LICHTGEDANKEN 05
The Magazine of the Friedrich Schiller University Jena

ENGLISH

INTERVIEW
LIGHT, LIFE, LIBERTY – CONNECTING VISIONS
President Walter Rosenthal about the success achieved in the Excellence Strategy competition

REPORTAGE
OPERATION ON THE OPEN EGG
Chicken eggs are being used to test the biocompatibility of nanoparticles

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MICROBES DECOMPOSE HARMFUL SUBSTANCES
Epsilonproteobacteria need an oxygen-free environment to render CFCs harmless

FEATURE

MADE-TO-MEASURE MEDICATION

Jena researchers are working on packaging medicines in tailor-made nanoparticles and sending these directly to the precise location of the disease.

UNIVERSITY INFORMATION DAY 2019

at the Friedrich Schiller University Jena
Saturday, 25 May 2019 beginning at 9.30 at Ernst-Abbe-Platz

On the University Information Day, the faculties will present around 200 study opportunities ranging from ancient history to zoology. We kindly invite future students and their parents to visit information stands and learn subject-specific opportunities. Do not miss more than 50 presentations and campus tours. If you are interested in the Student Paradise Jena, you may also join one of our sightseeing tours.

FURTHER EVENTS

University orientation sessions
23 May and 8 October 2019

University taster courses
during the lecture periods:
from 15 April 2019 to 5 July 2019 (summer semester)
from 21 October 2019 to 2 February 2020 (winter semester)

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Dr Ute Schönfelder, Editor
Communications and Marketing Office
Friedrich Schiller University Jena

Connecting Visions

Working together for success: the Friedrich Schiller University has been named one of the winners of the Excellence Strategy run by the German government and federal states thanks to its »Balance of the Microverse« research cluster. Since the beginning of 2019, the Jena-based research network has been entitled to around six million euros each year for the next seven years. As such, Jena is one of three locations in eastern Germany, along with Berlin and Dresden, to receive the seal of excellence.

The President, Prof. Dr Walter Rosenthal, who we interviewed for this edition of LICHT**GEDANKEN** (p. 7), sees it »as a great success for the research profile of the Friedrich Schiller University«. The University has a new motto »Light, Life, Liberty—Connecting Visions« and is forging a wide range of connections: between the focal research areas Light, Life and Liberty, between its ten faculties and non-university institutions, and by integrating individual projects.

The large cluster also incorporates future-oriented research, which we present in our main topic: »Made-to-measure medication«. Even in 2019, there are still many diseases for which there are no cures or for which only insufficient treatments exist. Generally, it is not a lack of active ingredients that is causing problems, it is rather the difficulty of getting the active ingredients to the precise location of the disease in an efficient manner. Researchers at the University of Jena are forging new paths to improve precisely this aspect: they are using precision techniques to analyse the molecular control centres within the body. They control the metabolic processes and are where the body's own signal molecules or active agents dock. Other teams of scientists are designing and testing nanoparticles which package the active ingredients efficiently and activate these control centres within the body. As such, it is possible to reduce side effects and to significantly improve the efficacy of medication. The present edition of our research magazine is devoted to these projects and presents some of them as examples of the work being conducted (p. 12 ff).

The University also collaborates in other areas. For example, it exchanges items from its research and teaching collections with museums and research institutions far beyond Germany's borders. This establishes links with these institutions whilst also bringing together thousands of years of cultural history (p. 58 ff). Some exhibits from the University's antique collections are currently on display at the world-famous Louvre museum in Paris (p. 56).

I hope that you will enjoy reading this edition. I also look forward to receiving your feedback. Please do not hesitate to contact the editorial team or myself: presse@uni-jena.de.

Jena, March 2019

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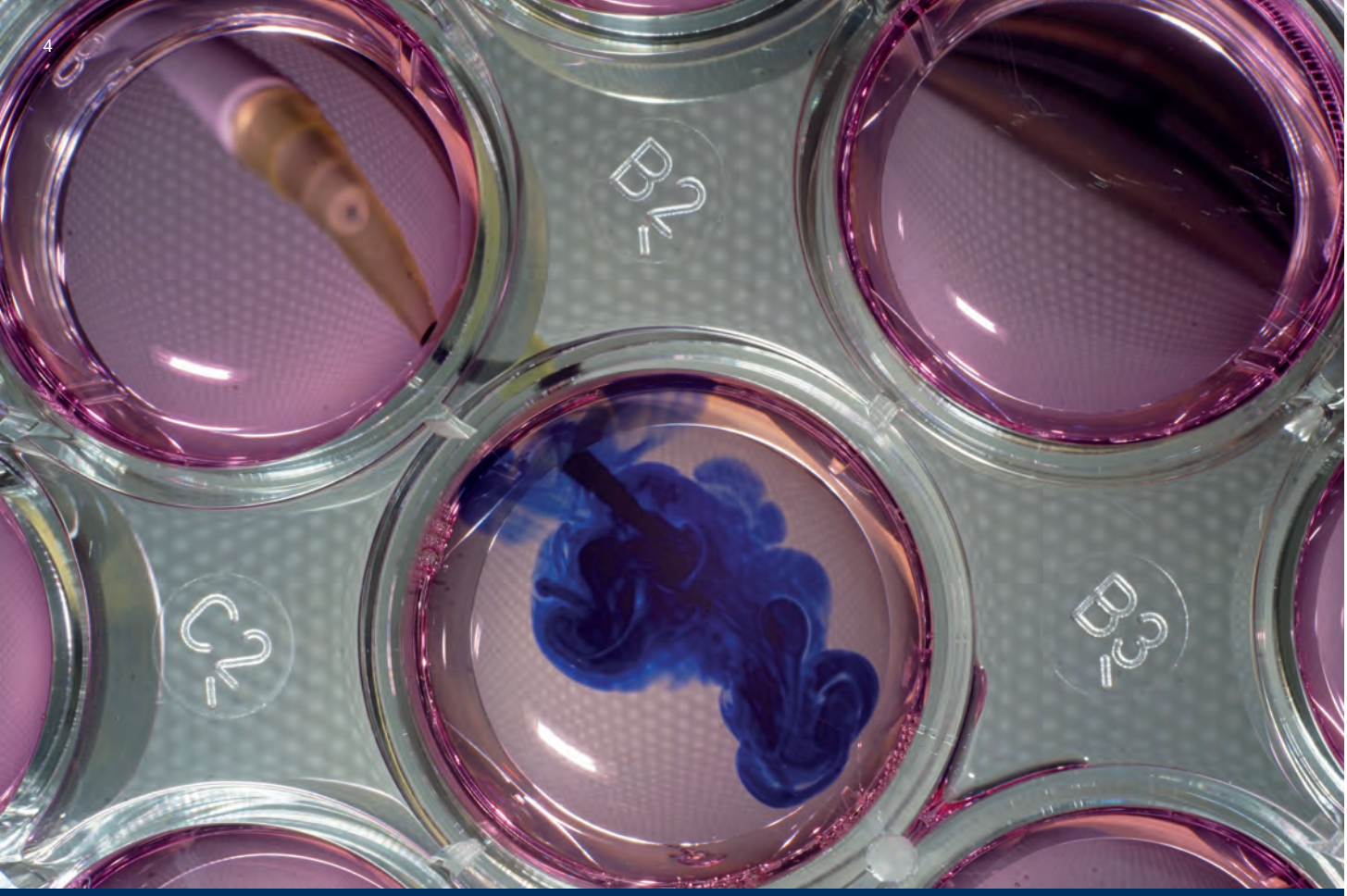
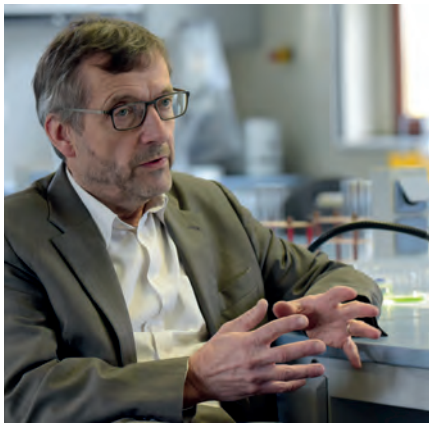
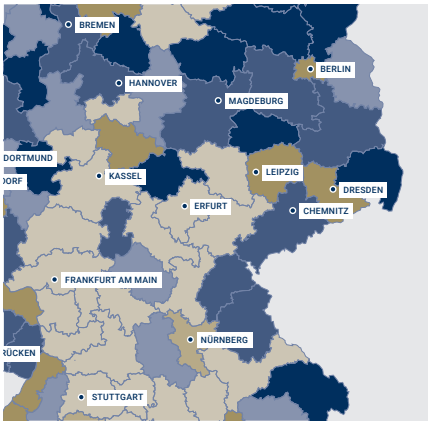
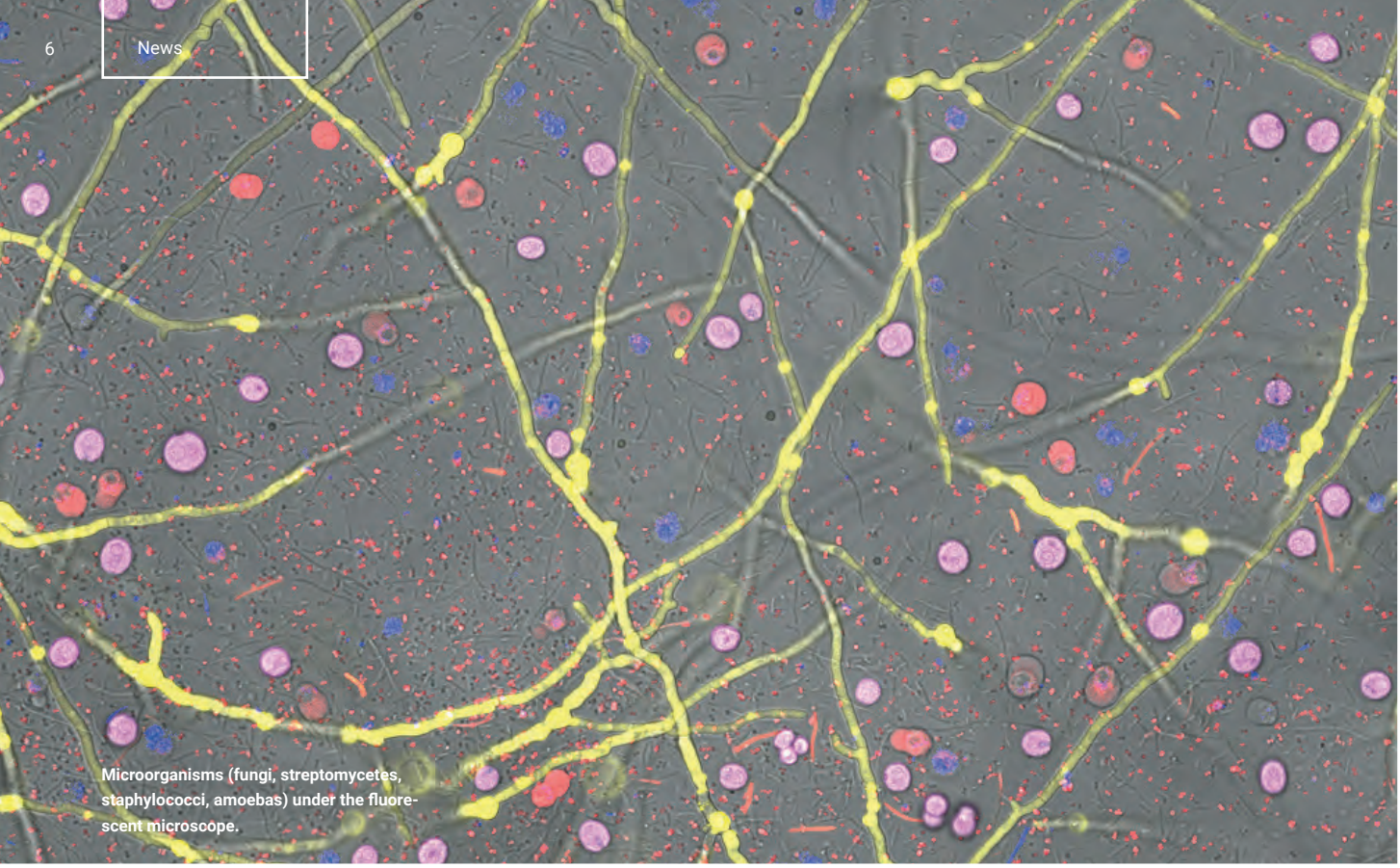


FEATURE

Made-to-measure medication







Microorganisms (fungi, streptomycetes, staphylococci, amoebas) under the fluorescent microscope.

Research cluster receives a seal of excellence

The Friedrich Schiller University Jena was granted funding for one Cluster of Excellence. As announced last September by the selection committee, the cluster »Balance of the Microverse« was one of the 57 chosen clusters that will be funded over the next seven years as part of the Excellence Strategy by the German government and federal states. This is the first time Jena has been given funds for a Cluster of Excellence.

»This is excellent news for the University, for Jena as a research location, and for the Free State of Thuringia«, stated the President of the University of Jena, Walter Rosenthal. He believes this funding acknowledges the development of the research profile at the University which has been taking place in recent years, now combined under the motto »Light, Life, Liberty—Connecting Visions«. The President is convinced that this success will transform the science and business region of Jena into an international beacon.

The big picture and the smallest of the small

The »Balance of the Microverse« Cluster of Excellence concerns the complex symbiotic communities of microorganisms. These microbiomes have a stabilizing influence on living beings and the environment, for example, on the health of humans, animals, plants as well as on soil fertility and the quality of water bodies. Research into the functions and dynamics of these systems is still in its infancy. The aim of the research cluster is to find out which overarching principles dictate the interactions between microbial communities, for example, which factors stabilize these systems and how can human beings intervene to restore the balance in a microbiome. The research programme is about to advance the research areas having been developed by Jena School of excellence, »Jena School for Microbial Communication«, and four existing collaborative research centres, both in terms of content and methodology.

»We are, of course, thrilled that our work in recent years has been rewarded with the seal of excellence and that we can now take a leading position in the field of research«, says Prof. Dr Axel Brakhage, a spokesperson for the Microverse cluster. A large team has developed that spans across all the participating disciplines and institutions. »Elucidating the function of microbiomes will open up completely new paths in prevention and treatment of disease and in environmental protection.«

The new research network sees scientists and researchers from the Faculty of Mathematics and Computer Science, the Faculty of Physics and Astronomy, the Faculty of Chemistry and Earth Sciences, the Faculty of Biological Sciences, and the Faculty of Medicine in Jena all work together. Non-university partners include the Max Planck Institutes (Chemical Ecology, Biogeochemistry, Science of Human History), the Leibniz Institutes (Natural Product Research and Infection Biology; Photonic Technologies), the Fraunhofer Institute for Applied Optics and Precision Engineering, the Jena Helmholtz Institute, and the DLR Institute of Data Science. US

»Light, Life, Liberty—Connecting Visions«

University President Prof. Dr Walter Rosenthal on a flying visit to the Matthias Schleiden Institute of Genetics, Bioinformatics and Molecular Botany: this is where research will be conducted into single-celled green algae as part of the »Balance of the Microverse« Cluster of Excellence. In this interview he speaks about the result of the Excellence Strategy competition and strenghting the profile of the Friedrich Schiller University.

INTERVIEW: UTE SCHÖNFELDER

Does standing in a laboratory like this awaken the researcher within you?
Absolutely. I think it is fascinating to see that an algae cell has a lot in common with a human cell. All life processes are variations on a »theme«, just as in music. There are universal biological fundamentals that appear in extremely diverse forms.

Which aspects that are being investigated as part of the »Balance of the Microverse« Cluster of Excellence are you most interested in personally?
The great thing about this cluster is that it poses fundamental questions. Like, how can single-celled organisms—in other words, very simple organisms—form highly complex communities? We know that microorganisms communicate using chemical molecules, but we still do not know the basic rules for how this happens. And that is precisely the objective of this cluster: to elucidate these basic rules. It is fascinating. Not least because of the huge number of different applications. After all, these microbial communities are immensely important, especially for us human beings. We are literally ecosystems of microorganisms: they live in our mouths, in our lungs and in our gut. The microbial communities have a clear impact on our health. Part of the thrill of this cluster is that it combines fundamental questions with concrete applications.

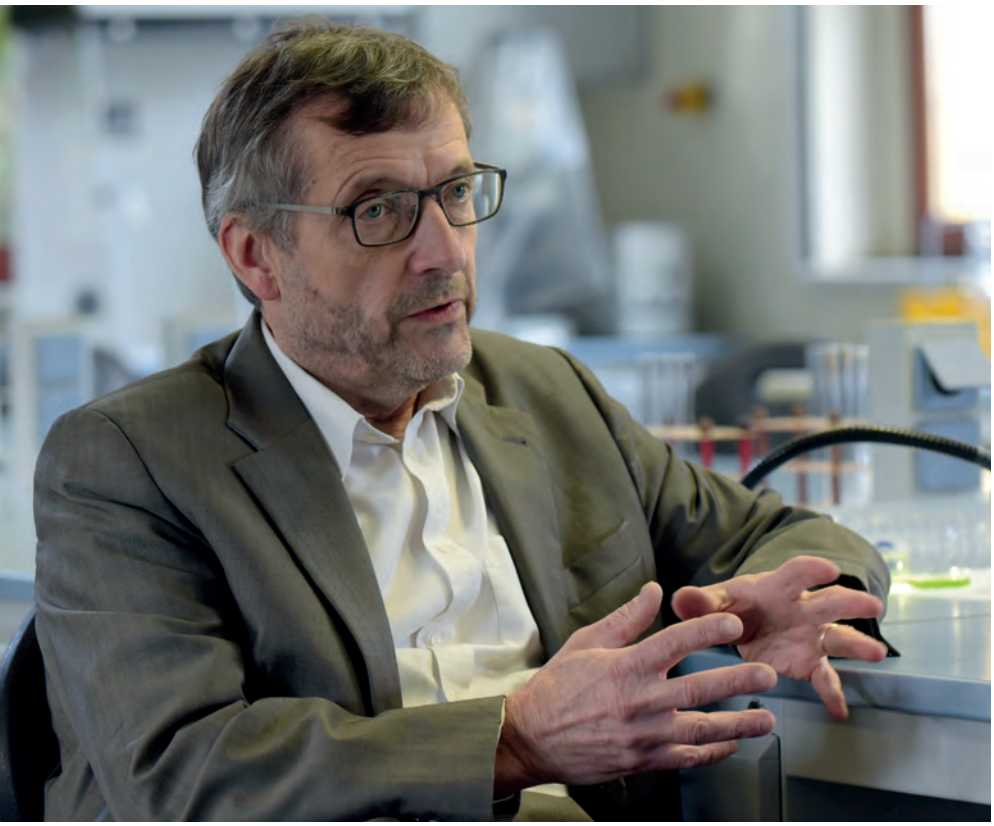
What was 27th September 2018 like for you, when the results of the Excellence Strategy run by the German government and federal states were announced?
It was a very joyous occasion for me. I was always very optimistic about our chances of success. However, given the tough competition, the result was anything but certain. »Balance of the Microverse« is the first Cluster of Excellence at the Friedrich Schiller University. And we celebrated in style. We met all the researchers and scientists involved in the Senate Hall, and the spokesperson for the cluster, Prof. Axel Brakhage, who was abroad at the time, joined us via Skype. It was a great moment.

Prof. Dr Maria Mittag (left), PhD student Yu Hou (right) and PhD student Vivien Hotter (2nd from right) give the President of the University of Jena, Prof. Dr Walter Rosenthal, an insight into their research into the single-celled green algae *Chlamydomonas reinhardtii*.

Despite this, there were surely disappointed faces too, as the University's second cluster application »Enlightening the Receptome« was not selected for funding.
Yes, but the work that has been invested here has not been in vain. On the one hand, this cluster includes a very strong methodological aspect in the field of high-resolution microscopy methods. We want to further expand upon this area. The life sciences and other associated fields, such as chemistry, physics and materials sciences will also benefit from this. On the other hand, the fact that we submitted two clusters has certainly moved the University forward as a whole.

In what way?
With the two clusters, we had the chan-

The slogan »Light, Life, Liberty—Connecting Visions« describes the focal research areas of the Friedrich Schiller University as a multidisciplinary university and we want to stay this way.



ce to apply for funding to become a University of Excellence. In order to prepare for this, we had to put a very broad strategy in place—a strategy that involved all of the different status groups at the University. We analysed the current situation very closely and discussed the future of the University. Ultimately, we owe this second cluster to an intensive strategic process, and one that is still ongoing.

How will the University of Jena continue to strenghten its profile over the coming years?

We are currently working on a strategy document, which is expected to be passed in mid-2019. In it we describe how we will structure our University over the next five to six years; not only in the field of research, but also in teaching and the promotion of young talent. Our motto for this is »Light, Life, Liberty—Connecting Visions«.

Can you elaborate?

The slogan describes the main lines of the Friedrich Schiller University as a multidisciplinary university and we want to stay this way. Our focus now is on strengthening the focal research areas of Light, Life and Liberty. These areas are interdisciplinary, but they each have a specific thematic direction. The aim of our strategic process now is to link the research areas that have already begun to bear fruit in recent years. We want to provide them with resources and to give them a structural anchor: each area will be given a seat in the Senate, alongside the faculties. »Connecting Visions« is our guiding principle for all of these measures.

What is the role of the »minor disciplines« and research groups that are not assigned to the focal research areas in the strategic process?

