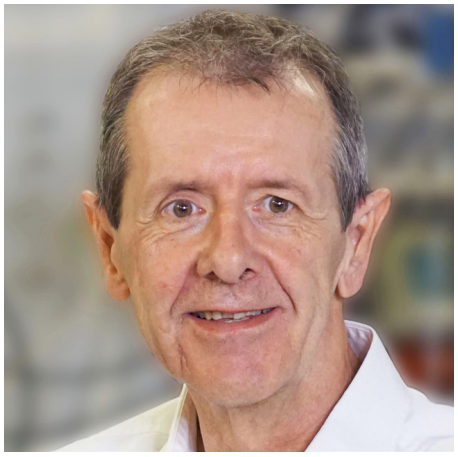
University of Basel

Swiss Nanoscience Institute

SNI SWISS NANOSCIENCE INSTITUTE
EINE INITIATIVE DER UNIVERSITÄT BASEL UND DES KANTONS AARGAU

SNI update December 2017



Dear colleagues,

Once again the year is racing to a close. Personally, this year has come to a much better end than last year, when I was recovering from a serious accident and was uncertain how things would continue. As I look back on 2017, I feel very positive – not only because my health has improved, but also because the SNI has continued to evolve.

Most of the doctoral students who joined the SNI PhD School when it first opened in 2013 successfully completed their doctorates this year. The results of their research are now being published, allowing us to report on some fascinating findings. It is particularly pleasing to see these students enjoying good job prospects and beginning their professional careers in a range of sectors.

Over the past few months, I have also got to know the nanoscience students more closely, presenting 24 of them with their bachelor's certificates in October and joining them for an informal chat over pizza in November.

At the Dies Academicus, former nanoscience student Adrian Najer received this year's faculty prize for his excellent doctoral dissertation. Adrian worked in the group run by Wolfgang Meier and Cornelia Palivan in the Department of Chemistry and at the Swiss Tropical and Public Health Institute, developing nanotechnology methods that could be used to treat and prevent infectious diseases such as malaria. It is fascinating to see the great potential of these and similar polymer vesicles. This *SNI update* also features an article about our colleagues in the Department of Chemistry, who have succeeded in activating and deactivating enzymatic reactions inside more complex polymer capsules for the first time.

The SNI's calendar is always busy in the last quarter of the year. Many of the TecDays held at Swiss high schools by the Swiss Academy of Engineering Sciences (SATW) take place during this time, and thousands of children and young people flock to Europa-Park in Rust (Germany) for the Science Days. These events are great opportunities for the SNI team to introduce young people to and awaken their interest in the sciences using simple experiments.

Hopefully I have awakened your interest too – happy reading!

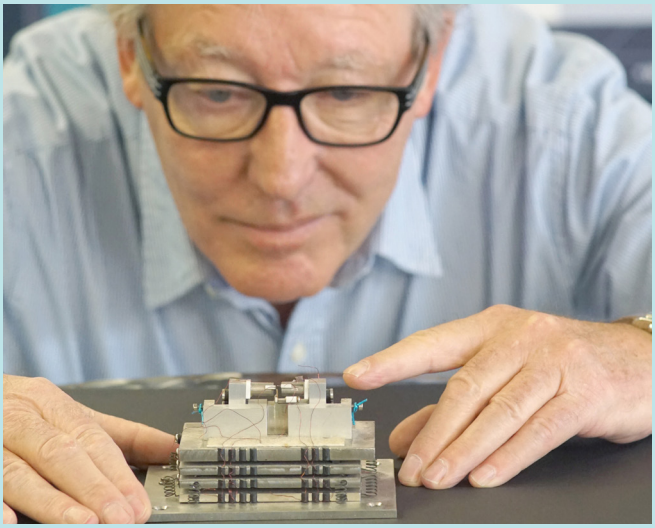
I would like to wish you all a peaceful

and relaxing festive period and a healthy, successful, and happy New Year. I am already looking forward to early 2018, when I will be reading numerous contributions to the annual report, and thank you all for supporting every aspect of the SNI.

