

# Annual Report 2021

## 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.

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### COVER IMAGE

Optotracing is a new and innovative technology developed by AIMES researchers. Optotracers are tracer molecules acting as molecular light switches. They start to emit fluorescent light upon binding to biopolymers such as amyloid proteins and polysaccharides. Here, optotracers added to the nutrient agar of a Petri dish illuminates biopolymers (red, yellow) produced by Salmonella (green) growing as a biofilm. For details, see: Choong *et al*, A semi high-throughput method for real-time monitoring of curli producing Salmonella biofilms on air-solid interfaces. *Biofilm*, Vol. 3, 2021.

# Preface from the Chair of the Steering Group

I am pleased to conclude another great year 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. We are grateful for the strong and continued support from the leadership at both universities.

AIMES continue to demonstrate that interdisciplinary solutions to solve societal and global challenges is the way to move forward. To identify relevant problems, come to an understanding in what key factors and stake holders that are important for a solution and then implement collaboration to make a change.

We learn a lot from the pandemic and have found new ways around several challenge that came in the way of our planned activities. Despite the limitations in meeting in person for a long period of time we have created different forums for interactions to develop our collaborations and our organization. Digital internal meetings kept the discussions going and allowed us to continue the exchange of knowledge and to established processes that will facilitate collaborations. Our international webinars seminar series has continued and engaged both speakers and audience from around the globe.

I had the great pleasure of talking at the AIMES Progress Forum, a digital internal meeting to open for new interdisciplinary collaborations within AIMES. I was delighted to participate in the debate and listen to pitches about ongoing projects and how they can align and give further understanding to a common scientific question and exchange of knowledge.

AIMES co-organized KI 2nd conference on Sustainable Development on the theme “From Basic Science to Better Health for all – making innovations reach those in need”. The take home message is once more that an interdisciplinary approach is the key to succeed in giving a better health for all, a chain of collaborating partners is important in the work for reaching the sustainable development goals, SDGs and realizing Agenda 2030.

AIMES pervades the interdisciplinary, need-oriented and broad way of thinking in all aspects of the organization and develop standard and processes to facilitate partnership between universities and other sector of the society. I hope this model will set a standard in how universities can cooperate and make way to implement interdisciplinarity in research and education on all levels. It is apparent that the kind of environment AIMES provides is attractive to young researchers and we are happy to welcome Dr Erica Zeglio as a new Team Leader.



**Pam Fredman**  
Chair of the Steering Group  
Professor emerita in Neurochemistry, University of Gothenburg  
President of IAU – International Association of Universities



**Christer Höög**  
Dean of Departmental group Solna at KI  
Professor at KI



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



**Helene Svahn**  
Member of the supervisory board of  
Mercedes Benz Group AG and board  
member of Axel Johnson International AB  
& Professor at KTH



**Clara Hellner**  
Director of Research & Innovation,  
Region Stockholm

AIMES steering group possesses a broad field of competences and I appreciate the input that has been given during the year. We welcome a new member in AIMES Steering Group, Clara Hellner, she will further strengthen the group and add new angles to the continued development of AIMES. AIMES has identified some of the obstacles and our work will continue to contribute to a solution for further progress.

Cooperation with private and public sector is needed to make a societal impact and improvement. AIMES vision to provide an environment that can bring together knowledge from

different disciplines is establishing and will continue to bring cohesion between academy and stake holders in private and public sector.

I would like to thank AIMES Steering Group, Management Group and All Members for a great year and great progress despite the difficulties that followed the pandemic.

I look forward to support and lead the long-term effort and growth of AIMES together with AIMES Steering Group, Management, members and partners.

# Director's View

AIMES - Center for the Advancement of Integrated Medical and Engineering Sciences at KI and KTH enters its third year still very much focussed on offering an academic environment that promotes interdisciplinary research and education, along with innovation and entrepreneurship. AIMES intent remains to meet the needs of intrinsically interdisciplinary scientists, such as engineering scientists wishing to build sub-groups in (bio)medicine, and vice versa, scientists from the medical faculty seeking to complement their groups by engineering competences and infrastructure.