Each subject has its own role at the University. In establishing our profile, we do not want to streamline the subjects on offer at our University. Disciplinary diversity is our strength. There is no pressure to fit in somewhere. Each researcher can decide where they participate. I have always been interested in the so-called »minor disciplines« and I still am. They are important and also contribute to large collaborative projects.

Does that mean that there will still be scope for individual research at the University of Jena in the future?

Of course. The focal research areas are important with their great collaborations. But we also need individual research to reach new insights and come up with new ideas. We currently have over 260 individual projects on the go at the University, funded by the German Research Foundation. And I am convinced that a university must always make room for both these aspects: individual research and collaborative research. As far as I am concerned, they are both equally important.

How do you view the national and international standing of our University with its Cluster of Excellence and its profile?

We have a global reputation and are competitive in certain fields of research. And that is not just down to our Cluster of Excellence. It also applies to the humanities and social sciences, for example, with research into the romantic period or research into social change and, of course, in the field of optics and photonics. We are able to recruit outstanding international researchers in these fields. In 2018, one quarter of our newly appointed professors came from overseas. We also have a reputation across Germany as a high-performing university: we have enjoyed success in all of the federal government's major funding programmes in recent years; for example in the »Innovative Hochschule« funding measure, in the »Qualitätsoffensive Lehrerbildung« (Quality drive for teacher training), in the »Tenure Track Programme« for young scientists, or with regard to the new »Max Planck Schools«—one of them being coordinated in Jena. Since 2013, we have established six collaborative research centres. The results speak for themselves and confirm our University's research potential.

Where will the University of Jena be in seven years' time, when the first funding period for the Cluster of Excellence expires?

I am committed to ensuring that the development that I have just described continues and that we progress to be counted among the top 20 universities in Germany. In order to achieve this, we need to be successful in raising funding for both individual and collaborative projects. I hope that we will be able to raise funding for two to three new collaborative research centres over the next two years and that, by 2025, we are in a position to apply for another Cluster of Excellence. ■

Chemical communication between green algae and bacteria

The chief objective of the **»ChemBioSys« collaborative research centre** (see p. 10) is to explain the fundamental control mechanisms in complex biosystems. This research group is an essential pillar of the **»Balance of the Microverse« Cluster of Excellence**, which has been granted funding to the value of around six million euros per year from 2019.

The team, which is led by Prof. Dr Maria Mittag and Dr Severin Sasso from the Matthias Schleiden Institute of Genetics, Bioinformatics and Molecular Botany, works within »ChemBioSys« and is dedicated to researching the coexistence of single-celled green algae (*Chlamydomonas reinhardtii*) and other microorganisms. The researchers are currently studying the interplay between green algae and *Pseudomonas protegens* bacteria.

They have made an amazing discovery: if the two-micrometre-large bacteria surround the green algae, which are around five times larger, a deadly cocktail emerges. The encounter is not good for the algae. They lose their flagella, which help them to move normally in the water. They deform, lose the ability to reproduce, and most eventually die. Together with the team working with Prof. Dr Christian Hertweck from the Leibniz Institute for Natural Product Research and Infection Biology—the Hans Knöll Institute—Prof. Mittag and her colleagues have managed to explain the underlying chemical mechanisms behind this process. They found evidence that the bacteria release a chemical substance, which activates specific ion channels in the algae. This leads to a rapid influx of calcium ions, which in turn causes the loss of the flagella.

The figure above shows an agar plate with a thick layer of green algae. You can clearly see inhibited algae growth in the shape of a halo around the small round area in the centre of the image, which contains the *Pseudomonas protegens*.

Chemical relationships

The »ChemBioSys« collaborative research centre has started a new phase of funding. The German Research Foundation will be financing the centre over the next four years with around 9.5 million euros. The scientists and researchers are investigating the complex means of communication and interactions between different organisms and their environment in 21 individual projects. The focus is on natural substances that serve as mediators—they act as the »chemical language of nature«.

Doctoral candidate Arite Bigalke works with algae cultures in the »ChemBioSys« centre.

The centre brings together research groups at the University of Jena, the Leibniz Institute for Natural Product Research and Infection Biology (Hans Knöll Institute), the Max Planck Institute for Chemical Ecology, and the University of Potsdam. The research groups are represented by two spokespersons: Prof. Dr Christian Hertweck (Professorship of Natural Product Chemistry, University of Jena; Head of Biomolecular Chemistry, Hans Knöll Institute) and Prof. Dr Georg Pohnert (Professorship of Instrumental Analytics/Bioorganic Analytics, University of Jena).

The communication mechanisms within biosystems are based on small chemical molecules. While previous research largely focused on analysing how these molecules are exchanged between organisms or two different types of organisms, the research being conducted in the centre focuses on the relationship networks as a whole and is investigating how these community structures are created and how their diversity is retained. With this research approach, the collaborative research centre stands as stands as a central pillar in the »Balance of the Microverse« Cluster of Excellence (p. 6). US

Second phase of the nutrition cluster begins

The German Federal Ministry for Education and Research will be funding the cluster for nutrition and cardiovascular health, »nutriCARD«, for another three years with a total of around 5.6 million euros. The joint project between the universities of Halle, Jena and Leipzig can thus continue its very successful research and development work, which has been running since 2015.

The aim of »nutriCARD« is to improve the health of the general population. Around 40 percent of cardiovascular diseases relate to diet. Some 40 scientists and researchers from different disciplines, and 80 practice partners, are working on nutriCARD.

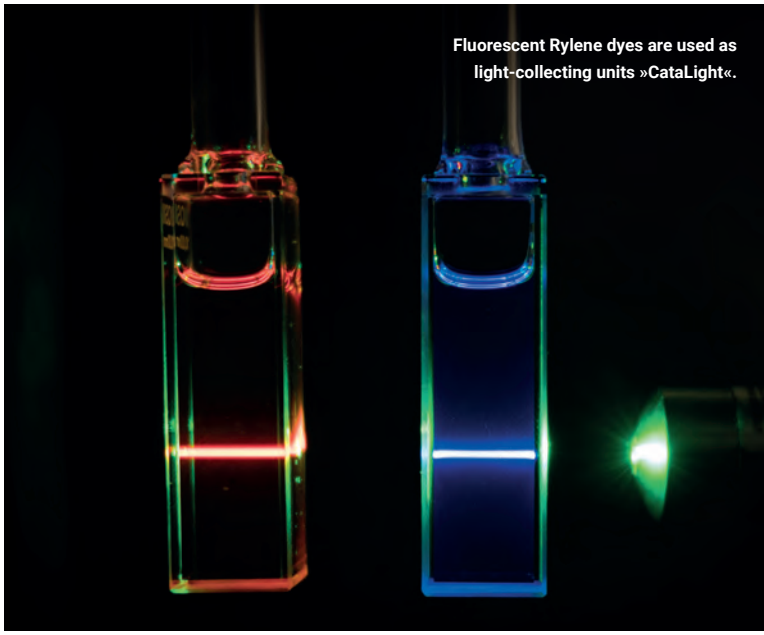
»Over the past three years, we have proven what nutriCARD can achieve. nutriCARD stands for validated, scientifically verified, evidence-based information. This includes basic research and the practice-oriented development of heart-friendlier food as well as as innovative approaches to communication and marketing«, says Prof. Dr Stefan Lorkowski, the spokesperson for the cluster. The Professorship of Biochemistry and Physiology of Nutrition emphasises the translational approach. In other words, findings from the basic research are directly transferred into new food-related and nutrition concepts, so that they are comprehensible to consumers.

Those involved plan to use the next stage of funding to improve heart health by replacing nutrients and through the optimization of recipes in certain product groups, such as convenience foods, baked goods, sauces and ice cream: with less salt, fat and sugar, but still with the same taste and familiar consistency. In the field of basic research, the next three years are about identifying and validating biomarkers relevant to food and interactions between genes and nutrients. The third focus is on education and communication relating to nutrition. For this purpose, nutrition concepts for institutions are being developed, for example, for childcare settings. PM

Using light to create high-energy chemicals

The German Research Foundation is funding the new transregional collaborative research centre »CataLight« at the universities in Ulm and Jena which is about to investigate sustainable energy converters based on those found in nature. The consortium, which also includes the University of Vienna, the Max Planck Institute for Polymer Research in Mainz, and the Leibniz Institute for Photonic Technologies e. V. in Jena, is to receive around ten million euros of funding over the next four years.

The aim of the multilocational research group is to investigate the basic functioning of innovative photocatalytically active materials. The researchers from the fields of chemistry, materials science, and physics are interested in utilizing light to produce high-energy chemicals as well as in the ability to design specific new materials for sustainable energy conversion. »CataLight« stands for light-driven molecular catalysts in hierarchically structured materials—synthesis and mechanistis studies.
The researchers in the project use natural photosynthesis as a model. They want to develop molecular catalyst systems for the light-controlled production of hydrogen and oxygen from water. The focus of the work is on the interplay between molecular photocatalysts and their polymer-based environment. The long-term goal of the research is to produce artificial »chloroplasts«, i.e. cell organella in which photosynthesis takes place in plants. Before this is possible, a lot of basic research needs to be conducted in the chemical process itself. The new findings about this process should be available by the end of the first phase of funding. AB



Fluorescent Rylene dyes are used as light-collecting units »CataLight«.

Junior teams are revolutionizing microscopy

The work of two research units at the Institute of Applied Physics has led to innovative ideas in microscopic imaging. Together with their colleagues from the Fraunhofer Institute for Applied Optics and Precision Engineering, they are conducting basic research into quantum technology and are gauging its potential for the field of microscopy.

Led by Prof. Dr Falk Eilenberger, the group known as »NanoScopeFutur-2D« has been awarded funding from the German Federal Ministry for Education and Research amounting to the value of 2.5 million euros over the next five years. The funds were granted for examining transition metal dichalcogenides. These can have a very strong interaction with light and nd can, for example, collect light in a volume that is significantly less than the wavelength of the light.
Quantum technological applications that take advantage of these properties can, for example, be used to help microscopes better penetrate the nanorange of a sample. Light sources can also be developed that can be used instead of dyes in fluorescence microscopy. They can be used to observe the processes that take place within a cell.

The »FOQUOS« group, which is coordinated by Dr Frank Setzpfandt, consists of researchers from the University of Jena and the Technical University Ilmenau, and has been given 700,000 euros for the next three years by the Thuringian state investment bank. The focus is on research into quantum light imagery.
As quantum-mechanically entangled photons always occur in pairs, a sample can be illuminated with a photon light and the entangled, second photon can be detected. This information can then be correlated to establish an image of the sample, without the need for a camera to observe the actual sample. Thus, recordings can be made in the infrared range, which is, in turn, relevant for the investigation of biological and chemical processes. sh

Cell samples are placed in a microtitre plate in a laboratory at the Centre for Applied Research. Researchers and scientists are using cell cultures to test the safety of new nanoparticles which are intended to be used as pharmaceutical excipients.

FEATURE

Made-to-measure medication

Precise substances—targeted therapies

How do headache tablets know where they need to take effect? And how does the active substance get there from the stomach? Of course, the tablet does not »know« anything and the medicine is distributed all over the body—both to the place where it needed and elsewhere. Whereas taking pills for headache is rather unproblematic, ingesting highly toxic substances, for example, those used in the treatment of tumour cells, may result in strong side effects. That is why scientists and researchers at the University of Jena are developing new nanosystems which would be able to guide active substances to the precise area within the body where they are needed. Other research teams are focusing on receptor molecules—the docking stations for the body's own neurotransmitters—so they can be used for new diagnostic and tailor-made therapies. »

Nanoparticles with a light switch

Researchers working with Prof. Dr Felix Schacher and Prof. Dr Benjamin Dietzek are developing nanoparticles that release encapsulated active substances »on demand«. In an initial proof-of-concept study, the chemists showed that it is possible to control the release of a model substance encapsulated within the nanoparticle using ultraviolet rays. Currently, the concept is about to be adjusted in to order to apply it to biologocial systems, for instance, in medicine.

BY UTE SCHÖNFELDER

Nanoparticles with a built-in light switch—this is one way of describing the concept that the team of chemists, led by Felix Schacher and Benjamin Dietzek, want to realize as part of the collaborative research centre »PolyTarget«. The researchers are developing photosensitive nanoparticles which can be triggered through exposure to light at specific wavelengths to release their content »at the touch of a button«.

»One of the great benefits of this type of nanoparticles is that we can control their size, shape as well as functionality, and can load it with desired substances«, says Schacher. As a result, this can prevent active substances from reacting in the wrong parts of the organism—and causing unwanted side effects. »On the other hand, the packaging means that significantly larger amounts of active substances can be administered as they are transported to the desired location in high concentrations rather than in dissolved form.«

However, this benefit can only be realized if the package containing the active substance can be released precisely where they should take effect. There are various strategies to achieve this. The simplest one is the package simply dissolving after a certain period or at a specific pH value, e.g. in the stomach, and thus releasing its content. »Applying this method, you can only control the time span, the effect, however, often remains non-specific and can thus cause side effects«, explains Schacher. A far more promising method is to integrate a mechanism into the particle which allows the release of the encapsulated substance to be controlled externally

Dye-marked nanoparticles flourescing under ultraviolet light. Chemists Prof. Dr Schacher (p. 14, on the left) and Felix Wendler (on the right) use ultraviolet irradiation to cause the nanoparticles releasing the substances encapsulated within. The chemists want to develop the concept, so that the particles would react to radiation from the visible and infrared spectrum and medicines could be administered more accurate.

meaning that it is released at a specific time and location. Jena's chemists use small, molecules sensitive to light which are stimulated by light at a specific wavelength resulting in the active substance being released.

Fluorescent dye as a test substance

Doctoral candidate Felix Wendler has produced light-responsive nanoparticles made from so-called terpolymers for this purpose as part of his doctoral thesis in Schacher's team. These polymers consist of three distinct components called monomers that organize themselves into nanostructures of a defined size in aqueous solution. Wendler has used light-sensitive photoacids as a building block for the synthesis of these polymers. In addition, the fluorescent dye »Nile red« has been encapsulated into the particles. »In this experiment, the dye acts both as test substance, and as a probe«, explains the young chemist Wendler. A specific fluorescent signal can be detected whereas the dye remains within the polymer assembly or package. If the vessel is then irradiated with UV light, the photoacid molecules integrated within the particle become stimulated and change the local pH value.
»As a result, the particles disperse and the dye escapes into the surrounding solution which can be tracked directly by measuring the change in the fluorescence signal«, says Wendler. Although the photoacids have been proven to be efficient »light switches« for nanopar-

ticles in numerous studies, they are not yet suitable for use in biological systems, for instance, those in the human body. »Everyone knows about the health risks posed by UV radiation«, states Schacher. »Administering medicines that require intense UV radiation to be released into the body is not an option.«
The chemists therefore aim for shifting the wavelength required to stimulate these light-sensitive nanoparticles to, from biological point of view, safe range, i.e. visible and near infrared wavelength range. When working within this »biological window«, exposure to light within this wavelength range allows deep penetration of up to ten millimeters into the tissue which was already proven to be well-tolerated.

Energy converters set off a chain reaction

Photosensitive molecules within this wavelength range, which can achieve similar effects, have not been available by now. Schacher and his team thus opted for an alternative approach. In cooperation with Prof. Benjamin Dietzek's research group, they want to integrate so-called energy converters into the nanoparticles. These are either molecules or small crystallites which are able to absorb harmless infrared light and convert it into high-energy UV radiation at a specific location. This could then activate the photoacids and thus induce the release of the active substance from the particle. »As this happens locally, within the particle, the UV light cannot harm the organism«, highlights Felix Schacher.

Lego model blueprint for nanoparticles

The chemist uses a 20-centimetre model made of coloured Lego bricks to show what the blueprint for light-controlled nanoparticles might look like (see photograph on p. 17). The particles are made up of several layers which combine the different functions. They contain a core made of lanthanide-doped nanoparticles (NaYF4:Yb,Tm) and have a diameter of approximately 20 nanometers. This core acts as an energy converter. It absorbs the irradiated visible or infrared light and converts it into short-wavelength and high energy ultraviolet radiation. The core is surrounded by the active, light-sensitive layer (red). This is where the potential active substance is located (green). When the photoacids are »switched on« by the UV light, this layer swells and the active substance is released from the particle. In order to make the whole ensemble suitable for use as a transport system for medication, the nanoparticles must be surrounded by another layer (yellow). This layer is made of polyethylene glycol, or PEG, and protects the particles from the accumulation of proteins in the blood which can extend their circulation time. ■

The team led by Prof. Dr Felix Schacher is not just inventive in the field of photochemistry. They are also using a Lego model to show the structure of the nanoparticles with a »light switch«. The green bricks represent the photoacids which are embedded in a polymer matrix having a different solubility depending on the pH value (red bricks).

Further information
Light-Responsive Terpolymers Based on Polymerizable Photoacids, Polymer Chemistry (2017), DOI: 10.1039/c7py00571g

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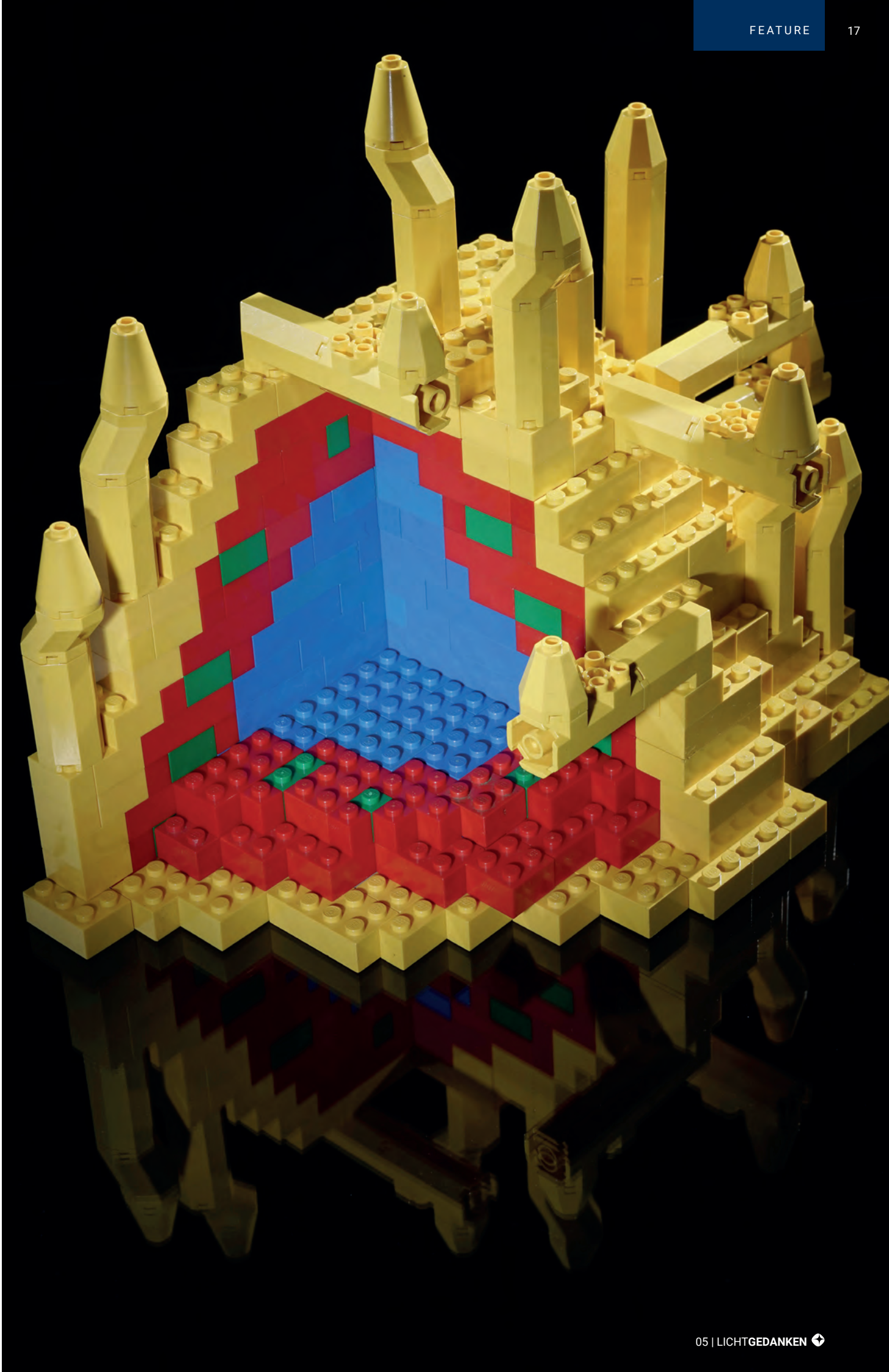
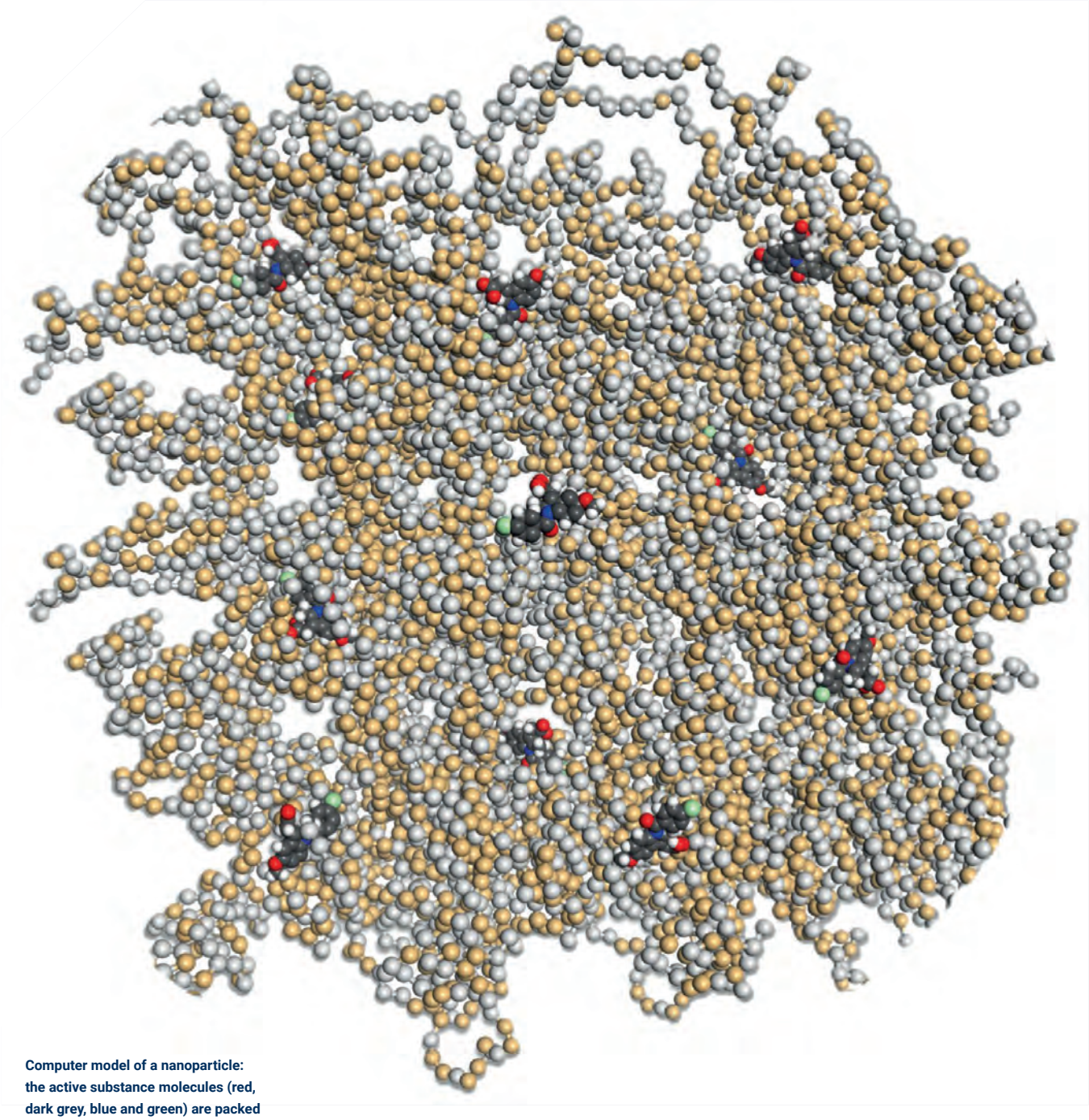


