AIMES

CENTER FOR THE ADVANCEMENT OF INTEGRATED MEDICAL AND ENGINEERING SCIENCES

Annual Report 2020

Karolinska Institutet | KTH VETENSKAP OCH KONST

IN PARTNERSHIP WITH

GETINGE

Vision

AIMES' vision is a world in which the improvement of human well-being can be achieved alongside responsible utilization of Nature's resources.

Mission

AIMES' mission is to offer an academic research environment that promotes interdisciplinary research and education alongside innovation and entrepreneurship. By unifying basic and applied research in open dialogue with industry and the public sector, AIMES will bring science to society offering solutions to a number of global societal challenges.

Preface from the Chair of the Steering Group

I have had the great honour of chairing the steering group for AIMES – Center for the Advancement of Integrated Medical and Engineering Sciences at Karolinska Institutet and KTH Royal Institute of Technology. AIMES was formed in 2020 and it is inspiring to see what has already been achieved in this annual report. Despite the limitations imposed by the ongoing pandemic, the inauguration of AIMES took place on September 30 with a high quality program and with a very positive reception from participants. AIMES' vision supports the role of our Universities being key actors in reaching the 17 sustainable development goals, SDGs and realizing Agenda 2030. It is generally accepted that reaching the sustainability goals requires interdisciplinary approaches, cooperation, and cohesion between academia and stakeholders in society. However, there are national and global common obstacles which need to be overcome to achieve these goals.

Firstly, the traditional structure of our Universities is mono-disciplinary. It is important to be able to both promote the strengths of individual disciplines while also promoting interdisciplinary research and education. Bringing together researchers and students from different disciplines to answer common questions will foster a deeper understanding of diverse disciplines and improve overall knowledge development. The inherent interdisciplinarity of AIMES addresses this directly.

A second major obstacle relates to cooperation with private and public sector and the expectation of social impact of research and education. A successful cooperation must build on mutual interests but also on respect for, trust in and understanding of each stakeholder's goals and legal conditions. This includes academic freedom and institutional autonomy, the cornerstones for the unique role of our academic institutions in society.

AIMES is not starting from zero. AIMES represents the ongoing development of the Swedish Medical Nanoscience Centre with more 10 years' experience of interdisciplinary work between technology and medicine and cooperation with private and public sector.

An international outlook shows that Sweden has the advantage of a long tradition of trust- and respectful cooperation between universities and the private and public sectors, not least in the field of health and technology. The vision of AIMES is to provide a platform to facilitate and further develop this cooperation.

The recognition and support of AIMES by rectors Ole Petter Ottersen (KI) and Sigbritt Karlsson (KTH) is both appreciated and is crucial for the development and future of AIMES.

Finally, the success and quality of any Center is depending on the competence of the staff and students and their engagement to fulfil the vision. I will do my best as chair for the Steering group to support this work and I foresee that AIMES will be a role model to follow.

Pam Fredman

Chair of the Steering Group

Professor emerita in Neurochemistry, University of Gothenburg, President of IAU, International Association of Universities

The Steering Group

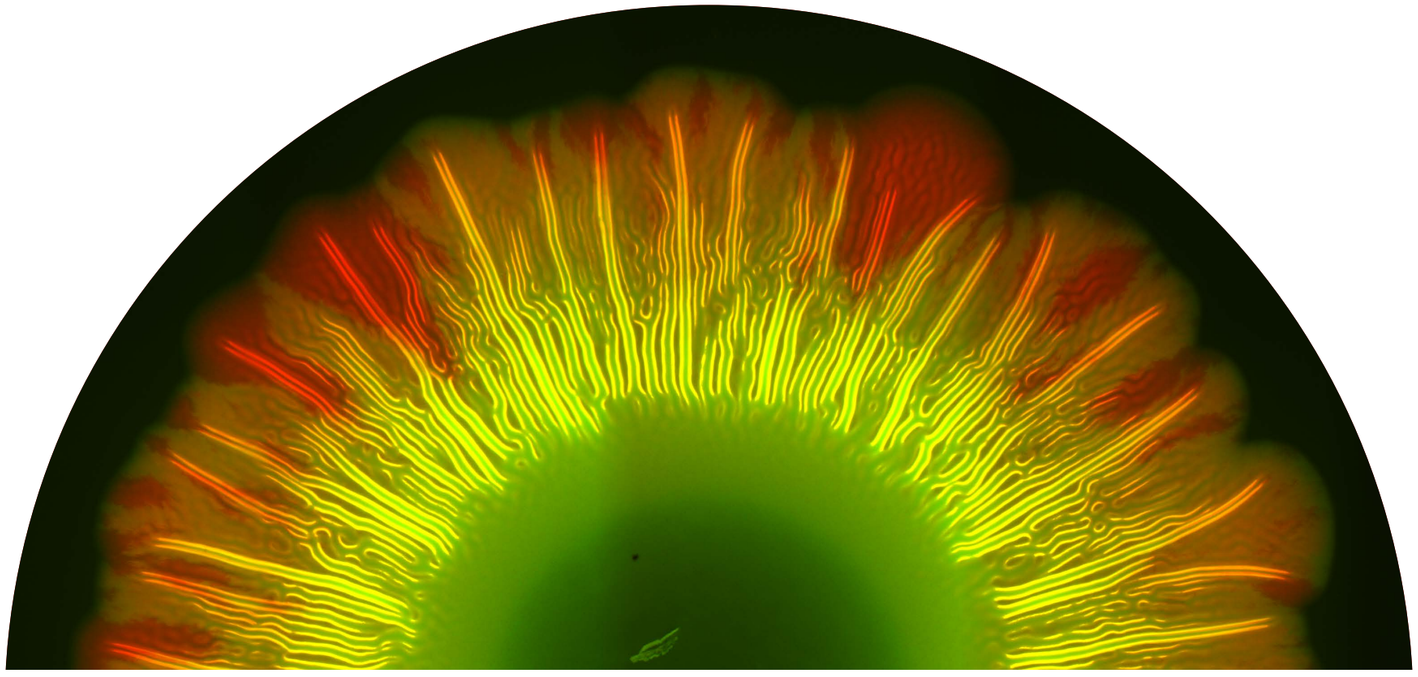
Pam Fredman, Professor emerita in Neurochemistry, University of Gothenburg, President of IAU, International Association of Universities

Helén Andersson Svahn , CEO Haldex & Professor KTH

Christer Höög, Dean of KI Campus Solna & Professor at KI

Mikael Lindström, Head of School of Engineering Sciences in Chemistry, Biotechnology and Health & Professor at KTH

Director's View



Optotracing showing bacteria forming a biofilm. Courtesy of F.X. Choong.

Agneta Richter-Dahlfors

Director of AIMES

Professor in Cellular Microbiology at KI

Professor in Chemistry and Biotechnology at KTH

'A world free from poverty, hunger and disease' This inspiring vision, formulated by the UN Member States, is intended to become a reality by the year 2030, a mere 10 years from now. To guide this transformation, improving the human condition while caring for the environment and confronting climate change, the UN defined a number of Sustainable Development Goals. To achieve these goals, and the vision, will require a massive undertaking that requires intensive collaboration and cooperation between specialists in widely different areas.

Academic research projects spanning several different disciplines are defined as interdisciplinary. Young researchers who are capable of driving interdisciplinary projects have recently emerged in parallel to the majority of scientists who customarily focus on a single topic. The intrinsically interdisciplinary scientists dare to cross the boundaries between subject areas and across faculties, often with a strong determination to bring their research to innovation and societal benefit. However, pursuing such an interdisciplinary strategy is often challenging in the current academic system, which is rooted in old traditions which typically reward monodisciplinary fundamental research.

AIMES - Center for the Advancement of Integrated Medical and Engineering Sciences was established to meet the need for an academic environment that promotes interdisciplinary research and education, along with innovation and entrepreneurship. This need had become apparent to me as I had increasingly developed my research away from being monodisciplinary. Around the turn of the millennium, my group at Karolinska Institutet (KI) had started collaboration with scientists at Chalmers in Gothenburg. We studied epithelial cells growing on nanopatterned surfaces, an area relevant for the development implant materials. We also pioneered the field of Organic Bioelectronics. In 2006, together with scientists at Linköping University, we established a Center of Excellence in Organic Bioelectronics, developing new techniques for communication between cells of living organisms and electronic devices. In addition to new knowledge, this work generated a number of patents with broad applicability in multiple sectors. Spurred by both the positive insights and challenges of these projects, in 2009 we launched the Swedish Medical Nanoscience Centre at KI. With governmental and industrial support, this centre offered an intellectual and infrastructural environment for interdisciplinary scientists to solve medical problems with a range of educational backgrounds.

Now, as we capitalize on all of this previous work and experience, we are excited to enter a new phase of expansion as KI and KTH Royal Institute of Technology join forces in the establishment of AIMES - Center for the Advancement of Integrated Medical and Engineering Sciences.

Importantly, AIMES is a bottom-up initiative, established to meet the needs of engineering scientists wishing to build sub-groups in (bio)medicine, and vice versa, scientists from the medical faculty, seeking engineering competences and infrastructure. At our inauguration AIMES already consists of 13 principal investigators and future faculties all sharing a vision to:

- deliver interdisciplinary research and education of the highest standards
- demonstrate the relevance of academic research to society
- facilitate the translation of research results into societal use

At AIMES, we intend to create the long-term conditions required, both scientifically and financially, to ensure the growth of our intrinsically interdisciplinary researchers and students, whose skills are required to successfully address the bold societal challenges such as those proposed by the UN Sustainable Development Goals. However, this unconventional approach, the desire to cross the borders of subject areas, faculties, and even universities, is challenging in today's academic structure. Our first year has generated immensely positive insights and output, which we hope you will enjoy when reading this report. We have however also met a number of challenges, mostly of administrative nature, which, with determination, we will address during the coming year.