Scientists at AIMES are dedicated to i) deliver interdisciplinary research and education of the highest standards; ii) demonstrate the relevance of academic research to society; and iii) facilitate the translation of research results into societal use. Although the pandemic made the last year immensely challenging for everyone, our members have had great success in advancing the positions of the three key pillars of AIMES. Despite circumstances, we have also expanded our global community of interdisciplinary scientists. Via web-based tools, we have continued to hold our well-attended serie of Crossing Border webinars in conjunction with academics and industry representatives across Europe, USA, Africa, Asia, and Australia/New Zealand.

Crossing the borders of subject areas, faculties, and universities is challenging for any scientist in today's traditional academic structure. I am delighted that we during 2021 have developed AIMES organisation in a clear and transparent way such that we are able to accommodate researchers no matter where in the pre-clinical and clinical KI and KTH organisations they have their main employment. We have strengthened our presence on the medical side with AIMES team leaders establishing themselves at clinical KI departments, and we have welcomed new young team leaders from KTH.

The role of AIMES to facilitate interdisciplinary research, inspire innovations across disciplines, and transfer technologies to stakeholders, puts us in prime position when addressing the UN Sustainable Development Goals. Successful achievement of the SDGs requires intensive collaboration and cooperation between specialists in widely different areas. While SDG 3 Good Health and Well-being obviously build on medical research, it also embraces areas such as material sciences, electronics, nanotechnology, microfluidics, and mathematics to name a few. At AIMES, scientists are indeed broadening the perspectives of SDGs for health as you will see in this report.

AIMES development has been possible thanks to great contributions of our researchers, students, founders, and Steering Group. It is very clear that everyone involved in AIMES remains jointly committed to our visions of delivering interdisciplinary break-through science and education, develop novel technologies addressing unmet societal needs, and act as inspiration for the next generation of intrinsically interdisciplinary research leaders.



**Agneta Richter-Dahlfors**  
Director of AIMES  
Professor in Cellular Microbiology at KI  
Professor in Chemistry and Biotechnology at KTH

# AIMES from a collaboration point of view

The core idea of AIMES is the integration of biomedical, clinical, material, and engineering sciences, hosting and fostering transdisciplinary research. As such, AIMES is a true connector between Karolinska Institutet, one of the world's leading medical universities, and the KTH Royal Institute of Technology, one of Europe's leading technical and engineering universities. While strong in their own rights, there is an immense added value in collaboration. To address complex research challenges, such as building a functional biomedical device, require complementary skills, knowledge, and infrastructure. In neither aspect are we always self-sufficient.

From a KTH perspective, the liason with Karolinska Institutet provides a new arena for KTH researchers to collaborate with experts in biomedicine and clinicians. In addition, AIMES provides access to top-equipped laboratories (Biological Safety Level 2), which allow work with human tissue, pathogenic bacteria and viruses, as well as testing of new biomedical materials and sensors in animal models and perform infection experiments. New functional materials can thereby be tested in a way that directly connects their chemistry and function to the needs in medical practice. Affiliated with Fibre and Polymer Technology at KTH, I can personally attest how collaboration within AIMES contribute to the department's vision to advance and realize sustainable material use in society.

AIMES is further devoted to translating and implementing research results with relevance for the global community. With a shared network of stakeholders and a shared understanding of the needs and required advancements, we can push progress far beyond the borders of each individual field. Building a strong arena for collaboration and the fostering of the next generation of transdisciplinary researchers are two outcomes of AIMES that we believe will have a strong impact on society.



**Ulrica Edlund**  
Vice Director AIMES  
Professor in Polymer Technology, KTH  
Affiliated Researcher, AIMES, KI

# SDG Conference

AIMES co-organized with KI the 2nd conference on Sustainable Development on the theme “From Basic Science to Better Health for all – making innovations reach those in need”.

The event aimed to increase the knowledge and understanding of the Agenda 2030 for KIs staff and collaborators and to inspire how you can address the Sustainable Development Goals (SDGs) in your research activities. The conference was a hybrid conference with around 170 participants of whom 80 were onsite at Biomedicum. The afternoon included a poster session.

We congratulate PhD students of Team Russom that won the prize for Best Poster at the 2nd KI Conference on Sustainable Development, presenting their work on their Covid-19 Project. On the occasion, the team received encouraging comments from many people and received a few offers for collaboration from both industry and academia.