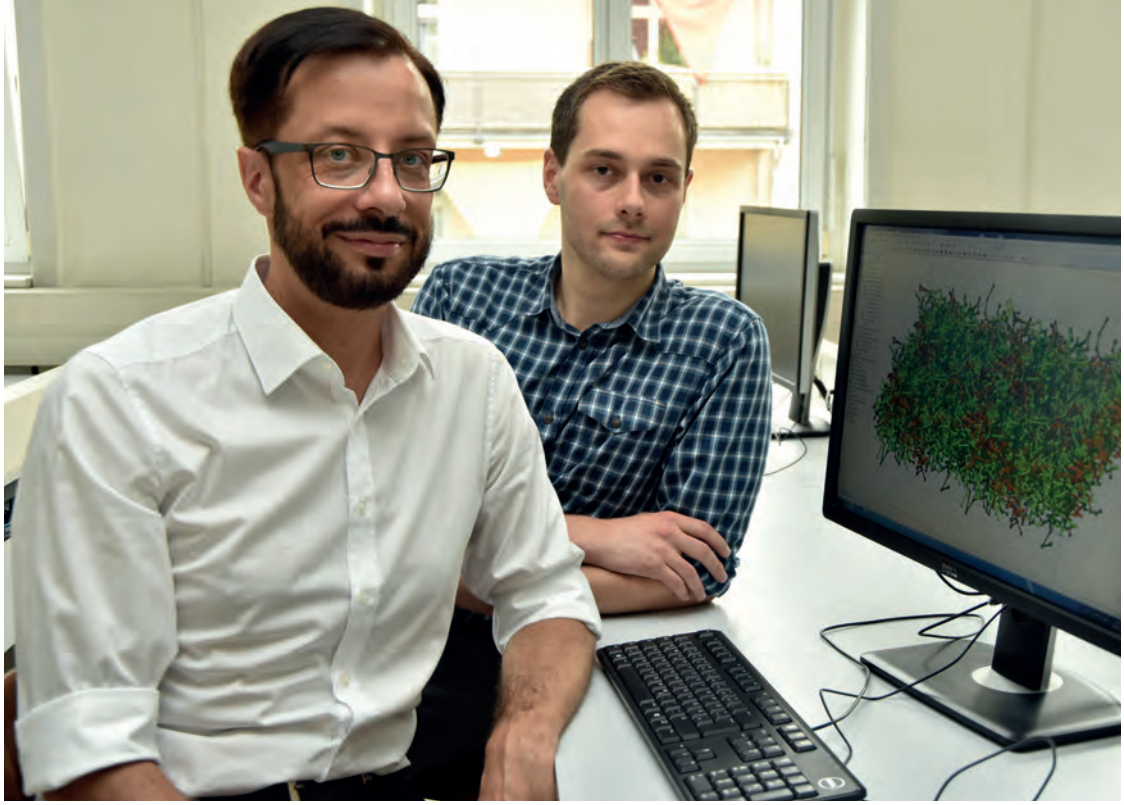
Active ingredients in a tailor-made suit

A mainframe computer instead of a lab bench: when Prof. Dr Marek Sierka and his team work with new polymers for nanoparticles, they wear neither a lab coat nor gloves. Rather than experimenting, the materials scientists are developing new chemical structures in a purely virtual environment. They are using computer simulation to search for the optimum fit between active substances and polymers. We interviewed the Professor of Computational Materials Science to discuss this »chemical dating agency«.

INTERVIEW: UTE SCHÖNFELDER



Computer model of a nanoparticle: the active substance molecules (red, dark grey, blue and green) are packed in polymer chains (light grey and beige).



Prof. Dr Marek Sierka (left) and doctoral candidate Andreas Erlebach's »laboratory« is actually a PC—supplemented with an arsenal of mainframe computers, which are housed in a server room in the Jentower.

What would an ideal nanoparticle for use as a medicine carrier actually look like?
The particles need to be able to enclose as much of the active substance as possible. Their surface should be functionalized so that the content arrives precisely where it is needed and that is also where the substance must be released from the nanoparticles. The remaining parts of the particles must also be biocompatible—in other words, harmless for the organism.

That is quite a big ask.
It gets even more complicated: the chemical diversity of the active substances that need to be transported into the organism by nanoparticle is great and thus the polymers that make up the particles need to be just as varied.

Why?
The only way to safely »package« medicines and administer them in high concentrations is for the active substance and the polymer to fit together perfectly in terms of their chemical properties and structure.

In other words, you need to find perfect chemical matches?
Exactly. And I can find these using a process of »trial and error«. I can take an experimental approach to find out which polymer goes with which active substance. But this is not a very efficient way to do it.

And that is why you recommend taking a different approach?
Yes. Chemical syntheses often take a very long time, especially when you are dealing with new types of polymers. A doctoral candidate may spend around a year »cooking« a specific type of polymer. And if you then discover that the result doesn't fit with the active substance as required, you have wasted a lot of time without achieving any tangible results. By simulating the formation of nanoparticles on a computer, we can significantly accelerate and systematize the procedure.

What are the defining criteria for »matching« the medicine and the polymer?
Our goal is to achieve the maximum absorption capacity for the active substance and the maximum efficiency for its release from the polymer particles. We use our simulations to predict these properties for certain polymers. We want to systematically vary the polymer structure and calculate the compatibility with selected active substances—and to do all of this within the computer model. On the basis of a polymer-based structure from polyketones and polyesteramides, we will simulate the effects of chemical modifications to this basic structure on the absorption capacity for specific active substances. More specifically, this concerns changes in the hydrophobicity of the polymers; in other words, their behaviour compared to solvents such as water.

Which substances are we talking about?
On the one hand we work with model substances, such as dyes, to test and optimize our procedures. On the other hand, we also use real active substances, which are being investigated in other sub-projects of the »PolyTarget« collaborative research centre. For example, we want to find matching polymers for the substance »Ex527«. This substance is currently being investigated as a possible drug for the treatment of neurodegenerative diseases.

How do your findings end up being used in real-life scenarios?
We have been working with a large team of synthesis chemists from the very beginning. As such, we are able to verify the results of our simulations directly through experiments. After all, we will only reach our goal if simulation and synthesis can work together hand-in-hand. ■

Operation on the open egg

Tiny particles are playing an increasingly vital role in medicine and pharmacy: nanoparticles can no longer be ignored, whether it be with regards diagnosis or in the fight against diseases. However, in order to find the perfect particle for the specific application, the primary materials must be investigated in great detail. Jena pharmacists have adopted an unusual approach: they are experimenting with chicken eggs. Our author visited the scientists in their laboratories.

BY SEBASTIAN HOLLSTEIN

It is Tuesday morning. Two young men don their white coats and enter a large, brightly lit room: neon tubes bathe their workplace in white light. The air conditioning quietly hums and silences all other noises that may pass through the broad window from outside. No one says anything. The two men are happy with this set-up; the work processes are part of the routine. While one places a box of brown chicken eggs on the table, the other has already taken his place and is opening a pocket knife. He carefully lays it on the table in front of him, with the sharp side of the blade facing upwards. Then, without looking up, he takes one of the eggs, hits it against the table with a swift hand movement, slowly opens the egg and carefully pours the yolk and egg white into a small glass dish. Finally, he places a glass lid on top, moves the receptacle to one side and reaches for the next egg. The two men get through around 500 chicken eggs a month; sometimes more, sometimes less.

Yet Martin Rabel and Paul Warncke—as the scientists are called—do not work in a bakery or in a large kitchen; instead they are completing their doctorate at the Institute of Pharmacy at the University of Jena. They are investigating nanoparticles and exploring how they interact with tissue and blood, and how they behave within an organism. The tiny materials are becoming increasingly important in the development of new medicines. They can be used to transport active substances to specific targets within the body where they are needed (see interview on page 25). Nanoparticles are also found in contrast agents used in diagnostics. However, before they can be used, it must be proven that they will not harm the organism. But how do these small particles behave in the body? Can they even move within the body? And what happens when the particles disintegrate into their components? Scientists have to answer all of these questions by conducting extensive tests on each individual material in order to find the ideal particle for each application.
Initially, the scientists check the safety of nanoparticles using two-dimensional cell cultures. They place the particles on these cultures and observe over several days whether or not the cells die. »This process doesn't tell us how the nanomaterial behaves in a natural environment, what happens when the particles are flushed past a cell, interact with components of the blood, and whether they damage blood vessels or easily flow through them«, explains Warncke.

The delicate blood vessels in the egg can be used as a test system

In order to take a closer look at these processes, Jena scientists are turning to fertilized chicken eggs. »Generally speaking, the eggs that we receive are one day old«, says Martin Rabel. »We then store them in an incubator for three days, open them and look to see if they have developed normally. We then return them to the consistently warm environment for a further 24 hours.« The compact incubator is right next to their workstation. It looks like a vault; but, instead of gold, it is the egg yolk that shines on the stacked glasses. You can see that a blood vessel system is already developing within the eggs with the naked eye: the bright yellow yolk is covered with fine blood vessels. A small red node can be seen in the centre of this network: this is pumping the blood through the vascular system and will develop into the chicken heart. Even at this early stage, it ensures there is a constant blood flow. And this is exactly what the two scientists need for their work, so that they can find out how nanoparticles behave within a vascular system. But how do the tiny particles get into the fine blood vessels within the egg? Paul Warncke has retrieved a four-day-old egg from the in-

Image left (from the left): Doctoral candidate Martin Rabel, Prof. Dr Dagmar Fischer and doctoral candidate Paul Warncke investigate the long-term effects of nanoparticles as part of the project »Biological elimination of complex diagnostic nanoparticles« (NanoBEL). They are using the blood vessels in fertilized chicken eggs as model tissue. Image right: Martin Rabel examines the chicken eggs, which are a few days old and stored in an incubator.

cubator and placed it on a microscope. He places the filled petri dish on the slide. A bright light illuminates it from below. Martin Rabel brings a small box containing rows of ampoules. They have coloured lids for ease of identification and come with adhesive labels. They contain the nanoparticles. The liquids within the small plastic containers are either light or dark brown. »We are mainly investigating different iron oxide particles and they are generally dark brown«, says Rabel.

Deep blue flows through red veins, surrounded by bright yellow

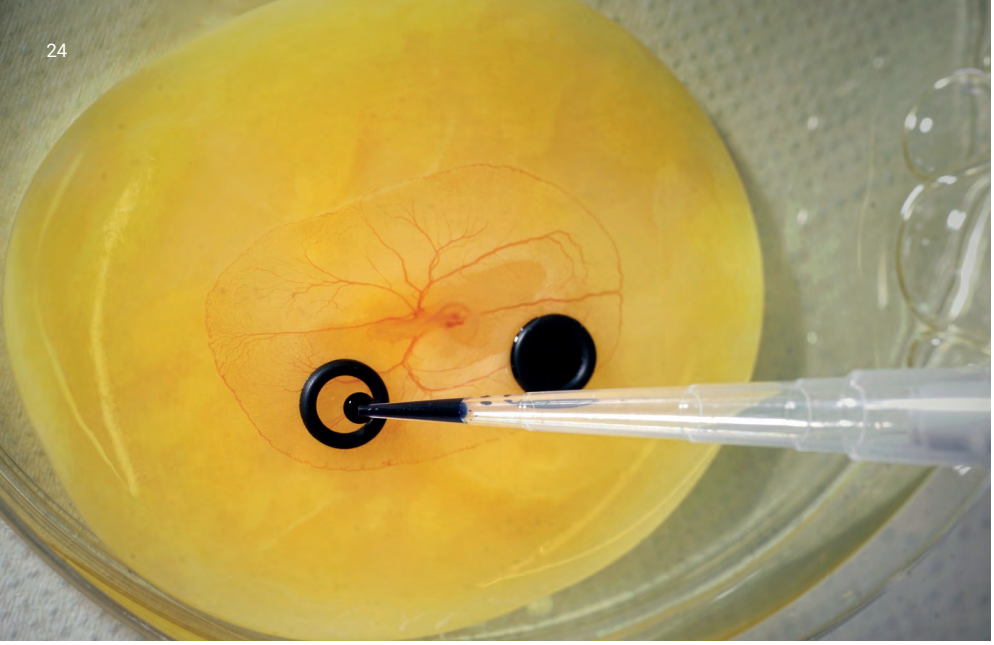
The liquid containing the particles can be easily gathered into a syringe with a microinjector on the front. The small device has a needle at the tip. As it is very hard to distinguish the brown of the nanoparticles from the red blood with the naked eye, the two early-career scientists have opted for a methylene blue solution for today for demonstration purposes.

Warncke looks through the eyepiece of the microscope whilst holding the injector in his right hand like a pen. He slowly approaches the egg with the needle, pierces the yolk and injects two microlitres of the blue liquid directly into the vein leading to the heart.

This operation on the open egg is reminiscent of vascular surgery. »It is not easy to hit the vein precisely without piercing right through it«, says Warncke. The speed and accuracy suggest that he has done this experiment many times before. Gradually the blue spreads from the injection site through the entire network of veins. If the brown particle solution had been used instead; millions of nanoparticles would now be flowing through the veins. The two researchers use the microscope to closely observe how they behave—initially at hourly intervals and then at daily intervals. They also take regular photographs of their findings. They can record around ten particle types each week using this procedure.

The investigations are so extensive, because one particle generally comprises a core and a covering layer. They each have different primary materials. The core is surrounded by a polymer that protects it, makes it easier to transport it through the body and increases biocompatibility. Together, the two components form a nanosystem with specific properties, which differ from those of the two substances if they were separated. And, even though they are introduced into the body together, they could then disintegrate; either accidentally during transportation through the body, or once the particle has reached its destination and degraded. In addition, as the nanoparticle comes into contact with body fluids, proteins and other organic components are deposited on the nanoparticle and form a so-called biomolecule corona, which lends the nanoparticle an entirely new biological identity and can affect the toxicity of nanoparticles, their interaction with cells and their distribution within the body. In an ideal scenario, these changes would improve the impact of the nanoparticle; but often they also destroy it. In any case, this variety of possibilities equates to a lot of work in the laboratory for the scientists.

While Warncke injects nanoparticles into the egg, Rabel places another egg into the petri dish beside him. He is interested in the surface of the egg. He holds a pair of tweezers in his right hand, which he uses to pick up a small black ring of plastic, which he then calmly places on the yolk. He then uses a pipette to drop a little of the blue liquid into the tiny pool. The circular boundary means that none of the liquid can spill over the surface—as such, the nanoparticles remain localized.



A great deal of sensitivity and a steady hand required: using a ring with a diameter of just a few millimetres, the pharmacists create a tiny pool on the egg yolk in which they can test the toxicity of nanoparticles.

A method developed in Jena is used to test whether particles are toxic

The Jena scientists developed this refinement to the research method themselves. They can now observe the effects on the egg and draw conclusions about what would happen if the particles met human mucous membranes, for example in the mouth or eyes. »If the nanoparticles are toxic, they can destroy the surface«, explains Rabel. »Or they penetrate the bloodstream and stop it.« Furthermore, various processes could cause the blood or tissue to clot, which would cause a thrombosis or embolism. The diversity of the nanoparticles means that the range of reactions is vast. As part of one project, the pharmacists tested a variety of iron oxide particles and their polymers, which can serve as a coating.

The team working with Prof. Dagmar Fischer has already spent ten years studying nanoparticles. Ten to twelve members of staff are currently working on egg experiments. »We believe it is very important that all early-career scientists working within our field carry out the experiments themselves, so that they can learn and understand the method«, says Dagmar Fischer.
In addition to the work on their own research, for example within the framework of the »PolyTarget« collaborative research centre, they are also carrying out tests for other disciplines, such as material sciences or photonics, and for other research facilities as well as for private companies.

Experiments using the chicken egg model help to reduce animal testing

This has led to the creation of an extensive database of information about nanoparticles. Despite the many important insights that can be gained from the chicken egg models, scientists will still need to use animal testing in the final stages to find out how the various nanoparticles affect the human body. But, thanks to the egg experiments, the number of these experiments required will be significantly less. »We clarify many properties of the particles in advance«, says Martin Rabel. »This speeds up the research and makes it more cost-effective.« It also highlights the ethically responsible approach, which is omnipresent with the work with the eggs.

The diligence shown in the laboratory is clear, despite the routine. They work quietly and deliberately. Each move must be accurate—so no more eggs than necessary are used. Paul Warncke has already once again started filling a stack of petri dishes with the transparent nutrient solution, which feeds the egg and prevents it from drying out whilst in the solution. The doctoral students will open a few hundred eggs today alone. »One thing's for sure, I don't eat eggs at home on days like this«, says Martin Rabel. ■

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Barrier-free access to the target tissue

Not all nanos are the same. In this interview, Prof. Dr Dagmar Fischer discusses which nanomaterials are best-suited to reaching their destination in the organism, how the particles behave once in the body's bloodstream and why it has been so hard to use them in the human organism to date.

INTERVIEW: UTE SCHÖNFELDER

Nanomaterials have been in use for a long time now. Why do we need new nanoparticles?

You can certainly argue that »nano« is »old hat« in pharmacy: titanium oxide nanoparticles can be found in sun creams, while silicon dioxide is used in cosmetics and in matrix tablets. One new aspect and the thing that is currently being intensively researched is nanomaterials that can be used as transporters for active substances, so they can be better dosed or transported through biological barriers to their specific destination.

How does it work?

By packaging active substances in nanoparticles, toxic, unstable or poorly soluble substances can be introduced into the organism. On the other hand, nanoparticles can be given a target control that directs them to the desired cells or tissues. The packaging prevents toxic substances, such as chemotherapeutic agents, from damaging healthy tissue and from causing side effects. The latter works already very well in the cell model but often only to a limited extent in humans.

Why is that?

I think it is simply because we don't know enough about it. We need a valid taxonomy to show which polymers, with which chain length, are best-suited to which applications. We need to systematically record how shape, size, charge and the ligands of the particles determine their properties. It would then be possible to develop a kind of modular system, from which the optimum particle could be created depending on the application. This is what we are currently working on as part of the »Polytarget« collaborative research centre.

Dagmar Fischer holds the Professorship for Pharmaceutical Technology and Biopharmacy. Her research interests include the development and application of nanoparticles that can release substances in a controlled manner.

When it comes to the specific targeting of nanoparticles in humans—in other words the targeted transportation to the target tissue and the overcoming of biological barriers—that is still a great challenge. Presumably because the human body is a very complex system. For example, we see that nanoparticles can be modified by the body as soon as they are introduced into the bloodstream. They are covered with a thick layer of proteins, which can completely change the properties of particles. Blood flow and the blood vessels also play a role: the human body is a really large organism and nanoparticles have to overcome extreme distances—in relation to their size—and do so under flow conditions—a lot can go wrong en route.

