SWEDISH FOUNDATION FOR STRATEGIC RESEARCH

Future research leaders

The program Future Research Leaders from the Swedish Foundation for Strategic Research supports young, particularly promising researchers with leadership potential. The grants provide selected scientists with the financial base required to establish their own internationally competitive research group, as well as a unique training course in academic leadership. The program was first launched in 2001, during which 21 individual research grants were allocated, and complemented by a second and third round in 2004 and 2008, when 18 and 20 additional researchers were supported. The researchers presented in this booklet were all granted in the fourth call of this program.

The Swedish Foundation for Strategic Research

The Swedish Foundation for Strategic Research (SSF) was established in 1994 with capital from the former wage-earner funds, with the objective to support research in natural science, engineering and medicine that will strengthen Sweden. The Foundation thereby promotes the development of strong research communities of the highest international standard and with instrumental importance for Sweden's future competitiveness.

The foundation uses several different forms of support, but two types of grants predominate; framework grants and individual grants to leading younger researchers. Framework grants are given to scientists with similar or complementing expertise working together to solve an important scientific problem, either at the same or different universities. The individual grants, allocated through the well-established programs Future Research Leaders and Ingvar Carlsson Award, are much appreciated and give young researches an opportunity to focus on their scientific work and build strong research groups. Finally, a third program aims to enhance the mobility between university and industry, in both directions. Typically, grants run over a period of between three and six years.

SSF identifies high priority areas within Swedish research through a comprehensive strategic planning process performed at regular intervals. Our current high-priority areas are:

- Life sciences technology and medical research
- System, information and communication technologies
- Electronics and photonics
- Materials development
- Process and product development technology

Future research leaders

Presenting the research leaders of the future

In this booklet we have the great pleasure of presenting 18 of the most talented young scientists working in Sweden today. These are exceptionally driven, innovative and skillful men and women with the potential to become the next generation of internationally recognized research leaders.

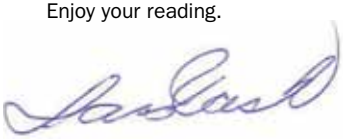
Through our Future Research Leader Program, we will support and promote the work of these rising talents. As well as attending a leadership training program, each participant will receive research funding for five years. This will allow them to set up individual lab groups and conduct research over a longer period of time than would otherwise be possible.

Providing promising young scientists with this kind of long-term funding is crucial for a number of reasons. Without it, Sweden runs the risk of losing many young scientists to research labs abroad. More importantly, without such funding it would not be possible to conduct the kind of ambitious, exciting and groundbreaking research that fills the pages of this booklet.

The work of our participating scientists covers diverse fields across science, technology and medicine, and has wide application. Examples of research outcomes are: new ways of treating chronic pain, cancer and Alzheimer's disease; contributions to the elimination of antibiotic-resistant bacteria; and the development of improved solar cells, lasers and software. These projects have the potential to save many lives, push the borders of technology, and open our minds to what is possible.

We hope you will find them as interesting and inspiring as we do.

Enjoy your reading.



Lars Rask
Executive Director, the Swedish Foundation for Strategic Research

NAME	*Alexander Dmitriev*
BORN	*1975*
YEAR OF PhD DEGREE	*2003*
UNIVERSITY	*Chalmers University of Technology*
PROJECT TITLE	*Scanning Tunneling Nanoplasmonics*

Building ultra-thin materials with ground-breaking properties

By bringing together two fields of research, Dr Alexander Dmitriev will be able to analyse and design new ultra-thin materials on a nano level. If successful, this approach could be used to develop more efficient solar cells, ultra-fast computer memory, and high-performance biomedical sensors – to name just a few.

In his project "Scanning tunneling nanoplasmonics", Dr Dmitriev, assistant professor in the Department of Applied Physics at Chalmers University of Technolgy in Gothenburg, will combine methods of scanning tunneling microscopy (STM) with research in nanoplasmonics (the science that studies light coupling with metal nanostructures). The aim, he explains, is to develop an instrument that can be used to design a wide range of ultra-thin (nano) materials with ground-breaking properties.

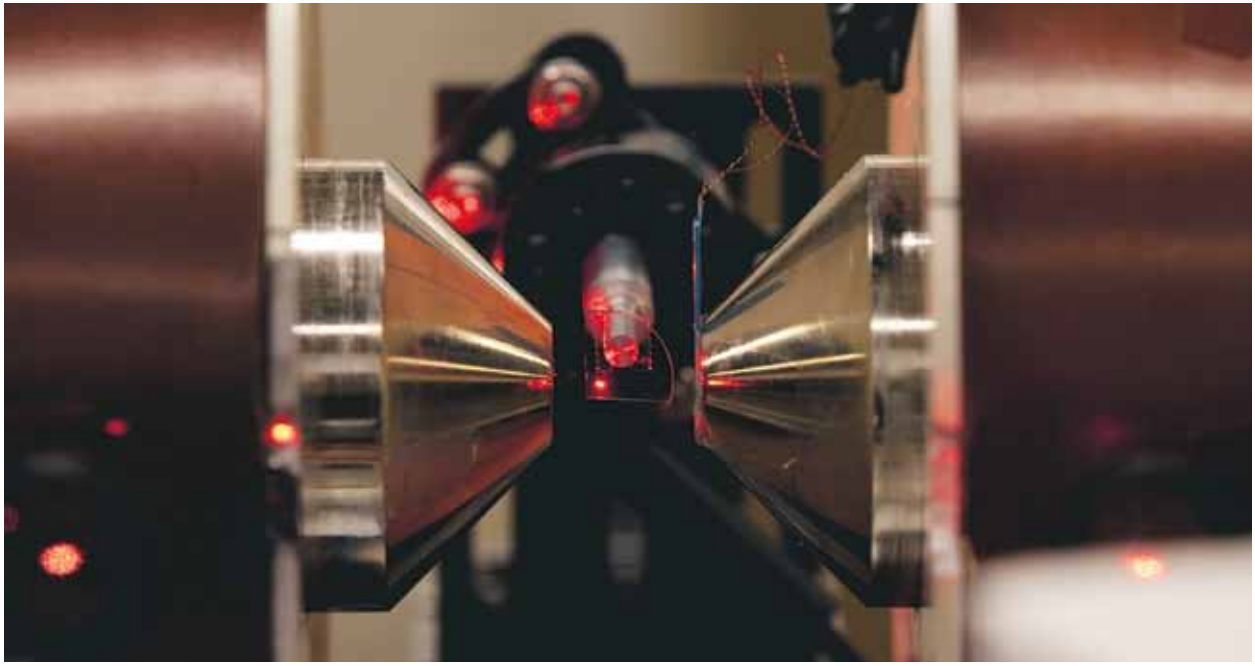
"By applying STM to plasmonic nanostructures we hope to gain a deeper understanding of how optics function at the nanoscale, how optical nanomaterials get their unique characteristics, and how these characteristics could be tailored."

In the STM experiments, a sharp metallic needle is brought very close to the surface of the material that is to be analysed. By applying voltage between the tip of the needle and the sample material, a "tunneling current" can flow between the two. If, at the same time, the tip is moved across the material's surface, changes in the current can be used to detect single atom or molecule bumps, thus providing researchers with a "map" of what the surface of the material looks like on a nano level. Once a material has been analysed, Dr Dmitriev explains, this method can be used to further enhance the material's properties.

"By delivering light into the STM we will be able to use the instrument to design nanoplasmonic architectures at the atomic and molecular scale. This will enable the creation of ultra-thin materials with new, exciting properties and functionality."

The new angle on the idea of bringing the fields of STM and nanoplasmonics together came about as a result of Dr Dmitriev's decision to change direction in his research after finishing his PhD.

"After completing my doctorate, in which I studied self-assembled molecular structures by STM, I decided it was time to learn



something new. I was interested in nanoplasmonics and was fortunate enough to receive a fellowship to start as a post doc at Chalmers. At the time, some of my colleagues told me this was unwise – to leave a research field in which you just gained recognition for one in which you are completely new. But you don't do research just to make a career. Mostly you do it because you love it and because you want to discover new things. So I left one field I loved and entered another exciting one, and after some time I realised I could put the two together."