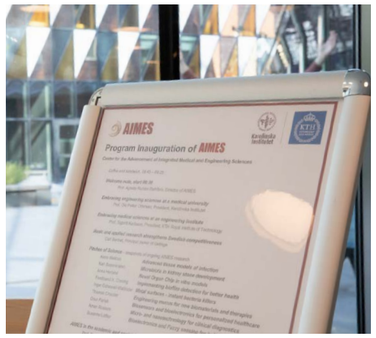
By far the biggest challenge during our first year has been the COVID-19 pandemic. Seeing what our AIMES scientists have been able to achieve this year, despite the difficulties posed by the pandemic, enables us to look forward with great expectations to what can be achieved in a 'normal' year.

We are very appreciative of the support we have received from the leadership at KI, KTH, and Getinge, as well as from national and international funding organisations. Together our members look forward to the coming years, as we embrace both the English and French translation of AIMES: we can achieve our goals while loving what we do!

Inauguration of AIMES

AIMES originally planned to have its grand opening in the spring of 2020, but obviously, it had to be postponed. As the pandemic situation changed during the summer, the inauguration could to take place on September 30th. In compliance with the Public Health Agency of Sweden's regulations at the time, the event was held on-site in Biomedicum, Karolinska Institutet for invited guests, while live streaming at the official KI Youtube channel enabled a larger number of people to join in on the event.

The event took place in the auditorium of Biomedicum at Karolinska Institutet Campus Solna.



The inauguration program represented an exciting mix of topics and formats, including talks, films, pitches of science, and web presentations.

Due to the pandemic, the number of participants in the auditorium was restricted to 50. Safe distances were arranged by indicating permitted seats by the "goodie bag" that was provided by the sponsor Ebba Biotech.

The live stream of the event at the official KI Youtube channel opened for wider participation.

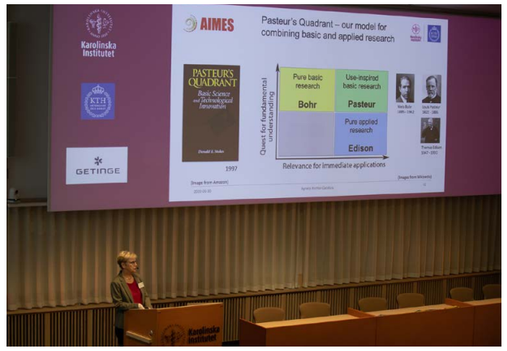
President of Karolinska Institutet, Professor Ole Petter Ottersen, consider AIMES inauguration as a true milestone in the collaboration between KTH and KI. In his view, AIMES stands as the epitome of Life Science, and he put great expectations on AIMES as "a sorely needed academic hub where researchers and students from medicine and engineering, from basic and applied sciences, can work side-by-side with industry and healthcare partners to create the kinds of innovations needed to advance human health". The President summarizes his impression of AIMES inauguration in his blog.

President of KTH Royal Institute of Technology, Professor Sigbritt Karlsson, discussed the essential role of technology and engineering for the development of Sweden into the prosperous country we are today. She exemplified how a majority of current medical innovations stems from technological findings, and she emphasized the importance of areas such as material sciences, polymer chemistry, electronics and electrical engineering, among others, as vital components in interdisciplinary projects to ensure future medical innovations. This view is in perfect alignment with AIMES!

The Chair of AIMES' steering group, Professor Pam Fredman, was strongly advocating for academia as one of the primary stakeholders needed for the successful realization of the UN Sustainable Development Goals and Agenda 2030. This resonates profoundly with the vision of AIMES.

The role of AIMES in strengthening Sweden's competitiveness was the topic for Getinge's principal owner Carl Bennet's keynote speech at the inauguration.

The inauguration ceremony ended with the Presidents tying a knot, rather than cutting a ribbon, to symbolize AIMES as an entity that unifies the two universities. Ulrica Edlund, Agneta Richter-Dahlfors and Carl Bennet cheerfully observed.



Based on the so-called Pasteur's Quadrant, Agneta Richter-Dahlfors explained how AIMES scientists work in a way that allows engagement in fundamental as well as applied research.

Agneta Richter-Dahlfors and Carl Bennet are excited to see the realization of AIMES at KI and KTH, deriving benefit from more than ten years of collaboration.

Pressmeddelande Göteborg den 30 september 2020

Getinge stöttar nyinvigt forskningscenter i Stockholm

Press releases | 2020-09-30

Getinge är en av de branschpartner som står bakom nyskapade AIMES - Center for the Advancement of Integrated Medical and Engineering Sciences som invigs idag i Stockholm.

AIMES är resultatet av ett samarbete mellan Karolinska Institutet och Kungliga Tekniska högskolan (KTH). Centrets uppgift är att främja tvärvetenskaplig forskning och hur den kan omvandlas till samhällelig nytta.

Getinge announced their engagement in AIMES in a press release, in which Harald Castler, President Life Science at Getinge, says:

- We are very proud to be part of AIMES. The project's clear focus on societal benefits will generate new products that can help medical teams around the world save more lives while highlighting Sweden's competitiveness in medical research and technology.

Vice-President Anders Gustafsson in conversation with Ingemar Petersson, member of the Board of Karolinska Institutet. In the background, Lars Hultman, CEO of the Swedish Foundation for Strategic Research, in discussions with Sigbritt Karlsson, President of KTH, and Pam Fredman, Chair of AIMES steering group.

Getinges Ulf Andersson, Chief Technical Officer at Acute Care Therapies, and Johan Widman, Senior Director R&D in Acute Care Therapies and Critical Care, grabbed the opportunity for a chat with Getinge's Carl Bennet and Professor Pam Fredman, Chair of AIMES steering group. Seated to the right is Eva Halén, CEO at Ebba Biotech, a sponsor of the event.

Professor Amelie Eriksson Karlström, First Deputy Head of the School of Engineering Sciences in Chemistry, Biotechnology, and Health at KTH, and Professor Inger Odnevall Wallinder, member of AIMES, engaged in interesting conversations.

Professor Göran Stemme, head of Division of Micro and Nanosystems at KTH, in conversation with Professor Ulrica Edlund, vice-Director of AIMES.

Our research environment

Anette Schulz

Ann-Charlotte Westerdahl

Linda Thörn

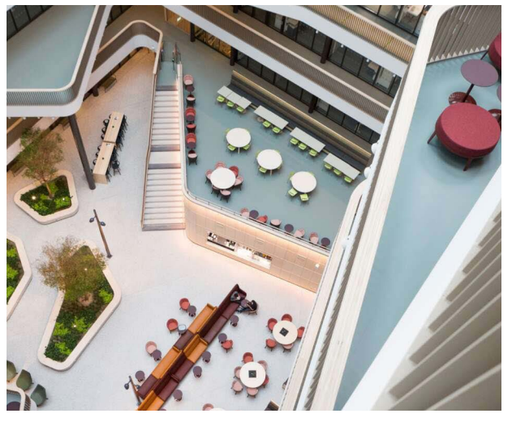
AIMES is physically located in Biomedicum at KI, Campus Solna. The safety level of laboratories and animal facility allows work with human material and disease-causing microorganisms. Compliance to the regulatory frameworks governing research is guided by the Lab managers Anette Schulz and Ann-Charlotte Westerdahl. Researchers have access to local infrastructure in Biomedicum and to core facilities at KI and KTH.

Scientists at AIMES often have dual affiliations: the main position at one university and an affiliation to the other. Team leaders can complement their main group at one university (eg KTH) with a sub-group at the other (eg KI). Combined presence in medical and technological environments, both intellectually and infrastructurally, is essential for the type of projects driven by AIMES' intrinsically interdisciplinary scientists. Adherence to the guidelines of both universities is guided by Operations controller Linda Thörn.

Project driven at AIMES are of fundamental as well as applied character. The philosophy of the Pasteur's Quadrant opens for basic science and technological innovation to thrive at AIMES. By assessing the Technology Readiness Level of our projects, the maturity of new technologies is monitored in all progression phases, thereby supporting translation towards societal use.

AIMES Management Group

Agneta Richter-Dahlfors	Director
Ulrica Edlund	vice-Director
Linda Thörn	Operations Controller
Onur Parlak	Chair, Board of Research
Anna Herland	Chair, Board of Education
Ferdinand X. Choong	Chair, Board of External collaboration



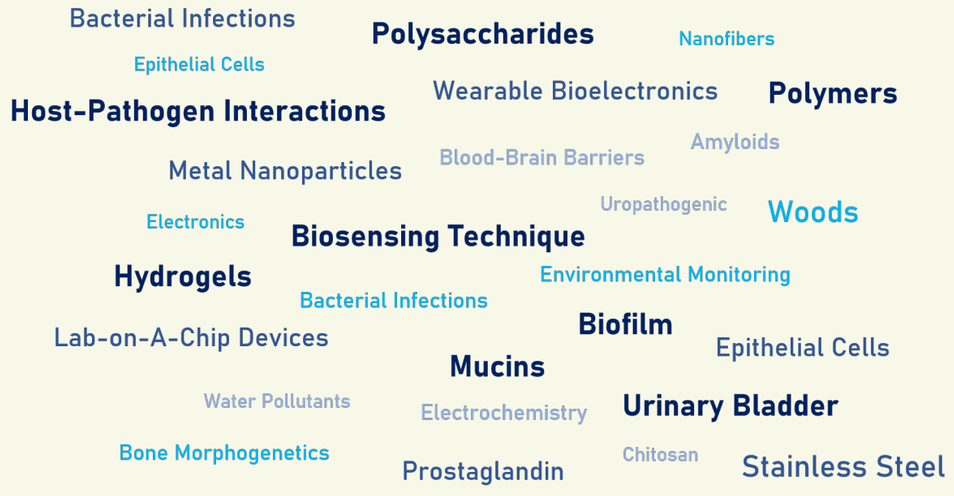
Interdiciplinary scientists

Academic research is typically organized according to subject areas. At AIMES, we do it differently. As the central letters of our name (IME) indicates, the main criterium for an AIMES scientist is a commitment to "integrated medical and engineering" projects. Whether these projects involve infection, neuroscience, or cancer from the medical perspective, or electrical, material chemistry, or biotechnology from the engineering perspective is irrelevant. We welcome scientists whose work spans across the disciplines - intrinsically interdisciplinary scientists.