How can we overcome these challenges?

The only way is by doing more basic research and creating better models. Observing the effects of nano-active substances in cell culture models is just

not enough. We need models that allow us to simulate the behaviour of nanomaterials, even after they have been altered by the body through the so-called protein shell, or flow in the blood vessels. We don't necessarily need to use animal testing for this.

What can we use instead?

We have developed a chicken egg model, which gives us an insight into the blood vessel system and allows us to directly observe the behaviour and the effect of nanoparticles (see reportage on p. 20 ff). Thus, we can answer lots of questions that classic cell cultures do not cover and we can significantly reduce the number of tests on animals required.

What are the possible side effects of nanomaterials?

It depends on the kind of materials and particles, what they are degraded for and how long they remain in contact with the body. There are nanoparticles, which are made from biocompatible and biodegradable polymers. They are degraded in the body after a short period and their components are metabolized. These are expected to be harmless. But there are also particles made of metals or metal compounds, which are used as a contrast agent in various diagnostic procedures, for example. These can remain in the body for several months and can, in some situations, be toxic or may cause immune responses.

How can these side effects be avoided?

This is another of the »PolyTarget« fields of research. One method that we already know about is to make the surface of the particles »invisible« to the immune system. Water-soluble molecules, such as polyethylene glycol, are anchored to the surface. If these particles reach the bloodstream, the organism can no longer »see« the particles and thus, immune responses are inhibited. Just like stealth aircraft, which are invisible to radar, these particles are called »stealth« particles.

Where do you see the greatest potential for the use of nanoparticles in medicine?

In the treatment of cancer and infections. This is because the blood vessel barrier on tumour cells and inflamed tissue cells is changed. To put it simply, they have holes in them. In the case of tumour tissues, these holes can be so large that they can function as entry points for nanoparticles. Intact tissue, i.e. without holes, cannot uptake the particles. Active substances, such as highly potent chemotherapeutic agents, only act in the tumour tissue without side effects in the healthy tissue. ■

Sample tubes containing nanoparticles.

Small scar, big effect

For centuries, infectious diseases had been a scourge on humanity claiming millions of victims. For more than 150 years, we now have had vaccines—a great weapon against this suffering. We need to make sure that this weapon remains effective.

COMMENTARY BY STEPHAN LAUDIEN

Vaccinations protect—and not just one's own health. A high vaccination rate prevents the spread of diseases.

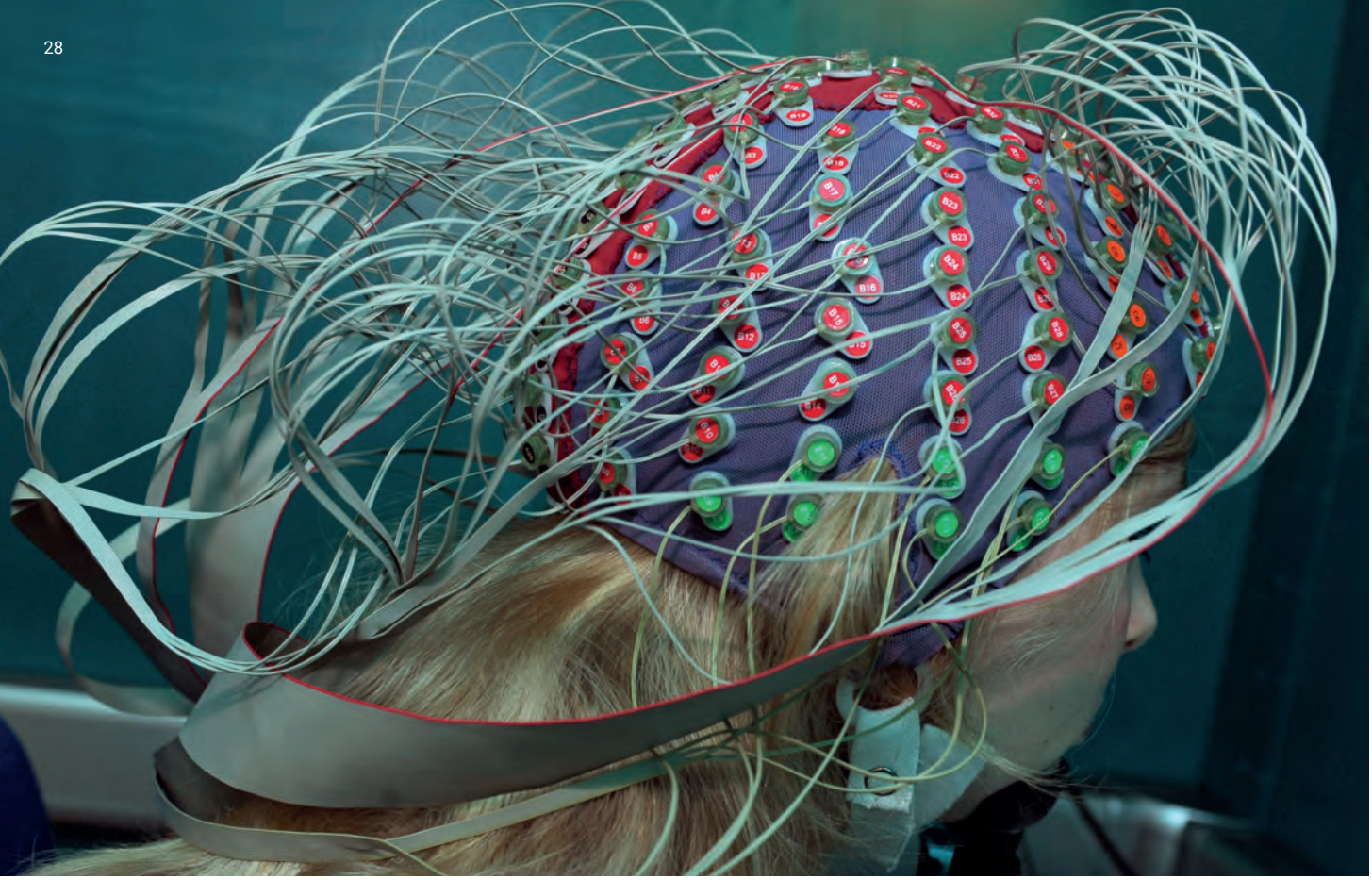
At some point during the last extremely hot summer I was at an outdoor pool with my son Ivo, and he asked me what the mark on my upper right arm was. This crater-shaped scar, barely the size of a small coin. I told him that it was a memento of my smallpox vaccination. I was just about to tell him all about vaccinations and smallpox in particular, but the three-meter slide appeared to be far more exciting than a disease that had been eradicated from the world back in 1980.

Infectious diseases have been claiming the lives of thousands, sometimes millions of victims, since time immemorial. The plague was the scourge of the Middle Ages, raging in times of difficulty. During the final stages of the First World War, some 100 years ago, the so-called Spanish flu pandemic claimed the lives of up to 25 million people. Nowadays, there are regular reports about the Ebola virus in Africa. Many of these diseases have lost their terror for us; diseases like polio, smallpox, and measles. To a certain extent, this is because of an improved hygiene and clean drinking water. Yet the greatest weapon that we have against these insidious viruses are vaccinations. People have been attempting to use weakened disease-causing agents to create a vaccine for millennia. Over 2,000 years ago, there were attempts in China to use the scab from pockmarks as a vaccine. With the discovery of viruses and a growing understanding of the interplay between pathogens and the immune system, the first vaccines were created back in the 18th and in the late 19th century in particular.

Pioneers in this field include Robert Koch, Louis Pasteur, Edward Jenner, Paul Ehrlich, and Georg Friedrich Ballhorn. Their findings were truly beneficial, many of them being the result of heroic self-experiments.

Once reliable vaccines had been developed, the World Health Organization called for action to combat epidemics. As part of a global campaign using vaccination guns, war was declared on smallpox. It was a mammoth task, especially as back then, the world was split into hostile camps as a result of the Cold War. Despite this, the vaccination campaign was a success: the last documented case of the disease occurring was back in 1977. Three years later, the victory over smallpox was announced.

I cannot remember how long I have had the small scar on my upper arm. But I do have very clear memories of the first vaccinations my children received. I remember the doctor asking whether we consented to the vaccinations. What a question! Of course, I know that there are opponents to vaccinations: people who call into question the efficacy of vaccinations, people who believe that vaccinations only benefit the pharmaceutical industry. They talk about the dangers of vaccination, of possible severe side effects. Yet, for my wife and myself, there was only one answer: we approve of vaccinations! ■



Brain on fire

Back in 2016, the film »Brain on Fire« brought a disease, previously hardly known, into the public eye: an autoimmune-related brain inflammation with the complicated name anti-NMDA receptor encephalitis. This rare disease leads to symptoms such as respiratory disorders and delusions, and is still hard to diagnose to this day. A team of German and Spanish scientists working, with Jena neurologist Prof. Dr Christian Geis, has now been able to explain the essential molecular mechanisms of the disease.

BY UTA VON DER GÖNNA

The autobiography of Canadian journalist Susannah Cahalan was published under the title »Brain on Fire« and the film based on the book was later released with the same name. Critics were not overly impressed with the film, but it did serve to bring the disease—a rare, autoimmune-related brain inflammation known for a decade—into the public eye. Triggered by certain tumours or viral infections, antibodies are produced which attack neurotransmitter receptors in the central nervous system. In Susannah Cahalan's case these antibodies attacked the NDMA receptor which led to confusion, psychosis, coma, and respiratory disorders. »NDMA« stands for N-methyl D-aspartate. This substance binds specifically to this receptor. Neurology has since discovered a whole range of different subtypes of these autoimmune brain inflammations, which see the immune system attack a receptor on nerve cells.

A research group from Jena, Barcelona, Würzburg, and Leipzig has now been able to explain the mechanisms of the autoimmune disease, in which the AMPA receptor becomes the target. »AMPA« is the abbreviation for α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid. Like the NDMA receptor, the AMPA receptor is one of the glutamatergic receptors and controls the transmission of nerve impulses in the brain; as such, it is vital for learning and memory processes. »Affected patients suffer from seizures, confusion, memory impairment, and personality changes«, explains Prof. Dr Christian Geis, a neurologist at the University Hospital and senior author of the study, the symptoms of the disease.

Using antibodies from patient samples

In order to conduct their research, the researchers used antibodies having been acquired from patient samples. These antibodies are specifically directed against a subunit of the AMPA receptor, which is vital for the electrical properties of the receptor. Receptors with this subunit are largely located in the synapses—the point of contact between two nerve cells—and are indispensible for the rapid transmission of impulses between the nerve cells.

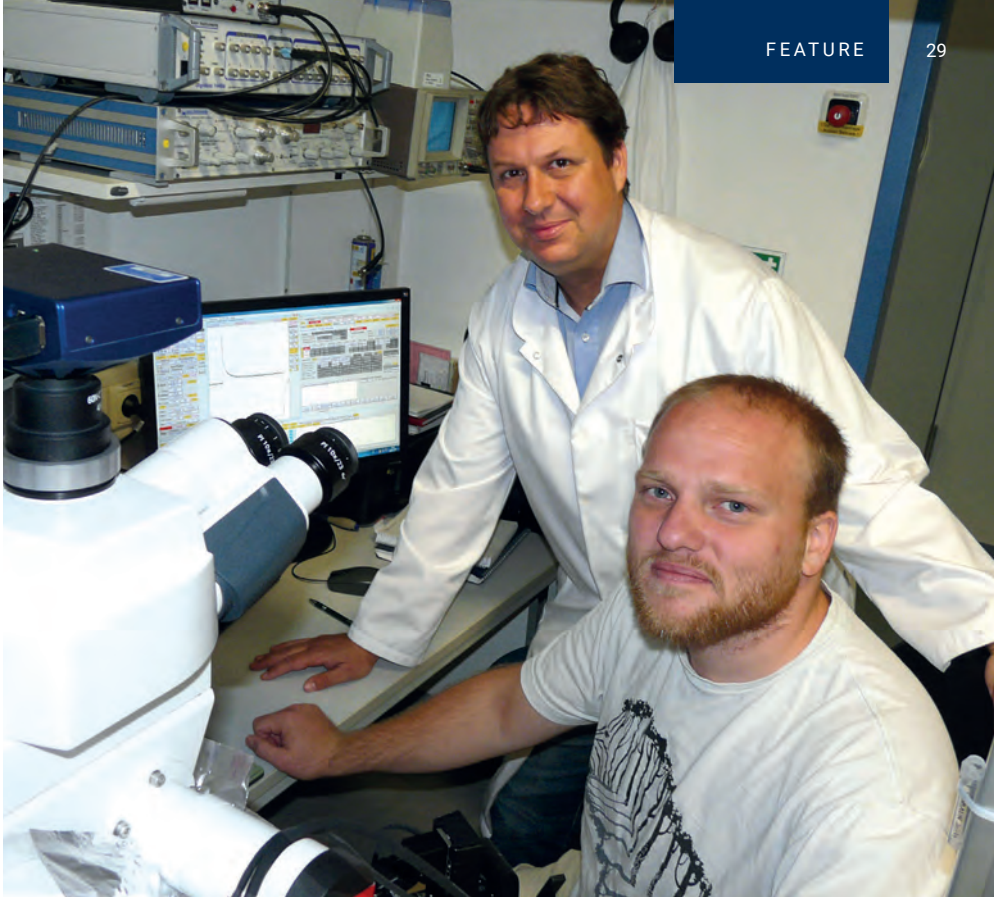


Photo on the left: test subject during an electroencephalogram (EEG). In the case of an encephalitis, changes to the brainwaves can be measured.

Prof. Dr Christian Geis and Dr Holger Haselmann (in the front).

Initially, the team of scientists studied nerve cells in cell culture. »Step by step, we could prove how the antibodies cause the withdrawal of the AMPA receptors with this subunit in the cell. We were able to trigger a chain of compensation mechanisms which lead to AMPA receptors without this subunit taking over the signal transmission in the synapses«, explains the biologist Dr Holger Haselmann. »With fatal consequences for the functioning and excitability of the synapse.« The next stage saw the researchers induce the disease in an animal model and investigate the nerve cells in the mice's brain, which had been administered with the antibodies. The same reorganization processes that had occurred to the AMPA receptors in the cell culture were once again recorded.

The consequences of this reorganization also became clear in the animal model. Holger Haselmann: »The ability of the synapses to adapt to the activity requirements was reduced in the ill mice in comparison with the healthy ones.« Known as »synaptic plasticity«, this characteristic is required for networking processes in the brain. Finally, behavioural tests showed that the animals with the disease suffered from limited cognitive performance. By way of comparison: patients with AMPA-receptor-autoimmune encephalitis suffer from confusion and problems with short-term memory.

Revealing the pathophysiology of the rare autoimmune disease

The scientists work in Jena and Würzburg as part of the »ReceptorLight« collaborative research centre are investigating the functioning of receptors using high-end microscopy. High-resolution fluorescence microscopy can be used to show the AMPA receptors in the synapse region with a resolution of 40 nanometers. »This state-of-the-art imaging technology makes it possible to grapple with and answer clinically relevant questions at a molecular level«, highlights Christian Geis. »We have been able to explain the underlying pathophysiology of a rare autoimmune disease.«

This allows the scientists to contribute to a faster diagnosis of the autoimmune inflammation of the brain, the symptoms of which are sometimes difficult to classify and and misunderstood occasionally. If the disease is suspected, immune tests can be used for a fast diagnosis. And, once the autoimmune disease has been diagnosed, it can mostly be treated successfully, as was the case for Susannah Callahan. ■

Original publication:
Human Autoantibodies against the AMPA Receptor Subunit GluA2 Induce Receptor Reorganization [...], Neuron (2018), DOI: 10.1016/j.neuron.2018.07.048

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Why the pain does not subside

Effective painkillers are a real blessing for medicine—but they also have a clear downside. Taken over a certain period of time, they lose their effect and can lead to addiction. A team of scientists from Jena, Sydney, Melbourne, and Marburg has now shed light on molecular details of the development of tolerance to opiates. The results could support the development of synthetic substances with low drug tolerance and reduce addiction potential.

BY UTA VON DER GÖNNA

Opiates such as morphine and synthetic opioids remain the most important painkillers in the treatment of pain, for example, after surgery or when having cancer. However, their use is severely restricted by a reduced respiration and represents a huge potential for addiction, too. The risk of these side effects is increased by a habituation effect. Developing tolerance means that the dose may need to be increased ten times to achieve the desired level of pain relief. These are key factors in deaths caused by overdose of opioids. The number of those has risen dramatically over the last decade, especially in the United States.

Specific docking sites for painkillers on nerve cells

For several years, the research group working with Prof. Dr Stefan Schulz at the Jena University Hospital has been researching the molecular mechanisms involved in the regulation of opioid receptors—the specific docking sites for these active substances on the surface of nerve cells. »Reducing the sensitivity of receptors in the case of an oversupply of neurotransmitters is actually a sensible protection mechanism against long-term stimulation by the cells«, explains the Professor of Pharmacology and Toxicology, the process that increasingly reduces the effect of painkillers. Once the receptor is stimulated by the active substance, enzymes ensure that phosphate groups are bound to areas of the receptor molecule lying within the cell interior. The scaffold protein arrestin is then bound to the receptor, which will eventually be incorporated in the cell. »In previous studies, we were able to show that this process is more noticeable in the case of synthetically manufactured highly effective opioids than with the drug morphine, the latter occurring naturally«, explains Stefan Schulz. »The signaling pathways for drug tolerance differ for these groups of active substances.«

Dr Elke Miess is lead author of the international study on the desensitization of opioid receptors. Together with her colleagues, she has been able to show that morphine and synthetic opioids have a different habituation effect due to varying mechanisms.

Drug tolerance mechanisms explained using bio-optical methods

Together with the colleagues from Sydney, Melbourne, and Marburg, the Jena-based researchers have now been able to provide further details about the mechanisms involved in the development of tolerance. They focused their research on the precise spatial and temporal sequences of the binding processes. »We discovered phosphorylation patterns which are highly specific for the different active substances and

On the photo, there are various medicines. Those with an analgesic effect, which are acquired from opium or synthetically produced, are called opioids. Their effects are based on the bonds of the active substances with endogenous opioid receptors.

control a sophisticated interplay of enzymes and scaffold proteins. In comparison to morphine, synthetic opioids increase the activity of enzymes and accelerate the desensitization of receptors,« sums up the lead author of the study, Dr Elke Miess. In addition to the standard molecular genetic methods, which were used in the cell culture, the scientists also applied highly sensitive bio-optical methods in their research. The proof that the protein arrestin had been bound to the receptor in individual cases was provided from three different procedures.

»We were able to explain vital molecular details of drug tolerance to opiod analgesics«, summarizes Stefan Schulz the results of the study. »The study provides helpful approaches for the development of opioids that are less addictive and less prone to tolerance.« ■

Original publication:
Multisite phosphorylation is required for sustained interaction with GRKs [...], Science Signaling (2018), DOI: 10.1126/scisignal.aas9609

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Is it all down to luck?

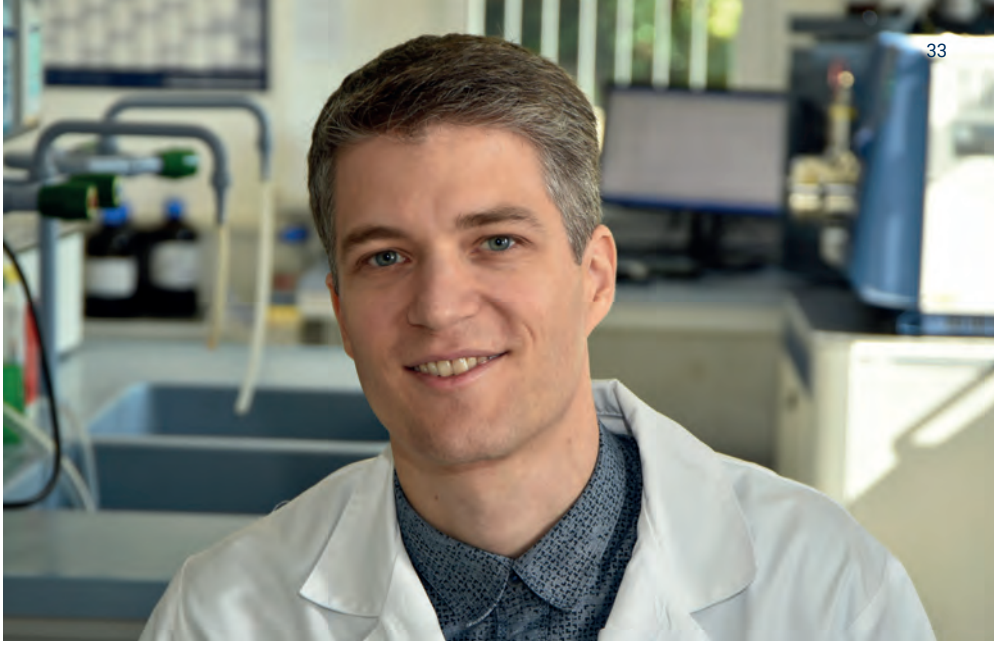
It is said to stop skin from aging, reduce joint degeneration in rheumatism and arthritis, and even protect against cancer and cardiovascular diseases. For nearly 100 years, researchers have been studying the effects of vitamin E and they have to a great extent clarified the chemical basis of its action in cell and animal models. However, vitamin E has so far failed to convince in clinical studies on patients. Biochemists and pharmacists from Jena, together with an international team have now explained the reasons for this.