Agneta Richter-Dahlfors and Ulrica Edlund joined forces during their talk on the importance of integrating and addressing several SDGs in one single project.

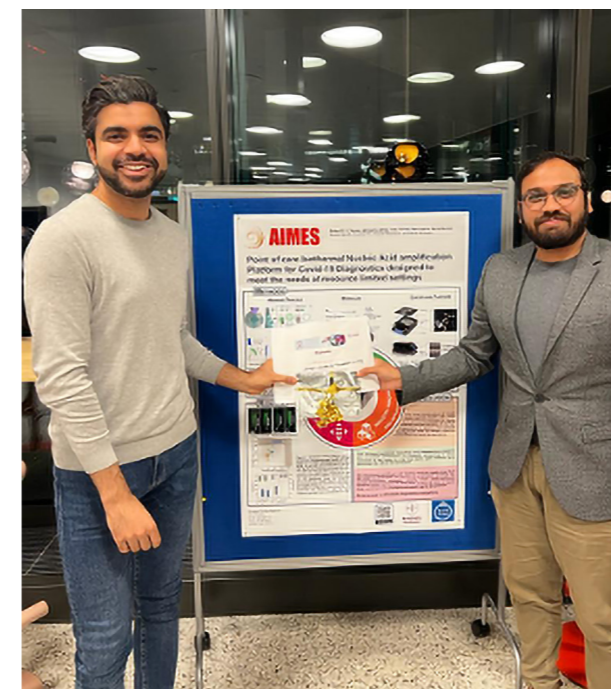


Ferdinand Choong shows that in order to address global health problems in the research, the approach needs to be curiosity driven and goal oriented.

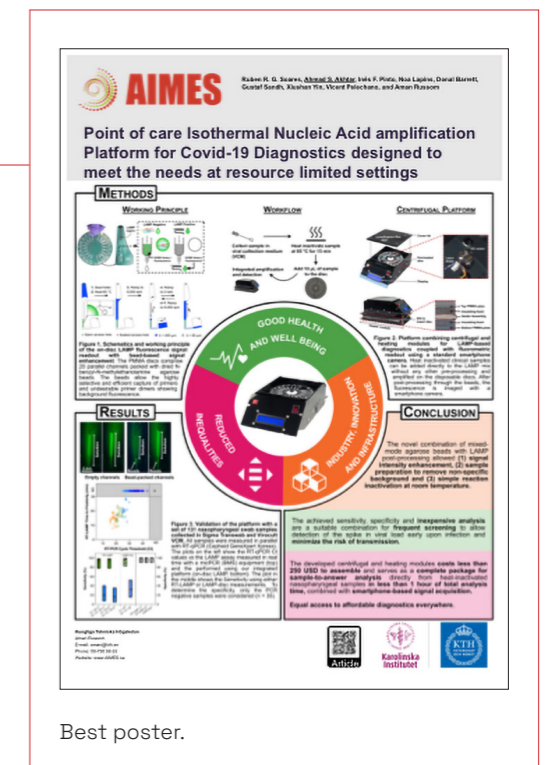
Photos: Linn Sjöberg



President of Karolinska Institutet, Ole Petter Ottersen during his introductory talk where he emphasized the role universities need to take as a driving force for change.



Ahmad Saleem Akhtar and Tharagan Kumar, Phd students in Team Aman Russom won the award for Best Poster on Point of Care Diagnostics for Covid-19.



Best poster.

# Our research environment

To ensure high quality and security we continue to develop our environment and routines to meet the needs of the intrinsically interdisciplinary project that are carried out in our environment in Biomedicum BSL2 facilities.

Lab manager Elham Jalalvand and Operation Controller Linda Thörn team up and assure that compliance to the regulatory frameworks governing our research is carried out. Structures, routines and communication are crucial for AIMES environment and we are constantly working to facilitate and develop best practice.

AIMES encourage dual affiliations: the main position at one university and an affiliation to the other. Team leaders can complement their main group at one university (e.g. KTH) with a sub-group at the other (e.g. KI).