At the start of AIMES, the projects run by the founding scientists could be broadly organized in six themes. These themes however are not static and the environment at AIMES has facilitated a dynamism in our work, which means our scientists are rapidly expanding and developing their work across both discipline and institutional borders. We foresee that this adaptability and flexibility means that these 'research areas' will continue to evolve. This evolution is an exciting natural consequence of fostering this environment in which creative scientists can and will adapt to the rapidly changing landscape of research science.

Tissue microbiology	Biosensors in healthcare
Bacterial biofilms	Organ models
Point-of-care diagnostics	Green materials

A bibliometric summary of the key words of research performed at AIMES in 2020 clearly demonstrates the interdisciplinary nature of our projects.



Infections and biofouling caused by bacteria and biofilm affects many layers of society: good health, food security, good manufacturing practices etc. Choong furthers our knowledge of biofilm physiology and pathogenicity and develops new strategies for infection treatment and biofilm removal. He also drives the discovery, development and validation of novel optical sensing techniques for real time in situ detection of polymeric materials in bacterial biofilm, and in the renewable resources lignocellulose biomass and algae. This will aid in the optimization of current processes for a move towards a circular bio-economy.

Ferdinand Choong | PhD, Assistant Professor in Microbiology and Glycobiology, AIMES, KI

Mucus is a hydrogel that covers the wet epithelium of our eyes, nose, respiratory, gastrointestinal, and reproductive tracts. With an ability to hydrate and lubricate surface, this thin layer protects epithelia from dehydration, shear stress, and viral/bacterial attacks. Crouzier works at the interface of chemistry, biology and material science. Examining mucus from the view of materials engineering, he deepens our understanding of mucus biology, and develops new ways to assemble mucins into materials with useful medical application, exemplified by a non-hormonal contraceptive.

Thomas Crouzier | PhD, Researcher in Glycoscience, KTH
Affiliated Researcher, AIMES, KI

Biomass (everything growing on our planet) represents a highly underutilized natural resource. Committed to develop new green materials from renewable resources, Edlund develops methods to extract polymers from terrestrial (wood, agricultural residues such as kernels, leaves, stems of locally produced biomass) and marine (algae) sources from which she designs renewable functional materials. Many inventions stem from her work: bioplastics from algae, and renewable films, coatings, microspheres, and hydrogels from non-cellulosic fractions from wood processing operations.

Ulrica Edlund | PhD, Professor in Polymer Technology, KTH
Affiliated Researcher, AIMES, KI

Developing new drugs is a major challenge for society and industry. Systems closely mimicking human organs, so-called Organs-on-chip, will improve our understanding of diseases and promote drug development. Herland applies microengineering and bioengineering technologies to recreate body-like environments, i.e. the brain and its vasculature, as she wants to understand the interactions between neurons and neurovascular cells in terms of metabolic function and neuronal activity. She also develops organic bioelectronic interfaces to mammalian cells and bacteria, optoelectronic interfaces to mammalian cells, and nanopores/gaps for single biopolymer identification. Herland works closely with pharma industry, studying the distribution and effects of drugs.

Anna Herland | PhD, Associate Professor in Hybride Bioelectronic Systems, KTH
Researcher, AIMES, KI

Advanced sensing technologies, like optotracing and biosensors, are uniquely suited for high-throughput applications, which creates large amounts of data. Making use of all data is challenging. With a background in biomedical sciences and signal processing, Löffler develops tools for data management, visualization and analysis for bacterial detection technologies based on database management systems tailored to the application. Also, she develops user-friendly data analysis tools for pattern identification and graphic representation of key features of the data. Löffler's research thus empowers users to take control of their data and to apply advanced data analysis models with minimal effort.

Susanne Löffler | PhD, Assistant Professor in Organic Bioelectronics for Bacterial Infection, KI

Human skin hosts a wide range of bacteria, and *Staphylococcus aureus* (*S. aureus*) is one of the most common. Human skin differs significantly from animal skin in terms of structure and immunological function. To understand how methicillin resistant *S. aureus* (MRSA) causes infection on otherwise healthy human skin, Melican has developed humanized *in vivo* models of infection: human skin tissue models and a xenograft model. She also studies the dynamics of pyelonephritis - infection of the kidney by uropathogenic *Escherichia coli*. Using cutting-edge techniques, including intravital imaging, she deciphers the dynamic host-pathogen interplay during infection, which is essential for the development of new treatments.

Keira Melican | PhD, Researcher in Tissue Microbiology, AIMES, KI

An in-depth understanding of diseases is essential for development of diagnostic tests and treatments. A class of optoelectronic material with remarkable potential in detecting disease associated markers may be key to such understanding. Nilsson pioneers the design and synthesis of thiophene-based ligands, generating a new class of optoelectronic material with many applications. The multimodal, chemically defined ligands create the next generation material for molecular imaging, diagnostics and therapeutics. The technology helps us to deepen our understanding of neurodegenerative diseases such as Alzheimer's disease, as well as bacterial infections and cancer.

Peter Nilsson | PhD, Professor in Organic chemistry, Linköping University,
Affiliated researcher, AIMES, KI

Depending on location and the state of environment, metallic surfaces can strongly affect human health. Odnevall Wallinder studies the link between material properties and surface reactivity on one side, and the environmental fate as well as the health aspects of metal dispersion from metals and alloys widely used in our society. Using a plethora of analytical techniques, she gains fundamental and applied understanding of the performance of metals and alloys with and without organic coatings in a diverse range of societal applications. This work has major implications for how we use metals as construction materials in buildings, in food related utensils and surfaces, as implant materials, and in consumer products.

Inger Odnevall Wallinder

PhD, Professor in Surface Chemistry and Corrosion Science, KTH
Affiliated researcher, AIMES, KI

Quality healthcare builds on the availability of accurate patient information. Innovative concepts of health monitoring are developed by scientists at the interface of medicine and engineering, in the area of biosensors and bio-electronics. Parlak combines bioelectronics, materials sciences, and biology to develop biosensors that monitor health and disease. Health monitoring is achieved by the new concept “wearable electronics”, which in the form of a skin patch can sense compounds in sweat as a person exercise. For disease monitoring, Parlak focus on bacterial infections, as he generates novel tools that provide extremely detailed information of bacterial biofilms. The highly innovative science thus tackles two key areas of critical importance to all of us: our health status versus disease.

Onur Parlak

PhD, Assistant Professor in Biosensors and Bioelectronics in Medicine, AIMES, KI

Salmonella enterica causes more than 350 000 deaths annually and is linked to the problems of antibiotic resistance. Better understanding of the infection pathogenesis is needed. Rhen study the complex infection pathogenesis of Salmonella. He identifies the functions of virulence factors during bacterial interactions with immune cells, the gene expression profiles of bacteria growing within immune cells, and he explores pathways enabling bacterial biofilm formation. Persistent infection is also studied, by analyzing the expression profile of virulence genes in a strain causing persistent salmonel-losis. Collectively, this work deepens our understanding of salmonellosis, leading to improved treatment strategies.

Mikael Rhen

Professor in Cellular Microbiology, MTC, KI
Affiliated researcher, AIMES, KI

Infections are multifaced phenomena difficult to recreate and study.
By integrating knowledge and techniques of medical and engineering science, Richter-Dahlfors uses advanced techniques when studying the integrated pathophysiology of bacterial infections. Acknowledging the need for better analytical tools to advance research, she develops, tests and disseminates novel methods and technologies. Of special note is conducting polymers that allow rapid, precise, and real-time monitoring of information pertinent to healthy and diseased conditions. Due to the generic nature of the methods, she has expanded her work to also include plant science. To bring science to affect change in society, she works closely with industry.

Agneta Richter-Dahlfors

Professor in Cellular Microbiology, AIMES, KI
Guest Professor in Chemistry and Biotechnology, KTH

Affordable, robust, and accurate diagnostic tests are essential to rapidly determine the condition of the patient. Russom employs microfluidic technologies to develop point-of-care tools for many applications. This tech-nology allows sorting of rare circulating tumour cells for cancer diagnostics, and isolation of bacteria from blood for molecular analysis. Committed to develop affordable healthcare for all, Russom develops compact, portable, and robust devices for resource-limited settings in, where the prevalence of ubi-quitous pathogens claims tens of thousands of human lives every year, mostly due to the lack of effective diagnostics and therapy. Eventually, this research may serve to introduce advanced molecular point-of-care tests in rural areas.