BY UTE SCHÖNFELDER

»Vitamin E is an antioxidant; it neutralizes cell-damaging free radicals«, explains PD Dr Andreas Koeberle from the Chair of Pharmaceutical Chemistry. What has been sufficiently proven in cell and animal models under laboratory conditions has so far failed to convince in practice: »Clinical studies have produced very heterogeneous results«, says Koeberle. »It is not just that the positive effects of vitamin E often do not occur to the expected degree; sometimes there are even detrimental effects«, continues the biochemist.

Dr Koeberle and his colleagues have now found a possible cause for this: as

Doctoral candidate and lead author of the publication, Helmut Pein, uses a tandem mass spectrometer to analyse the metabolites of vitamin E.



Head of the study, Dr Andreas Koeberle.

the Jena research team has proven in a broad interdisciplinary study together with partners from France, Austria, Italy and Germany, the effect of vitamin E, which is taken as a tablet or capsule, is not related to the vitamin itself, but rather to a metabolic product. This substance, which goes by the name of α-carboxychromanol, has, amongst other things, a very promising anti-inflammatory effect.

Personalized medicine could make therapy more successful

α-carboxychromanol is formed in the liver. »The extent to which this happens varies greatly between patients, however«, explains Prof. Dr Oliver Werz, who led the study together with Dr Koeberle. As the Jena scientists have shown, the level of the metabolite in the blood of participants ranges widely between individuals. »If the effect of vitamin E depends on the extent to which the bioactive metabolite is formed, then we have a very good explanation as to why the same amount of vitamin E can have a specific effect for one person and a far more marginal effect in the case of others«, clarifies Werz. The pharmacist believes that this proves the great benefits that personalized medicine has to offer. »If we start by characterizing a patient's metabolism, successful treatments can be achieved with far greater precision, and not just for vitamin E.«
In this study, the researchers investigated the anti-inflammatory potential of α-carboxychromanol in detail. The bioactive metabolite inhibits a key enzyme involved in the inflammation processes (5-lipoxygenase, or 5-LO). Koeberle believes that these findings are extremely promising, because 5-LO plays a central role in inflammatory diseases such as asthma and arthritis.

Patent registered for a drug derived from α-carboxychromanol

»Until now, there has only been one approved drug that inhibits 5-LO, but its use is extremely limited due to its severe side effects.« The researchers want to use their findings to develop a new potential drug for the treatment of inflammatory diseases. One candidate derived from α-carboxychromanol has already been patented, explains Andreas Koeberle. ■

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»When the hammer does not hit the nail«

One diagnosis—one drug. In reality, it is normally not this simple. The effect of medication depends on many factors: in addition to age and body type, gender also plays a significant role. Personalized medicine takes these factors into account. In this interview, pharmacologist Prof. Dr Oliver Werz discusses its promises and limitations.

INTERVIEW: STEPHAN LAUDIEN AND TILL BAYER

What does personalized medicine mean?
Personalized—or, better, stratified medicine—takes the biological constitution of patients into account during treatment. Factors such as the patient's age, weight, gender and body fat potential all influence the effect of medication and how it is broken down in the body. An example: if a small, slim woman and a heavy man take the same dose of a drug, they will each experience different results. I work in the field of gender-specific medicine.

Where is stratified medicine used?
The main areas of treatment are in cancer therapy and the treatment of viral diseases. The patient's genetic make-up is of crucial importance. If, for example, a cancer patient does not have the specific mutated gene that the medicine combats, targeted therapy doesn't make any sense. You can't hit the nail on the head if there is no nail to hit. The medicine only takes effect if the gene is functioning in a specific way. It is now mandatory to perform certain tests before respective medication is prescribed.

What kind of research is being undertaken in Jena in the field of personalized medicine?
As far as I am aware, we are the only Institute of Pharmacy in Germany that is researching the effect of medication in regard to gender. We have discovered that the efficacy of drugs, especially those used to combat autoimmune diseases such as rheumatoid arthritis, differs between men and women. Women are significantly more prone to autoimmune diseases than men. One reason for this is that women have two X chromosomes and certain alleles are present twice over. Furthermore, sex hormones have a major influence. The problem is that the drugs are still developed based on the male organism. One first step would be to adjust the dosage, so it is gender-specific.


Prof. Dr Oliver Werz.

Why is the dosage so important?
The body's ability to metabolize the active substances in medication has a huge impact on how effective they are. Some patients have slow metabolisms, some have normal and some have fast. Also, because the active substances are often stored in fatty tissue, body fat percentage also plays a role. The »King of Pop« Michael Jackson, a very slim man, probably died as a result of an excessive dose of a relatively harmless drug. This drug (propofol) is broken down more quickly in women and is redistributed from the blood into the fatty tissue.

Is the third gender taken into account in the research?
There are only very few studies about the third gender. There have been studies into the effect of sex hormones following sex changes, for example. The problem is that there is too little biological test material, such as blood samples, available. Overall, I am sorry to say that intersex people have thus far been neglected from the research.

What about children?
The dosage is generally adjusted for children. A well-known medicine such as paracetamol or certain antibiotics are prescribed depending on age and body weight. Children are not allowed to take some medication in any form, as it would affect growth processes. But there is a need for further improvement in this field too. In addition, puberty—which means the period of transition from childhood to adulthood—is largely disregarded.

In other words, there is a need for an approach that is more tailored to individual characteristics?
We can see a very clear need for action where the parameters are soft. Nevertheless, classic personalized medicine, which focuses on individual circumstances, is an important field of research. But you have to keep an eye on the practicalities too. Lab-based genetic testing is not cheap and also prompts ethical questions. Many patients do not want their genes to be investigated. Often, they don't understand that these tests will only concern specific genes. ■

On the photo on the right, a paediatrician Prof. Dr Bernd Gruhn was able to treat Yuna's rare, immature, and acute lymphoblastic leukaemia with targeted antibody therapy. Yuna's father is on the left.

Therapy for Yuna

The little Yuna and her parents can finally smile again. Following an eight-month-long treatment in the Paediatrics unit at the Jena University Hospital, the 17-month-old toddler is now free from leukaemia cells. It has been a long journey to get to this point. Jena physicians saved Yuna's life with individually tailored antibody therapy.

BY ANNE CURTH

When she was just ten weeks old, doctors diagnosed Yuna with a rare acute lymphoblastic leukaemia (ALL). They also found signs that are typical of an acute myeloid leukaemia (AML). Acute leukemias are malignant diseases of the haematopoietic system. The leukaemia cells suppress the normal blood formation in the bone marrow. Neither special chemotherapy nor an antibody therapy at a clinic in Valencia did not take effect against the persistent leukaemia.

But her parents did not give up. Shortly before Yuna was born, they had emigrated to Spain from Germany. They were searching for a hospital in Germany that would be able to help their daughter with the transplantation of haematopoietic stem cells. They received ten rejections from other hospitals in Germany before receiving a positive response from the Jena University Hospital.

»As Yuna was still relatively well at that point, despite her illness, we saw an opportunity to help her by transplanting blood stem cells«, says Prof. Dr Bernd Gruhn from the Paediatrics unit. The 50-year-old Bavarian was found to be an ideal stem cell donor.

Individually tailored antibodies effectively destroy leukaemia cells

In order to reduce the risk of relapse after a transplant, the number of leukaemia cells must be reduced as far as possible in advance. Since chemotherapy had not worked in Valencia, the Jena paediatric oncologist opted for antibody therapy targeted specifically at Yuna's leukaemia cells. The young patient was given the medicine each week via an intravenous drip. Three different antibodies—»gemtuzumab«, »daratumumab« and »inotuzumab«—were used and carrying the active substance, a toxin, to the leukaemia cells to destroy them effectively.

»It is not just the combination of these antibodies, it is also the use of the drugs daratumumab and inotuzumab that was special, as no child had been treated in this way in Jena before, and only a few in Germany«, explains Gruhn. The individualized antibody therapy was successful. Following the last infusion, there were no further traces of leukaemia cells in the bone marrow.

Combination of four medicines used for the first time in Germany

But the actual transplantation of blood-forming stem cells was still to come. In order to ensure that the new blood stem cells were not rejected, Yuna's own bone marrow had to be destroyed and her immune system suppressed. For this purpose and the first time in Germany, the Jena-based physicians used a combination of four different medicines. They then transplanted the donor's bone marrow into Yuna. Yuna underwent intensive examinations 30, 60, 100, and 150 days later—always with the same result: her bone marrow is free of leukaemia cells. ■

Microbes decompose harmful substances

In a laboratory at the Institute of Microbiology, Dr Stefan Kruse is preparing a bacterial culture for investigation into a so-called anaerobic chamber. Being cultivated in an oxygen-free environment, the epsiloproteobacteria decompose pollutants such as chlorofluorocarbons (CFCs). During the process, hydrogen is produced.

Althöfer rolls the dice!

Ingo Althöfer actually wanted to be an astronaut. But things turned out rather differently. Instead of spending his time in the infinite vastness of space, he roams the world of mathematics. And, contrary to the stereotype, he is a very grounded academic. The fact that he now teaches in Jena is owed to a series of coincidences—or the work of a »higher power«. This portrait presents a researcher, whose curiosity knows no limits.

BY STEPHAN LAUDIEN

When you enter Ingo Althöfer's office, you immediately notice a globe. »I like to ask my visitors to show me where they are from«, says Althöfer. This this often helps to break the ice. It may also help to get over the initial shock. Because, when you see the chaos in the room, you would be hard pushed to guess that Althöfer actually teaches mathematical optimization. One shouldn't jump to conclusions, however: it may not look tidy, but Althöfer always knows where to find whatever it is that he wants to show his guest. And—even better—he has a story to tell about each and every artefact. There is, for example, a ball with cork discs attached to it. Guests are invited to leave a farewell greeting on it as they leave—in the form of a prime number. A cake box stands next to the globe. It belongs to an Austrian colleague, says Althöfer. It is there so his colleague doesn't forget it next time he pops by.

The fact that Ingo Althöfer became a mathematician is owed to a series of happy coincidences. A hyperactive child, Ingo Althöfer followed the Apollo 8 mission by the Americans and was clear about what he wanted to be when he grew up: »I'm going to be an astronaut!« But his father soon brought him back down to earth: »You feel sick even driving in a car«, and so the youngster decided he would rather teach maths. His grandfather may have been his role model. He spent three days developing a perfect lottery system but didn't win. »Our family has a great propensity for these kind of crazy antics«, says Ingo Althöfer. He had a penchant for numbers even as a child. As such, it was not that big a step to make the switch from being an astronaut to a maths teacher. Encouraged and pushed on by the headmaster of his school in his hometown Lage/Lippe, following his A-levels, Ingo Althöfer moved a few kilometres to Bielefeld to study mathematics. The ambition to become a professor was stirred up by his father. After his cousin had become a professor (of political sciences), his father set him the same goal. In 1986, Althöfer wrote his doctorate on »Some mathematical foundations of computer chess«. Five years later he received his habilitation (= doctorate B) with a thesis on error propagation in game trees and recursion trees.

Ingo Althöfer has been teaching at the Friedrich Schiller University in Jena since autumn 1994. He openly admits that Jena was not his dream destination. »I had applied to Dortmund and Passau«, explains the 57-year-old. During an excursion with his local church—Ingo Althöfer is a member of the United Methodist Church—the bus travelled along the A4 past Jena-Lobeda and the bus driver pointed out the city of Jena on the left. Back then there was no Lobeda tunnel, and so the view of the city was not particularly inviting. Years later, Ingo Althöfer held a lecture in Jena and then got offered a chair. He asked for time to think, and spent a week by the River Saale, learning to paraglide. During that week, there were a few coincidences that tipped the balance towards Jena: FC Carl Zeiss (soccer, bottom of second league in Germany) won a match against Borussia Dortmund (top of Bundesliga) and, whilst rummaging through a box of books, Althöfer came across the book »The Decline of Passau«: two signs that his preferred destinations might not be the appropriate ones. »Of course, lots of people just see these as coincidences, but I believe in a higher power!«
Thanks to this higher power, Ingo Althöfer now commutes to Jena from Lage each week. He hasn't moved to Jena because of his wife Beate, who is wheelchair-bound. He is only here from Tuesday evening to Friday: »On Tuesdays I look forward to seeing my students; on Fridays I look forward to my wife!« Prof. Althöfer doesn't just teach his students about the basics of mathematical optimization, he also gives them tools for

There is still a lot of space on the cork ball, which the mathematician Prof. Dr Ingo Althöfer gets his guests to mark with prime numbers as a souvenir.

their future lives: »I don't just teach my students about maths; I also teach them how to communicate with non-mathematicians.« Althöfer knows, of course, that mathematicians are often seen as being out of touch with reality; as nerds who bury themselves in their work and forget about the world outside. That is the reason behind his rule that the beginning and end of exam theses must be written in generally understandable language—»the magic of math can happen in the middle!«

The mathematician has developed numerous games

The ability to lose oneself in mathematical problems is also one of Ingo Althöfer's traits. But he maintains a connection with »worldly« topics. Thus, for example, the passionate chess player was fascinated by the idea of playing against international chess masters with a three-brain method. Three brains, that is to say two computers and Althöfer, competing against a professional chess player. The two computers each suggest a move and then Prof. Althöfer plays one of these candidate moves. In 1997, he used this method to defeat the German number one, Artur Yusupov. In the City of Culture Year 1999, there was supposed to be a match against Garri Kasparov, but it didn't take place. »Kasparow had lost to Deep Blue and didn't want to compete against a computer in public again«, says Ingo Althöfer. It would also have been difficult to raise the 500,000 Marks needed to pay for the spectacle.
After the three-brain experiments with chess, Ingo Althöfer turned his attentions to the game of Go. Computers have now defeated humans in this game too. Ingo Althöfer has recently founded a German Freestyle Go League, in which the use of computers is permitted. He expects the strongholds of German informatics, Karlsruhe or Paderborn, to win; unfortunately, the team »Jena International Go School« missed the application deadline.
Ingo Althöfer is fascinated by games. »Stacheldraht« is his favourite game. It is also known as »Rauf-und-Runter« or »Wizard of Oz«. The mathematician has developed numerous games himself. His most successful game is »Finale« alias »Torjäger«, with 240,000 sold copies. Ingo Althöfer says that his best game is »EinStein würfelt nicht« (or Einstein doesn't roll dice), which he published using his own label. What makes a good game? »You need to be able to understand the rules in in one minute without the need for 80 pages of instructions.« When negotiating with games publishers, he believes it has been advantageous to not let on that he is a mathematician: »We are seen as being too highbrow and complex; it scares people off.« Occasionally, Ingo Althöfer goes on stage to prove that mathematics isn't witchcraft: he has already taken part in the »Einstein Slam« three times. At the Première 2015 in Jena, he won with »Roulette with physics«. One year later, he came third with his lecture on »The physics and mathematics of high heels« and in 2018 he came second. The title of the lecture: »Lego bricks in the washing machine«.

Althöfer's latest project doesn't have anything to do with games. Over the next year he wants to write a biography of the mathematician Lothar Collatz, whose 200 boxes of work he found in the Hamburg University archive. »I didn't realise how fun it is to dig around in the archives.« He now wants to share this joy with his readers. The book about the numerical mathematician Collatz, who left behind 1,200 academic schoolars, is intended to be an entertaining read that is also suitable for non-mathematicians. You don't need a prophetic gift to be able to predict the success of this next endeavour by the down-to-earth academic Althöfer. ■

Doing humanities in the age of Trump

A humanities scholar in the USA: historian Dr Alexander Schmidt (photo) held a summer seminar at the University of Chicago in 2018. At first, it hung in the balance. The Jena-based researcher and his Chicago collaborator suddenly found themselves competing with Donald Trump's border wall with Mexico.

BY STEPHAN LAUDIEN

What is the use of studying Rousseau nowadays? What do Immanuel Kant or Hegel have to offer? In this era of the efficiency rule, obsession with economic growth and austerity measures, the humanities are under scrutiny. The situation in Germany is not entirely different from that in the United States. Yet there are clear differences according to Dr Alexander Schmidt, who teaches and researches at the Research Centre »Laboratory of the Enlightenment« at the Institute of History. Schmidt's work focuses on the history of ideas of the 18th century.

In July 2018, Alexander Schmidt returned to the University of Chicago, where he hold a summer seminar entitled »Invisible Bonds: the Enlightenment Science of Society from Mandeville to Hegel« together with historian Professor Paul Cheney. The seminar, which was aimed at faculty teaching in American higher education, was made possible by an extensive competitive grant from the National Endowment for the Humanities (NEH).

Choosing the participants was an exciting task, says Alexander Schmidt. There were over 40 applications from across the USA and overseas for the 16 scholarship places. »We had to find a working mixture of academic quality, communication skills and a diverse background that reflected the academic reality beyond the private elite institutions«, highlights Schmidt.

As a US federal agency, the NEH is under growing pressure. At the beginning of 2017, the Trump government intended to completely slash the funding for the NEH and the National Endowment for the Arts. »The fate of our application for a grant was suddenly linked with Trump's prestige project—the funding of the border wall with Mexico.«

A growing acceptance problem for humanities in the United States

Alexander Schmidt speaks of growing issues of acceptance for the humanities in the United States, not least since Trump became president: »There is a popular view, especially amongst conservative think tanks, that humanities encourage liberal, left-wing opponents and that funding these subjects should be down to philanthropists not the state.«

At the same time, the humanities have traditionally played a surprisingly key role in American higher education according to Schmidt. The Liberal Arts Education is mandatory for all students at many colleges. In other words, anyone who has enrolled to study physics or medicine first has to read texts written by Homer and Plato. »A general education in the humanities is seen as the foundation to a democratic society«, says Schmidt. He stresses that it is essential for a functioning democracy that citizens are encouraged to make their own judgements and to engage critically with problems, using their creative skills and capabilities.

Alexander Schmidt experienced the exercise of these intellectual capacities developed in American higher education at first hand during the seminar on the Enlightenment political thought in Chicago. Discussions included whether the ideas and ideals of the Enlightenment apply to all humans or whether they had been merely developed by and for derived from a handful of »old, white men« and thus do not really apply to people of colour, slaves or homosexuals.

The seminar was attended by a broad mixture of participants at different stages of their academic careers: there was, for example, a political scientist with Pakistani roots who teaches military veterans at a community college in Arizona; a Canadian professor from the American University in Cairo; and an Israeli postdoc from New York.

The aim of the seminar was not just to analyse the debate about the nature of society as a central hub of Enlightenment thought; but also, to inspire the participants in their own teaching and research. Some participants were thrilled to just have access to the University's excellent Regenstein Library. The budgets of higher education managers, who are driven by efficiency, have seen the funding for established subject libraries be slashed. Who needs printed books when you have the »Kindle«? ■

Field post to Professor Cartellieri

The First World War ended 100 years ago leaving deep scars behind at the University of Jena, too. Three out of every four male students interrupted their studies to go and fight as soldiers. In the courtyard of the Main University Building, large memorial plaques hang in remembrance of their fate.

BY TILL BAYER

15 April 1917, somewhere in Russia. Hans Müller's unit has been fighting Russian soldiers, whose nation has been shaken by the end of the tsarist regime, for days. Suddenly, Russian infantrymen rise from their trenches waving white handkerchiefs and approach the wire entanglement of the Imperial German army. The Germans soon realize what is going on. Their opponents want to celebrate Easter with them. Müller feels like he is in a »childlike dream«: the soldiers unanimously throw their weapons to the ground and shake hands. Unfortunately, this moment of peace was short-lived. The Russian artillery fired on their own troops and forced the soldiers to continue the fighting.

This remarkable report from Hans Müller is part of a collection of written correspondence that the students sent from the front lines to Jena Professor Alexander Cartellieri. The conservative historian stored the documents and sent the senders sweets and small gifts in return. Today, the letters can be found at Thuringia University and State Library. The letters represent important documents from the period as they provide first-hand accounts of a war in which three out of four men enrolled at the University took part in between 1914 and 1918. Among other things, they tell of the atrocities of the struggle, the rigours of marching, and how soldiers spent their time between operations. Above all, the letters show how differently people perceived the experience of being on the frontline. Ernst Bischof, for example, claimed that he had never experienced »a purer, deeper joy« than in the trenches. He enthusiastically describes heroic deeds. Following a bomb explosion, he was the only surviving officer in his battalion and believed it to be a »divine intervention«.

Meanwhile, the words of Heinrich Simons, who was deployed in France, express disillusionment. Following his deployment, he dreamt »of battles and charges, of man-on-man fights«. The reality was a life with the fear of ending up as »cannon fodder«.

Memorial plaques remind us of the Jena students who lost their lives in the First World War.

Teaching severely restricted during the war years

The young soldiers remained enrolled at the University of Jena to keep up apperances of a functioning operation. But in reality, the University was severely constrained during the war years. Events were cancelled and the general scarcity of resources meant that funding for heating, lighting, and laboratory costs was slashed. This status only changed following the German defeat and the end of the First World War on 9th November 1918—a date that also marked the transition from a monarchy to the democracy of the Weimar Republic. The real student numbers rose once again and reforms of the University life were introduced. The various different war experiences and interpretations having been expressed in the letters had a strong effect on the political conflicts which went hand in hand with these reforms. The end of the war in 1918 came too late for over 400 students. They never returned to Jena from the battlefields of the First World War. In remembrance of their fate, the memorial plaques were installed in the courtyard of the Main University Building. ■

PSYCHOLOGY

Beneficial crises

USA, France or Australia? Spending a year studying abroad is a big step for young people. You don't just live in a different country, you often go through a proper identity crisis. A study by psychologists at the University of Jena has now proven why it is still worth leaving your familiar surroundings, family and friends for a long period of time.