Kind regards,

Prof. Christian Schönenberger
SNI Director

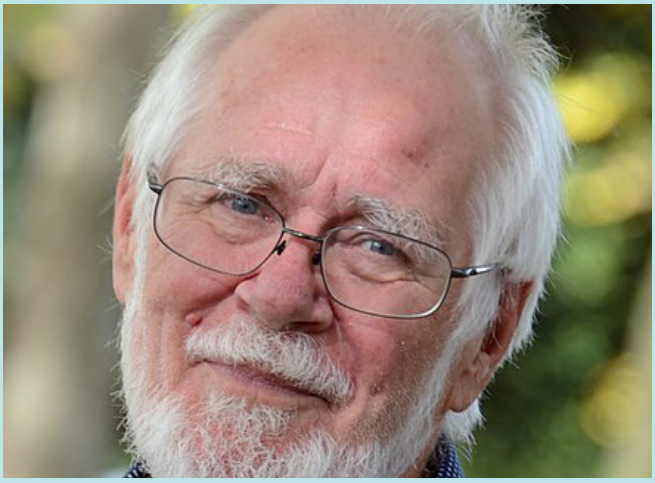
Save the date! Public event in honor of Professor Christoph Gerber



At 5 pm on February 26, a public event will be held in the Oris cinema in Liestal in honor of Professor Christoph Gerber, winner of the Kavli Prize. Professor Gerber and some of his colleagues will give short talks explaining how the atomic force microscope came to be developed, how it has evolved, and the ways in which it can be used today.

Save the date – registration details will soon be announced at www.nanoscience.ch.

Save the date! SNI/Biozentrum lecture with Professor Jacques Dubochet



On the afternoon of April 11, 2018, Nobel Laureate Professor Jacques Dubochet will give a SNI/Biozentrum lecture.

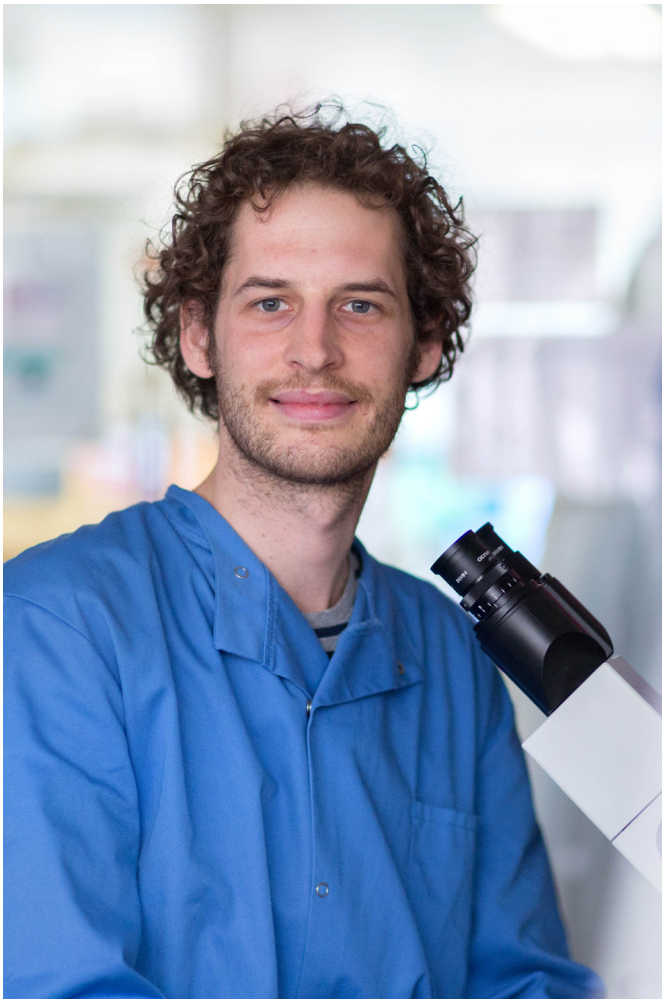
As part of a mini-symposium, he will join Professor Andreas Engel and Professor Ueli Aebi to report on the pioneering developments and achievements in electron microscopy.

You won't want to miss this!