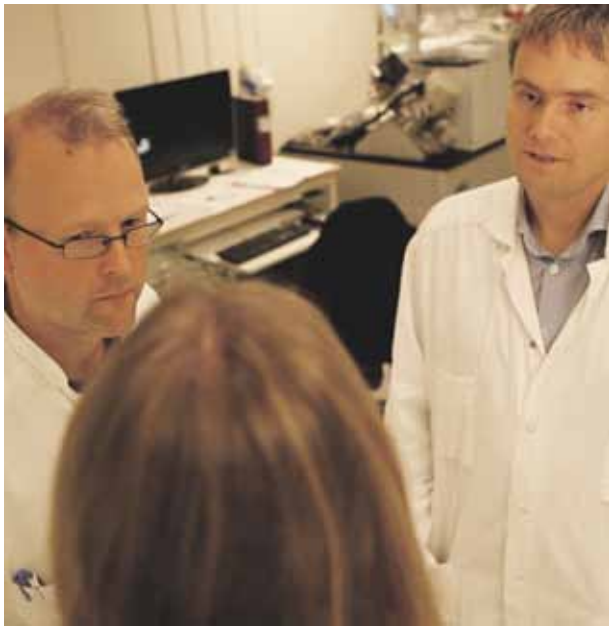
The result of this scientific marriage is an instrument and a method that could be used to deepen our understanding of and improve the characteristics of many nanomaterials.

"There are so many areas where this research could bring new knowledge," Dr Dmitriev says. "So far we have started investigating the processes in plasmon-enhanced photochemistry, as well as begun work on improving the efficiency of solar cells, the performance of biomedical sensors, and attempting to unveil potentially new ways towards ultra-fast memory devices. And I am sure many more practical applications will appear, who knows what waits down the road"

NAME	*Anders Nordström*
BORN	*1974*
YEAR OF PhD DEGREE	*2004*
UNIVERSITY	*Umeå University*
PROJECT TITLE	*Kinetic Metabolomics: A Strategy for Drug Target Discovery*

A new paradigm in identifying drug targets

One of the main problems in developing pharmaceuticals is that very little knowledge of the mechanisms of disease exists. As a consequence, drug development today is to a large extent driven by chance. By developing a new method of measuring molecules in mass spectrometers, Dr Anders Nordström may help to change that.



According to Dr Nordström, assistant professor at the Department of Molecular Biology at Umeå University, our lack of knowledge of disease mechanisms is holding back pharmaceutical development.

"Today, the process of drug development consists of pharmaceutical companies trying out their library of molecules on various diseases. At best they will find the basis for a drug that has an effect and is not harmful for users. Why and how it works will remain a mystery. Obviously, finding a solution to a problem you don't really understand easily becomes very expensive, which is probably why many companies spend their resources re-branding and selling existing products rather than developing new pharmaceuticals."

In the research project "Kinetic metabolomics: a strategy for drug target discovery", Dr Nordström will use new methods of mass spectrometry to develop a framework that can be used to locate the mechanism of any disease.

In his method, called kinetic metabolomics, small molecules are extracted from a cell culture sample, creating what Dr Nordström refers to as a "molecular soup". By adding a marking agent to the soup and running it through a mass spectrometer – a scale so sensitive it can measure the weight of a single molecule – the researchers will be able to determine changes in enzymatic activity over time.

"In this particular project we will use our method to investigate why some cancer cells develop a resistance to chemotherapy," Dr Nordström explains. "By taking some 100,000 cells each from a leukemia cell line and a drug-resistant leukemia cell line,

and then applying our methods to the samples and running them through a mass spectrometer, we can measure how the activity of resistant cells deviates from that of treatable ones. The result is an understanding of what behaviour in the resistant cancer cells needs to be targeted in order to eliminate the disease."

Having worked as a post-doctoral fellow with mass spectrometry world leader Gary Siuzdak at the Scripps Research Institute in San Diego, USA, Dr Nordström has spent some 10 years developing strategies to measure molecules in mass spectrometers.

In his current project, these strategies have been developed into a completely new approach to metabolomics. For the first time, not only will the composition of metabolites be determined but also the rate at which these metabolites change over time. This development, Dr Nordström says, is a significant step towards a new paradigm in identifying drug targets.

"If developed further, our method could be used to locate the underlying mechanisms of any disease. Thus transforming the process of drug target discovery from an expensive gamble into a more straightforward problem-solving activity."

NAME	*Arne Lindqvist*
BORN	*1974*
YEAR OF PhD DEGREE	*2005*
UNIVERSITY	*Karolinska Institutet*
PROJECT TITLE	*The dynamics of DNA damage checkpoint recovery*

Towards a more efficient treatment of cancer

Treating cancer today often is a game of chance, in which the DNA of all cells is damaged in the hope of eliminating the tumour without too many side effects. By investigating the mechanisms behind cell division in normal cells, as well as in cells with damaged DNA, Dr Arne Lindqvist will open up possibilities for the development of more efficient and less painful cancer treatments.

According to Dr Lindqvist, assistant professor of cell and molecular biology at Karolinska Institutet in Stockholm, the development of efficient treatments for diseases such as cancer is held back by our lack of knowledge of one of the most fundamental aspects of life.

"There is a general misconception that we know why and how cell division takes place, but we don't," he says. "This lack of understanding prevents us from seeing how the development of sick cells differs from that of healthy ones."

In his research project, "The dynamics of DNA damage checkpoint recovery", Dr Lindqvist combines what are normally two separate disciplines in order to investigate how the activity and interaction of important proteins lead to cell division.

"As the protein activity increases in a non-linear fashion, the process is too complicated to be explained using methods of classic biology," he says. "In order to fully understand what happens it is therefore necessary to describe the activity leading up to cell division using mathematical models."

However, in contrast to many projects of a similar kind, the computational part of the research is not driven by the results of other scientists. Using a novel method of quantitative microscopy, developed by Dr Lindqvist himself, the research group will

be able to make sure they get the experimental data they need to run the equations.

"If cells are in contact with each other they will start interacting," Dr Lindqvist says. "By keeping them separate, letting tens of thousands of identical cells grow side by side on special micropatterns, we can obtain reliable data with little deviation that can be inserted into our mathematical models and used to explain the process leading to cell division."

Apart from studying the processes leading to cell division in normal cells, Dr Lindqvist will also investigate the activity of cells in which damaged DNA has been repaired. By comparing normal cells with cells with damaged and then repaired DNA, it is hoped that new possibilities for future treatments of cancer will emerge.

"Cancer is only found in cells that once contained damaged DNA, and such cells develop differently than normal ones," he says. "Once the differences in protein activity have been located it should be possible to use the results in more applied research to design treatments that affect only the cells in which protein activity deviates from the norm."

Such a development, Dr Lindqvist argues, would turn a treatment that is now an inefficient and painful gamble into a well-calculated risk.

"Today the disease often is treated by damaging the DNA of all the cells in the hope the cancer cells will die. If we can build a model of how cells decide to divide, we could fit data from an individual cancer into this model. This would allow us to predict what kind of treatment to combine with DNA-damaging drugs to more efficiently target these cancer cells. The result of which would be a more efficient treatment with less side effects."

NAME	*Camilla Svensson*
BORN	*1973*
YEAR OF PhD DEGREE	*2005*
UNIVERSITY	*Karolinska Institutet*
PROJECT TITLE	*Arthritis and chronic pain: new models and central targets*

Relieving chronic pain

Affecting 15 to 20 percent of the population, chronic pain is one of the biggest health problems in the western world today. The lack of effective treatments and understanding of the condition results in extensive costs for society and leads to a lower quality of life for hundreds of millions of people. However, if Dr Camilla Svensson's unique hypothesis is proven right, relieving chronic pain could be no further than a drug development away.

Having been involved in pain research for more than a decade, Dr Svensson, assistant professor at the Department of Physiology and Pharmacology at Karolinska Institutet in Stockholm, has come to believe chronic pain is what happens when the body's alarm system backfires.

"Pain is an amazing warning system designed to protect us," she explains. "When we are injured it forces us to stay still and allow time for rest and repairs. However, in our research we have found that in the case of some long-term inflammatory conditions not only is the pain amplified but it also remains after the inflammation is gone."

