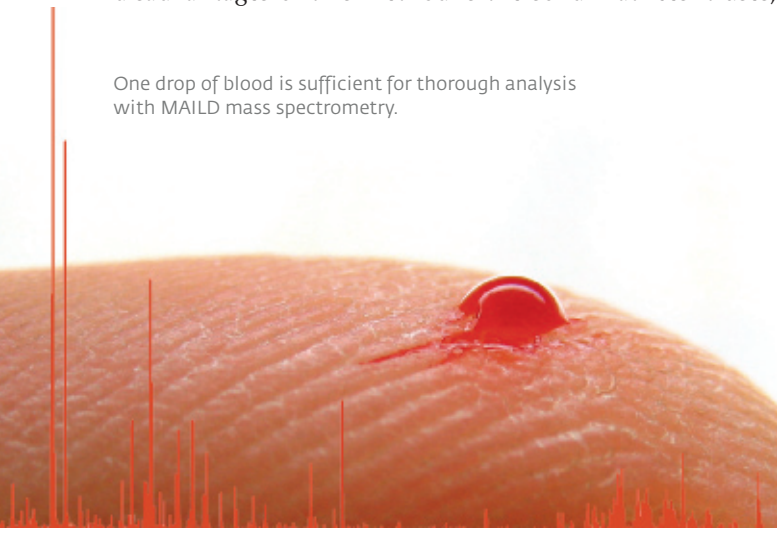
What's in a Drop of Blood? The Full Diagnosis

Mass spectrometry is used to identify chemical compounds. In the MALDI (Matrix-Assisted Laser Desorption/Ionization) process, for instance, proteins are crystallized with the matrix and broken down into small protein ions with laser beams. These are then traced and analyzed. One of the disadvantages of this method is the solid matrices it uses, because, in addition to the ions produced by the laser light from the mix of substances being analyzed, ions with masses of less than 500 daltons also emerge from the matrix. As a result, the many small molecules that play a part in the metabolism of living beings cannot be detected. "The ions from traditional matrices are the haystack in which we are looking for some important needles," explains Aleš Svatoš, who heads the research group at the Max Planck Institute for Chemical Ecology in Jena.



One drop of blood is sufficient for thorough analysis with MAILD mass spectrometry.

Together with colleagues from the Czech Academy of Science, his team has now modified the matrices so that they no longer produce disruptive ions. The new method, called matrix-assisted ionization/laser desorption (MAILD), has helped the researchers reliably and quickly identify in excess of 100 different molecules. They also use clinical samples: it is possible to detect a whole range of organic acids that are specific to blood in a single droplet – less than a millionth of a liter. The methods used for these analyses in medical practice are complex and unwieldy. If it were possible not only to determine the presence of the metabolites, but also to quantify them, MAILD might advance to become a method for rapid analysis in biomedicine. As it holds such great potential for diagnostic applications, this process has now been patented.

Made-to-Measure Sugar Chains

Carbohydrates not only satisfy hunger, they are also used as a basis for new vaccines. It is now much easier to manufacture substances and test their effectiveness as vaccines, thanks to an automatic synthesizer developed by scientists at the Max Planck Institute of Colloids and Interfaces. The new device can produce any carbohydrate from individual sugar molecules. Carbohydrates located on the shells of pathogens offer the immune system a point of attack and are suitable as vaccines in that they train the immune system to deal with the microbes. The researchers have already identified almost a dozen candidates for vaccines, including one acting against the malaria pathogen, and produced them with the new apparatus.

The right mixture for carbohydrates: Peter Seeberger and his team have developed a fully automatic carbohydrate synthesizer that facilitates the search for new vaccines.

"Our automatic synthesizing system currently offers an unbeatably fast method of manufacturing complex carbohydrates," says Peter Seeberger, Director at the Max Planck Institute in Potsdam. "As there used to be no efficient way of doing this, biologists and doctors tended to have a problem with carbohydrates." In many cases, they even had to give up their work because there was no equipment they could buy that would produce the substances. Finding the situation profoundly irritating, Seeberger decided to do something about it.

He presented his synthesizing device for carbohydrates at the 237th Meeting of the American Chemical Society in Salt Lake City – and received the Claude S. Hudson Prize in Carbohydrate Chemistry from the Society. The device can make complex molecules from linked sugar molecules in just a few hours. The technology that is commonly used now takes months or even years.

Photos: MPI of Colloids and Interfaces (bottom), MPI for Chemical Ecology, Aleš Svatoš (top)

A Clear View of Young Planets

When the converted jumbo jet takes off for its first scientific flight in the near future, some of the technology on board will be from Germany: *GREAT*, the *G*erman *RE*ceiver for *A*stronomy at *T*erahertz frequencies, was developed by a consortium of German research institutions led by Rolf Güsten from the Max Planck Institute for Radio Astronomy in Bonn. Following extensive laboratory testing, the instrument successfully passed the pre-shipment review in early December last year and was taken on board *SOFIA* for its first deployment. *SOFIA* is a joint American-German project to operate an aircraft observatory at an altitude of 13 to 14 kilometers. It allows the universe to be examined in infrared light, at wavelengths that cannot be received on the ground because the radiation is absorbed by the water vapor in the Earth's atmosphere. *GREAT* will help improve our understanding of the physical processes involved in the formation of young stars and planetary systems.