Portrait

Adrian Najer wins faculty prize

During the Dies Academicus in November 2017, young nanoscientist Dr. Adrian Najer received the prize for the best doctoral dissertation in the Faculty of Science at the University of Basel. Adrian Najer studied nanoscience in Basel before beginning his award-winning work in the Department of Chemistry at the University of Basel and the Swiss Tropical and Public Health Institute. In the course of this work, he developed two innovative nanotechnology methods that could be used to treat and prevent infectious diseases such as malaria. After completing his dissertation, he continued to fight the ever-increasing threat presented by malaria. Supported by an Early Postdoc Mobility grant from the SNSF, he is currently investigating improved treatment options at Imperial College London.



Adrian Najer is currently working at the Imperial College in London and is supported by an Early Postdoc Mobility grant from the SNSF (Image: Thomas Angus, Imperial College London).

Crowning glory

The faculty prize is a wonderful conclusion to Adrian's successful period of study at the University of Basel. Back in 2005, he came along to an information day and heard about the nanoscience degree program for the first time. He soon realized that nanoscience offered the perfect combination of science subjects.

In 2006, he began to study nanoscience at the University of Basel. He particularly enjoyed the block courses that students complete in various research groups in the third year of their bachelor's studies. "This gives you an early insight into the diverse research currently underway and teaches you a great deal about academic work," he recalls. In one of these block courses, he worked in the group run by Professor Cornelia Palivan and Professor Wolfgang Meier, where he first discovered the artificial membranes and polymer vesicles used for a wide range of applications.

Planning his own project

During a project at Lund University in Sweden funded by an SNI travel grant, Adrian developed a concept of using these polymer vesicles to fight infectious diseases such as malaria. "I simply cannot accept that around half a million children are still dying of malaria each year," he explains. "I want my research to help reduce this threat." He convinced Professor Wolfgang Meier and Professor Hans-Peter Beck of the Swiss TPH to supervise a master's thesis in this field.

Adrian completed his master's studies in September 2011 with top grades. Still fascinated by the complex and multi-layered topic of malaria, he continued his research with a doctoral dissertation in the Department of Chemistry and the Swiss TPH,. Here, he developed two different nanotechnology approaches to target the parasite cycle in human blood.

Outsmarting parasites and optimizing release

Malaria parasites of the Plasmodium genus, which are carried by the Anopheles mosquito, infect and breed in human red blood cells. The infected blood cells rupture and the parasites are set free to infect new blood cells. To stop this cycle, Adrian Najer has developed minute polymer vesicles that, thanks to certain sugar molecules on their surface, look like red blood cells to the parasites. After release, these nanomimic cells block the parasites. Once attached to the nanomimics, the parasites will then be absorbed by immune system cells. “We expect an effect similar to a vaccination that is intended to protect against further infection,” Adrian explains. “Many other pathogens use the same mechanism to identify host cells, so this strategy could be applied to other infectious diseases as well,” he adds.

Adrian has also used minute polymer particles in his work to better distribute instable or poorly soluble drugs throughout the body. To achieve this, the drug is encapsulated in the polymer particles. Parasitic infection of the red blood cells alters the intracellular environment so that the polymers disintegrate. The drug is released and kills off the parasites. Blood cells that are not infected do not absorb the particles; outside the cells, the particles remain intact and the drug remains inside.

Promising nanotechnology approach

In investigating these two concepts, Adrian Najer has revealed whole new approaches and delivered promising results to treat this highly complex disease. The committee that awards the annual faculty prize was impressed by his work, and Wolfgang Meier, Adrian’s supervisor over the last few years, is also full of praise: “Adrian has worked with great efficiency, diligence, independence, and creativity to open up a new, complex field of activity and has made a significant contribution to the future treatment of infectious diseases.”

For Adrian, his dissertation is far from the end of the line. He is convinced that a nanotechnology approach is one step in the right direction, and is therefore continuing his research as a postdoc at Imperial College London. After many years in Basel, he is enjoying big-city life and drawing inspiration from his colleagues from all over the world. He would like to spend a few more years abroad as a postdoc before ideally finding a position as an assistant professor in Switzerland. His goal is to form his own research group to apply nanotechnology to the study of infectious diseases and the development of innovative treatments.