Aman Russom

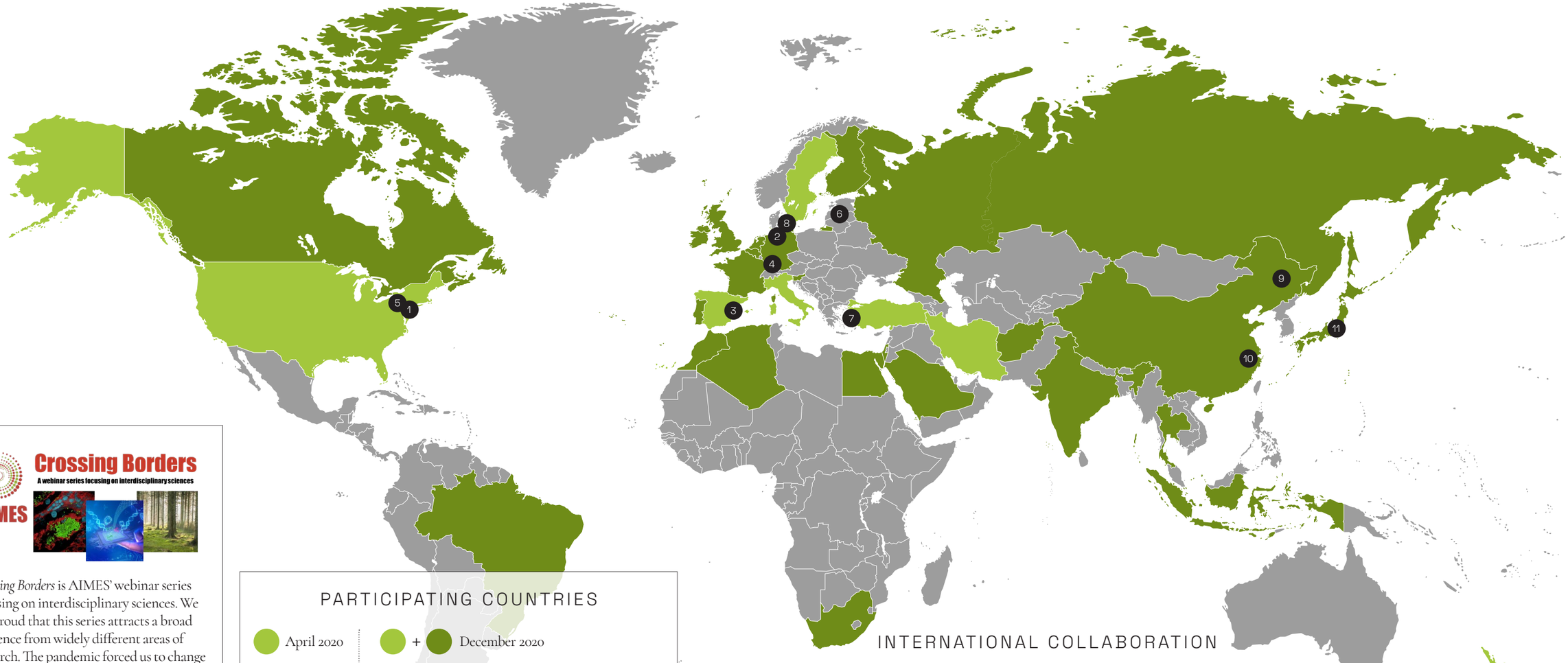
Professor in Clinical Microfluidics, SciLifeLab, KTH
Affiliated researcher, AIMES, KI

Countless problems can happen when bacteria enter the urinary tract.
An infection often results from bacteria trapped in stagnant urine.
When stones block the urinary tract for a long time, urine backs up in the tubules within the kidney, causing excessive pressure that leads to swelling and eventually kidney damage. Being a urologist, Svennersten combines his clinical and laboratory perspectives when addressing questions related to the involvement of bacteria in kidney stone formation, and how patients are best treated to prevent formation of kidney stones. He also examines the nervous control of the bladder, defining measures to improve the quality of life in patients with spinal cord injuries.

Karl Svennersten

MD, PhD , Affiliated researcher,
Dept of Molecular Medicine and Surgery, KI
Affiliated researcher, AIMES, KI

Connecting the world of interdisciplinary scientists



Crossing Borders
A webinar series focusing on interdisciplinary sciences
AIMES

Crossing Borders is AIMES' webinar series focusing on interdisciplinary sciences. We are proud that this series attracts a broad audience from widely different areas of research. The pandemic forced us to change the format from live seminars inhouse in Stockholm to online webinars. This gave us an exceptional opportunity to reach interdisciplinary scientists all over the globe. At start in April, our online webinar attracted scientists from 7 countries. At the end of the year, we confirmed the attendance of scientists from 33 countries! We have received many emails from grateful and contented researchers, which confirms to us the effectiveness of webinars as a means to gather and grow a world-wide community of interdisciplinary scientists.

PARTICIPATING COUNTRIES

April 2020

- Iran
- Italy
- New Zealand
- Spain
- Sweden
- Turkey
- USA

\+ December 2020

- Afghanistan
- Algeria
- Belgium
- Brazil
- Canada
- China
- Egypt
- Finland
- France
- Germany
- India
- Indonesia
- Iran
- Ireland
- Israel
- Italy
- Japan
- Morocco
- New Zealand
- Portugal
- Russia
- Saudi Arabia
- Singapore
- Slovenia
- South Africa
- South Korea
- Spain
- Sweden
- The Netherlands
- Thailand
- Turkey
- United Kingdom
- USA

INTERNATIONAL COLLABORATION

1. University of Pennsylvania, USA
2. University of Hamburg, Germany
3. University of Valencia, Spain
4. Freiburg University, Germany
5. Penn State University, USA
6. University of Latvia, Latvia
7. Izmir Instute of Technology, Turkey
8. Copenhagen University, Denmark
9. Harbin Institute of Technology, China
10. Zhejiang University, China
11. University of Tokyo, Japan

ATTRACTING FOREIGN SCIENTISTS

Thomas Crouzier

PhD, Researcher in Glycoscience, KTH
Affiliated Researcher, AIMES, KI

I was born and raised in France. I received my education between France (undergraduate and PhD) and the USA (master degree and postdoc). In 2015, I was looking worldwide for an opportunity to establish an independent research group. Sweden offered an amazing opportunity to do so, supported by a junior researcher grant. Hosted at KTH, I was able to secure other grants including a Future Research Leader grant from the Swedish Foundation for Strategic Research that provided the opportunity to establish a group, long term visibility and the freedom to engage in high-risks high-reward research. When AIMES was assembled, it became clear to me this initiative was filling a gap in the Stockholm area research scene. The interface of engineering and medical bioresearch is exactly where my research interests fall. To me, it is initiatives like AIMES that clearly contribute to reinforcing Stockholm and Sweden in general as an attractive place for researchers like me.

What happens during a cerebral hemorrhage? Every year thousands of people of all ages are affected by a brain bleed. The causes vary between trauma, high blood pressure, brain tumors or aneurysm rupture. What do they all have in common? The irritating effects that blood and its components have on brain cells. My research aims to understand how brain cells behave in the presence of blood. The idea is to combine the Karolinska Institute's expertise in cellular studies with the KTH's expertise in the study of microfluidics and biosensors. We want to build more complex cell culture models that can better represent the disease and understand each cell type's role in the complex pathophysiology of a brain hemorrhage. The final goal is to identify new possible treatments for the disease.

Laura Nicoleti Zamproni, guest researcher from CNPq, Brazil.

THE STOCKHOLM TRIO AND UNIVERSITY OF TOKYO

As part of a collaboration between the Stockholm Trio (Karolinska Institutet - KTH Royal Institute of Technology - Stockholm University) and University of Tokyo, AIMES participated in the "Online Workshop 2020 on Sustainable Development." While the original plan was for the Japanese scientists to visit Stockholm, however, the pandemic forced us to go on-line.

AIMIES was proud to host a session on the theme Nano-biomaterials. The 2-day session gathered around 80 inter-disciplinary scientists working in the fields of biomaterials, renewable biomaterials, biosensing technologies, micro-biology, infection, and neuroscience. In common for all presentations from the Swedish and Japanese speakers was that they clearly demonstrated the relevance of cutting-edge, interdisciplinary research from a basic research perspective, while also putting the spotlight on societal uses of research results. Scientists in both countries look very much forward to the day when we again can meet in real life, scaling up the collaborations.

GUIDED BY THE UN SUSTAINABLE DEVELOPMENT GOALS

AIMES works closely with strategic global directives such as the United Nations' Sustainable Development Goals (SDGs) in Agenda 2030. Research covering a range of areas aim to implement academic research as an answer to the needs of humanity. The 17 SDGs are often considered in isolation, when they in fact are highly communicating vessels. Effects on one end translate to others, interacting in complex ways not fully understood. The SDGs cut across all layers of the biosphere, society, and economy.

SDGs seek to end poverty and hunger, ensure good health and well-being, provide clean water and sanitation, ensure protection of the planet and its natural resources, among others. In line with this ambitious blueprint, AIMES research projects, broadly organized into 6 areas, are exceptionally relevant for several sectors of society wherein sustainability is a main theme.

Tissue microbiology – SDG 3, 10
By studying infections in real-time inside the infected organ, research aims to improve our understanding of microbe-host interactions, shedding new light on the pathogenesis of infections.

Bacterial biofilms – SDG 2, 3, 6, 12
Bacterial biofilms challenge many layers of society, ranging from people's health, food security, safe and hygienic shelter, to good manufacturing practices. AIMES research aim towards gaining a better understanding of biofilms during infection and biofouling, and the development of tools and techniques to diagnose, control and remove the biofilms.

Biosensors in Healthcare – SDG 3, 10
Interdisciplinary teams of engineers, clinicians, and microbiologists are developing an array of biosensors to provide simple, fast, sensitive, and cost-effective analysis. This enables detection of signs of disease at a very early stage, allowing therapeutic intervention and prevention of the spread of infectious diseases.

Organ models – SDG 3, 12
Understanding the cause and effect of diseases and the development of new drugs are major challenges for society and industry. Research at AIMES aim towards the development of organ models that reproduces the 'human condition' and contributes to the 3R (Replace, Reduce, Refine) principle.

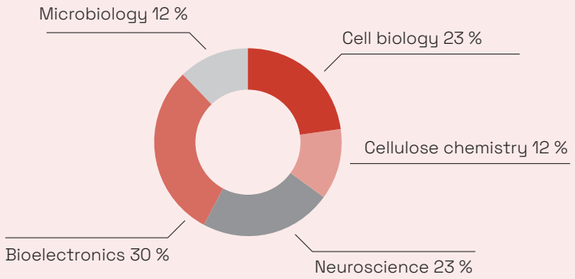
Point-of-care diagnostics – SDG 3, 10
There is great need for assessing patients and diagnosing diseases outside hospital premises. AIMES scientists develop point-of-care diagnostics to allow doctors at bedside and persons at home to detect infections and causative pathogens, thereby guiding the acquisition of proper treatment and alleviating the patient load in hospitals.

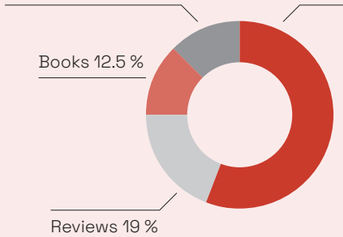
Green materials – SDG 7, 11, 12, 14, 15
Utilization of biopolymers in biomass as renewable chemicals and materials addresses the major challenge of substituting petroleum with renewable sources, the achievement of sustainable management, and efficient use of natural resources. Collectively, this research may help to reduce CO_2 emissions and ultimately a reduction in the fossil dependence.