AIMES is physically located in Biomedicum at KI, Campus Solna, hosted at the Department of Neuroscience. The safety level of laboratories and animal facility permits work with human material and disease-causing microorganisms. Members have access to local infrastructure in Biomedicum and to core facilities at KI and KTH.

Project carried out 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.

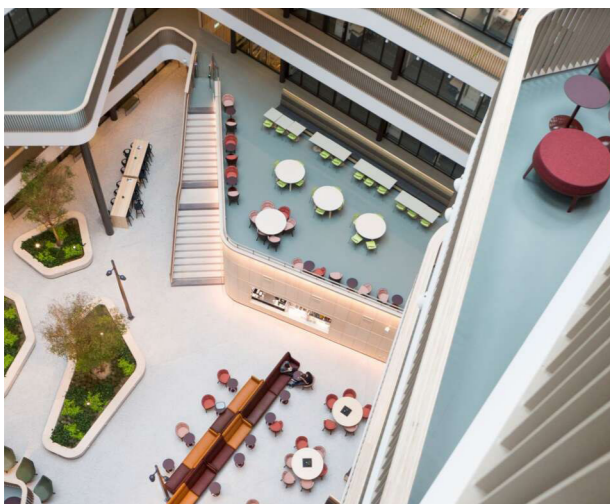


Linda Thörn

Elham Jalalvand

### AIMES Management Group

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



# Interdisciplinary scientists

Since our inauguration, we at AIMES have continued to do it differently. The main criterium asked of AIMES's 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.

As part of our continued efforts to promote interdisciplinary research, and transcend traditional academic silos, the projects run by the scientists at AIMES are broadly organized in six multidisciplinary themes. These themes 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 2021 clearly demonstrates the interdisciplinary nature of our projects.





Detecting physiological changes in the body, both massive and minute, is essential in the research of diseases and development of treatments. Organic electrochemical transistors (OECT) are devices capable of simultaneously controlling the flow of electronic and ionic currents. This unique feature renders the OECT the perfect technology to interface man-made electronics, where signals are conveyed by electrons, with the world of the living, where information exchange relies

on chemical signals. Zeglio aims to advance current materials used for bioelectronic devices, leading to better performance, advanced functionalities for bio-interfacing, and stability. Her vision is to create a new generation of organic electronic materials that brings together device performance and sustainable design. The long-term goal is to develop devices that can seemingly interface with cells and tissues to sense and stimulate biological functions.

*Erica Zeglio*

PhD, Affiliated researcher, Division of Nanobiotechnology, SciLife Lab, KTH  
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*

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



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



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, Associate Professor in Microbiology, 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



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



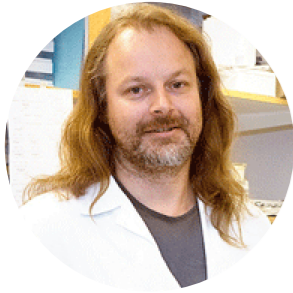
Advanced sensing technologies, like optotracing and biosensors, are uniquely suited for high-throughput applications, which creates large amounts of data. Making use of all data is challenging. With a background in biomedical sciences and signal processing, Löffler develops tools for data management, 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





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*

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 bioelectronics. 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 salmonellosis. Collectively, this work deepens our understanding of salmonellosis, leading to improved treatment strategies.



*Mikael Rhen*

PhD, Professor in Microbial Pathogenesis, MTC, KI Affiliated researcher, AIMES, KI

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 technology 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 ubiquitous 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*

PhD, 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 com-

bines 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.