We wish him every success and congratulate him on this prestigious award!

Nano-Tech Event

On February 15, 2018, the SNI and the Hightech Zentrum Aargau organize a Nano-Tech Event, that informs about projects within the Nano Argovia program.

The event will take place at Brugg Flex from 4.00 – 6.30 pm and will be followed by an apéro that offers excellent opportunities for networking.

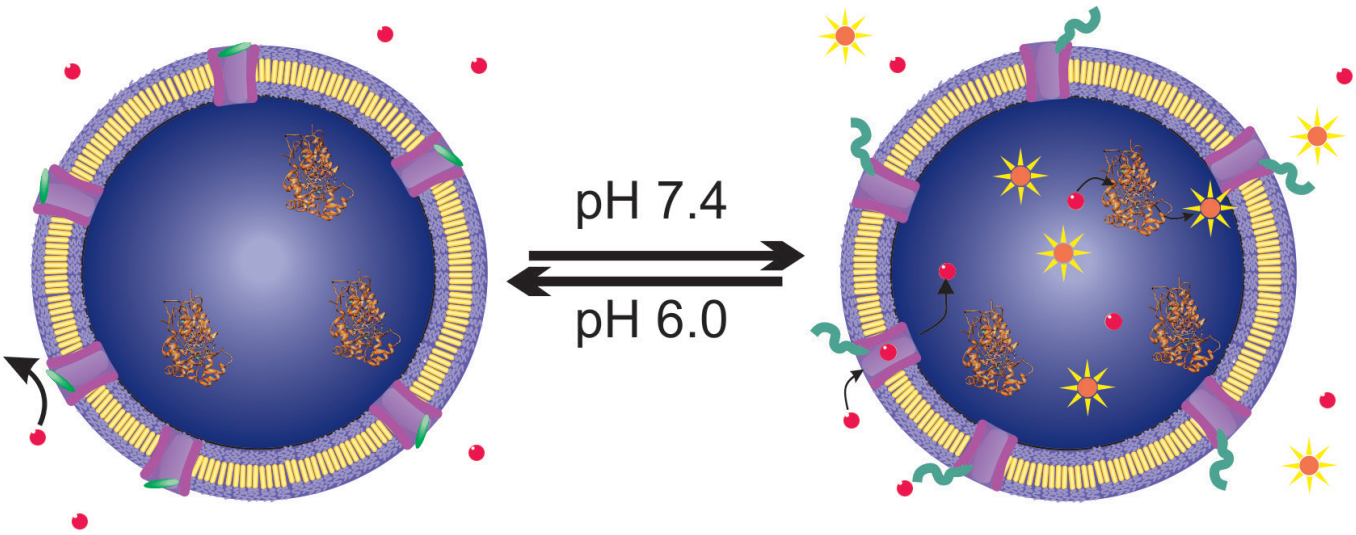
More information at:

https://nanoscience.ch/wp-content/uploads/sites/8/2017/12/nano-tech-event_a4_quer.pdf

Cover Story

Controlling nanocapsules with biovalves

The group run by Professor Cornelia Palivan and Professor Wolfgang Meier from the Department of Chemistry at the University of Basel has recently produced synthetic nanocapsules that allow enzymatic reactions to be controlled externally. To achieve this, the team integrated biovalves into the capsule membrane that can be switched on and off once a certain pH value is reached. This creates the conditions required to activate and deactivate a controlled enzymatic reaction inside the capsule. This innovative technology, used for the first time, has great potential for medical applications, catalysis, and analytical chemistry.



At a neutral pH, the biovalve opens, chemical compounds can enter the capsule, and are enzymatically converted. As soon as the pH in the environment changes and becomes slightly sour, the biovalve closes (Image: Departement of Chemistry, University of Basel).

Cells of higher organisms are divided into compartments with different functions (mitochondria, peroxisome, nucleus, etc). These compartments are separated from the cytoplasm by membranes. Proteins integrated into these membranes control the active and passive passage of chemical compounds in and out of the different compartments. Often, passage is triggered by external stimuli such as pH, membrane potential, specific chemical substances, or light.