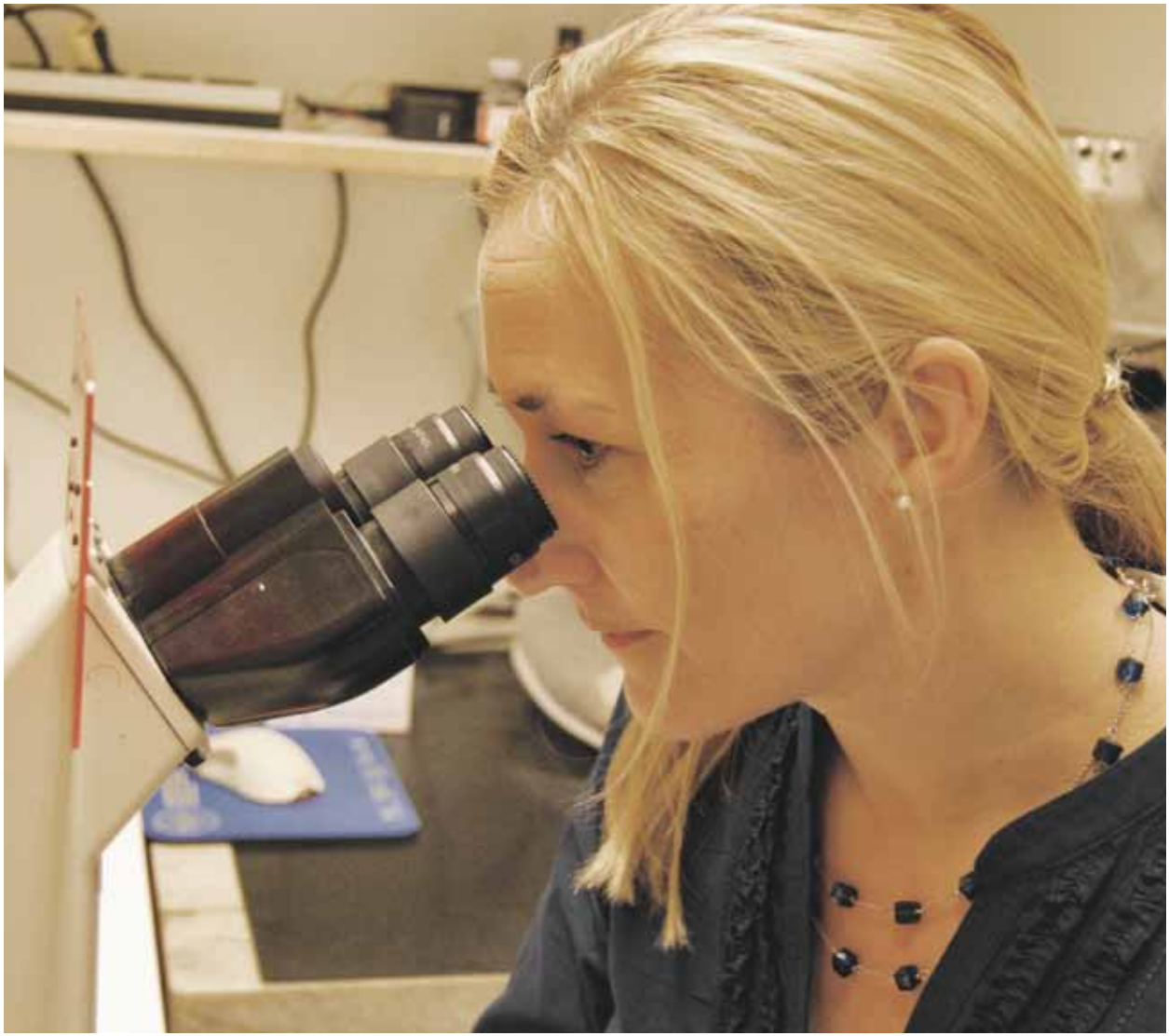
One of Dr Svensson's hypotheses is that long-term inflammation in the joints triggers a group of cells in the central nervous system to amplify or prolong that pain. The reason it has taken so long to make this connection, she believes, is that the amplifying qualities of the cells, called microglia and astrocytes, were initially overseen as researchers thought they were functioning mainly as support cells in the central nervous system. The discovery of the pain-regulating properties of microglia, made in 2002 by Dr Svensson and her former colleagues at the University of California, came as a major surprise.

"At first we thought we had done something wrong," she says. "But when I talked about our results at a meeting it turned out a number of other groups had made the same 'mistake' in their projects. I still remember the sense of excitement that filled the room once we realised we had discovered a completely new mechanism of pain that, if properly understood, could be used to control chronic pain."

In her project, "Arthritis and chronic pain: new models and central targets", Dr Svensson and her research group will investigate new links between astrocytes and the regulation of persistent pain induced by inflammation in the joints. The main challenge, she explains, is to develop methods for measuring ongoing pain that relate to the human experience.

"By collaborating with outstanding arthritis researchers at Karolinska Institutet and using mouse models that are well established in the rheumatology field (but not previously used for pain research), we hope to reach a new understanding of the mechanisms that drive chronic pain in humans."

"We'll start by investigating rheumatoid arthritis induced pain. If our hypothesis is proven right, we'll move on to see if the same is true for all other chronic inflammatory diseases. If we are correct, a new avenue for developing drugs to relieve chronic inflammatory pain could be within reach."



NAME	*Carlota Canalias*
BORN	*1975*
YEAR OF PhD DEGREE	*2005*
UNIVERSITY	*KTH - Royal Institute of Technology*
PROJECT TITLE	*Sub-wavelength structured ferroelectrics*

Pushing the development of optical materials

Research into ferroelectric crystals is recognised as one of the key areas for further innovation in laser development and sensing. In her new project, Dr Carlota Canalias will investigate and engineer materials that will allow for the production of improved and novel optical components, such as lasers, sensors and filters.

Internationally renowned for her ability to manipulate ferroelectric crystals, Dr Canalias, research leader in the Department of Laser Physics at the Royal Institute of Technology (KTH) in Stockholm, has successfully engineered crystals with micrometer-scale domains for use in lasers and optical experiments. Now, in the project "Sub-wavelength structured ferroelectrics", she will attempt to push her field of research one step further.

"By building structures of nanoscopic size in the crystal – the same as the wavelength of laser – it will be possible to develop materials that have no counterpart in the world today," she says. "Apart from creating optical and electro-optical components in which you can control the output in detail, devices with completely new and unique properties could be produced."

If they can be engineered, ferroelectric crystals with nanoscopic domain structures would have many areas of application. Among others, they could be used to create compact lasers with outstanding precision and novel characteristics, as well as to build more sensitive optical sensors and filters to measure and investigate anything from air quality to bio-cells.

However, as Dr Canalias explains, no one has managed to create these structures on a nanoscale before, and no example of them exists in nature. In order for the project to be successful, her group must first understand the physics involved in the process.

“The project is a kind of proof of principle,” she says. “Our prior experiments have shown that this really works. Now we need to investigate how it works. Once this is accomplished we can move on to develop the methods and techniques needed to build these materials.”

In order to do this, Dr Canalias will make use of, and manipulate, some of the properties specific to ferroelectric crystals.

“These crystals have a permanent electric polarisation that, just like a magnet, can assume two different directions. (A region with one direction is called a domain.) By applying an external electrical field to the crystal, the direction of domain polarisation can be changed. If this is done periodically, it creates a grid, which can be used to steer or change the colour of a laser. By making these domains smaller we can increase our control of the laser. And by making them smaller than the wavelength of light, new effects will appear.”

Building these structures is considered an extremely difficult process that, according to Dr Canalias, would not be possible were she based anywhere else.

“In order to study this area, a great investment of time and infrastructure is necessary. The laser physics group at KTH has made this investment and spent more than twenty years building up an internationally outstanding knowledge base about these materials. There simply is no place in the world better suited for conducting these experiments.”

NAME	*Daniel Fällman*
BORN	*1975*
YEAR OF PhD DEGREE	*2004*
UNIVERSITY	*Interactive Institute, Umeå*
PROJECT TITLE	*The Design of Engaging Information Technology*

Developing a more engaging information technology

For a long time usability has been the keyword when developing new information technology applications. By creating principles for an alternative design philosophy based on human engagement and involvement, Dr Daniel Fällman hopes to move the focus of development from the function of a product to the needs and desires of its users.

According to Dr Fällman, associate professor in the Department of Informatics at Umeå University, most decisions regarding IT development are being made by programmers and engineers, and, as a result, important design and experience- related aspects that take into account human engagement often get lost along the way.

"Usability is still an important concept when developing new technology, just as ergonomics is still important when designing a chair. However, with so many new products on the market, focusing solely on usability is not enough," Dr Fällman says.

Using the success of Apple's iPhone as an example, Dr Fällman believes companies that learn how to develop products and services that foster human engagement and involvment will gain a competitive advantage.

"Designing engaging technology is not a new phenomenon, but it has not been done in a conscious or strategic way before," he explains. "As there exist no well- developed scientific theories or frameworks to describe the process, convincing decision-makers of its importance has proven very difficult."

In his project, "The design of engaging human technology", Dr Fällman and his research group are aiming to establish a new direction in the field of human- computer interaction, in which ideas from phenomenological philosophy and design theory are applied to IT-development. The group hopes to develop new theories, methods and techniques that showcase the importance of user engagement and involvement.

Apart from applying theories of more traditional design to IT development, an important factor in Dr Fällman's new field of research, called Design of Engaging Information Technology (DEIT), is its focus on social responsibility. "I believe designers have a responsibility for what they design and how their designs come to affect society," he says.