BY SEBASTIAN HOLLSTEIN

There are plenty of good reasons for young people to spend a year studying abroad: they learn about other people and cultures, improve their language skills and become more independent. And they experience crises of identity, which may shake them over the short-term but actually strengthen their character over the long term, as psychologists at the University of Jena have now discovered. As part of the PIRATS—»Personality, Identity, and Re-

Image left: Discovering the world is well worth the effort. And not just in terms of language skills; it is also beneficial for personality development.

Image right: Psychologist Prof. Dr Franz J. Neyer is in favour of funding stays abroad.

lationship Experiences in Adolescent Trajectories«—project, which is funded by the German Research Foundation, they interviewed 741 school children aged between 14 and 17 years; 457 of them had completed a year abroad.

Self-image is definitely questioned during the stay abroad

»Generally speaking, identity development follows a fairly straight trajectory on the road to becoming an adult«, says Prof. Dr Franz J. Neyer, who carried out the study, together with his colleagues Dr Henriette Greischel and Prof. Dr Peter Noack. »Despite this, we have been able to show that this process can fluctuate.« This has now been proven for the first time in longitudinal research: the Jena-based psychologists surveyed the pupils prior to spending a year abroad, as well as during and after their return. As such, the transition periods could also be tracked.

As a result, the researchers discovered that young people questioned their self-image as a result of their new perspectives, and thus went through an »identity crisis«. »The school children didn't necessarily feel great during this period, but they got through it. And the experiences that they gained from this process later proved to be positive and important«, says Neyer.

The psychologists focused on two parameters in particular in their evaluation of identity development: the relationship to the home country and the notion of friendship held by the respondents. The international students identified very strongly with their home country shortly after moving abroad. After their return, however, these values were significantly weakened.

»By expanding their own horizons, the school children posed questions that those who stayed at home simply didn't consider; for example, where they actually come from, whether they would like to live in Germany or if they could imagine living in a different country«, explains the expert from Jena.

There is a similar pattern in relation to social environment. Ties to friends and parents were stronger at the beginning of the stay abroad, but they were brought into question more after the return. Thoughts arise like: Does this circle of friends suit me? How much do I identify with my friends?—as such, the youngsters undergo an intense process of reflection, which can prove valuable in later years. The scientists were not able to determine such effects in the comparison group.

Those going abroad are usually already open-minded and extroverted

It is important to stress that young people develop well even without spending a year abroad. Not everyone is well-suited to these exceptional situations. Most of the pupils who complete a year abroad are already open-minded and extroverted. »But our research suggests that funding in this sector should be increased, so that periods of studying abroad are not dependent on the educational background and income of the children's parents«, says Neyer. ■

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SOCIOLOGY

Right-wing working-class movements

Right-wing populist opinions are growing in popularity, also among unionized workers. According to the results of a study conducted by the sociologists at the University of Jena, the social question—i. e. the conflict between those at the »top« and those at the »bottom« of society—is increasingly interpreted as to conflict between »the Germans« and »the migrants«. A trend that poses a dilemma—not only within trade unions.

BY SEBASTIAN HOLLSTEIN

Some workers' representatives were worried prior to the works council elections in the spring of 2018. They feared a shift to the right among the representatives to be elected. As the studies conducted by the sociologists at the University Jena show, this is because of the fact that even active and unionized workers are increasingly adopting right-wing positions. Recently, this has been proven by a study conducted by the sociologists working with Prof. Dr Klaus Dörre which was published in the Berlin Journal of Sociology. »There may only have been a few candidates who aggressively professed to hold right-wing positions during the works council elections«, says Dörre. »But that does not mean that these views do not exist.« 19 percent of workers and 15 percent of union members voted for the German right-wing party »AfD« (Alternative for Germany) in 2017. As the party's overall vote percentage was 12.6 percent, this proportion is clearly above-average.

In their study, the sociologists showed that followers of right-wing populist positions within the working class are certainly not just found on the corresponding electoral lists, but also within established and enthusiastic members of trade unions, and other bodies representing workers. In an earlier study in 2006, Dörre and his colleagues showed that right-wing populist views were already established amongst the working class, but it had not been visible among active trade unionists back then. Since then, however, a clear sympathy for the views of the AfD and groups such as Pegida have been identified amongst active minorities.

»We see the patterns of interpretation stiffening, so that it is not longer possible to debate with arguments with those

On the photo on the left, there is a poster from the demonstration against a rally by the xenophobic Pegida offshoot Thugida in Jena. As the sociologists observed, right-wing populist parties and groups have had an above-average number of supporters among workers.

On the right photo, the sociologist of work Prof. Dr Klaus Dörre who led the recent study.

people involved«, explains the Jena-based sociologist. »When compared with our previous study, we must also realize that supporters of right-wing populist views consider themselves to be true democrats.«

While the democratic parliamentarianism was still met with reservations during the previous study, they are now arguing for more direct democracy. However, they define the concept »people« based on ethnicity, not on belonging to a state. »The radicalism which has seen the social question—in other words, the conflict between those at the bottom and those at the top of society—becoming a conflict between those inside and those outside, i.e. between so-called »Biodeutschen« (»the native Germans«) and »the migrants«, has reached a new level«, says Dörre. »This is further compounded by the fact that the AfD has attempted to charge the social question with populist ideas, for example, with the national social wing led by Björn Höcke.« The ongoing wage inequality and change to the population structure in the eastern parts of Germany has even intensified the right-wing tendencies.

Distinctions and open debate are necessary

The unions themselves have still been looking for a strategy to tackle this problem. However, a significant majority of their members remain steadfastly against right-wing populist orientations. Despite this, the unions are faced with a dilemma: »On the one hand, they fear losing members if they clearly distance themselves from the right-wing populist opinions«, explains Dörre. »On the other hand, if they do not make a clear distinction between these positions, the right-wing members will exploit the political neutrality of the trade unions, which will in turn create pressure from the left.«

Dörre is convinced that workers' representatives need to seek to encourage open debate whilst also making it clear that populist opinion is an »explosive charge« for trade union solidarity. Solidarity can only function by bridging genders, ethnicities, and nations. »The trade unions must ensure that their members are able to argue effectively against right-wing populist opinions, to dissect them, and to expose the demagogy behind them.« ■

Original publication:
Arbeiterbewegung von rechts? Motive und Grenzen einer imaginären Revolte, Berliner Journal für Soziologie (2018), DOI: 10.1007/s11609-018-0352-z

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CHEMISTRY

A shortcut in the sulphur cycle

Plankton plays a key role in the global sulphur cycle. Although this has been known for a long time and is well-studied, chemists from Jena have now made an unexpected discovery: they found a previously unknown metabolic pathway in tiny marine algae and bacteria, which has a huge impact on the global sulphur cycle.

BY SEBASTIAN HOLLSTEIN

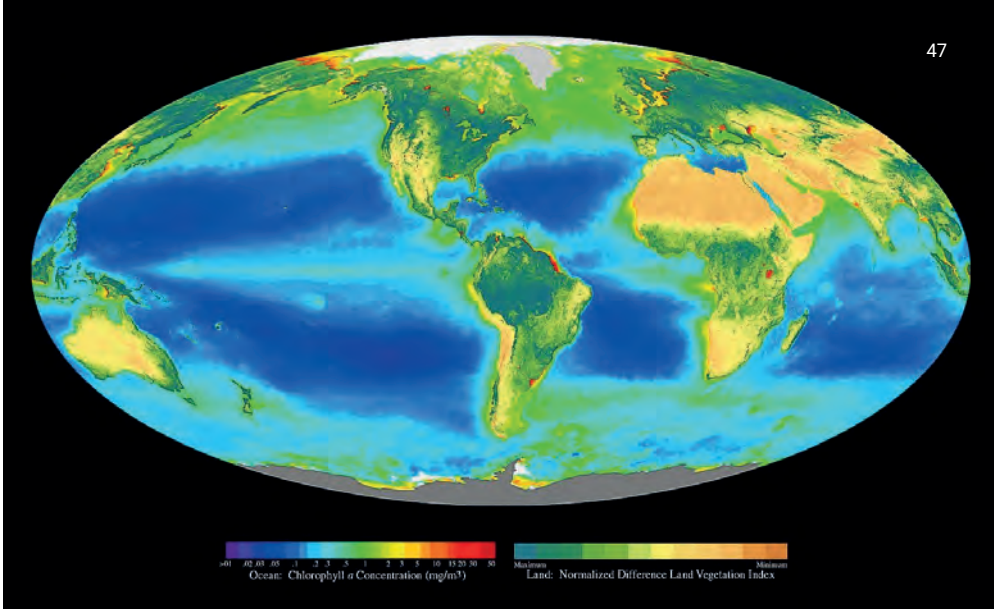

Image left: Prof. Dr Georg Pohnert inspects algae cultures that are bred in a special container.

Image right: The graphcal representation of our globe by the space agency NASA shows the amount of chlorophyll, which is produced by marine algae in the oceans. In addition, the tiny algae produce huge amounts of the sulphurous substance DMSOP.

Sulphur can be found everywhere on earth: in the atmosphere, in the oceans, and on land. Its forms of appearance are connected in a cycle. »Sulphur is initially reduced from the mineralic form sulfate and transferred into organic compounds; it is then passed around by organisms until it finally reaches the atmosphere and is then oxidized to sulfate before it is returned to the land and oceans via rain«, says chemist Prof. Dr Georg Pohnert, explaining the global sulphur cycle. Together with colleagues from the USA, he and his team from the Institute of Inorganic and Analytical Chemistry have discovered a »shortcut« in this well-known cycle.

It is tiny organisms in ocean plankton that are responsible. »We've found that certain single-cell algae and bacteria, which form part of the plankton in the sea, produce a chemical compound with the complicated name Dimethylsulphoniopropionate, or DMSOP for short«, says Pohnert. »This has allowed us to deduce valuable information about the global sulphur cycle, and we can now provide a new explanation for huge quantities of sulphur flow in the cycle. Even though one microalga only produces negligible quantities of the compound, we're talking about several tera-grams in total, so several billion kilograms a year.« This is because single-celled algae are extremely active in the world's oceans. The findings made by Jena's chemists thus give better understanding of Earth's sulphur cycle, which offers important knowledge for atmospheric and climatic models.

Sophisticated system as stress protection for algae

However, the findings do not just help us to better understand the sulphur cycle. The scientists found one reason for the production of DMSOP by investigating how the algae adapt to their environment. »These single-celled organisms are permanently moving around in the sea, and so they're constantly exposed to different salt contents and oxidative stress«, explains Pohnert. »The new compound now shows how this stress can be balanced out through a sophisticated system of chemical reactions.« One way of doing this is by producing and breaking down highly polar organic molecules. DMSOP plays a key role here.

The Jena-based scientists, whose work is supported by the »ChemBioSys« (see p. 10) collaborative research centre, investigated water samples from different ocean regions for their research. The aim was to find out whether the production of the sulphur-compound was a global phenomenon. »We found DMSOP in all investigated samples taken from the Arctic to the Mediterranean«, explains Prof. Pohnert. »So, producers of the sulphurous compound can be found everywhere.«

These new results have provided with important information about the functioning of microbial communities in the ocean. The results are also relevant for possible concrete applications. »More and more algae are being grown in aquaculture to produce animal feed, foodstuffs and energy. That's why it is important to fully understand their metabolism«, says chemist Pohnert. »These latest insights have once again revealed the incredibly complex and effective system that is hidden away in plankton.« ■

Original publication:
The metabolite dimethylsulfoxonium propionate extends the marine organosulfur cycle, Nature (2018), DOI: 10.1038/s41586-018-0675-0

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The psychological map of Germany

North Germans are stand-offish, South Germans are friendly—big city dwellers are open-minded; those living in the countryside are more reserved. There are plenty of stereotypes about people living in different regions of Germany; not least with the East-West comparisons. But how much truth is there in these attributions and what causes regional personality differences? A study provides some answers.

BY SEBASTIAN HOLLSTEIN

Economists at the Friedrich Schiller University have been working together with psychologists from Australia, the United Kingdom and the United States and have discovered that many of the stereotypes attributed to different population groups are actually accurate. The researchers have compiled »psychological maps«, which consider the level of five different personality traits. They analysed the data from over 73,000 people aged between 20 and 64, who took part in an online personality study as part of the international »Big Five Project«.

»Important progress has been made in research into cultural differences between regions recently thanks to large datasets like these«, says Prof. Dr Michael Fritsch, who conducts research at the University of Jena together with his colleague PD Dr Michael Wyrwich. »Our work focused on the so-called Big Five. This concerns five personality traits, which remain relatively constant throughout adulthood and which can be used to comprehensively describe the personality structure of a human adult«, explains Prof. Dr Martin Obschonka from the Queensland University of Technology. These five personality traits are: extraversion, i.e. an outward, active and sociable attitude; tolerance, in the sense of a willingness to cooperate and altruism; conscientiousness, i.e. organized, carefully planning and reliable; an openness to new experiences, which are identified through an active imagination, curiosity and a preference for variety; and neuroticism (low emotional stability) and a tendency for anxiety, nervousness and uncertainty.

Tolerant Bavaria—conscientious Mecklenburg

When you depict the degrees of these personality traits on a map, you can see certain characteristic profiles that partly confirm common stereotypes, despite the great diversity. You can, for example, see that South Germans and residents of large cities, such as Berlin, Hamburg and Munich, are more open-minded than those living in coastal areas, for example. There is a similar difference between former East and West Germany, which confirms the stereotype of East Germans being more introverted in comparison to the rather more extroverted West Germans. Tolerance is less pronounced in Mecklenburg-Western Pomerania than in southern Bavaria, the south-west of Germany near Freiburg and in western Saxony-Anhalt, for example. By contrast, residents of the Mecklenburg Lake District show higher values of conscientiousness—unlike the region around the Baden-Württemberg capital of Stuttgart. People in southwestern Germany tend to be more emotionally stable than those in southern Thuringia or in the area around Bremerhaven. »When it comes to the regional distribution of neuroticism in Germany, we noticed a two-way split within Germany and, surprisingly, it clearly follows the historic Limes line—the lower values are found south of the Limes. In other words, people there exhibit a more stable emotional personality, which is connected to well-being and psychological resilience«, explains Fritsch.

And, a general rule: people living in rural areas tend to have a lower degree of openness to new experience than city dwellers. The most open people tend to live in Berlin and in the metropolitan regions around Hamburg and Cologne, as well as Leipzig and Dresden.

East-West differences and migration patterns

There are relatively few differences between East and West Germany. Nevertheless, it appears that East Germans tend to be slightly less extroverted, less emotionally stable and less open to new experiences than West Germans.

The scientists also took a closer look at migration patterns. »The study shows that people who were born in the countryside and moved to the city are significantly more open-minded than those who stayed in the countryside«, says Michael Wyrwich. »In the case of people who take the opposite route and move from the city to the countryside, extraversion, openness and tole-

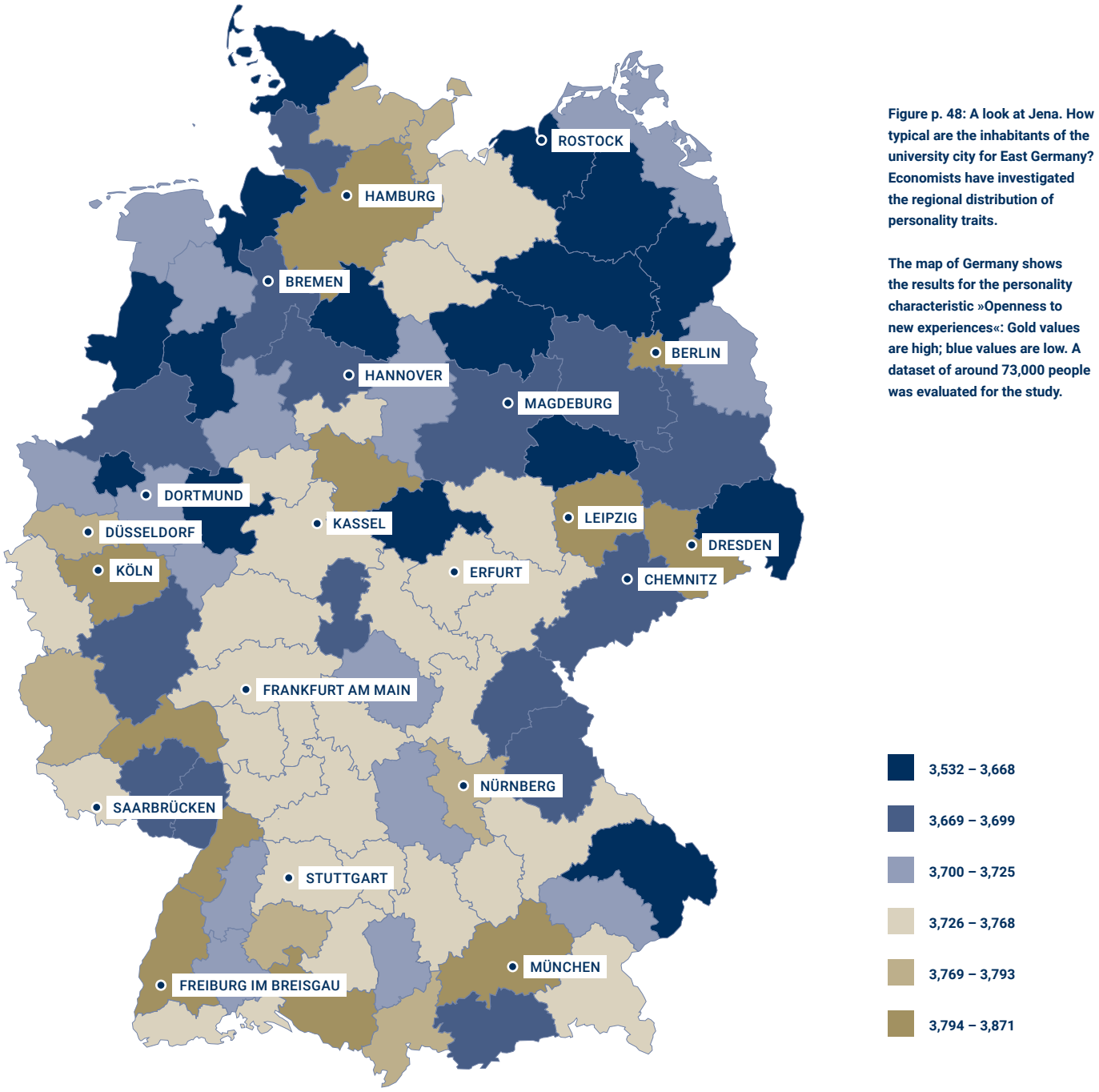

Figure p. 48: A look at Jena. How typical are the inhabitants of the university city for East Germany? Economists have investigated the regional distribution of personality traits.

The map of Germany shows the results for the personality characteristic »Openness to new experiences«: Gold values are high; blue values are low. A dataset of around 73,000 people was evaluated for the study.

rance are more pronounced, and they are more resilient.« East Germans who move to West Germany also tend to be more open-minded, emotionally stable, conscientious and more extraverted than East Germans who stay in East Germany.

The study does not explain why these characteristics appear to different degrees in different regions. »We can perhaps see a correlation between a lower resilience and poorer economic regions; but it is not clear what came first«, explains Fritsch. »Despite this, economically relevant information can be derived from the results. If we consider the personality traits in a region with an especially high number of business start-ups, for example, we can learn something about entrepreneurial personality structures.« ■

Original publication: Von unterkühlten Norddeutschen, gemütlichen Süddeutschen und aufgeschlossenen Großstädtern [...], Psychologische Rundschau (2018), DOI: 10.1026/0033-3042/a000414

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Crossing boundaries

Physicist Dr André Großardt is attempting to »balance« quantum mechanics with gravitation theory. He has been awarded the Freigeist fellowship—worth almost one million euros—by the Volkswagen Foundation for his unconventional research idea.

BY JULIANE DÖLITZSCH

André Großardt is attempting to combine two seemingly incompatible fields of research.

It is not just lay people who find quantum mechanics and gravitation theory baffling; physicists themselves also see them as lying worlds apart. While in the former the largest unit under investigation is a molecule with 800 atoms; it is only masses weighing over several hundred grams that are relevant to the field of gravitation. »It is like the relationship between a grain of salt and the Mount Everest«, explains Dr André Großardt.

The theoretical physicist wants to significantly reduce this discrepancy »so that the interaction between quantum mechanics and gravitation can be investigated in the future.« He has been awarded a Freigeist fellowship by the Volkswagen Foundation for this exceptional project. The foundation is funding his project »Decoherence in gravitational quantum systems and quantum systems in the gravitational field« with around 960,000 euros over a period of five years. Eight fellows with unconventional and daring research ideas were selected from around 90 applications.