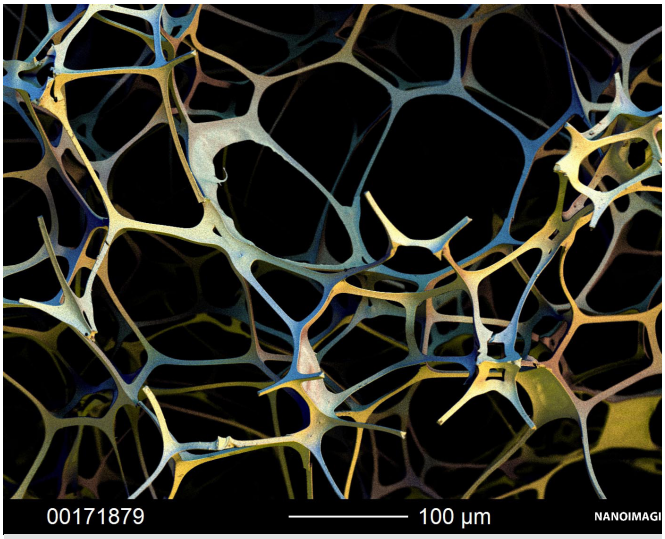
Nature as a role model

Researchers led by Professor Cornelia Palivan and Professor Wolfgang Meier from the SNI and Department of Chemistry at the University of Basel have taken nature as their role model in developing controllable compartments. First, they created robust, synthetic compartments using synthetic membranes that enclose natural enzymes. They then combined modified channel proteins with a peptide that is sensitive to pH changes in the environment, and integrated these into the polymer membranes. At a neutral pH, the biovalve opens, chemical compounds can enter the capsule, and are enzymatically converted. Afterwards, the products of the enzymatic reaction can leave the capsule again.

As soon as the pH in the environment changes and becomes slightly sour, the biovalve closes. As the passage of the essential substrates is blocked, no enzymatic reaction takes place in the compartment.

Basis for numerous applications

With this innovative strategy, scientists from Basel have developed synthetic nanocapsules with reversible "gates" through which enzymatic activity is triggered by external stimuli. They have combined the advantages of the robust and variable polymer capsules with those of genetically modified natural channel proteins by attaching a stimuli-responsive peptide to the channel protein. "In comparison to other strategies, our approach is technically simple," says Palivan. The capsules are formed by self-assembly. As the enclosed and well-protected enzymes in the capsules can be varied, and the properties of the polymer membranes can be changed according to specific needs, this strategy has great potential for applications in medicine, catalysis and analytic chemistry.



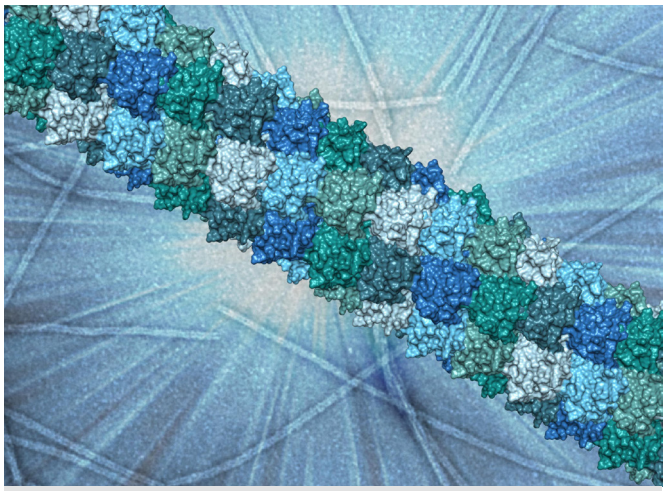
The beauty of foam
Corinne Mattle, Student Nanoscale Sciences
REM-image taken during the block course at the Nano Imaging Lab.

Awards and prizes

Nano Image Award

This year, more than 50 stunning images were submitted from the nano and micro worlds. The SNI management team had a tough time selecting the most outstanding.