Research

A core mission of AIMES is to conduct interdisciplinary research of highest standard. In 2020, AIMES scientists published 17 scientific articles in 12 different leading and high-impact factor journals spanning across a wide range of disciplines.

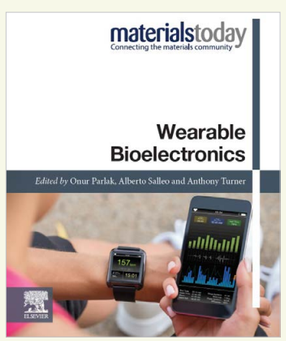
The interdisciplinarity of AIMES research is clearly witnessed from the assortment of journals presenting our work. These includes Advanced Biosystems, Biosensors & Bioelectronics, Brain, Cellulose, Frontiers in Microbiology, Lab on a Chip, Macromolecular Bioscience, Molecular and Cellular Neuroscience, Nanoscale, Nature, Nature Biomedical Engineering, and npj Biofilms and Microbiomes.

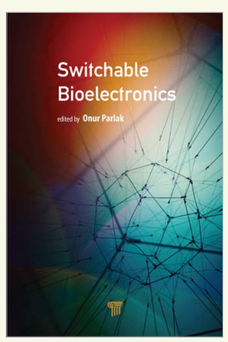




Besides research articles, AIMES scientists publish review articles and book chapters. As specialists in their field, they have been Editors of books on exciting so-called enabling technologies, which amalgamates the merger of medical and engineering sciences.

More than 60% of the articles were published in journals with an impact factor above 4. The average impact factor was 11. Two of our highest impact articles have been accessed a combined total of close to 40 000 times, and have had an online presence in the 98th percentile of tracked articles of a similar age.





Wearable Bioelectronics by Anthony Turner, Alberto Salleo, Onur Parlak. (Elsevier, 2019).

Switchable Bioelectronics by Onur Parlak (CRC Press, 2020).

SCIENTIFIC PUBLICATIONS

How much is best?
Animal models often do not accurately predict how much drugs are needed to be effective in humans. Artificial organ chips may be a better alternative.

A. Herland, B. M. Maoz, D. Das, M. R. Somayaji, R. Prantil-Baun, R. Novak, M. Cronce, T. Huffstater, S. S. F. Jeanty, M. Ingram, A. Chalkiadaki, D. Benson Chou, S. Marquez, A. Delahanty, S. Jalili-Firoozinezhad, Y. Milton, A. Sontheimer-Phelps, B. Swenor, O. Levy, K. K. Parker, A. Przekwas, D. E. Ingber. 2020. Quantitative prediction of human pharmacokinetic responses to drugs via fluidically coupled vascularized organ chips. Nature Biomedical Engineering, 4, 421–436.

Sea lettuce, a sustainable source of nanomaterials
Cellulose is an environmentally friendly material, but extracting is not, involving a long list of chemicals. AIMES researchers offers a new under-utilized alternative in a push towards circular economy

N. Wahlström, U. Edlund, H. Pavia, G. Toth, A. Jaworski, A. J. Pell, F. X. Choong, H. Shirani, K. P. R. Nilsson, A. Richter-Dahlfors. 2020. Cellulose from the green macroalgae Ulva lactuca: isolation, characterization, optotracing, and production of cellulose nanofibrils. Cellulose. 27, 3707–3725.

Healthy fashion
Wearable biosensors, the future of home-based personal medicine

O. Parlak, V. F. Curto, E. Ojeda, L. Basabe-Desmonts, F. Benito-Lopez, A. Salleo. 2020. In Wearable Bioelectronics, O. Parlak, A. Salleo, A. Turner, Eds. (Elsevier), pp. 65–88.

Seeing earlier and better
Leading investigators at AIMES offer their insights on the novel technologies that will improve how we diagnose infections

O. Parlak, A. Richter-Dahlfors, 2020. Bacterial sensing and biofilm monitoring for infection diagnostics. Macromolecular Bioscience. 20, e2000129.

Interfacing with nature
How do we tap into living biological systems with electronics?

O. Parlak, 2020. Switchable Bioelectronics (CRC Press).

Breathing with no air
During infection, the ability to thrive in a world without oxygen may be a strong factor affecting how diseases develop. AIMES researchers show how.

A. J. Martín-Rodríguez, M. Rhen, K. Melican, A. Richter-Dahlfors. 2020. Nitrate metabolism modulates biosynthesis of biofilm components in uropathogenic Escherichia coli and acts as a fitness factor during experimental urinary tract infection. Frontiers in Microbiology 11, 26.

Birthing the stars of our minds
Our brains contain a substantial number of star shaped cells, astroglia, which perform many important functions. AIMES researchers reveal how they can be made.

A. Lundin, P. Ricchiuto, M. Clausen, R. Hicks, A. Falk, A. Herland, 2020. hiPS-derived astroglia model shows temporal transcriptomic profile related to human neural development and glia competence acquisition of a maturing astrocytic identity. Advanced Biosystems. 4, e1900226.

Economising cutting edge technology
Affordability is often a key challenge to life saving technology. AIMES researchers show a cost-effective type of 'organs-on-chips' with great potential.

T. E. Winkler, M. Feil, E. F. G. J. Stronkman, I. Matthiesen, A. Herland, 2020. Low-cost microphysiological systems: feasibility study of a tape-based barrier-on-chip for small intestine modeling. Lab on a Chip. 20, 1212–1226.

Being on point to diagnose infections
Rapid and accurate diagnostics at the point-of-care are needed to allow clinicians to improve treatment decisions. Optotracing offers a way.

K. Butina, A. Tomac, F. X. Choong, H. Shirani, K. P. R. Nilsson, S. Löffler, A. Richter-Dahlfors. 2020. Optotracing for selective fluorescence-based detection, visualization and quantification of live S. aureus in real-time. NPJ Biofilms Microbiomes. 6, 35.

Recreating the nervous system
AIMES researchers offer insights on the advances in in vitro platforms that are bringing us closer to recreating human physiological functions and understanding neurological disorders.

P. Nikolakopoulou, R. Rauti, D. Voulgaris, I. Shlomy, B. M. Maoz, A. Herland, 2020. Recent progress in translational engineered in vitro models of the central nervous system. Brain. 143, 3181–3213.

Towards accessible testing for all
Close to 65% of cancer related deaths occur in low- to middle-income countries, where testing is not a priority due to limited resources. Today, simple and affordable tools are just as important as life-saving drugs.

T. Kumar, R. R. G. Soares, L. Ali Dholey, H. Ramachandraiah, N. A. Aval, Z. Aljadi, T. Pettersson, A. Russom. 2020. Multi-layer assembly of cellulose nanofibrils in a microfluidic device for the selective capture and release of viable tumor cells from whole blood. Nanoscale. 12, 21788–21797.

Piecing together a picture of addiction
Newly discovered pathways in cells of the neurovascular unit brings us closer to understanding the damaging effects of Meth intoxication.

A. Herland, B. M. Maoz, E. A. FitzGerald, T. Grevesse, C. Vidoudez, S. P. Sheehy, N. Budnik, S. Dauth, R. Mannix, B. Budnik, K. K. Parker, D. E. Ingber. 2020. Proteomic and metabolomic characterization of human neurovascular unit cells in response to methamphetamine. Advanced Biosystems. 4, e1900230.

Building better borders
Recreating the blood brain barrier is important to study diseases and develop treatments. AIMES researchers highlights key challenges and future perspectives

L. Delsing, A. Herland, A. Falk, R. Hicks, J. Synnergren, H. Zetterberg. 2020. Models of the blood-brain barrier using iPSC-derived cells. Molecular and Cellular Neuroscience. 107, 103533.

Recreating the senses
Considerations when designing electrochemical interfaces to sense biological phenomena and how they can be characterised.

O. Parlak, 2020. Introduction to dynamic bioelectronic interfaces. Switchable Bioelectronics, 1.

Robotic researchers
In the growing need for automation in biological experiments, robots and AI may be the new face of research.

R. Novak, M. Ingram, S. Marquez, D. Das, A. Delahanty, A. Herland, B. M. Maoz, S. S. F. Jeanty, M. R. Somayaji, M. Burt, E. Calamari, A. Chalkiadaki, A. Cho, Y. Choe, D. B. Chou, M. Cronce, S. Dauth, T. Divic, J. Fernandez-Alcon, T. Ferrante, J. Ferrier, E. A. FitzGerald, R. Fleming, S. Jalili-Firoozinezhad, T. Grevesse, J. A. Goss, T. Hamkins-Indik, O. Henry, C. Hinojosa, T. Huffstater, K.-J. Jang, V. Kujala, L. Leng, R. Mannix, Y. Milton, J. Nawroth, B. A. Nestor, C. F. Ng, B. O'Connor, T.-E. Park, H. Sanchez, J. Sliz, A. Sontheimer-Phelps, B. Swenor, G. Thompson 2nd, G. J. Touloumes, Z. Tranchemontagne, N. Wen, M. Yadid, A. Bahinski, G. A. Hamilton, D. Levner, O. Levy, A. Przekwas, R. Prantil-Baun, K. K. Parker, D. E. Ingber. 2020. Robotic fluidic coupling and interrogation of multiple vascularized organ chips. Nature Biomedical Engineering, 4, 407–420.

RESEARCH HIGHLIGHTS

RESEARCH HIGHLIGHTS

When the world bec omes infection crazy

Dr Keira Melican, senior researcher at AIMES, presenting her research at the inauguration.

To be an Infection Biologist in the time of COVID-19 has been an interesting experience. Suddenly the world became obsessed with the intricacies of host-pathogen interaction, how a pathogen enters their hosts and innate and adaptive immunity. From the researchers perspective this was both thrilling and terrifying, the speed of spread of both the virus but also misinformation was incredible.