"Jugend forscht" Winner Meets Nobel Prize Winner

Jugend forscht (bottom left), MPS (top right)

More than 10,000 young people took part in Germany's 43rd national "Jugend forscht" (youth research) competition, which was held under the motto "Du willst es wissen" (You want to know). Two hundred of them qualified for the final, which was held in Osnabrück. Like every year, the Max Planck Society endowed all five prizes awarded in the Biology category. Nobel laureate Bert Sakmann made a special trip to Osnabrück to present the proud winners with their certificates.

Nobel Prize winner Bert Sakmann congratulates 21-year-old Felix Baier, the national champion in the Biology category.

Half-Time for the Science Express

In April of this year, a host of prominent politicians, including Chancellor Angela Merkel and Federal Research Minister Annette Schavan, waved the Science Express off on its journey. The exhibition train has now stopped at 28 stations throughout Germany and filled almost 100,000 visitors with enthusiasm for science and research.

http://www.expedition-zukunft.org

Peter Gruss next to Angela Merkel, with Annette Schavan and Hartmut Mehdorn on the right.

Photos: Expedition Zukunft/ArchiMeDes (bottom right)

A Question for the President

Why did you study one of the natural sciences?

I owe my enthusiasm for biology to excellent teachers who also challenged me. Particularly in junior high school, we enjoyed exciting and ambitious chemistry and biology lessons with fantastic teachers who also experimented along with us. I can remember one experiment with the fruit fly *Drosophila* very clearly – but that was a bit later. The experiment was about the smells that attract and repel the fly. I was totally fascinated by the molecular details that lay behind it. I think it is crucial that young people in junior high be so engaged by physics, chemistry or biology that they can imagine studying these subjects at a later stage, because this is usually the age at which the decision is made. The teaching must reflect how dynamic these subjects are – more than it has done up to now. There is always something new to think about when you study the natural sciences. The most fascinating developments can currently be observed in physics and chemistry, and particularly in biology, and all of these areas offer a whole range of exciting jobs and work opportunities.

"The findings of biosafety research must be accepted"

In June, a podium discussion about green genetic engineering was held at the Max Planck House near Munich's Hofgarten. Afterwards, Bernd Müller-Röber, a professor at the University of Potsdam and also the head of a research group at the Max Planck Institute of Molecular Plant Physiology, answered questions on the status of the genetic engineering debate.

Bernd Müller-Röber

Politicians are currently polarized on the issue. Minister Aigner is not allowing the Bt-Mais Mon 810 maize (corn) plant to be grown, but has authorized cultivation of the genetically altered Amflora potato, at least for experimental purposes. Yet the EU is refusing to grant permission for this. How do you view the political situation at the moment? How much of the debate is still founded in scientific fact?

Bernd Müller-Röber: I find the political situation difficult. And I don't believe it is always guided by scientifically based fact. Biosafety researchers, including those in Germany, have conducted many tests on Mon 810 in particular, and the results have shown quite clearly that, in many cases, Mon 810 exhibits less genetic variability than other maize plants, and the effects are less pronounced than the variability between different varieties. Furthermore, different locations can also affect the results. Indeed, the influence of the environment and soil on the plant's composition can be greater than any genetic modification. Biosafety research has received a lot of funding, and rightly so, and now we need to accept the findings. And I personally have a problem with politicians who don't do that.

And what is the situation with Amflora?

Müller-Röber: I believe that the problem with the Amflora potato is actually the fact that a marker gene that makes it resistant to antibiotics has been engineered into its genome. It would probably be much less difficult to discuss the Amflora issue if the plant did not contain this gene. However, its use was evaluated many years ago. This is a gene that frequently occurs in bacteria, and thus in any sewage treatment plant and any soil. Seeing this as a new danger is unjustified from a scientific point of view.

The difficulty of the debate about green genetic engineering is undoubtedly also due to the fact that corporations are, of course, pursuing commercial interests. Particularly the patentability of genes or even entire genomes engenders a great deal of resentment in people. Would a greater proportion of publicly funded research whose objective was not first and foremost an economic one help make green genetic engineering more acceptable?

Müller-Röber: As field trials are extremely complex and require special expertise, particularly for their execution, we have already discussed whether we shouldn't perhaps create centers across Germany, for example in different climatological areas with different soil types. At these centers, researchers could undertake organized field trials and associated biosafety research, naturally with the aim of evaluating genetically engineered modifications in the field. To win over the public, or at least to arrive at a more neutral basis for discussion, it might be helpful to think about how these field trials could be carried out with the participation of different experts – some who carry out genetic engineering, some who are more involved in environmental research, and some with their eye on the more economic aspects of the plants. When that is publicly funded and an explanation offered to the public, then we might have achieved something.