During the project, a number of software and hardware prototypes of engaging information technology will be developed, tested and analysed. The idea is to focus on what Dr Fällman refers to as “extreme users” and “extreme environments”. “Technology has a tendency to conquer new areas, automate tasks, and force users to adapt to existing solutions,” he says. “By choosing unusual environments and users not normally associated with IT development, we want to push ourselves into designing products and services that resonate with the needs and desires of these users.”

In the first of these projects, conducted in partnership with Swedish company ABB, the Fällman group designed a new monitoring system for a paper factory. The idea was to transform the old “Homer Simpson” type system, in which control panel lights flash to indicate problems in the production line, into a 3D model with a multi-touch screen that workers could use to zoom in and out and see different parts of the factory.

“We think it was a success,” Dr Fällman says, “because when we came to pick up the prototype at the end of the trial period the staff refused to give it back, so we ended up leaving it at the plant.”

NAME	*Johan Elf*
BORN	*1975*
YEAR OF PhD DEGREE	*2004*
UNIVERSITY	*Uppsala University*
PROJECT TITLE	*New techniques for intracellular biophysics*

A better tool for understanding living matter

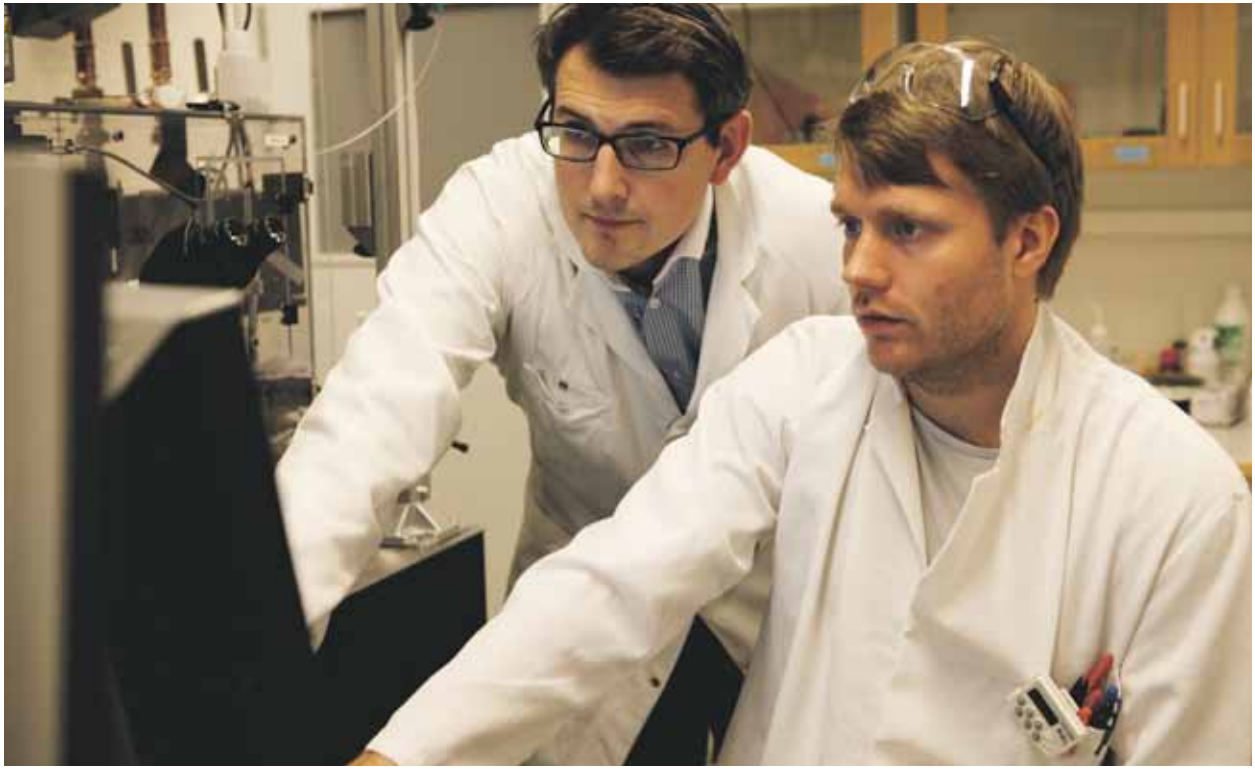
A majority of the pharmaceutical discoveries made in the field of biochemistry during the last thirty years are based on the studies of molecules in test tubes. By switching focus, and base observations on individual molecules in living cells, Dr. Johan Elf has taken a significant step towards developing a better understanding of complex diseases and their treatments.

According to Dr. Elf, associate professor of molecular biotechnology at Uppsala University, one of the major limitations of his field of research is that, essentially, all studies of the dynamics of biomolecular interactions are conducted with purified molecules in test tubes, and not in the complex interior of living cells.

"As molecules often act differently in test tubes as compared to their natural environment, we are missing important pieces in the puzzle if we cannot study reaction kinetics in living cells," he says. "We may also fail to see important interaction related to diseases and their treatments."

In his research project "new technology for intracellular biophysics" Johan Elf and his team investigate biochemical processes in living bacterial cells to see how they differ from those in vitro. By building microscopes designed specifically for the purpose, the scientists are able to see and trace how single protein molecules move inside the living cells and investigate, for example, why and how genes are turned on and off. A critical and unique component of Dr. Elf's lab group research is that the studies of molecules in living cells are combined with equally detailed physical models of the intercellular processes.

"Only by combining mathematical or computational models with quantitative experimental studies is it possible to understand the principles that govern the molecular makeup of living matter,"



In the long run Johan Elf is certain other research groups will adapt his techniques and simulation methods and use them to study the eukaryotic cells found in humans. This will enable future scientists to address fundamental questions about the molecular reason behind diseases, such as cancer, which are too complex to study in a test tube.

Dr. Elf says. “By taking advantage of new technology and advances within a number of different fields we now have an opportunity to study molecular kinetics in a way that has not been possible before.”

For the biotechnological and pharmaceutical industry the long-term consequences of the project could be immense. Apart from creating a better understanding of living cells as such, the new technology and computational methods developed in the Dr. Elf’s lab also could lead to an increased understanding of diseases and their treatments.

“As we work with bacterial cells one of the first things we will investigate is why some bacteria develop a resistance to antibiotics and others don’t. Knowledge that could be used to develop a more efficient type of antibiotic,” Dr. Elf says.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ÅRE SWEDEN

NAME	*Johan Malmström*
BORN	*1975*
YEAR OF PhD DEGREE	*2003*
UNIVERSITY	*Lund University*
PROJECT TITLE	*Genome- and proteome-wide analysis of bacterial virulence*

Understanding and targeting antibiotic-resistant bacteria

Bacterial infections present a major global health problem, which is aggravated by a rapid increase in antibiotic resistance in many pathogenic bacteria. By developing a new tool for investigating and analysing bacteria, Dr Johan Malmström will greatly increase our chances of understanding and eliminating such diseases.

According to Dr Malmström, assistant professor at the Department of Immunotechnology at Lund University, it is crucial we start dealing with the problem of antibiotic-resistant bacteria now, before the problem gets completely out of hand.

"By being too generous with the distribution of antibiotics, humans have created a growing ground for antibiotic-resistant bacteria. This is a problem because once a bacteria has developed resistance it spreads very quickly. In the long run this could have devastating consequences, and turn many everyday hospital procedures into potential death traps."

In the project "Genome- and proteome-wide analysis of bacterial virulence", Dr Malmström develops new mass spectrometry methods that can be used to investigate why bacteria develop resistance to antibiotics, why certain bacteria cause serious disease, and what proteins need to be targeted in order to eliminate disease. More specifically, he will apply his method to study Streptococcus pyogenes, a bacteria normally found to be the causative agent of tonsillitis.

"Mostly [S. pyogenes] is harmless, but in about 500,000 cases each year the bacteria travels from the throat into the blood stream, causing deadly blood poisoning. We want to understand why this happens and find the proteins that need to be targeted in order to stop the bacteria from entering the blood."

Dr Malmström first came across mass spectrometry in 1998 when he was studying lung diseases such as asthma and chronic obstructive pulmonary disease at the pharmaceutical company AstraZeneca, in Lund. Despite the method being undeveloped at the time, he instantly realised its potential.

"As a classic biologist I was used to investigating one protein at a time, bit by bit, which is extremely time consuming and frustrating as you do not see the bigger picture that is needed to understand cellular behaviour. And then this technology came along with the promise of quickly investigating large populations of proteins."

Dr Malmström left the field of classic biology and devoted himself to developing the technology and software for mass spectrometry analysis. His quest took him to Seattle in the United States where he worked as post doc for one of the world's authorities on mass spectrometry, Professor Ruedi Aebersold. After this, Dr Malmström transferred to Zurich where he was CEO for the company Biognosys (founded by him and Professor Aebersold on the basis of their research).