At AIMES a major research focus is the mechanisms of host-pathogen interaction, how microbes cause infection. Dr. Keira Melican has built a career on using cutting-edge approaches to understand better the holistic effect of microbial infection on the host. Together with Prof. Richter-Dahlfors, Dr. Melican pioneered the use of advanced microscopy to visualize deep into different organs in the body and study how they respond to bacterial infection. From the very beginning of this work it was clear that by using these highly technical methodologies, an entirely new picture of host response was emerging. An early finding was how within hours of bacterial infection in the kidney, the small blood vessels surrounding the infection would begin to clot, that the infection was sending signals to the tissue to initiate a protective response before any immune cells could arrive. Dr. Melican has continued this work and outlined different mechanisms driving this signaling from both the host and pathogen perspectives. In the past year, this work came back into focus as it became apparent that COVID-19 was causing unexplainable blood clotting issues in patients. One of the signaling factors implicated in bacterial induced clotting has been shown to be an alternative cell binding target for SARS-CoV-2. These sorts of incidental findings will be critical to ongoing understanding of both COVID-19 but also other emerging infectious pathogens. Understanding the complex interactions between host and pathogen will put us into a better position to face future infectious threats.

Aman Russom, Professor in Clinical Microfluidics, at AIMES inauguration.

Prior to COVID-19, one of the biggest concerns in Infection Biology was increasing antimicrobial resistance. This threat has not gone anywhere in the past 12 months and it a driving force for much of the infection focused work at AIMES. The infrastructure at AIMES is ideally suited to ongoing development of this work, the ability to combine the cutting edge emerging technologies to age-old medical questions has enabled not only new insight but an ability to rapidly adapt to pressing medical questions.

From the onset of the pandemic, it quickly became apparent that access to scalable, rapid and sensitive viral diagnostics was important to help contain the rapid spread of infection and prevent overwhelming the capacity of health systems. While high-income countries have managed to rapidly expand diagnostic capacities, such is not the case in resource-limited settings of low- to medium-income countries. Aiming at developing cost-effective viral load detection systems for point-of-care COVID-19 diagnostics in resource-limited and resource-rich settings alike, professor Aman Russom and his collaborators have developed an integrated modular centrifugal microfluidic platform to perform loop-mediated isothermal amplification (LAMP) of viral RNA directly from heat-inactivated clinical samples. The patent pending technology was validated with a panel of 162 nasopharyngeal swab samples collected from patients with COVID-19 symptoms at Karolinska Hospital and is fit-for-purpose to diagnose patients with a high risk of viral transmission.

Keira Melican	Senior Researcher in Tissue Microbiology

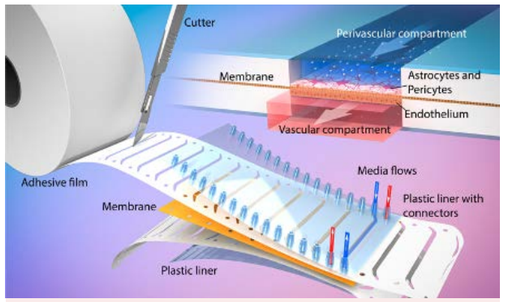
Aman Russom	Professor in Clinical Microfluidics

RESEARCH HIGHLIGHTS

How “Organ-on-Chips” can be used to understand the human body

In medical research, researchers want to create a better understanding of the human body and its diseases. The results can ideally be used to develop better treatments and diagnostic methods. Humans cannot be used as exploratory test objects in most experiments, so researchers must instead use model systems. Experimental animals are widely used, but the gap between the physiology of animals and humans is large. Another class of model system is based on culturing human cells in the laboratory, but there are very few of our human physiological functions or diseases that can recapitulated with one cell type is a cell culture dish. Anna Herland, Associate Professor at AIMES is one of the world-leading experts in developing new kinds of human cell culture models based on miniaturized flow systems and human cells, so-called "Organ-on-Chip" technology. She combines microengineering, technologies originally developed for electronics, with cell culture directly from human tissue or cells derived from human stem cells into what she called “minimally functional units” of tissue. One example are blood vessels in the brain, where the key functional unit is the blood vessel cells and closely surrounding cells. This unit gives the brain blood vessels their unique property of being able to protect the brain from toxicants and infections while still supplying more energy supply per volume than to any other organ in the body. Annas has been able to recreate the function of the brain’s blood vessels and used microengineering to get novel insight in cellular functions, drug effects and drug penetrance across the vessel wall. In a recent study in Nature Biotechnology, she and the co-authors showed new models of interactions between the brain’s blood vessels and neurons. Now she is running a VR-project with AstraZeneca to validate the advantage these Organ-on-Chips have versus standard models for permeability of small drugs but also novel, human-specific drugs.

Organ-on-Chips can easily be equiped with a blood-vessel like channel. Anna published two papers in Nature Biomedical Engineering last year where the blood vessel channels were used to connect up to 10 different Organ-on-Chips,



Relevant publications:

Winkler, T. E., Feil, M., Stronkman, E. F. G. J., Matthiesen, I., & Herland, A. (2020). Low-cost microphysiological systems: feasibility study of a tape-based barrier-on-chip for small intestine modeling. Lab on a Chip, 20(7), 1212–1226. doi:10.1039/D0LC00009D

Herland, A., Maoz, B. M., Das, D., Somayaji, M. R., Prantil-Baun, R., Novak, R., … Ingber, D. E. (2020). Quantitative prediction of human pharmacokinetic responses to drugs via fluidically coupled vascularized organ chips. Nature Biomedical Engineering (2020). doi:10.1038/s41551-019-0498-9.

Maoz BM, Herland A, FitzGerald EA, Grevesse T, Vidoudez C, Pacheco AR, Sheehy SP, Park T-E, Dauth S, Mannix R, Budnik N, Shores K, Cho A, Nawroth JC, Segrè D, Budnik B, Ingber DE, Parker KK. A linked organ-on-chip model of the human neurovascular unit reveals the metabolic coupling of endothelial and neuronal cells. Nature Biotechnology.

2018;36:865-874. doi:10.1038/nbt.4226.

to a Body-on-Chip concept. By combining chip studies and computer modelling, the team could predict drug uptake and secretion as well as study drug induced effects. This technology is still expensive and work demanding. Anna has made an effort in democratizing Organ-Chips by publishing a system that is 10-100 times cheaper than commercial variants.

The pharmaceutical industry and regulatory authorities are very interested in this new technology and at AIMES we are involved in fundamental development of the systems as well as industrial collaborations and standardization discussions. Most of Anna’s Organ-on-Chip research is funded by Knut och Alice Wallenberg’s stiftelse, she has just been awarded the prestigious extension of their Wallenberg Fellow Program. She will focus that research to develop Organ-on-Chips for studying metabolic diseases in children.

Anna Herland	PhD, Associate Professor in Hybride Bioelectronic Systems, KTH Researcher, AIMES, KI

Wearable bioelectronics redefines medicine

Wearable bioelectronics is an exciting, recent breakthrough that has attracted great attention worldwide. This new technology has the potential to change the ways we traditionally approach medicine and biotechnology. Wearable bioelectronics offers immense promise to become an integrated part in consumer products, due to their ease of miniaturization, the possibility of rapid and in-situ analysis, and the potential for low-cost fabrication. Although the field is in its infancy, wearable bioelectronics are expected to develop such that novel approaches and methodologies will open new and exciting avenues for the maintenance of well-being and the delivery of personalized healthcare. However, successful establishment of paradigm shifts requires significant research and innovation regarding new materials, interfaces, circuit designs, power sources, and data processing. Moreover, the translation of research results on wearable bioelectronics to their successful integration in consumer products are expected to require new business models. Dr. Onur Parlak is an Assistant Professor at AIMES and one of the world-leading experts in wearable bioelectronics. In 2020, the first book on Wearable Bioelectronics was published with Dr Parlak as the leading Editor. The book surveys recent trends in wearable bioelectronics and their implications for healthcare applications. Following up on the great interest for this new and exciting area, Dr Parlak is currently acting as Editor for a Special issue of the world-leading journal Biosensors and Bioelectronics, who in the September 2021 issue will focus on the wide range of new and exciting applications of wearable biosensors.

Dr Parlak is a Team leader in biosensor research at AIMES. His current research focuses on personalized diagnostics and digital medicine using wearable devices, specifically for bacterial infections. Previous to KI, he worked at Stanford University where he developed the first microfluidic-integrated skit patch that senses various hormones in the sweat of a person doing physical exercise. The work attracted much attention, leading to industrial collaboration for prototype development for real-world applications.

Onur Parlak	PhD, Assistant Professor in Biosensors and Bioelectronics in Medicine, AIMES, KI

RESEARCH HIGHLIGHTS

Interdisciplinary advances in surgery

When the British surgeon Joseph Lister adapted the revolutionary findings of the French chemist Louis Pasteur, he transformed surgery from a horrible occupation with poor outcomes into a lifesaving and respectable medical procedure. This anecdote illustrates a core advantage of AIMES, how sharing knowledge between fields can lead to great progress in previously unrelated areas.

Dr Svennersten is presently a resident in urological surgery, but he has a research background with a PhD thesis in Organic Bioelectronics, making him a true interdisciplinary scientist. According to Dr Svennersten surgeons need to be humbly aware that surgical skill is only one part of what contributes to the overall outcome for the patient. The post-operative phase when the patient recover from the trauma of an invasive surgical procedure is critical. How does the patient's body reacts to foreign materials placed in the body during surgery and how are the materials affected by the body environment? These are questions that are best addressed in interdisciplinary environments in close collaborations with engineers, chemists and biologists.

In his first publication as an independent researcher Dr Svennersten showed how molecules previously only known as energy carriers also could function as signaling molecules for the sensation of mechanical stimulation in the urinary bladder. This was achieved by using innovative materials with mechanical properties. These materials are now under investigation to understand how they affect the cells that interact with them but also how the materials are affected by the cells. This knowledge is critical if these materials are to be considered in future implants or medical products.

In the Stone Microbiome project, initiated by Dr Svennersten, basic chemistry and microbiology are fundamental. The project involves building a biobank of kidney stones and urine from kidney stone patients and healthy volunteers. This biobank will be used to study kidney stone formation and particularly how the chemical composition of urine and the associated microflora of the urinary tract affect stone formation. The process of biomineralization, a key element of kidney stone formation, has been studied in many different environments from the seabed to industrial production plants. Dr Svennersten acknowledes there is a lot we can learn and apply from these studies to kidney stone formation in patients.