You mentioned the benefits that green genetic engineering can have for organic farming. However, the point of view in that camp seems to have been elevated to the status of ideology.

Müller-Röber: Yes, I do think it is a problem that genetic engineering, as a method of changing the genetic information in a plant, is categorically unacceptable in organic farming. As long as this categorical rejection is maintained, organic farming will not accept any genetic modification that might actually have some benefit. But it is not easy to sell the public on the genetically modified plants currently on the market. Just try persuading someone that herbicide-tolerant plants make sense. That's really difficult. There are two reasons why developments have taken this course in the past: First, it was precisely this kind of genetic modification that was relatively easy to achieve, compared to those that researchers and breeders are trying to accomplish today – such as better nutrient utilization or drought tolerance. And second, the companies backed these first, because it was so easy and because they were most likely to earn money from them.

Photo: Axel Griesch

Herschel and Planck in Space

We have lift off! On May 14, an *Ariane 5* rocket transported two satellites, *Planck* and *Herschel*, into space. Over the next few years, the two space probes will orbit the Sun at the second Lagrange point, around 1.5 million kilometers from Earth. From this location, *Planck* will record cosmic background radiation with previously unachieved levels of precision, and the infrared satellite *Herschel* will look into the hidden universe. While scientists at the Max Planck Institute for Astrophysics developed major software components for *Planck*, researchers from the Max Planck Institutes for Extraterrestrial Physics, for Astronomy, for Radio Astronomy and for Solar System Research contributed to two of the three scientific instruments on board *Herschel*. *Herschel's* 3.5-meter telescope will scan space at wavelengths between 55 and 672 micrometers. The satellite will first resolve the diffuse cosmic infrared background into its individual sources. Other objectives include remote galaxies, star nurseries and objects within the trans-Neptune region to the limits of our solar system.

On June 14, the scientists had another reason to celebrate: *Herschel's* cryostat roof opened and the measuring devices had an uninterrupted view of the universe for the first time. The PACS instrument (Photo-detector Array Camera and Spectrometer) produced the first images, which exceeded every expectation. The subject was the famous Whirlpool Galaxy M 51 in the Canes Venatici constellation around 37 million light years away. The images were taken with the PACS three-band photometer at wavelengths of 160, 100 and 70 micrometers and hint at the huge potential of the new infrared satellite.

A giant eye sees infrared: The European *Herschel* satellite has arrived in space and scientists are already delighted – it transmitted the first images of the Whirlpool Galaxy in mid-June.

Photos: ESA/ESA & The PACS Consortium

On the Net

Pulsars in a PC
The Max Planck Institute for Gravitational Physics in Golm is coordinating the Einstein@Home project, which networks some 200,000 PCs around the world into a supercomputer. Idle computer capacity is being used to search the huge amounts of data received from the world's largest radio telescope: the Arecibo Radio Telescope in Puerto Rico, which is investigating such things as gravitational waves from undiscovered pulsars and galaxies, objects in our solar system, and the Earth's atmosphere. The data is sent via the Internet to the institute, where it is prepared and then distributed to computers throughout the world.
http://einstein.phys.uwm.edu

Vodcasts and the Like
The Max Planck Institutes for Extraterrestrial Physics and Astrophysics are turning to unconventional methods in an attempt to make their complex research more accessible to young people. Video podcasts explain in a humorous way how the *Planck* and *Herschel* satellites work, and try to put a positive spin on the black hole at the center of our galaxy.
http://www.mpe.mpg.de/POPUS/IYA2009/index-d.html#2

A cosmic comic
In the "International Year of Astronomy" the Max Planck Institute for Astrophysics tries an unusual experiment: a comic on the Internet about the physical processes that took place during the first 400,000 years after the Big Bang. Two fictitious high-spirited scientists of the institute, passionate surfers, take off to visit the early Universe. Not to do serious research there but to experience the ultimate ride on the plasma waves of the big bang. However, they quickly realize that they would be stuck without their knowledge of the physics of the early Universe. This is not meant to replace textbooks or scientific texts but to guide the reader in an amusing way through a series of phenomena of cosmic microwave background. Even one of the unsolved puzzles of cosmology – the strange "Cold Spot" in the microwave background – receives a new explanation …
http://www.mpa-garching.mpg.de/mpa/institute/news_archives/news_cosmic_01/news_cosmic_01-en.html

The Soundtrack of Research
The Max Planck Society has been giving a number of interviews to accompany the "Expedition Future" exhibition train, which will continue to travel through Germany until November. Max Planck researchers answer questions on important topics for the future, such as the climate, energy and the fight against infectious diseases. Many of these subjects are also illustrated in exhibits and films on the Science Express.
http://www.mpg.de/podcasts/scienceExpress/