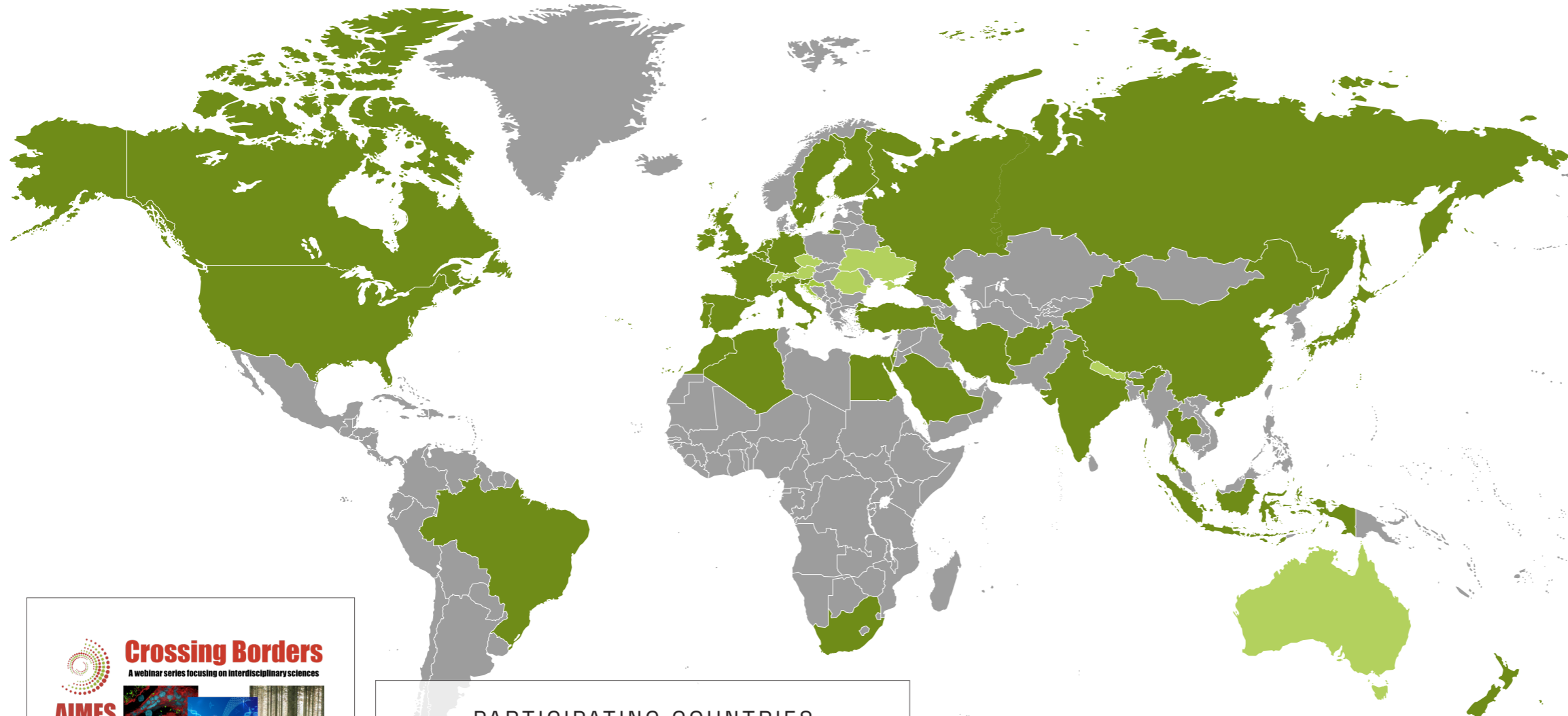


*Karl Svennersten*

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



# Connecting the world of interdisciplinary scientists



Crossing Borders is AIMES' webinar series focusses on interdisciplinary sciences. We are proud that this series attracts a broad audience from widely different areas of research. The pandemic showed us an opportunity to reach interdisciplinary scientists all over the globe. The online webinar gathers an international audience with a broad interest in interdisciplinary sciences. We are happy that the growing interest for the webinars reaches academia, health care and industry. During the year we confirmed the attendance of scientists from 41 countries!

PARTICIPATING COUNTRIES			
● New 2021	● + ● All countries 2021		
Australia	Afghanistan	Indonesia	Singapore
Austria	Algeria	Iran	Slovenia
Croatia	Austria	Ireland	South Africa
Czech Republic	Belgium	Israel	South Korea
Nepal	Brazil	Italy	Spain
Romania	Canada	Japan	Sweden
Switzerland	China	Morocco	Switzerland
Ukraine	Croatia	Nepal	The Netherlands
	Czech Republic	New Zealand	Thailand
	Egypt	Portugal	Turkey
	Finland	Romania	Ukraine
	France	Russia	United Kingdom
	Germany	Saudi Arabia	USA
	India		