Everyone can't know everything, but it is important that we learn enough about each other's fields so that we can communicate effectivly. Therefore, Dr. Svennersten strongly supports interdisciplinary education and is contributing as lecturer in several graduate courses promoted by AIMES.

Kalle Svennersten

MD, PhD , Affiliated researcher,
Dept of Molecular Medicine
and Surgery, KI
Affiliated researcher, AIMES, KI

SCIENTIFIC ACHIEVEMENTS AND AWARDS

Associate professor Anna Herland received a 6-years prolongation from Knut and Alice Wallenberg Foundation for the project on Organs-on-Chip for Translational Research in Brain Disease.

Researchers hope to develop drugs more efficiently using electronic chip systems that mimic processes in the body's organs. One part of Anna Herland's work is to develop models for how cells in the blood-brain barrier interact with brain tissue.

Dr Valentin Dubois is a Wallenberg postdoctoral fellow who joined AIMES this year following two years at Harvard Medical School. Valentin brings to AIMES team his strong background in fabricating nanoscale devices and finds within AIMES the complementary bio-focused practical knowledge necessary for his research. Valentin leverages a novel fabrication approach that controllably generates cracks in nanometer thin films and turns them into sensors targeting single molecules such as DNA and proteins. Valentin's research has brought him at the frontier between fundamental physics and mechanical engineering, with a keen focus on technologies that can be taken out of the lab into industry to ultimately benefit society and human health.

Dr. Ferdinand Xiankeng Choong has been awarded a position as Assistant Professor in Microbiology and Glycobiology at AIMES. In line with AIMES's mission to improve the health and wellbeing, his work focusses on the study and treatment of biofilm-associated infections, and the development of biopolymers and optical sensors to monitor them.

- AIMES is an exciting forum between academy and industry. As a researcher working on the fundamental science of how bacteria cause diseases, the opportunity to engage leaders of industry to refine ideas and understand what society needs is extremely valuable. Being at AIMES, using research to achieve grand endeavors such as the UN's Sustainable Development Goal of ensuring healthy lives and promoting well-being for all at all ages is possible.

Onur Parlak, awarded as KI Assistant Professor. Onur Parlak is working with Biosensors and Bioelectronics in Medicine with a special focus on bacterial infections.

- I believe that being a member of AIMES is a great opportunity and will help me to establish my research group to implement my research goals, allowing me to operate at the highest level internationally and help to set-up my position as an emerging group leader. Recently, I have been selected as promising young group leader with 6-years funding by the KI investment programme to recruit and support leading junior researchers with particularly outstanding scientific merits and future potential. I am now leading biosensor and bioelectronic research and acting as an Assistant Professor at AIMES where I specialize in personalized diagnostics and digital medicine.

Education

INTERDISCIPLINARY COURSES – A CHALLENGE NOT ONLY FOR THE STUDENTS

All levels of education call for a considerable expansion of courses offering an interdisciplinary curriculum. One mission of AIMES is to establish courses that enroll students from different educational backgrounds, i.e. engineering and (bio)medicine. Our work during 2020 revealed that this is more easily said than done. A number of hurdles of administrative nature have surfaced since each university is governed by their specific formalities. We are determined to resolve these challenges in order to find an interdisciplinary way forward for students at all levels.

AIMES SCIENTISTS ORGANISED THE FOLLOWING COURSES AT PHD LEVEL IN 2020

The PhD course Clinical and Molecular Bacteriology, developed within AIMES, was implemented for the first time. The course was run through the doctoral program in Biology of Infections and Global Health (BIGH) at KI, and engaged a combination of Masters and PhD students from KI, Stockholm University (SU) and Uppsala University (UU). The course focussed on bringing together clinical and molecular bacteriologists. Due to the pandemic the course had to be transformed to online format, which inevitably presented some challenges. However, the positive feedback from both the students and the lecturers confirmed our belief to offer this course again in 2021.

The PhD course Biomimetic Systems is specifically designed as an online course, as it is a multicentre course run between KI, KTH, and Tel Aviv University. The multidisciplinary course brought together graduate students with backgrounds in biology, technology, as well as engineering. The great interest from the students prompt us run this course bi-annually.

PhD STUDENTS

In 2020 I have written and printed my thesis, the scope of which was the development of novel technologies for prevention of bacterial colonization of surfaces, detection and identification of bacteria. Part of my thesis was work performed with our AIMES colleagues from KTH, which has been a great experience for me. Overall, AIMES has enabled or facilitated collaborations with KTH, something that I found extremely useful for my work. I really enjoy the interdisciplinarity of AIMES as it has expanded my horizons and presented new challenges and opportunities. I think the best thing with AIMES is that it has become so easy to approach scientists from different disciplines and join forces to answer complicated questions.

Karen Butina
PhD student KI

Sepsis is a life threatening condition characterized by a whole-body inflammatory state caused due to blood stream infection. It is a common pathway from most infectious diseases worldwide, including the current viral pandemic SARS-CoV-2/COVID-19. Misuse/overuse of antibiotics has led to the development of antimicrobial resistance (AMR) making the treatment for sepsis much more challenging. In bacterial sepsis, bacteria reach the blood stream from a local region of infection and spread, leading to organ dysfunction and death of the patient. The high mortality due to sepsis is mostly associated to the difficulty of diagnosing low concentration of bacteria in blood at its early stage. Thus there is an urgent need to develop a robust and quick method to diagnose sepsis.

My research at KTH is focusing to develop a novel sample preparation method for rapid and effective separation of low concentration of viable bacteria from blood in few hours using microfluidics and filtration techniques, unlike the present standard method that takes up to 2 to 3 days. The separated viable bacteria using my work can be further used for phenotypic (antibiotic susceptibility) and genotypic analysis.

The interdisciplinary research platform offered by AIMES, has opened up a perfect opportunity to help translate my research work into a potential commercial product that can be used in hospitals for quick sepsis test and to address the growing AMR challenge.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 675412.

Sharath Narayana Iyengar
PhD student KTH

How can advanced cellular techniques be used to study brain cells' interactions in neurological disorders?

In my project, I have been working on generating a specific brain cell type, the astrocytes, and the brain's endothelial cells (which populate the blood vessels in the brain) by using stem cell technology. Ultimately, I would like to study the interaction of these cell types in the context of oxidative stress and how that could potentially contribute to the onset/progression of neurological disorders, such as multiple sclerosis, stroke etc.

To better elucidate mechanisms during pathological conditions we need to use culturing platforms that better capture the conditions in the human body, organ-on-chips is one of those approaches.

Research within AIMES has provided an interdisciplinary platform and inspiration where it will enable me to model and study, through the synergistic action of stem cells and organ-on-chips approaches, complex biological processes in the brain.

Dimitris Voulgaris
PhD student KTH

Are bacteria our foe or friend? How are most of them living with us in harmony while some of them making us sick? Here at AIMES, our work focuses on studying the intricate interaction between host and bacteria using cutting-edge approaches of tissue microbiology. Coming all the way from the Master program of Biomedicine of Karolinska Institutet, AIMES provided me an opportunity to conduct my degree project, also to grow to be a future scientist. The past year of 2020 has been tough since every aspect of our work and life was affected by the ongoing pandemic. However, with all the effort from the management and mentorship, the start of my PhD study has been productive and satisfactory under special circumstances.

Tiangi Charles Zhang
PhD student KI

PhD STUDENTS

Microfluidics is emerging as an important technology for applications in high throughput cell isolation. The focus of my work is to develop microfluidic devices for sample preparation and isolation of rare cells for improved cancer diagnostics. Circulating tumor cells (CTC's) are rare cells that shed into the circulatory system from its primary tumor cite through metastasis process. The isolation and detection of CTC's from peripheral blood samples is minimally invasive and can allow for early cancer diagnosis. AIMES provided me the ideal collaborative platform to explore new possibilities to tackle clinical needs with novel engineering tools. In particular we used Cellulose, a novel biomaterial used in paper and cardboard industries, to modify the surface of a microfluidic chip, then used to efficiently capture and release cancer cells. Now together with AIMES we are looking into the possibility of testing and validating our technology with patient samples and take it one step closer to the market

Tharagan Kunar
PhD student KTH

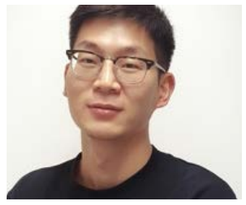
How can we improve our understandings of electrical communication within neuronal cell cultures or bacterial biofilm communities? In the scope of my Ph.D. project, we want to address this question using conjugated polymers. In contrast to conventional electronics made of metals such as Gold, conjugated polymers are made of organic material. They are flexible and provide a soft interface with cells. We want to use these characteristics to perform improved electrophysiological measurements in neuronal cell culture models as well as bacterial biofilms.

Supervised by Prof. Anna Herland and Prof. Agneta Richter-Dahlfors at AIMES I have the possibility and receive the support to work on such an interdisciplinary project. Despite the special corona year 2020, we managed to keep our research work going and continued step by step to improve electrophysiological measurements in cell cultures with organic electronics.

Sebastian Buchmann
Dual PhD student at KTH and KI

As a PhD student in AIMES I study interactions between bacteria and the host, and specifically how the nervous and coagulation systems are involved, during kidney infection. I have had the pleasure of participating in projects truly reaching from bench to bedside, but also back to bench again. We answer research questions by conducting molecular biology and cell culture experiments, animal experiments, as well as epidemiological studies on human patients. In 2020 we wrapped up two such conceptually different projects. AIMES enables a broad span of PhD projects, as the center attracts researchers with different expertise, and thus enables collaborations and projects beyond one discipline. I find it extremely fascinating being able to investigate if findings from the lab bench can be applied in a clinical reality, but also to investigate the underlying mechanisms of observations on the clinical side by going back to the lab bench.