In his current project, Dr Malmström will further develop the methods he worked on in Switzerland in order to solve the problem of antibiotic resistance in bacteria. However, this time he does not have to analyse the proteins one by one.

"Using our method we can measure all the proteins in a bacteria in a week, as well as focus in on groups of important proteins. This will greatly speed up the process and make analysis a whole lot easier, Dr Malmström says."

As the method is generic and can be adapted to the study of any bacteria, its impact on pharmaceutical development could be immense.

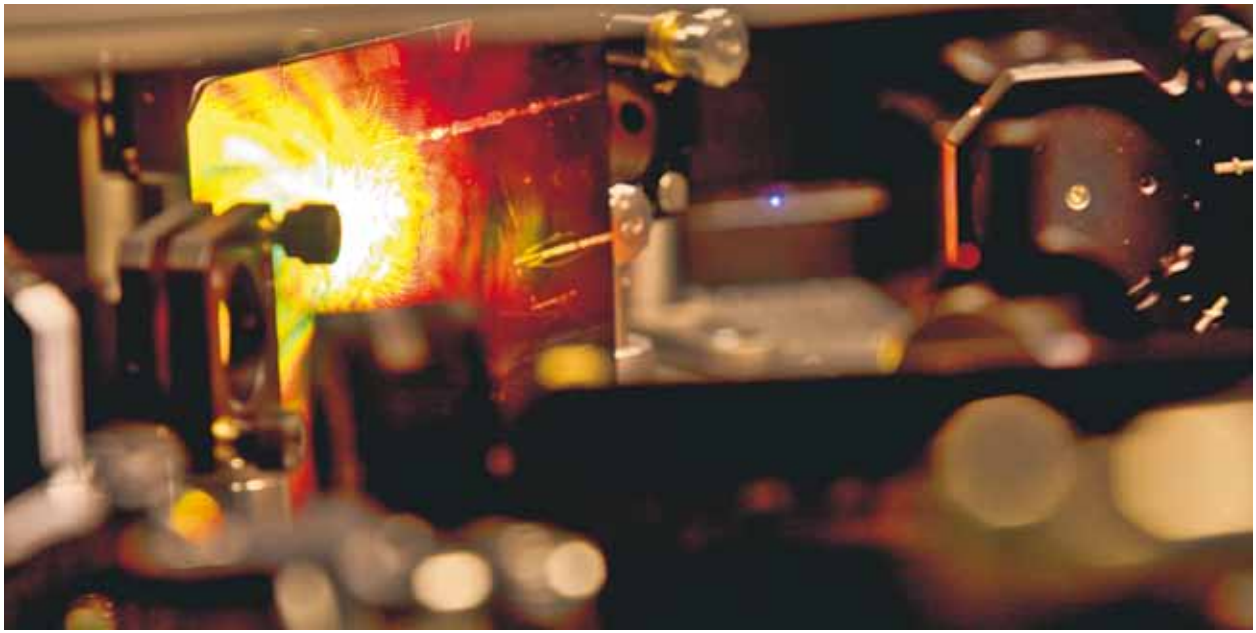
NAME	*Johan Mauritsson*
BORN	*1976*
YEAR OF PhD DEGREE	*2003*
UNIVERSITY	*Lund University*
PROJECT TITLE	*Attosecond science with multicolored light waves*

Uncovering the inner lives of atoms

By developing a technology for generating and controlling the fastest light pulses ever created, Dr Johan Mauritsson will be able to see and film electrons moving in real time. If successful, his investigations will open up a new field of research that could deepen our understanding of fundamental physical, chemical and biological processes.

In his project, Dr Mauritsson, associate professor in the Department of Atomic Physics at Lund University, will attempt to promote attosecond pulses as a new research tool by refining the techniques needed to study how electrons move in atoms and molecules.

"The reason electrons have never been studied in this way before is that it has not been possible to generate fast enough



pulses in a controlled way," he explains. "At best, scientists have been able to get snap-shots of the places electrons move between and use these to predict their movements. By developing an instrument that can measure attoseconds, the speed at which electrons move, we can get a more accurate picture of what actually happens."

Until recently, the general belief was that creating such a fast pulse was technically impossible. However, in 2001 two different groups showed that it could be done, and in 2003 Dr Mauritsson and his current research group also succeeded. By bombarding an atom with a strong laser field, they found electrons can be excited, ripped of their course, and accelerated by the field. If such an electron comes back and collides with the atom core, the additional energy from the laser field can be turned into an attosecond pulse.

"The problem," Dr Mauritsson says, "is that at this time the field of attophysics did not yet exist and there were no theories about how to use these pulses and for what."

In order to find out, Dr Mauritsson left Sweden and joined the group of Professor Ken Schafer at Louisiana State University, where he spent two years conducting the theoretical calculations needed to understand and further develop his field of study.

Back in Sweden, Dr Mauritsson used these theories to develop a technique for generating and controlling attosecond pulses. This resulted in an international breakthrough when in 2008 his research group became the first ever to film an electron riding on a light wave.

In his current project, "Attosecond science with multicolored light waves", Dr Mauritsson will further refine the technique. The aim is to find a way to generate a generic sequence of attosecond pulses that can be utilised in many situations, and a method to produce the optimal light field needed for any given experiment. If successful, an increased understanding of all fundamental physical, chemical and biological reactions could follow.

"All important reactions, from the effects of pharmaceuticals to those taking place in solar cells, are based on electrons moving in between atoms and molecules. By seeing these movements as they happen, we can understand them and, I believe, eventually also learn to control them," Dr Mauritsson says.

"Currently we use our technology to understand fundamental aspects of atoms, but we have also started a collaboration with chemists to investigate photosynthesis, and there are so many other areas to which it could be applied. It is a bit like the laser at the time of invention – a tool looking for an application, an answer looking for a question. And there are a great many questions out there."

NAME	*Marie Dacke*
BORN	*1973*
YEAR OF PhD DEGREE	*2003*
UNIVERSITY	*Lund University*
PROJECT TITLE	*Flight control in dynamic environments*

Using insects to teach robots to fly safely

For years engineers and programmers have tried and failed to teach autonomous flying robots to avoid unexpected obstacles. Dr Marie Dacke will attempt to solve the problem by mimicking the avoidance system of bumble bees and wasps.

According to Dr Dacke, assistant professor in the Department of Cell and Organism Biology at Lund University, the inability of autonomous flying robots to avoid sudden obstacles has greatly limited their area of use. “Currently, flying robots are only used in big open spaces, such as large- scale farms. Using them in more complex environments, such as a city, is impossible as there are too many unexpected things they risk flying into. Consquently, you will have to look long and hard to find people who want to invest a lot of money in a machine that crashes as soon as it hits a plastic bag.”

In her research project, “Flight control in dynamic environments”, Dr Dacke will attempt to teach robots to fly safely by mimicking the behaviour of two of nature’s most supreme navigators and avoidance experts – bumble bees and wasps.

“When flying through a field of swaying flowers, these insects constantly have to change their course and speed in order to avoid collision. Even though both of them have brains that are smaller than a grain of rice, they can do the most amazing manoeuvres to avoid sudden obstacles. We want to find out how they do it, and adapt their strategies for use in flying robots.”

In order to observe and analyse the avoidance strategies of the insects, Dr Dacke first teaches the bumble bees to fly throught a tunnel (by leading them to a tray of pollen), and then introduces different visual stimuli and obstacles in order to see how they regulate speed and movement in order to avoid collision.

By recording the flight with two high-speed cameras, the research group can recreate the flying paths of the insects on a computer and use the collected data to develop mathematical

models for obstacle avoidance. As a last step, in cooperation with engineers at the University of Lausanne in Switzerland, the models will be developed into software and tested in flying robots.

The idea, Dr Dacke explains, is to start with bumble bees and then move on to wasps to see if there are any general strategies for obstacle avoidance that can be applied when developing the software.

"Even though it most likely will be a process of trial and error to begin with, I believe it is only a matter of time before small autonomous flying vehicles become part of our everyday life," she says. "If they can be made safe, robots will be an efficient and environmentally friendly way to transport anything small, such as blood samples between hospitals."

Dr Dacke came up with the idea for her project when training insects in Canberra, Australia, as part of her PhD. She was studying honey bees, which traditionally had been the norm for such experiments. However, for her current project, bumble bees have turned out to be much more practical. "Not only do bumble bees have an amazing capability for avoiding obstacles, but they can be delivered via normal mail. It's great. You send in an order and a few days later someone appears outside your door with a big buzzing parcel and a puzzled look on their face."