In the end, the following images were chosen as the winners of the Nano Image Award 2017:



3D structure of the ASC inflammasome at atomic resolution
Lorenzo Sborgi, Biozentrum
The atomic-resolution structure of the ASC filament was obtained by combining experimental data from solid-state NMR spectroscopy and cryo-electron microscopy in a single structure calculation.

Peakcock's fan
Celestino Padeste, PSI
A perforated 200nm thick silicon nitride membrane that broke; size: 900 µm x 900 µm; size of the perforations: 10 µm x 10 µm.

Congratulations to all the winners and many thanks for all the beautiful images!

The Swiss National Science Foundation has also announced a competition for scientific images and short videos. For more information, visit:

www.snf.ch/de/foerderung/wissenschaftskommunikation/bilder-wettbewerb/Seiten/default.aspx

Outreach Award for Pascal Ankli

In mid-October, SNI Outreach Manager Dr. Kerstin Beyer-Hans presented this year's Outreach Award to Pascal Ankli.

The SNI launched this award two years ago to acknowledge the commitment of students and doctoral students at various public events and school visits. Without their support, the SNI would not be able to take part in scientific events such as tunBasel and the Science Days or to provide school classes and other interested groups with insights into the SNI's latest research.

Each helper is awarded points based on the time and effort required for the event, and the points are tallied every fall. Last year, Dr. Tomaž Einfalt – who has since completed his doctoral dissertation at the SNI PhD School – collected the most points. This year, Pascal Ankli topped the rankings.

Pascal studied nanoscience until the spring, when he switched to biology. "Pascal was and remains an enthusiastic contributor to a wide range of events and has a great rapport with children," said Dr. Kerstin Beyer-Hans after presenting the award. Although he is no longer studying nanoscience, he intends to continue supporting the SNI and, for example, took part in this year's Science Days at the Europa-Park.

We would like to thank everyone who supports SNI at its various public events and shares their enthusiasm for nanoscience and the sciences in general!

Seven new Nano Argovia projects

The SNI Board has recently approved seven new applied research projects within the Nano Argovia program. The 13th call for proposals attracted 16 submissions, which were evaluated by an interdisciplinary committee.

All Nano Argovia projects focus on applied questions that can be answered in no more than two years. Representatives from at least two different academic institutions in the SNI network work with companies in Northwestern Switzerland.

The new projects will take place in collaboration with GratXray AG (Villigen), Memo Therapeutics AG (Basel), Aigys AG (Rheinfelden), Medicoat AG (Mägenwil), Atesos Medical AG (Aarau), InterAx Biotech AG (Villigen), Huntsman (Basel), and Qnami (Basel). We will present these projects in more detail in upcoming issues of *SNI update*.

Events

“Big Bang goes Nano” premieres

For many years, SNI members have been attending the TecDays held at Swiss high schools on the initiative of the Swiss Academy of Engineering Sciences (SATW). A range of talks provide Swiss students with continuing insights into the fascinating world of nanoscience.

The SNI outreach team recently premiered its new program, “Big Bang goes Nano”. In the beautiful Alte Kantonsschule school in Aarau, Dr. Kerstin Beyer-Hans and Dr. Michèle Wegmann presented entertaining explanations of two completely different nanoscience topics. The interactive program was based on Sheldon Cooper and Amy Farrah Fowler, two popular characters from the series “The Big Bang Theory”. Sheldon, a somewhat odd physicist, focuses on graphene and its particular suitability for conducting electricity, while Amy, a young neuroscientist, explores the protein misfolding that can lead to diseases such as Parkinson’s.

After a theoretical introduction with some appropriate clips from “The Big Bang Theory”, the students sprang into action. Using a simple electricity circuit with a small LED, they saw how well the graphite in a pencil conducts electricity – even across a very thin layer on a sheet of paper. The students were even more impressed by the second part of the program, which allowed them to see for themselves the challenges of living with Parkinson’s. A vibrating glove demonstrated, for example, how difficult it suddenly becomes to thread a needle or drink a small glass of water. Weights on their ankles and wrists illustrated the effort it takes to climb stairs or carry shopping. “Before, I didn’t really know how hard and stressful it is to live with Parkinson’s. I see things in a completely different light now,” noted one student after removing the glove and weights.