Answering open questions in theoretical physics

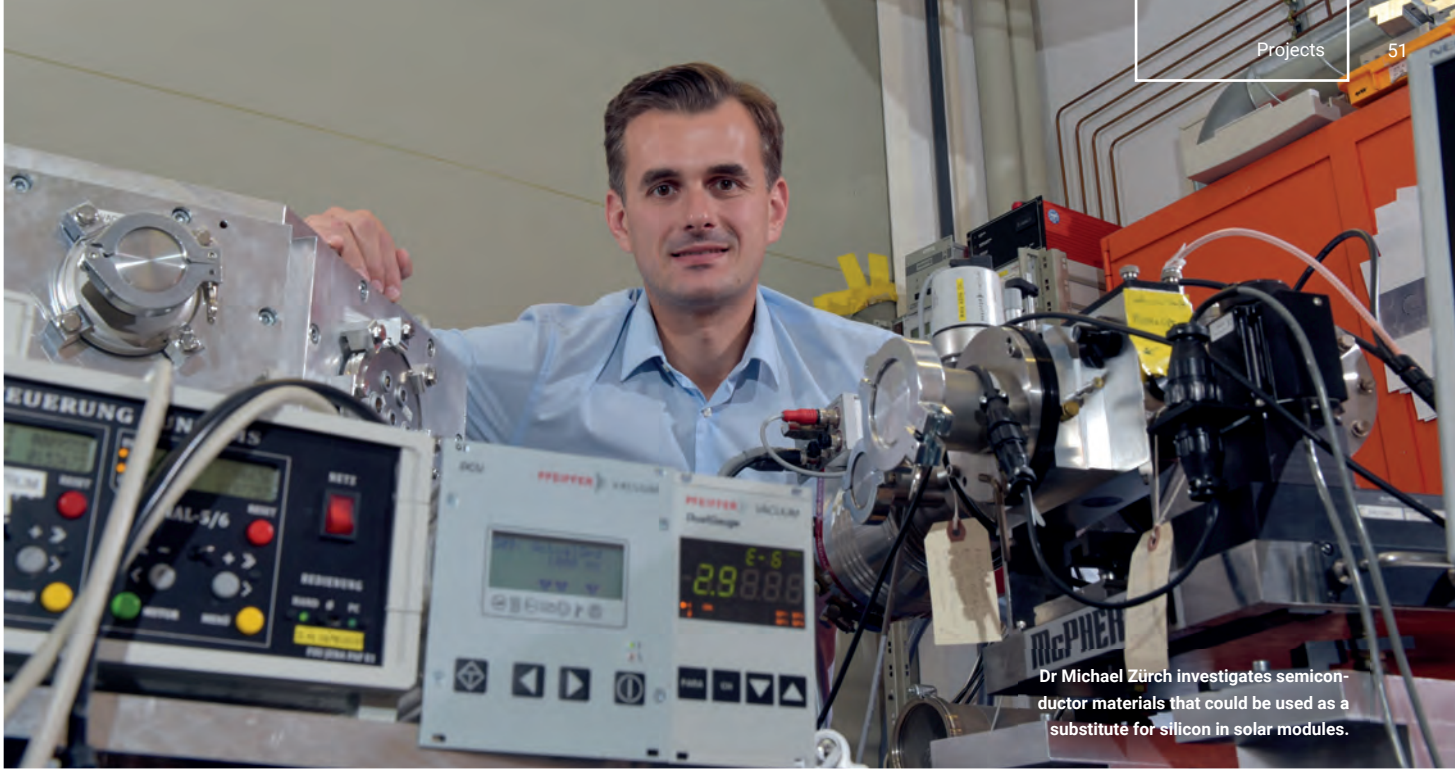
Since 2019, Großardt is leading a team of three doctoral candidates at the Institute of Theoretical Physics. »Until now, there has been no quantum description for the general theory of relativity. Conversely, gravitation is never considered in the field of quantum mechanics«, he explains. »We want to shed light on important unanswered questions in theoretical physics and thus to lay the foundation for experiments that will soon be possible.« It is possible to unify the two fields of research, which have been viewed as incompatible until now, using the superposition principle. »According to superposition, quantum mechanical particles can be in two places at the same time. We want to use laboratory experiments to investigate the power of attraction in this state to gain insights into the interplay of gravitation and quantum theory«, says the 34-year-old Freigeist scholarship holder.

Gravitation described as quantum theory

The planned experiments will bring grains of salt and Mount Everest closer together, so that the size difference is more reminiscent of an elephant and the Statue of Liberty. »One conceivable result would be for gravitation to be described as quantum theory: the particles would display similar behaviour as has already been investigated and understood for electrical force. Alternatively, the investigated particles could also retain the properties as described by the theory of relativity; in this case, gravitation would escape quantum theory and would be understood to be fundamentally different from other forces.«

André Großardt has been interested in this interdisciplinary topic since early in his scientific career: while his doctoral thesis dealt with Einstein's theory of relativity; his post-doctorate was predominantly concerned with quantum theory. He is also currently working closely with experimental physicists. ■

Through its Freigeist fellowship, the Volkswagen Foundation funds exceptional researchers who work between established fields of research, want to carry out risky research and who have gained their doctorate within the last four years. With their work, which shows great foresight, the Freigeist fellows are to act as »a catalyst for the overcoming of professional, institutional and national boundaries« states the Volkswagen Foundation.



Dr Michael Zürch investigates semiconductor materials that could be used as a substitute for silicon in solar modules.

New solar technology for the energy revolution

Physicists in Jena are developing and testing new materials for possible use as highly efficient solar cells. Their research project »QUESTforENERGY« is funded by the Federal Ministry of Education and Research under the »Make our Planet Great Again – German Research Initiative« and implemented by the German Academic Exchange Service (DAAD).

BY UTE SCHÖNFELDER

The earth should not get more than two degrees warmer compared to pre-industrial times. This target was set by the Paris Agreement in 2015. In order to achieve this goal, global emissions of climate-damaging greenhouse gases must be drastically reduced.

This, in turn, requires a global energy revolution: fossil fuels such as oil, gas and coal need to be largely replaced by renewable energy sources. There are, however, problems implementing the climate protection goals, and Dr Michael Zürch is convinced that this is not just due to a lack of political will. »The energy revolution would certainly accelerate if we had better solar technology«, says the physicist. He points to the fact that the silicon-based solar modules in use today are only up to around 20 percent efficient. In other words: about three quarters of the solar energy cannot even be used by the modules in use today. »We need alternatives to silicon that will allow for a more efficient conversion of solar energy into electricity.« Zürch will be taking a closer look at these alternatives over the next four years: together with his colleagues at the Chair for Quantum Electronics, as well as French and American partners, he has founded the »Quest for Energy« research project. The German Academic Exchange Service is funding this project with almost one million euros until 2022, within the framework of the German-French research initiative »Make our planet great again«.

Two-dimensional semiconductor nanomaterials to replace silicon

Semiconductor nanomaterials represent a very promising group of materials that could replace silicon in solar modules, as Prof. Dr Christian Spielmann explains. »These thin, two-dimensional materials comprise only a few atomic layers and possess quite extraordinary optical and electronic properties, which make them ideal semiconductors«, explains the physicist, whose team now houses Zürch's project. The best-known example of such 2D nanomaterials is graphene. The Jena physicists now want to take a closer look at a new class of these materials, into which very little research has been conducted to date: so-called transition metal dichalcogenide.

»These are composite materials whose properties vary based on their composition and which can be tailored to suit different applications«, explains Zürch. However, little is currently known about the fundamental processes that take place within these materials when they interact with light. Their special nanoproperties mean that the physical processes occur very quickly in these materials. The physicists now want to examine these in detail, in order to test their suitability as solar material. »We are specifically interested in observing the charge carriers—or the electrons—in the material when they are illuminated with light.«

The long-term goal for the researchers is to then use this information to pave the way for the targeted use of composite materials like this in solar technology. ■

Prof. Dr Stephan Fritzsche and his team want to provide theoretical developments and calculations, which can be directly used for the preparation and analysis of laser spectroscopic experiments.

Researching exotic nuclei with ISOLDE

The German Federal Ministry for Education and Research (BMBF) is supporting six German universities—including the Friedrich Schiller University—with 2.4 million euros in their research into ISOLDE. This is the name of a device used for the production of radioactive ion beams at the nuclear research centre CERN in Geneva. The scientists hope to use their experiments on »exotic« atomic nuclei to make discoveries about nuclear-physical processes in stars, amongst other things.

BY JÜRGEN REES

The abbreviation ISOLDE stands for »Isotope Separator On Line DEvice«. The BMBF is providing the funding for three years as part of its collaborative research support. Research groups at universities in Greifswald, Jena, Cologne and Mainz, and at technical universities in Darmstadt and Munich, are receiving the funding.

Developing highly sensitive detectors

The research focuses on »exotic«, or short-lived, nuclei. Even when using state-of-the-art methods, it is often only possible to produce them at CERN, and only in small numbers. Therefore, highly sensitive detectors need to be developed to not only verify the existence of the short-lived nuclei; but also, to accurately measure their properties—for example their size, dimensions and excitation spectrum. Nuclear physical methods, such as laser spectroscopy and mass spectrometry at low particle energies, will be used for this purpose. On the other hand, new interest in the field of high-resolution nuclear spectroscopy for the impact and disintegration of nuclei has been sparked after ISOLDE was recently extended to the so-called HIE-ISOLDE: with Higher (H) Intensities (I) and at higher Energies (E) for the particle beams.

The research project at the University of Jena mainly focuses on making precise theoretical predictions for the isotopic shift of various open-shell atoms and ions. These theoretical foundations are needed for the planning and evaluation of the laser spectroscopic investigations at ISOLDE, as well as for the spectroscopy of the super heavy elements nobelium and lawrencium. In many cases, precise structural calculations for the isotopic parameters are required in order to be able to reliably extract the core properties from the experimentally measured (isotopic) shifts to the transition frequencies. »The isotopic parameters, which describe the electronic response to the different masses and charge distributions of isotopes, are often sensitive to relativistic contributions and electronic correlations and can, therefore, only be adequately described with correlated many-particle methods», explains the Jena-based project leader, Prof. Dr Stephan Fritzsche. »The theoretical developments and calculations planned in our project will be used directly in the preparation and analysis of the laser spectroscopic experiments conducted by the research groups in Darmstadt, Heidelberg and Mainz«, continues the theoretical physicist, who works at the Friedrich Schiller University and at the Helmholtz Institute in Jena. From the experiments, the researchers hope to gain new insights, for instance into the core physical processes in stars. In addition to this basic research, the radioactive nuclei provided by ISOLDE and the experimental methods will also be used for the investigation of solid objects as well as medical issues. ■

The future in teaching is digital, too

As part of the Thuringian Higher Education Digitalization Strategy, the federal state is supporting pilot projects at universities which help to prepare students for life and work in a digitalized world. The Friedrich Schiller University Jena has received around 180,000 euros for three innovative projects.

BY AXEL BURCHARDT

The »Curricula of the Future« programme is intended to promote the development of study content and types of academic teaching and learning. »We applied for the funds for three innovative projects which show a clear potential for transferring the findings to other teaching areas«, explains the Vice-President for Learning and Teaching, Prof. Dr Iris Winkler. »The University is also supporting forward-thinking ideas concerning how to structure teaching and courses through internal project funding. The Academy for Teaching Development regularly issues different funding schemes.«

»EHealth and Communication« interdisciplinary study programme

Firstly, the state programme is funding the development of a model study programme for academic professions working within healthcare. The focus of the planned »EHealth and Communication« programme lies in the provision of information and communication in treatment and care processes which are being increasingly shaped by digital technologies. The project is managed by the medical scientist Prof. Dr Jutta Hübner.

In addition, the state is funding two projects for the development of the teaching curriculum; the »Digital Professionalism in the Teacher Training« project, led by educational scientists Prof. Dr Alexander Gröschner and Prof. Dr Nils Berkemeyer, aims to restructure the modules for minor subjects for educational science. The students should be familiarized with digital tools to aid their work and studies, so that they would be able to reflect on the use of tools and apply them in their professional life as teachers properly.

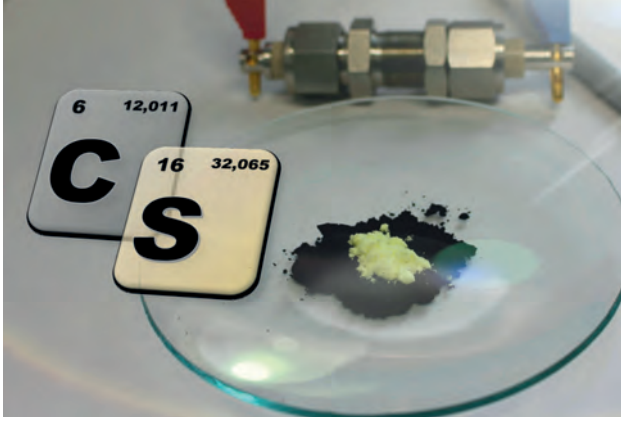
Teachers in the computer pool at the multimedia centre. The University Jena is increasingly using digital media in teaching, and not just as part of the three funded projects.

»Global Campus« prepares students for heterogeneity in everyday school life

Together with the University of Erfurt, the concept of »Heterogeneity-Sensitive Teacher Training« is being implemented and modules in the field of heterogeneity and inclusion are being provided on the »Global Campus« digital platform. The project is managed by Prof. Dr Bärbel Kracke (Educational Psychology). ■

Sea lettuce genome decoded

An international team of scientists has sequenced the complete genome of a large green marine algae for the first time (DOI: 10.1016/j.cub.2018.08.015). The genome from the sea lettuce »Ulva« consists of 98 million base pairs and 12,900 genes. »The decoded sea lettuce genome gives us new insights into biological developmental processes and furthers our understanding of algae growth and reproduction«, explains Dr Thomas Wichard from the University Jena (photo above), who is part of the research team. The sea lettuce is valuable both in terms of its ecological importance and its commercial value. It is able to grow extremely quickly and is, therefore, a very important food source. Sea lettuce is successfully grown as animal feed, but is also ideally suited for human consumption. PM

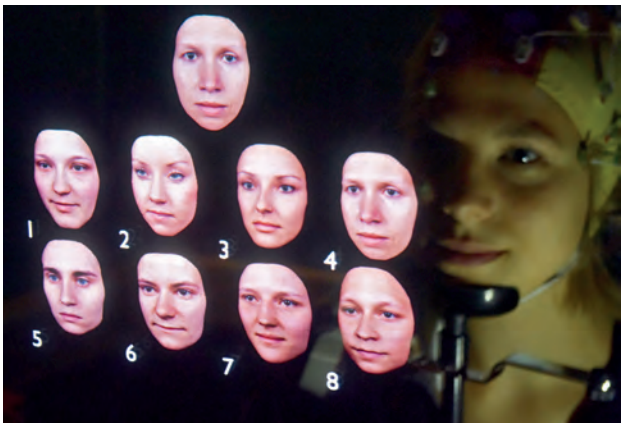


Carbon makes sulphur amorphous

As part of their mission to find the battery of the future, chemists and materials scientists are testing metal-sulphur combinations, which they consider will one day be able to compete with lithium-ion batteries that are commonly used today. Prof. Dr Philipp Adelhelm's team in Jena and Chemnitz has now discovered a phenomenon for this type of battery, which could significantly affect its operation (DOI: 10.1002/anie.201807295). The poor conductivity of sulphur means that it needs to be combined with conductive carbon. The two substances interact in an unexpected manner: after just a few days, the sulphur loses its structure and becomes amorphous. The researchers assume that this phenomenon will impact on all types of metal-sulphur batteries. sh

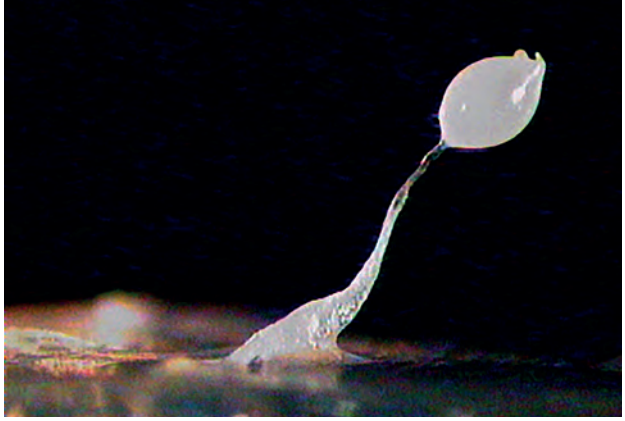
Useful properties of honey fungus

Jena pharmacists working with Prof. Dr Oliver Werz and Prof. Dr Dirk Hoffmeister have discovered a hitherto unknown process in immune cells during the formation of inflammatory messengers—and they did so using an unusual tool. They used melleolide, a highly effective substance which is made of honey fungus (photo above: fungi in petri dish) (DOI: 10.1016/j. chembiol.2018.10.010). The research teams were able to show that the fungus material reacts specifically with the enzyme 5-Lipoxygenase in the immune cells, thus inhibiting the formation of Leukotrienes. Leukotrienes play a crucial role in a variety of inflammatory diseases and autoimmune diseases. These findings could lead to new drug development strategies. sh



Recognizing faces even in old age

Psychologists at the University Jena have developed a training to improve face memory, and it even works at an advanced age (DOI: 10.1016/j.neuropsychologia.2018.08.010). Senior citizens between 61 and 76 years had to memorize various faces, as well as names and other information, twelve times within a period of four weeks for the study. The scientists used photo-realistic caricatures for the training. »Caricatures highlight specific characteristic features on a face which make it easier to remember«, explains Prof. Dr Stefan Schweinberger, who was in charge of the study. The psychologists took an electroencephalogram (photo above) of the subjects before and after the weeks of training to measure the success of the programme. sh



Parasite protects its host

Parasitism is a totally one-sided life form: the parasite enriches itself at the expense of its host. But Jena pharmacists have now discovered that parasites may also consider their host in certain circumstances—all in their own interest, of course. The researchers investigated so-called »mobile elements«. These are sections of DNA which infiltrate the genome of host cells or organisms and multiply for their own benefit.
In the study, the research team was able to show that mobile elements do not infiltrate and multiply indiscriminately in the genome of the amoeba dictyostelium discoideum. They only establish themselves at very specific locations in the genome, namely where they do not damage the amoeba (DOI: 10.1093/nar/gky582). sh

Flying germs

Armrests, folding tables, seat belts: dangerous pathogens settle on numerous surfaces in passenger aircrafts. With the ever-increasing air traffic, germs are also travelling around the world. Jena-based materials scientists working with Prof. Dr Klaus D. Jandt have now systematically analysed where the germs are most common and how the number of germs on airplanes can be reduced (DOI: 10.1016/j.tmaid.2018.07.011). »Infectious hotspots« include seat covers, door handles, and toilet flushing buttons. According to the team of researchers, the survival of microbes is highly dependent on the materials and on the physicochemical surface properties. The scientists are currently working on new antimicrobial material concepts to be used in aircrafts in particular. AB

Mountain air is good for moths

Tropical moths are larger in the mountains. This is the result of a study conducted by Jena scientists working together with colleagues from Marburg and Connecticut (USA). They measured over 19,000 moths from 1,100 different species (DOI: 10.1111/ecog.03917.). They wanted to find out whether the size of tropical moths changes in line with the sea level. »Body size plays a key role in the ecology and evolution of organisms«, explains Dr Gunnar Brehm, the lead author of the study. It would seem that the »temperature-size rule«, which was previously only applied to mammals and birds, also applies to moths. It states that animals develop as larger individuals at lower temperatures. The researchers were able to prove the trend for various species and also within the species. AB

Reading risk behaviour in the brain

Anxious people take fewer risks—not a surprising finding. But a team of psychologists working with Dr Barbara Schmidt (photo above, left) and partners from Würzburg and Victoria (Canada) has now succeeded in making this decision-making process in the brain visible—and, as a result, to predict the behaviour of individuals (DOI: 10.1111/psyp.13210). The researchers carried out an experiment to measure the risk behaviour of test subjects, whilst also observing their brain activity using electroencephalography (EEG). The results showed that a certain brain activity—the frontal midline theta power—is especially high during the decision-making process. It shows cognitive control— in other words, intensive deliberation—during the decision-making process. sh

Loan exhibits for the Louvre

Seven exhibits from the University's Antique Collections are currently on a trip. At the end of October 2018, they travelled by specialist courier to the Louvre in Paris. The pieces are part of the exhibition »Un rêve d'Italie—la collection du marquis Campana« (A Dream of Italy—The Marquis Campana's Collection).

BY STEPHAN LAUDIEN UND TILL BAYER

»This loan to the Louvre is quite special for us«, says Dr Dennis Graen, who is a custodian of the Antique Collections. The outstanding piece among the exhibits is the painted amphorae vase by potter and painter Sophilos from Athens. It was found in an Etruscan tomb and dates back to around the year 580 BC. Sophilos was one of the first artists who signed his works, says Dennis Graen.
Other pieces include Etruscan ceramics, so-called *bucchero*, including a smoking receptacle and a wine jug. The loan exhibits for Paris are supplemented by three further exhibits, which were part of the Jena collection from the mid-19th century, but were transferred to the Prussian Cultural Heritage Foundation in the 1980s. One of the exhibits, the plaster cast of a women's bust from Etruria, will be shown alongside the terracotta original in Paris.

The Paris exhibition combines large parts of the collection of Giampietro Campana (1808 to 1880), a dazzling figure of the 19th century art scene. Campana became a bank director early in his career and brought together one of the largest antique collections of his time. He even funded excavations. A gift made to Duke Joseph of Saxe-Altenburg in 1846 formed the basis for the Archaeological Museum of the University.
A few years later, the skies darkened for Giampietro Campana. His collection was sold after the collector was indicted for embezzlement in 1858. Campana had used his employer's money to expand his collection. As a result, he was sentenced to 20 years imprisonment. Napoleon III acquired the majority of the collection for the Louvre Museum.
Now, 150 years later, the works will once again be reunited for a short time.