NAME	*Martin Högbom*
BORN	*1974*
YEAR OF PhD DEGREE	*2003*
UNIVERSITY	*Stockholm University*
PROJECT TITLE	*Membrane protein structural biology and enabling technology*

Uncovering the secrets of membrane proteins

Membrane proteins are the targets of a majority of the pharmaceuticals on the market, yet very little is known about them. By developing new tools for determining the structure of these proteins, the work of Dr Martin Högbom could greatly simplify the process of finding important new drug targets.

According to Dr Högbom, associate professor at the Center for Biomembrane Research at Stockholm University, an increased knowledge of the structure and function of membrane proteins would greatly benefit pharmaceutical development.

"Membrane proteins are the doors and windows of the cell. They decide what comes in and what goes out, and are the targets of more than half of all available medicines. By studying what these proteins look like and how they work, a great many targets for new drugs could be found."

However, very little is known of the structure of membrane proteins. The reason, Dr Högbom says, is that their nature makes them very difficult to study.

"In order to understand the chemical details of how a protein works you need to determine its structure, and in order to do so you need to get hold of a sample of the protein you wish to study. Membrane proteins, in contrast to those inside the cell, are not soluble, so they first must be removed from the cell membrane. This is extremely hard to do while keeping the protein in a stable and functional form, and is the reason why structures of soluble proteins outnumber those of membrane proteins by a hundred to one."

In his project “Membrane protein structural biology and enabling technology”, Dr Högbom will develop methods for removing proteins from the membrane and use X-ray crystallography to determine their structure.

“Simply put, we trick bacteria into producing the protein to get the quantities up. The result is a kind of ‘bacterial soup’, from which we extract the proteins. Once removed from the membrane, we turn these proteins into a crystal. By exposing our crystal to X-rays, we can, through the use of mathematical models, calculate what the protein looks like on an atomic level.”

In the project Dr Högbom and his team will set out to determine the structure and functions of some 60 membrane proteins of particular scientific and medical importance. Apart from finding new drug targets, the aim is to provide a tool that could make pharmaceutical development a lot easier.

“If it is known that a protein has a connection to a disease and we know what this protein looks like and how it works on an atomic level, pharmaceutical companies could design molecules that bind to the protein and stop its damaging function. This would be a lot more efficient than the current method of more or less randomly trying out different molecules in the hope they will have an effect.”

As the field is new and of great importance for pharmaceutical development, competition is fierce. However, Dr Högbom believes the scientific climate of Stockholm University gives him and his group one great advantage.

“I have never before worked in such an open environment. This is a department that is world leading in bio-membrane research, and one in which I can bounce around ideas with experts from all kinds of backgrounds. It is true that we cannot compete with the big universities in the US in terms of money or resources, but we have another kind of freedom and openess here that I believe is paramount for scientific success.”

NAME	*Peter Nilsson*
BORN	*1970*
YEAR OF PhD DEGREE	*2005*
UNIVERSITY	*Linköping University*
PROJECT TITLE	*Multimodal tools for Molecular Diagnostics and Therapeutics*

A tool for the early detection of Alzheimer's disease

By building molecules that emit light when they bind to specific proteins, Dr Peter Nilsson has found a revolutionary new approach that could be used to detect, study and aid in the treatment of a number of serious diseases. In his current project he will further refine these molecule-building techniques in order to develop a tool for the early detection of Alzheimer's disease.

In his research, Dr Nilsson, assistant professor in the Department of Chemistry at Linköping University, makes use of the unique properties of a group of molecules called Luminescent Conjugated Oligothiophenes (LCOs) in order to detect and visualise disease.

"In the case of Alzheimer's and a number of other diseases, proteins with faulty structures tend to lump together in the brain as clusters. By building molecules that send out a light when binding to such clusters, we can find the disease at an early stage and locate its position," he says.

As there currently exist no methods for the early detection of Alzheimer's, the impact of Dr Nilsson's research could be immense.

"Today Alzheimer's is discovered either through cognitive tests or by doing an autopsy after the person has died. As it has not previously been possible to visualise the disease, no medical treatments exist (you cannot develop pharmaceuticals if you cannot measure their effect). Our method could help to change that."

It was in 2003 that Dr Nilsson, through a chance encounter, first realised "his" molecules could be used for these purposes.

"At the time I was working in polymer physics, the field in which these kinds of molecules are normally used. In those days I tested my molecules on anything I could get my hands on. One day Per Hammarström (an expert on Alzheimer's disease) came into the lab, and we instantly bonded over our mutual interest in heavy metal. As a result, I ended up testing my molecules on his protein clusters, and found that they gave off a light."

The discovery that the molecules – normally used in the development of solar cells and light-emitting diodes – also could be

used to detect Alzheimer's led to a change of field and a move to Zurich. Here, Dr Nilsson joined the group of Professor Adriano Aguzzi, which is world leading in the study of diseases such as Alzheimer's, type 2 diabetes and mad cow disease. As part of the team, Dr Nilsson refined his methods and tested his molecules on a number of diseases. The resulting discoveries led to an international breakthrough and the development of molecules that today are being used in laboratories all over the world.

In his current project, "Multimodal tools for molecular diagnostics and therapeutics", Dr Nilsson will refine his methods even further so they can be used in human diagnosis.

"Currently we can study Alzheimer's in live animals and in vitro in human and animal tissue samples. By modifying our molecules so their signal can be discovered by magnetic resonance imaging (MRI) and nuclear medicine imaging techniques, our goal is to develop a prototype for the early detection of Alzheimer's that can move on to clinical trials within five years."

Also, by modifying the basic function of the molecules, they could be used to study a number of other diseases.

"As our method can be used for basically anything, we are always looking for interesting new areas to investigate," Dr Nilsson says. "Apart from working with Alzheimer's, we are, among other things, building molecules that couple to specific cancer cells – a tool that could be used for early diagnosis as well as aid in the development of pharmaceuticals that only target cancer."

NAME	*Richard Lundmark*
BORN	*1974*
YEAR OF PhD DEGREE	*2004*
UNIVERSITY	*Umeå University*
PROJECT TITLE	*Endocytic membrane remodelling machineries*

Understanding how molecules access cells

Today we do not know much about how molecules access and enter cells. By seeking to understand and trace these enigmatic mechanisms, Dr Richard Lundmark could greatly increase our understanding of the cellular uptake of medicine, nutrients, viruses and bacteria – and how such processes could be blocked or encouraged.

In his research, Dr Lundmark, assistant professor in the Department of Medical Biochemistry and Biophysics at Umeå University, will investigate the basic mechanism of endocytosis, one of the processes by which molecules enter cells.

"Endocytosis is a method that cells use to transport molecules from the outside to the interior of the cell. Due to the complexity of the phenomena and the diversity of cells, our knowledge of the process is very limited. This is a problem, as an increased understanding of endocytosis is necessary if we want to be able to more efficiently target disease."

During endocytosis, parts of the cell membrane are turned into vesicles – "bubbles" that are created by the membrane and individual networks of proteins inside the cell. These bubbles perform a number of important functions; apart from working as a passageway through which nutrients can enter the cell, they regulate the exposure of cell surface receptors (which play a role in avoiding cancer). However, a number of other, more harmful molecules also use these methods to enter cells.

"Apart from nutrients, viruses and bacterial toxins use endocytosis to hack their way into cells. By understanding how they do this, as well as uncovering the processes that govern what is allowed to enter cells, it should be possible to find ways of blocking unwanted 'visitors'."

Dr Lundmark's project, "Endocytic membrane remodelling machineries", will utilise high-end microscopy to film and measure the movements of various cellular vesicles in order to map, analyse and understand the processes by which different molecules enter cells.

During the course of the research, a number of networks and partnerships will be established in order to apply the method to current problems within health care and pharmaceutical development.

"An understanding of how things get in and out of cells could be used in a number of important areas," he says. "From developing medicine that prevents viruses and bacterial toxins from entering cells, to designing drugs that target sick cells only."

Having personal experience of cancer treatment, Dr Lundmark has gained a painful insight into what could be avoided if more targeted treatments were developed.

"Being treated for cancer is horrible. It just knocks you out. It is a treatment in which all cells are blasted in the hope the cancer will die and healthy cells recover. A lot of medicine works according to the same principle – like antibiotics, which eliminate harmful as well as good bacteria. My hope is that our research will contribute to future treatments that target only the disease, such as a cancer medicine that only is taken up by cancer cells."

NAME	*Rickard Sandberg*
BORN	*1977*
YEAR OF PhD DEGREE	*2004*
UNIVERSITY	*Karolinska Institutet*
PROJECT TITLE	*The anatomy of a gene expression program*

Investigating the specialisation of cells

By utilising new sequencing technology and large-data computation techniques, Dr Rickard Sandberg will investigate why and how cells choose to specialise. Apart from attempting to answer a fundamental question of science, his research could be of great importance for the development of more efficient cell reprogramming methods in future stem cell therapies.