This practical experience will help the students to remember the theory behind the experiments, and may come back to them in a few years when choosing a degree course. “We always let the young people know about the University of Basel’s nanoscience degree program. It would of course be great to awaken their interest in our program,” explained Kerstin Beyer-Hans and Michèle Wegmann.

In the Alte Kantonsschule school in Aarau, students first examined how well graphite conducts electricity.

Later, they experienced the challenges of living with Parkinson’s.

Reaching the first milestone

In October, SNI Director Professor Christian Schönenberger had the pleasure of attending the bachelor's degree ceremony and presenting certificates to nanoscience graduates.

The young researchers have successfully completed their bachelors program in nanosciences.

Over the last few years, the 24 young scientists have successfully completed a challenging program and learned the fundamentals of physics, chemistry, molecular biology, and mathematics. In addition to numerous lectures and internships, they have also gained extensive practical experience in various research groups as part of their block courses. As master's students, they now face a choice: They can pursue a master's in nanoscience, which continues this interdisciplinary focus, or a master's in physics, chemistry, or molecular biology. Of this year's graduates, 87.5% decided to pursue the nanoscience master's program, which offers them broad variety.

50 pizzas for the students

Nanoscience students always emphasize how much they value the supportive atmosphere on their degree program and the close community among students. In November, the SNI management team invited all nano students to its first informal chat over pizza to support networking between students and the SNI management.

"We are delighted that more than 70 students took us up on our offer," say organizers Claudia Wirth and Christel Möller. "The positive atmosphere was perfect for renewing old contacts and meeting new people."

The SNI used the event not only for networking, but also to ask the students to support their various campaigns. Each year, nano students help out on the SNI stand at multi-day events such as tunBasel and the Science Days.

Ideally, students will also act as ambassadors for the degree program, for example by returning to their former schools to report on their experiences and rousing interest in this unique, challenging program.

Attendees were asked to put this into practice right away by making a spontaneous video. Twelve students helped to create a short clip in which they briefly state why they chose to study nanoscience and why they like it.

Twelve students spontaneously participated in the production of a short video.

https://nanoscience.ch/de/media-2/videos/.

World of experience for inquisitive children and adults

This year, the SNI once again returned to Germany's oldest science festival, the Science Days at Europa-Park in Rust, joining 85 exhibitors from Germany and beyond. The spotlight this time was on the subject of "humans".

Many children and adults used the opportunity to make a simple wooden model of an AFM and to inform themselves about nanoscale sciences.

The popular SNI stand gave visitors insights into how innovative microscopes are aiding research into human beings and helping to diagnose diseases. The focus was on the atomic force microscope, which is now used to film biological nanomachines at work, display chemical bonds, and diagnose malignant tumors. The many children and adults who came along had the opportunity to make a simple wooden model of an AFM to help them better understand the principle behind this special microscope.

"We received a huge amount of positive feedback. Although this year's hands-on activity was fairly technical, interest remained high," said Dr. Kerstin Beyer-Hans of the SNI following the three Science Days.

This success is all down to the team of 12 students and SNI colleagues along with Kerstin's perfect planning and preparation. As well as selecting a topic and making it suitable for children, she also had to make sure that even young visitors would be able to create a functioning AFM model. To prepare for the more than 300 models created over the three days, Kerstin cut 1,200 small blocks, drilled 1,200 holes, sewed many meters of material and Velcro tape, and broke three sewing machine needles!

Advice for current and aspiring young entrepreneurs

Do you have an idea for a start-up company?
SNI members can obtain advice from a range of sources:

- Take part in the Swiss Startup Challenge and benefit from numerous forms of support. For more information, visit:
  http://www.sechallenge.ch/startup/bewerben/
- The Hightech Zentrum Aargau offers consultations for SNI members who are thinking about setting up a company.
  www.hightechzentrum.ch
- University of Basel employees can contact the Innovation Office with questions about setting up or collaborating with companies.
  www.unibas.ch/de/Universitaet/Administration-Services/Bereich-Rektorin/Innovation-Office.html

Did you ever listen to molecules or watch them dancing?