A closer look at the Jena exhibits—the picture on the right shows the cabinet in the Louvre
Bottom row from left to right:

Oenochoe (650 to 600 BC)
»Oenochoe« is the name given to a jug with an opening in the shape of a shamrock. They were used to dispense wine. The bucchero oenochoe from the Campana donation has an egg-shaped body with a ring-shaped base and a broad handle. The body is fluted and features several concentric circles.

Goblet (600 to 570 BC)
The goblet is made of black, glossy matt Etruscan ceramics, known as »bucchero«. The upper vessel is surrounded by three concentric circles and features a stud in its centre (an »omphalos«). The goblet is distinguished by its »caryatids«, female figures serving as a supporting element.

Sophilos' amphorae (600 to 570 BC)
The terracotta amphorae, which was found in an Etruscan tomb, originates from Athens. On the front, there are two lions that turn their heads toward the rear. The rear depicts two sirens looking at each another.

Black-figured amphorae (500 BC)
The front of the terracotta amphorae shows Heracles wrestling with the sea god Nereus. The rear shows two hoplites in motion.

Plaster cast of a female statuette (prior to 1864)
The original of the female statuette was originally found in Campana's collection in Rome. Campana had this plaster cast replica made of it. In 1864, the replica was donated to the Archaeological Museum of the University.

Top row, second from left

Palmette antefix with dolphins (50 BC to 100 AD)
An »antefix« is a clay or stone block which was placed below the lowest roof tiles in antique buildings to seal the front opening. This type of antefix is typical of Rome and its surroundings. It depicts seven leaves which combine to form a palmette—a motif regularly used in ancient art. A dolphin adorns the palmette on each side above the base.

Top row, first from left

Antefix with a female head in a crown of leaves (300 to 270 BC)
This well-preserved antefix is decorated with a woman's head with curly hair, which is surrounded by a wreath of leaves. The face has been designed to depict ideal female beauty with its oval, even shape, almond-shaped eyes and delicately curved mouth. This type of design is a Campanian finding from the mid-6th century. It was also later adopted in Etruria and in the Latin-speaking world.

Collection exhibits on their travels

The Friedrich Schiller University Jena preserves and works on several millions of objects in its 42 scientific research, display and teaching collections. The collections are central points of reference for a wide variety of research questions, are used for courses, and are freely accessible in the University's digital library portal. In addition, items from Jena's collections are always being requested for exhibitions. The LICHT**GEDANKEN** image gallery presents some of the items which, being lent, has left the University for a while, and are being presented in exhibitions open to the interested public.

Picentes' double-headed bull

The six-by-five-centimetre trinket depicts a double-headed bull. The item dates back to the 6th century BC and is part of a collection of Iron Age burial objects from the central Italian people known as the Picentes (9th to 4th century BC). It was acquired at the beginning of the 20th century by the glass chemist Otto Schott and given to the University. These pieces are now part of the Collection of Central European Archaeology. The tombs were discovered in Montegiorgio near Ascona. They contained helmets, weapons, brooches, jewellery, ceramics, and amber objects. The amber had travelled a long way: it was taken from the Baltic Sea coast to Central Italy where it was turned into artistic jewellery.

The approximately 150 pieces from the Schott Collection were first presented to the public in 2005 in the »Treasures from Picenum« exhibition, which was held in the Schott Villa in Jena.

Cerussite

The nine-by-eight-by-seven-centimetre »cerussite« (also known as white lead ore) is from Russia and is part of the Mineralogical Collection. The mineral arrived in Jena in 1816, when it was presented as a gift by the Arnstadt mineralogist Dr Johann Lorenz von Pansner. Pansner was a student of the first Professor of Mineralogy at University Jena, Johann Georg Lenz. At the beginning of the 19th century, he embarked on a journey through the Baltic to Saint Petersburg. From there, he sent a range of the known Russian minerals to the »Jena Society for Minerology«.

Between October 2017 and April 2018, an exhibition was held in the world-famous Mining Museum in Saint Petersburg to mark the 200th anniversary of the foundation of the society. Together with other minerals from the Pansner gift shipment, the cerussite travelled from Jena back to Saint Petersburg for the occasion.

Ottoman coin

This gold coin, which weighs just over a gram, is from the Oriental Coin Collection and was minted in Istanbul in 1730. The year 1730 (equivalent to the year 1143 of the Islamic calendar) was the first year in the reign of Sultan Maḥmūd I who claimed the formerly Christian city of Constantinople for the Islam. By specifying »Islāmbūl« as the mint, Maḥmūd I highlighted the Islamic character of his reign.
The coin is currently on loan at Voigtsberg Castle Museum in Oelsnitz, Germany, along with other exhibits from the Oriental Coin Collection. It can be seen in a special exhibition on the forerunners of industrialized carpet production until April 2019.

Hapsburg family tree

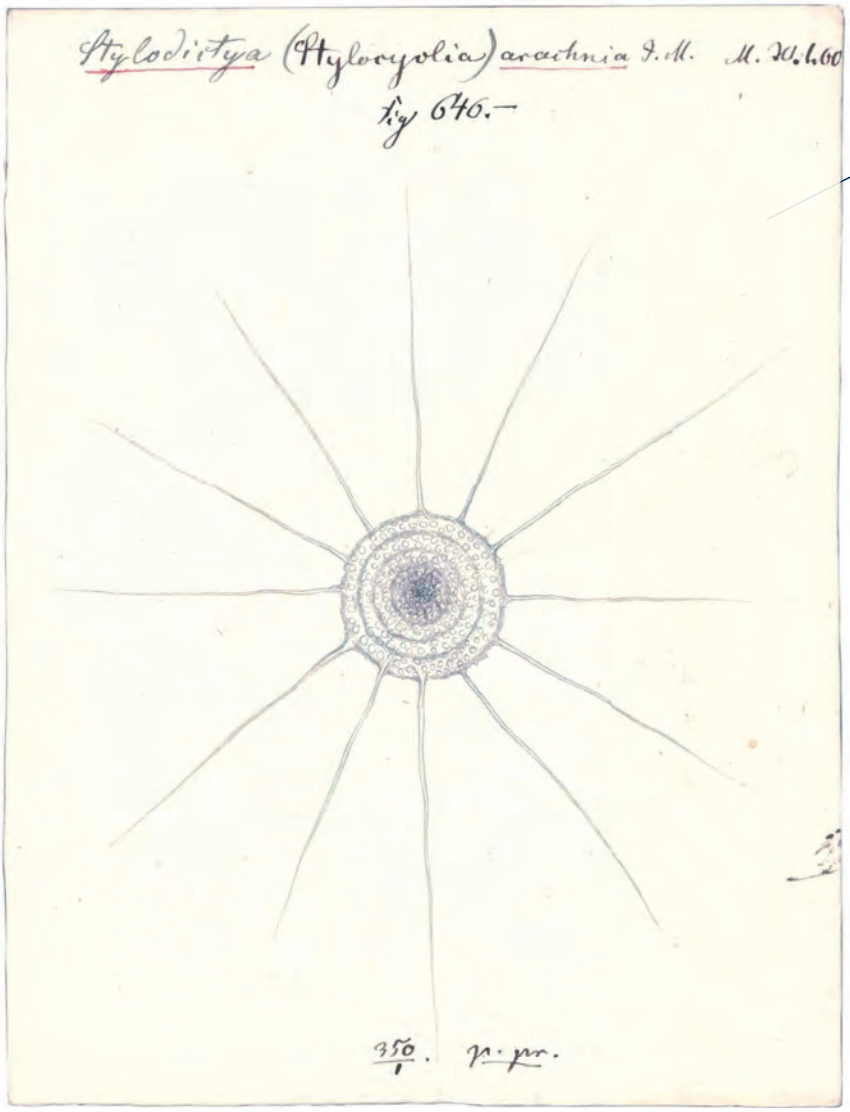
The coloured print and drawing from the University's Art Collection shows the family tree of Emperor Maximilian I. The family tree was created on two pieces of wood by Jörg Breus the Younger in around 1535. The work shows the Hapsburg within their network of European relatives as well as a genealogy from the Emperor Friedrich I to Charles V. The 120-by-60-centimetre work is made from high-quality materials (parchment on wood) and is lavishly coloured. It reached Jena from Wittenberg in the mid-16th century as a result of the relocation of the »Bibliotheca Electoralis«.
This and other outstanding objects from the University collections were displayed in the Thuringian state exhibition entitled »The Ernestines. A dynasty shapes Europe« in Weimar and Gotha in 2016.

Mummy of the Pharaoh Ramesses II

This photograph from the Alphons Stübel Collection of Early Photographs from the Orient shows the head of Mummy Ramesses II. The Egyptian Pharaoh ruled from 1279 to 1213 BC. The paper print was made by the egyptologist Emile Brugsch and is almost two and a half centimetres by two and a half centimetres in size. Brugsch discovered numerous mummies in 1881, including those of Ramesses II and had them brought to the Museum of Cairo. This and other photos were taken in Cairo and were put on sale. The photo was added to the collection belonging to the geologist Alphons Stübel and came into the possession of the University Jena at the beginning of the 20th century. The picture was displayed as part of the »The innocent eye. Orient pictures in early photography (1839 to 1911)« exhibition in the University of Göttingen Art Collection in 2017.

Shoulder blade of a bowhead whale

This right shoulder blade of a bowhead whale, which measures over one metre by one metre in size, dates back to the mid-17th century. It is one of the oldest and most important objects from the collection of the Phyletic Museum. Despite its original anatomical position, the piece was placed »upside down« for painting. The date of the painting can be seen at the top; it is from 1646. Below you can see a locket with a white stork. The painting shows a whaling scene. The old-Dutch lettering on the edge of the shoulder blade says: »door gods zorggende hangt vangtmen de walfisch ande noortkant«. This means: »With God's careful hand, the whale is captured at the northern edge«. This »northern edge« probably refers to the Arctic ice shelf. The whale shoulder blade can be seen in the permanent exhibition at the Phyletic Museum.

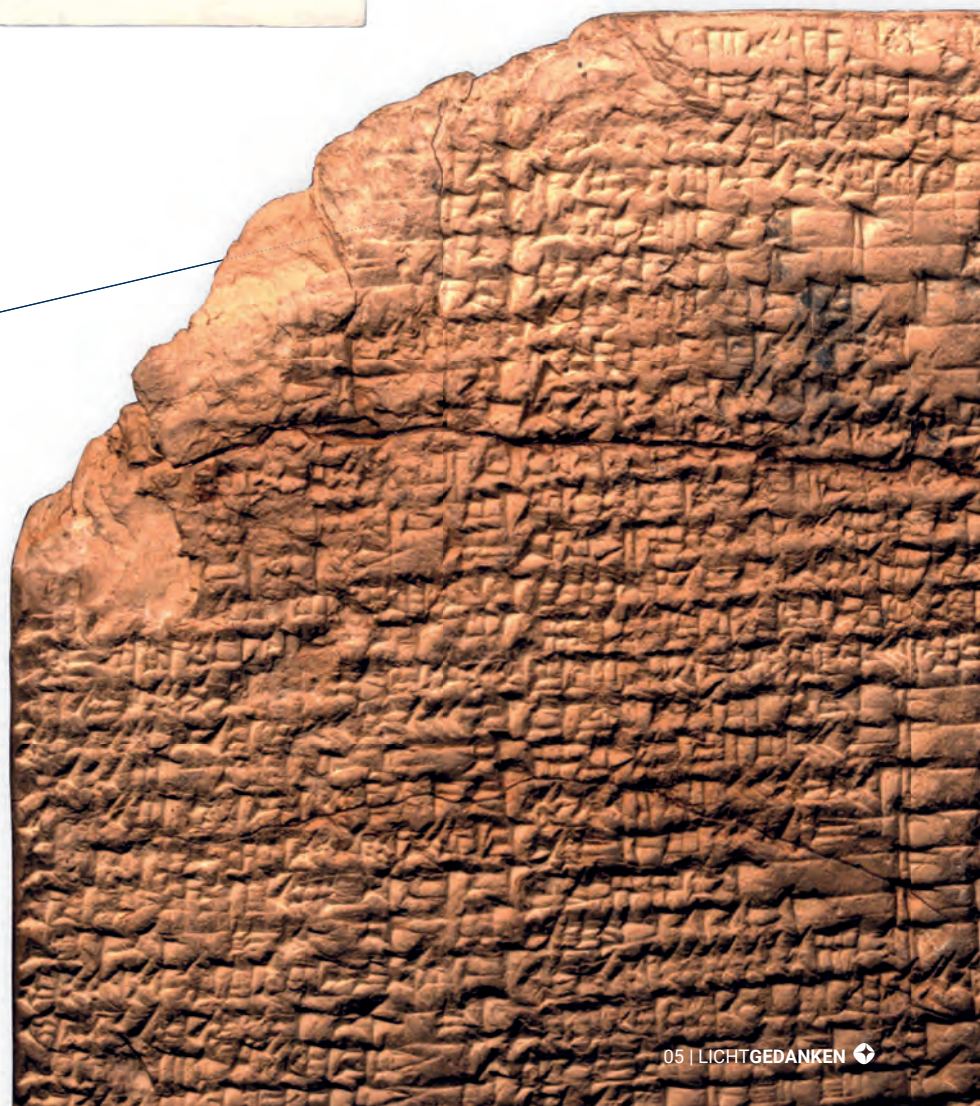


Sketch of a radiolarian

Ernst Haeckel completed this pencil drawing in 1859, whilst on a research and educational journey through Italy. In the gulf of Messina, he devoted himself intensively to radiolarians. Within just a few weeks, Haeckel collected over 100 hitherto unknown species. In a letter to his father from 15th December 1859, he reports on his work with these tiny animals: »These extremely strange and interesting creatures are the lowest form of animal life and are thus worth studying extremely carefully.« The 23-by-18-centimetre drawing from the Ernst Haeckel Archive shows an example of the Stylodictya arachnia and was on display for several months in the spring of 2016 in the »Architecture of Life« exhibition in Berkeley Art Museum & Pacific Film Archive (USA) along with seven other radiolarian sketches.

Clay tablet with cuneiform script

This cuneiform script tablet dates back to the Ancient Babylonian period (18th/17th century BC) and is part of the Hilprecht Collection. The tablet is approximately 20-by-15 centimetres in size and contains an epic poem in the Sumerian language. Sumerian literature is the oldest surviving written language: literary cuneiform texts in the Sumerian language have been preserved from approximately 2600 BC. The text tells how Lugalbanda—a legendary king of the city of Uruk—fell ill during a military campaign against Aratta, which lies in the eastern highlands (present-day Iran), and was left behind, helpless, in a cave, but was saved thanks to divine intervention. This tablet was on display with other cuneiform tablets containing mathematical, medical, and legal content in the exhibition »WorldKnowledge. 300 years of science in Berlin« from September 2010 to January 2011 in the Martin-Gropius-Bau.



THREE QUESTIONS TO

Dr Tilde Bayer

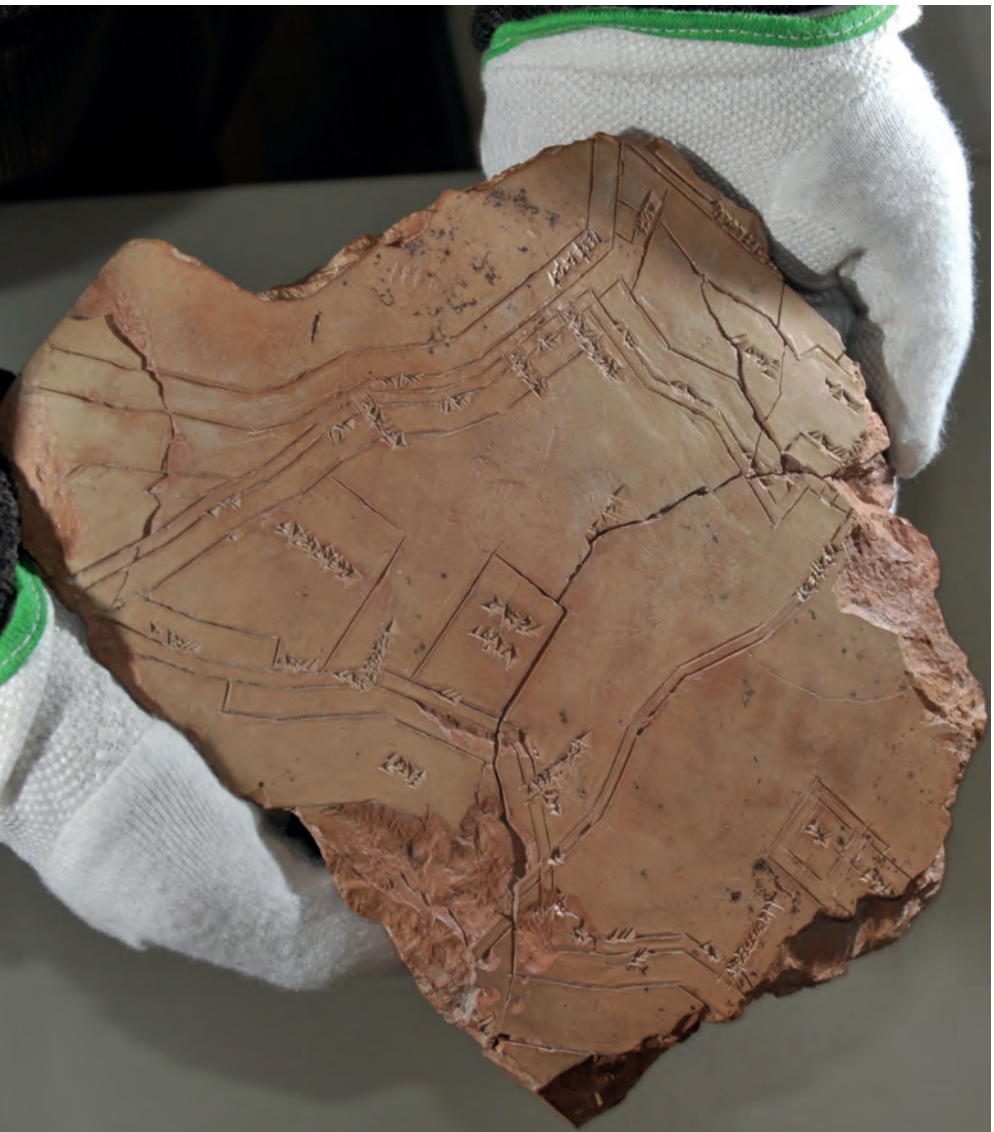
Special Representative for Collections at the University Jena

How often does the University loan out the objects from its collections to external partners?
When you put everything together, there are at least two dozen lending operations each year. And one lending operation can contain several exhibits.

Are there items that are loaned out on a regular basis?
The map of the City of Nippur from the Hilprecht Collection has been loaned out many times and is always in demand. However, it will not be leaving the collection again because of preservation reasons. Generally speaking, we do not receive enquiries because of a specific or several objects, it is rather because of the diversity of our collections.

What role does the physical exchange of exhibits still play in today's »digital age«?
A huge role! Now so more than ever museums need to attract visitors by offering interesting special exhibitions – it is not so easy just with permanent exhibitions.

Nowadays digitalization makes it possible to research exhibits for possible exhibitions in databases. These databases provide an insight into the items available. An »online visit« can also give the interested public an impression of the items, but it does not replace the sensory experience that you get from visiting a museum with real objects and exhibits.



This clay tablet is almost 3,500 years old and is the »oldest city map in the world«. It shows the layout of the City of Nippur in Ancient Mesopotamia, which lies in the present-day Iraq. The tablet from the Hilprecht Collection is an exhibition piece that is in global demand.

Current items on loan include...

- five objects from the Ernst Haeckel Haus, including the Monistenbund chest (Hygiene Museum, Dresden) and Haeckel's family tree from 1874 (Musée d'art et du Judaisme, Paris)
- seven objects from the Collection of Classical Antiquities (Louvre, Paris; see p. 56)
- seven objects from the Museum Anatomicum Jenense (Hygiene Museum, Dresden)
- two objects from the Hilprecht Collection (Hygiene Museum, Dresden)
- one object from the Astronomical Collection (Hygiene Museum, Dresden); this is the first photograph of a total solar eclipse on 28th July 1851.

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COOKBOOK **»SO IS(S)T DIE WELT«**

Thuringia is home to around 5,500 international students and approximately 900 students with an immigration background who have gone to school in Germany. Many of them frequent our canteens and like eating there. Who does not know the feeling, after having stayed abroad for a while, of being overcome with a particularly strong longing for their favorite dishes or for some of their mom's home cooking? A culinary homesickness of sorts is something that is not just experienced by international students, but also by those who might have grown up abroad or whose parents have international origins. This was reason enough for us at Studierendenwerk Thüringen to ask these students what they would like to have us serve them in our canteens.

We ended up cooking together. We invited students from twelve different culinary cultures to prepare authentic dishes from their homeland alongside our cooks in an intercultural setting. Things did not always go smoothly. Getting the correct consistency of Chinese sticky rice almost led us to sheer exasperation, as was the case with the difficult task of getting the shape of Pelmini right. However, we managed to master both these tasks through a successful intercultural exchange with the students.

We have been able to compile many more of these kinds of wonderful intercultural experiences in this cookbook.

Published by:	Studierendenwerk Thüringen
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Size:	21 x 28 cm
Pages:	252
Price:	**€ 14,95**

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