According to Dr Sandberg, assistant professor in the Department of Cell and Molecular Biology at Karolinska Institutet in Stockholm, a better understanding of the regulation of cell identities and specialisation would be of immense importance in the development of numerous scientific fields.

"When a human being develops from a fertilised egg, the process starts with a series of divisions and the sequential speciali-

sation of cells. As the embryo grows, more specialised cell types are formed. If we can figure out why and how this happens, a great many new avenues of research would open up in areas such as developmental biology and biomedicine."

In the project "The anatomy of a gene expression program", the Sandberg group will study the early embryonic development of mice to investigate how the expression of genes lead to the development of different cell types. The idea, Dr Sandberg explains, is to set up an experiment that enables the group to study an extremely complex phenomenon in its simplest possible form.

"We are focusing on the specialisation that occurs during the first four days of development," he says. "Within this time the embryo has developed from the fertilised egg into a sixty-four cell embryo, containing three distinct cell types. Two of these are more specialised and will only form support tissue, whereas the last one has specific stem cell characteristics and will form the whole organism."

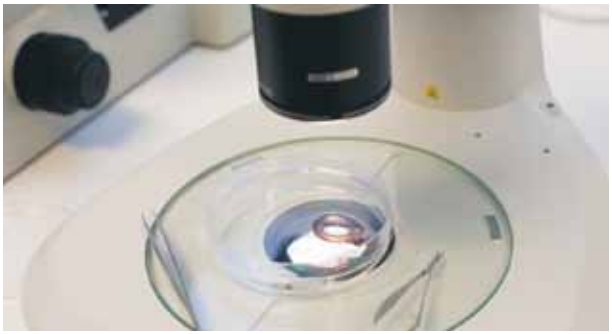
"By approaching this question with a technology that allows us to investigate what happens in each cell at each consecutive division as the embryo develops, we hope to uncover the genetical patterns responsible for specialisation, as well as to locate the mechanisms that specify stem cell characteristics."

In the project the group will utilise novel methods of RNA-sequencing technology that will allow them to obtain tens of millions of sequences from each cell. The challenge, Dr Sandberg explains, is not the ability to generate enough information, but to make sense of such massive amounts of data and to find important biological patterns.

"To find these patterns we will make use of, and further refine, computational analysis methods I have spent the last seven years developing," he says. "But in order to do so we have had to invest in large computational infrastructure with hundreds of terabytes, just to be able to store and process the necessary information."

Apart from helping us understand an enigma that has fascinated scientists for more than a century, Dr Sandberg believes an increased knowledge of the process of cell specialisation will be important for the future development of stem cell therapies.

"There is a current hope that stem cell reprogramming therapies will solve many problems that exist with current treatments for degenerative disorders, such as Parkinson's disease. If we, in our project, can improve our ability to reprogram cell identity and specialisation, it would be feasible to generate the clinically relevant cells directly from patients' own skin cells."



NAME	*Sebastian Westenhoff*
BORN	*1978*
YEAR OF PhD DEGREE	*2006*
UNIVERSITY	*Göteborg University*
PROJECT TITLE	*Structural dynamics of molecular reactions*

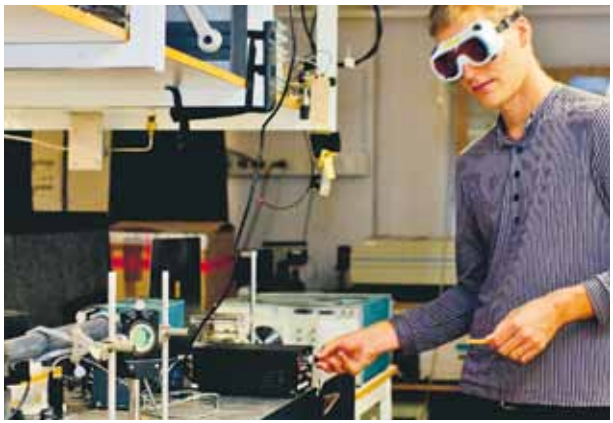
Filming atoms moving in real time

By combining modern laser technology with high-intensity X-ray beams, Dr Sebastian Westenhoff could be the first person to film atoms moving in real time. If successful, his project will lead to a radically increased understanding of chemical and biological reactions, which could result in a wide variety of applications – from developing smarter drugs for diseases such as Alzheimer's to improving the efficiency of solar cells.

According to Dr Westenhoff, doctor of biophysics in the Department of Chemistry at the University of Gothenburg, the ability to film the actions of atoms and molecules in real time will allow scientists to investigate structural changes in biological and man-made materials in a way that previously has not been possible.

"As we currently cannot see or measure atomic activity in real time, we do not really know what happens when, for instance, solar cells are hit by sunlight. By making use of new methods to visualise atoms and molecules, not only can we increase our knowledge of the reactions taking place but also gain an understanding of how to manipulate the characteristics of a material in a desired way."

In his project "Structural dynamics of molecular reactions", Dr Westenhoff will use a method called time-resolved X-ray scattering to uncover and understand the molecular structure of a number of dynamic reactions. This combination of modern laser technology with high-intensity X-ray beams (delivered by a large-scale synchrotron facility) could be used to investigate any molecular reaction.



However, in this particular project it will be adapted to study one of the most important biological reactions for the first time. The aim, Dr Westenhoff explains, is to better understand the process of cell membrane fusion.

"Cell membrane fusion is a great mystery," he says. "Ask any physicist and they will say it should not exist. Yet it does, and research shows the process is crucial in our ability to feel, sense and think, and that a number of diseases, such as Alzheimer's, diabetes and Parkinsons, are closely related to malfunctions in the cell membrane."

The challenges involved in pioneering the technique for use on organic materials are many. Among others, the Westenhoff group will have to develop new tools for filming atoms as well as to create a synthetic cell model (there will not be enough X-rays in the synchrotron to visualise real cells).

"Currently it is not possible to watch cell membranes fuse, not even with the best microscope," Dr Westenhoff explains. "By building an instrument that could take pictures in the synchrotron and apply time-resolved X-ray scattering to our cell model, it will be possible to see what happens on an atomic level when the membranes fuse. This will provide an understanding that could be used as a basis for developing pharmaceuticals to prevent or encourage fusion."

In addition to investigating the process of membrane fusion, in his project Dr Westenhoff will study structural evolution within a novel class of solar cells. The cells, made from plastic with semi-conducting properties, have the potential to produce clean, renewable and cheap energy, but are currently too inefficient to be commercially viable.

"Using our technique, we can find out how the structure of the material changes on an atomic level when it absorbs sunlight, investigate why energy is lost, and what needs to be done in order to improve the efficiency of the material."

NAME	*Sonja Buchegger*
BORN	*1973*
YEAR OF PhD DEGREE	*2004*
UNIVERSITY	*KTH - Royal Institute of Technology*
PROJECT TITLE	*Privacy-Preserving Social and Community Networks*

Preserving privacy in social networks

The main problem with social network applications today is that they do not allow for privacy protection of their users. By designing building blocks for a communication system in which each participant controls his or her own data, Dr Sonja Buchegger will lay the foundation for the development of a more human-oriented communication network.

According to Dr Buchegger, associate professor of theoretical computer science at the Royal Institute of Technology (KTH) in Stockholm, one of the major limitations in her field today is that most social network applications are controlled by central service providers.

"Services such as Facebook, Twitter and LinkedIn may appear free of charge, but users pay in information about their online activities," she says. "Consequently, these companies know a lot about us – where we have been, what we like, and what we do – and there is no way of knowing how this information will be used or to whom it ultimately will be sold."

As these operators often are based in countries other than those of their users, it is extremely hard to legally protect user privacy. The situation, says Dr Buchegger, is a problem not only in regards to privacy but also because the centralized control of information makes it impossible to make full use of the advantages of social networks.

Through her research project, "Privacy-preserving in social and community networks", Dr Buchegger and her team will investigate how to build a more socially acceptable and less intrusive communication network. The group will develop new methods of encryption in order to ensure user privacy, as well as to replace the service providers model of current-day social networks with one that allows users to control their own data.

"By using a peer-to-peer architecture, in which users make a portion of their resources available to other network participants, we can eliminate the need for central operators. The result is a more democratic system of communication," Dr Buchegger says.

The challenge, she adds, is to modify the peer-to-peer model so it can be used in a number of different circumstances by a large number of users, without having to compromise on issues of personal privacy.

Even though there are now ongoing attempts to create specific applications using similar methods, Dr Buchegger's project is the first of its kind to investigate the underlying principles needed to create any privacy-preserving social or community network.