Scientists of the NCCR MSE and the argovia philharmonic have teamed up for the project “Art of Molecule” and created a short video to stimulate the debate about ethical challenges of synthetic biology.

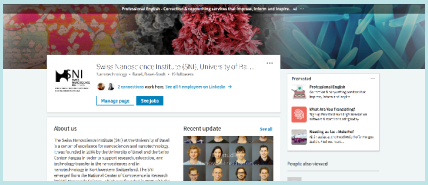
Video: https://youtu.be/z2lnwIfwQdw

If you want to know more about the project and the sound of molecules please visit:
www.nccr-mse.ch/en/ethics/art-of-molecule/sound-of-molecules-i-fiddle-with/

SNI on LinkedIn

The SNI has a LinkedIn page with news about the SNI and its members.

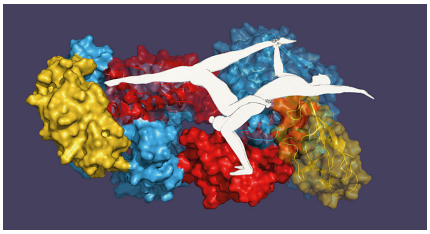
If you want to follow us, please visit:
www.linkedin.com/company/18255301/.



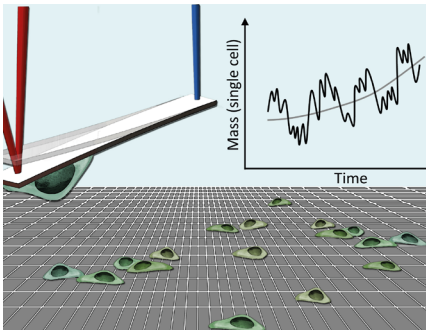
Media release and Uni News from SNI members

University of Basel, December 8, 2017. Acrobatic Duo in the Cells

Just like an acrobatic duo, some proteins lend each other stability. Researchers at the Biozentrum of the University of Basel have discovered that the protein “Trigger factor” recognizes a partner by instable, flexible domains, to then together form a stable protein duo. The study has been published in the current issue of “Nature Communications”.

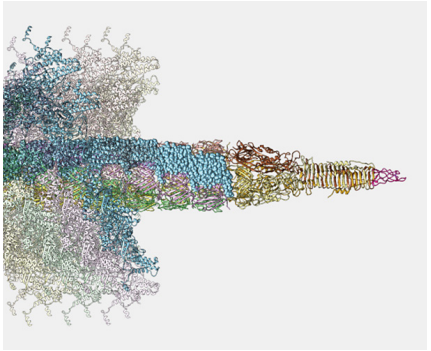


Swiss Nanoscience Institute, October 26, 2017. A nanoscale balance for individual cells



An interdisciplinary team from the University of Basel, ETH Zurich, and University College London have developed a new method that can be used to analyze individual live mammalian cells within a cell assembly. Based on a system of tiny cantilever probes, the technique records the cell mass over several days in millisecond steps and is accurate to within a few picograms. Using the new technique, the scientists have been able to observe for the first time that the cell mass fluctuates within the space of a few seconds. These findings and the new platform provide fundamental insights into the regulation of cell mass and into how this is disrupted in the event of illness. The study was presented in the journal Nature.

University of Basel, September 26, 2017. Bacterial Nanosized Speargun Works Like a Power Drill



Structure of the bacterial nanosized speargun – called type VI secretion system – during contraction. In order to get rid of unpleasant competitors, some bacteria use a sophisticated weapon – a nanosized speargun. Researchers at the University of Basel's Biozentrum have now gained new insights into the construction, mode of action and recycling of this weapon. As they report in the journal "Nature Microbiology", the speargun drills a hole into the neighboring cells in only a few thousandths of a second and injects a cocktail of toxins.

Next call for antelope

You can now apply for antelope, the successful career program for female doctoral students and postdoctoral researchers.

More information at www.unibas.ch/de/Forschung/Graduate-Center/antelope-Programme0.html

Your feedback is important!

Please send information for SNI update and feedback to: c.moeller@unibas.ch.