomy."

The program also involved experiments in the wild. The participants performed experiments relating to atmospheric pressure at an altitude of 3,000 meters in the Rocky Mountains. And Rebecca and her young colleagues captured all the activities on camera: "We recorded a film of our two-week expedition and also found out a great deal about the psychology of learning in the process." The camp was organized by the Bayer Science & Education Foundation in conjunction with the Bayer USA Foundation and the University of Colorado Center for STEM Learning.



Getting up close with anatomy: Rebecca Thielemann (left) and Alena Hensel get to grips with the organs of the human body. They found the brain model particularly fascinating.

## DIALOG BETWEEN EXPERTS AND YOUNG RESEARCHERS

# New generation of talented scientists for society

*Around 120 promising young scientists recently gathered at the Bayer Alumni Dialogue 2015 when the Bayer Science & Education Foundation invited current and former scholarship recipients and award winners to Berlin.*

Networking makes for more effective researching. This was one of the key messages



Creative thinker: medical doctor Pooja Merchant, who works in the Medical Affairs department, spoke at the Bayer Alumni Dialogue about a Foundation project for tuberculosis patients in Moldova.

that Dr. Ijad Madisch, co-founder and CEO of ResearchGate, a social community for researchers, shared with attendees at the Bayer Alumni Dialogue that took place in June 2015 in Berlin. In his speech, the virologist also highlighted how important it is for young scientists to inspire each other. The internet platform he launched stems from the idea that researchers achieve more when they network. Madisch urged the young audience to develop their own ideas and to become independent as a result.

The Bayer Foundation is likewise committed to this open exchange of ideas, which is why it invited scholarship recipients from all over the world to the German capital. The upcoming young scientists not only had the opportunity to network with each other, but also to talk with former scholarship recipients and current

award winners like Dr. Markus Bender, who received the Bayer Thrombosis Research Award 2015 (see also *research* 28 "When the body's own sticking plaster fails") for his work on a rare hereditary blood-clotting disease.

Talented minds, creativity and a passion for research are in demand at Bayer too, as are innovations to tackle social challenges. This aspect was addressed by four specially chosen young people from Bayer, one of whom was Pooja Merchant, a doctor who works in the Medical Affairs department at Bayer HealthCare in Berlin. She previously participated in a Foundation project where Bayer employees facilitated the care of tuberculosis patients in Moldova. After all, out-of-the-box thinking and ideas can make all the difference when creative thinkers get together.

## ASPIRIN SOCIAL AWARD FOR THE JOURVIE PROJECT

# An app to combat eating disorders

*Anorexia therapy through your smartphone – the Jourvie app provides support for people with eating disorders. It was developed by Ekaterina Karabasheva, and has earned her team first place in the Aspirin Social Award 2015.*

## Where did the idea for Jourvie come from?

A few years ago, I was suffering from anorexia myself. A key element of my treatment was keeping nutrition diaries, which I then discussed with my therapist. Of course, I was not keen to fill out these printed forms in public. I found it embarrassing, and often left them at home. Many patients feel the same way. However, this leaves therapists without essential information that can help them identify behavior and thought patterns related to the illness, making effective treatment virtually impossible. There were no smartphones back then, so I typed my diaries into my cell phone and saved them as text messages. It only occurred to me later that there was a better solution.

## How did this develop into an app?

I developed the concept in 2013 as part of my master's dissertation in communication science. I discussed it with doctors from the Department of Child and Adolescent Psychiatry at the Berlin Charité hospital. The question at the heart of the idea was always, "What do the patients need, and what do the therapists need?" Of course, it was the software developer on our team who was responsible for the technical implementation. Then, in 2014, I founded Jourvie, a charitable company that now consists of a four-strong team. The app has been available free of charge for Android devices since the beginning of 2015. It provides the patients with a straightforward way of keeping their nutrition diaries digitally. The app also gives them additional tips on dealing with difficult situations such as bingeing. Users can also save their own motivational strategies.

## Are you planning any more developments?

Yes, because more and more therapists and nutritionists are asking how they can use Jourvie. We are now not only working on a version for the iPhone, but also on software that will serve as a platform for direct data sharing between patients and their therapists. We are already working on a test version. We are also constantly receiving new ideas from users, researchers and other interested parties. For example, many patients would like to have motivating images, videos or music.

## What is it like to work as a charitable initiative?

Our workplace in the Social Impact Lab in Berlin gave us a key platform. In the early phase of our company, we were active there and were also able to network and share ideas with other start-ups and social companies. Our team is continuing to develop our idea – unfortunately we are not able to devote

ourselves to it full-time. We are dependent on funding and financial support. In future, we hope to receive more financing from research projects and health insurers.

## What does this award mean for your project?

We are using the prize money for the development of the app, but the award itself will also open doors for us. The Bayer name will be an enormous help to boost interest in our project from professional institutions. In July, for example, we exhibited with the Bayer Science & Education Foundation at IdeenExpo 2015 in Hanover. In addition, we were also able to make important contacts, with the German Competence Network Obesity for instance.



Digital nutrition diaries: as a former sufferer herself, Ekaterina Karabasheva knows exactly what anorexia patients need, and how the new app can provide them with optimum support in their daily lives.

## What about cooperation partners from research and medicine?

Berlin Charité is still our most important partner from therapy and science. We are currently also planning a research project with another clinic to check the Jourvie therapeutic results scientifically. This involves comparing two groups that have been treated with and without the app. We aim to use these results to persuade health insurers and other potential partners of the benefits of Jourvie.