"Our aim is not to create another Facebook, but to develop the building blocks needed to develop the next generation of social network applications," she says. "What we see today is only the beginning. Once we increase user control and get rid of the central operators, people will start producing applications no one has even thought of yet."

NAME	*Thomas Nolte*
BORN	*1977*
YEAR OF PhD DEGREE	*2006*
UNIVERSITY	*Mälardalen University, Västerås*
PROJECT TITLE	*PRESS - Predictable Embedded Software Systems*

Solving a critical technological challenge

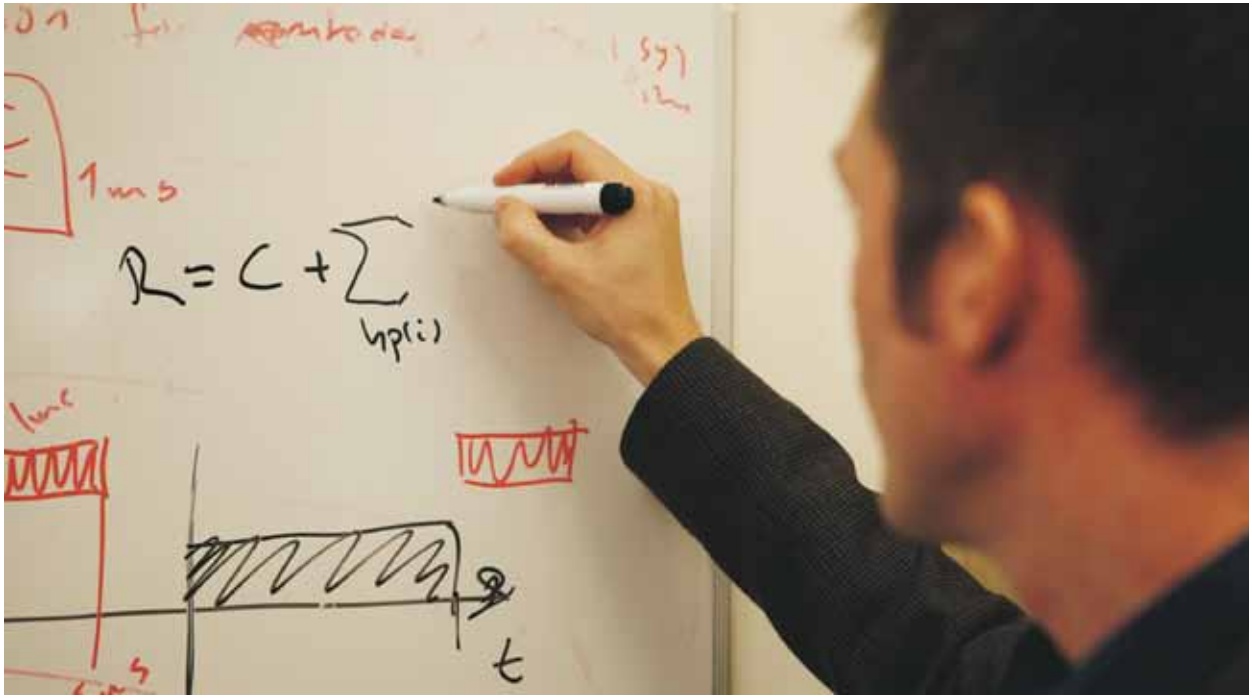
Technological components are often developed separately and then integrated into a larger system, such as that of a car, a train or a mobile phone. By developing principles for a virtual platform in which the function and timing of these components can be predicted, Dr Thomas Nolte has taken a big step towards solving one of the most critical challenges of technological development today.

According to Dr Nolte, associate professor in computer science at Mälardalen University in Västerås, the increased difficulty of guaranteeing predictable function of integrated components has quickly become one of the largest problems of the technological sector.

"Today, larger embedded systems of technology, such as a car or a train, contain so much electronics and software they have become difficult to develop and maintain. Often the whole system has to be analysed each time a new component is added to ensure the different parts do not interact in undesirable ways. This takes up a lot of resources and slows down the development of new technology."

These larger embedded systems often consist of up to a hundred little computers, which are not all necessarily produced by the same manufacturer. Until recently these components were controlled by individual single-core processors; however, with the introduction of multicore processors, the old hardware is disappearing from the market. This is a development, Dr Nolte explains, that has led to a great many problems.

"These days, if you put an airbag in a car it does not necessarily come with a separate processor, but with software that is to be integrated in the one multicore processor that controls the whole system. As a consequence, all components in embedded systems now run parallel, which makes it a lot harder to guarantee properties related to resource, usage and timing. This makes technological development extremely difficult; for instance, an airbag is useless unless you can make sure it is filled up with air at exactly the right time."



In his project “PRESS: Predictable Embedded Software System”, Dr Nolte will attempt to solve this problem by developing principles for a virtual platform that can be used to guarantee the timing and predictable behaviour of all components – new and old – in any embedded system. Using these principles as a starting point, his team then will adapt the platform for use in different operating systems.

“As this is a very difficult area to change, it is important that we let the industry know just how easy our system is to use and incorporate into existing development processes. In this project we will attempt to provide such a showcase by moving one of our industrial partner’s system of embedded components to a completely new platform.”

If successful, Dr Nolte’s virtual platform could be the solution to a problem that a great many companies from a large number of industrial segments are desperate to solve.

“In Sweden we have an amazing industry and many excellent products that have been developed over the years. However, if we cannot find better ways to leverage and integrate these products into new embedded systems of technology, we risk being overtaken by companies starting from scratch in countries such as China, India and Korea.”

NAME	*Tobias Larsson*
BORN	*1976*
YEAR OF PhD DEGREE	*2004*
UNIVERSITY	*Karolinska Institutet*
PROJECT TITLE	*Generation of novel treatments for cardio-renal disease*

Targeting a health problem of epidemic proportions

Once afflicted by chronic kidney disease, a person runs an extremely high risk of developing and dying of cardiovascular disease. By investigating the connection between the growth hormone FGF23 and chronic kidney disease, Dr Tobias Larsson is hoping to find an important missing link needed to alleviate a global health problem of epidemic proportions.

In his research, Dr Larsson, associate professor in medicine and staff physician at Karolinska University Hospital in Stockholm, is seeking to understand why chronic kidney disease (CKD) leads to a rapid acceleration of diseases normally attributed to old age.

"When developing CKD, a concentrated process of ageing begins," he says. "This leads to the development of a number of other diseases such as cardiovascular disease, which eventually will cause the patient's death."

In developed countries the relationship between CKD and cardiovascular disease (CVD), referred to as 'cardio-renal syndrome', has caused epidemical health problems; in America alone, 10 million people or more are affected. To make things worse, no efficient medicines or universal treatments exist to prevent development of CKD.

However, there is one promising lead, which Dr Larsson has been investigating for some 10 years – the relationship between CKD and the regulation of mineral metabolism in the body.

"In patients with CKD, the balance of calcium, phosphate and vitamin D is disturbed," he explains. "We believe this disturbance

accelerates the process of ageing. So, if the mineral balance can be restored, the harmful processes should be able to at least slow down."

In his research project "Generation of novel treatments for cardio-renal disease", Dr Larsson will investigate the connection between the growth hormone fibroblast growth factor-23 (FGF23) and CKD.

"We know from our previous research that FGF23 and its receptor klotho play a fundamental role in the regulation of serum phosphate, calcium and vitamin D levels. We also know that FGF23 levels are severely elevated in cases of CKD. Now we will investigate the reason for these rising levels and how best they can be restored."

In the project, Dr Larsson and his team will move from clinical observations to basic research (ranging from cell and animal studies), and hopefully then on to randomised clinical trials with patients suffering from CKD.

"Working as a doctor in internal medicine and nephrology allows me to understand and control the whole process needed to approach this problem – from basic research to clinical trials," he says. "It also means that I have access to a large number of clinical experts as well as relevant patient groups."

If successful, the project could lead to the development of novel treatments and tools that ultimately will reduce the severely elevated mortality risk of CKD.

"If our hypothesis is proven correct and we can find ways to restore the dys-regulation of FGF23, klotho and mineral metabolism in the body, less people would develop cardiovascular disease and die. Also, the results could be used to develop a tool of diagnosis, which could be used for early detection of CKD complications as well as other diseases related to high levels of FGF23."

The selected Future Research Leaders are, in addition to receiving research grants, also attending a five year long leadership programme organized by SSF. The programme, which consists of ten two-day seminars and a trip abroad, aims to provide the young research leaders with tools to practice leadership and create an individual leadership philosophy by increasing their insights in leadership and their self-reflection. The leadership programme addresses many different subjects that together form the elements of effective leadership, such as group dynamics, communication and management responsibilities. Finally, network creation between participating researchers is an important side-effect of the programme.

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