Svava Stiner
PhD student KI and MD



Mucus covers the epithelium surfaces playing a key role in the barrier, hydration and lubrication functions for human body. How can we modulate the mucus functions by changing its structure? Kun Jiang's PhD project is aiming to modulate the structure of mucus gel by changing its cross linking strategies, mucin molecular structures and mucin glycan components. The mucus with specific structures would have the designed functions to be applied in the regenerative medicine technologies for better human health. The 2020 within AIMES is productive for me, getting two papers accepted by journal Advanced Functional Materials and Biomacromolecules. The multidisciplinary research in AIMES gets us to find collaborators easily, and I got to know the world leading research works from the cross borders talks organized by AIMES.

Kun Jiang
PhD student KTH

Making an environment similar to human body is very important in medicine. Currently in drug development process, researchers are using 2D environments like simple cell culture system or 3D environments like animal models. 2D models can not mimic the real body reaction and 3D models have ethical problems. In 2010, human disease models could be successfully designed on multi-channel 3D microfluidic devices. This designing could simulate the physiological response of the injured organ to developed drugs. So, the 3D microfluidic devices are a very big advancement in medicine and drug development industry.

In my project, I am working on development of novel surface treatment materials that we can coat the surface of the channels inside the chip with. These novel biomaterials are mimicking the extracellular matrix of the organ, so they can help the cells to generate the real like organs that could be furtherly tested for developed drugs.

Negar Abbasi Aval
PhD student KTH

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Violetta Nikforvova
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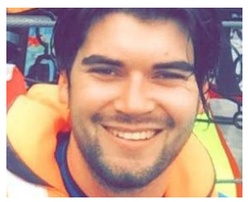
Masters student

Proud host of ERASMUS+ students

Working on my master thesis in the AIMES center, proved to be an invaluable experience for me, as I've been thrust into the world of interdisciplinary research through the guidance of assistant professor dr. Onur Parlak and dr. Karen Butina. We worked on developing a new method for biofilm analysis, using Organic ElectroChemical Transistors and fluorescence microscopy. Because I arrived just before the pandemic, I was very fortunate I could continue with my project throughout the whole of 2020, having been hired as a research assistant for another 6 months, at the end of my internship. Working within AIMES has exposed me to, and taught me a lot about scientific fields I never thought were, or could be connected to what I'm working on. Through this, I've realized that the future of research is interdisciplinary, as it all connects into a coherent unity of knowledge, with AIMES paving the way forward.



Filip Filipovic, Erasmus+ student from University of Ljubljana, Slovenia

Science-to-society

ENTREPRENEURIAL ENGAGEMENT AND INDUSTRIAL COLLABORATION

As a forerunner in Sweden for implementing research results into societal impacts, AIMES offers an innovative research environment that promotes entrepreneurial thinking. Patents emerging from creative projects driven by AIMES scientists form the foundation of start-up companies. Here are examples of what we have achieved so far:

CIRQLE biomedical

Offers an innovative non-hormonal contraceptive based on mucus engineering.

Ebba Biotech

Offers Optotracing for dynamic visualisation of nanostructures related to neurodegenerative diseases, bacterial infections, and plant biomaterials.

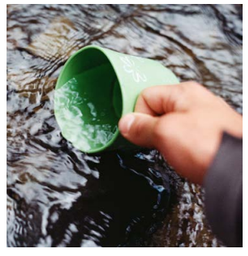
emulate

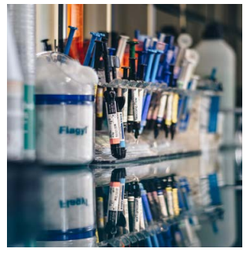
Offers living platforms that emulate the complexities of human biology to enable unprecedented insights into human biology and health

Richter Life Science

Offers intelligent sensing technologies applicable to the Med-, Bio-, Food-, Agro- and Green-Tech industries.

Societal impact is also achieved via collaborative research projects that embrace a variety of stake-holders, including industry.






MISTRA TERRACLEAN

COMPETENCE CENTRE DESIGN FOR CIRCULARITY: Lignocellulose based Thermoplastics FibRe

CLEAN CARE

MAQUET GETINGE GROUP

Science parks and incubators interacting with AIMES scientists

KTH INNOVATION

MEDEON

Sting BIOECONOMY

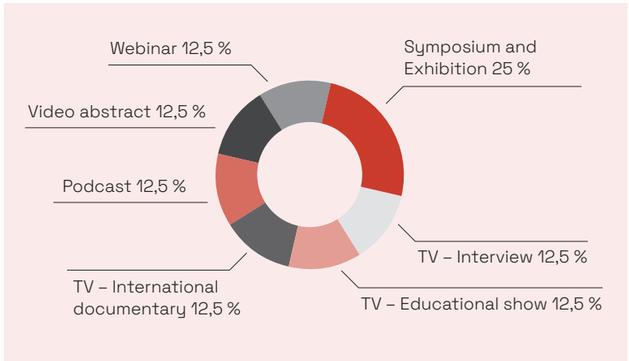
BioInnovation Institute

Karolinska Institutet Innovations AB

Media impact

CONSOLIDATING OUR MEDIA PORTFOLIO AND COMMUNICATION STRATEGY

Enabling translation of research results into societal benefit is challenging at many levels. One is to describe complex research results and their implications in an understandable way. The COVID-19 pandemic has highlighted the value of using a panel of media types, the use of online and digital media has seen a tremendous increase due to social distancing and lockdowns. AIMES has made an effort in developing a variety of media types to connect with the public, including press and social media channels. A streamlined system is in place in which the authors of research articles also produce "press packages" that are launched when a scientific article is published.



In 2020, Center scientists and their research have been featured in TV interviews and podcasts, press releases, webinars, symposium, video abstracts, short documentaries and photo exhibitions. The experience of engaging this wide range of media types has allowed AIMES to refine its 'press portfolio' and further improve its communication plan. Planning is already well underway for the release of several video abstracts in 2021.

HIGHLIGHTS OF 2020

Team Anna Herland: 'Organ-On-Chips' on CBS Boston and the Podme piece on 'the experimental animals'.

Team Karl Svennersten "Kan man dö av energidryck? In Emma Frans' educational TV-show

Team Aman Russom: "COVID, social distancing, and the economy: What can we learn from the Swedish experience"

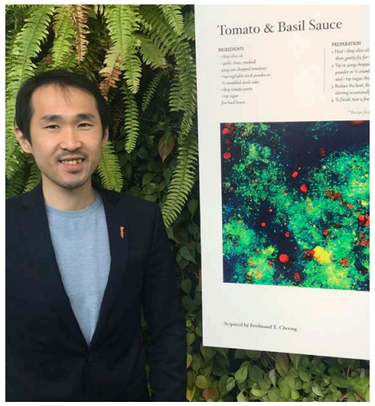
Team Ulrica Edlund: Sea lettuce offers sustainable source of nanomaterial

KEPACH PRODUCTIONS

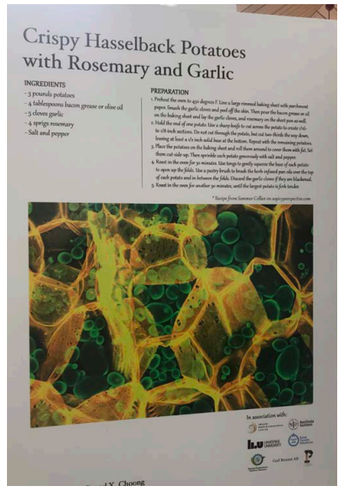
Team Agneta Richter-Dahlfors: Man 2.0, a documentary series on the role of science in shaping human life, showcases the artificial nerve cell.

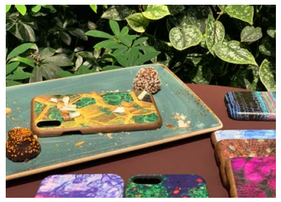
ART AND GASTRONOMY BRINGS SCIENCE TO SOCIETY

In a project specifically aimed for communication of research results to the society, Dr. Ferdinand Choong showcased the beauty of nature's chemistry in an art exhibition at Karolinska Institutet. The colorful images are not only stunning, they also convey information on the chemical content of plants we eat. Via posters, cell phone cases and place mats, educational consumer products were also showcased at AIMES inauguration.



Ferdinand Choong at the art exhibition at KI.





The colorful images show the location of cellulose (yellow) and starch (green) in a slice of potato.

SOCIAL MEDIA ENGAGEMENT

In 2020, the best social networks were Facebook, Instagram, Twitter, Pinterest, LinkedIn and Snapchat. Starting with channels most popular amongst researchers, AIMES launched its social media presence on LinkedIn and Twitter. While conducting exciting research, the AIMES communications team steadily increased the Centre's online visibility through publishing events, sharing and commenting on our research publications and interesting posts.

As a Swedish institution, AIMES' reach is to date primarily local and in the Nordics. A growing pool of followers is also found in Europe and South Asia. In line with the mission to effect change in education, research and healthcare, AIMES' reach extends strongly into areas and industries such as 'Higher Education', 'Research', 'Biotechnology', 'Pharmaceuticals' and 'Hospital & Healthcare'. An interesting, growing pool of followers from 'Government Administration' may point to a future where AIMES's discoveries affect change in policy and society.

In addition to the Centre's online portfolio, individual scientists have prominent social media presence that reaches across the globe. As a Team, the combined network of AIMES's members put the Center in a great position to set up local and international collaborations, reaching our mission of bringing Science to Society.

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AIMES 2020

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Helén Andersson Svahn
Haldex CEO Haldex & Professor KTH

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Our work at AIMES addresses a number of the UN sustainability goals and one we are very proud to address is Goal #5 Achieve gender equality and empower all women and girls. Research Science in general, and particularly the engineering sciences, have long been male dominated. At AIMES we strive for equality across all aspects of our work. Our current team consists of a very even gender spread all the way from student intake to leadership roles. This type of interdisciplinary environment has proven to be very attractive for female researchers coming from both engineering and medical backgrounds and we look forward to continue contributing to growing equality in research and development.

AIMES

CENTER FOR THE ADVANCEMENT OF INTEGRATED MEDICAL AND ENGINEERING SCIENCES

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Karolinska Institutet | KTH VETENSKAP OCH KONST

IN PARTNERSHIP WITH GETINGE