## INTERNATIONAL COLLABORATION

- |  |   |
|--|---|
| SIGHT, Stockholm                                       | Satakunta University of Applied Sciences, Finland |
| Cellink AB, Göteborg                                   | Standford University, USA                         |
| Umeå University  | Sun-Yat Sen University, China                     |
| Linköping University                                   | Tampere University, Finland                       |
| Aarhus University, Denmark                             | Technical University of Munich, Germany           |
| Biostrike, Portugal                                    | Tel Aviv University, Israel                       |
| Cambridge University, United Kingdom                   | Università of Milano Bicocca, Italy               |
| Copenhagen University, Denmark                         | University of Freiburg, Germany                   |
| Kinetikos Health, Portugal                             | University of New South Wales, Australia          |
| Ming Wai Lau Centre for Reparative Medicine, Hong Kong | University of Porto, Portugal                     |
| Nanyang Technological University, Singapore            | University of Tartu, Estonia                      |



The series 'Crossing Borders' is literally crossing Sweden's borders. AIMES program enriches the attendees with knowledge on variety of subjects, that go from a more scientific perspective, where you get acquainted with innovative and hot topics, to more organizational and global health subjects. Through this almost 2 years of virtual sessions, it helped me figure the next steps that I'd like to take in Science, and to better shape my career."

*Mariana Hugo Silva*

Marie Curie PhD student between Janssen Pharmaceutica (Belgium) and University of Limerick (Ireland)

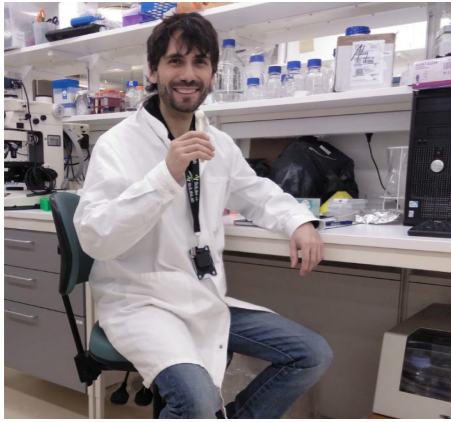


I join the sessions because I like the interdisciplinary nature, and the global health perspective. I enjoyed Goran's talk most because I could relate as an alumnus of both KI and Makerere. I think this series is important because it opens the minds of researchers (and policy makers if they attend) to new scientific challenges and innovative solutions outside of their everyday environment. The sessions are also good for networking.

*Johnblack K. Kabukye*

Medical doctor and informatician, Uganda Cancer Institute, PhD student in Medical Informatics, Amsterdam UMC, Location AMC

## ATTRACTING FOREIGN SCIENTISTS



I am a Spanish PhD researcher leading a European project with the aim to develop a microfluidic device for the diseases diagnostic by using biological fluids in a non-invasive way. To be part of the group led by Prof. Aman Russom at AIMES offers me the opportunity to learn from his wide experience on nanotechnology and microfluidics to develop point-of-care (POC) microfluidic devices for clinical diagnosis. Moreover, the Team is located in a brilliant and unique interdisciplinary environment that puts at my fingertips the most advanced technology in translational medicine and molecular biosciences.

*Pablo Gimenez Gomez*

Post doc  
Team Aman Russom

My previous studies, in both India and USA, made me realize that application science has the greatest advantage in solving human health issues. I approached the field of tissue engineering where I developed novel oxygenated 3D-bioinks to alleviate the hypoxia during tissue transplantation and cell therapy. AIMES bridge this gap by conducting interdisciplinary research from basic science to tissue microbiology and application science under one roof. AIMES provides a state-of-the-art facility to do excellent science and this motivated me to join AIMES. My research is focused on studying the formation of biofilms in 3D printed models and validate their antimicrobial susceptibility.

*Sivakoti Sargabathuni*

Post doc  
Team Agneta Richter-Dahlfors



I am an interdisciplinary scientist from India at the interface of Bioelectronics and Microbiology. With studies from India and USA, being an expert on the bioelectronics and material properties of biofilms, I want to develop technologies for biofilm sensing and eradication. I wanted to join an interdisciplinary group combining biologists, medical doctors and engineers because my own research interests combine equal parts engineering, biology and medicine. As a part of AIMES I believe I will become a better engineer and material scientist. I endeavour to contribute my expertise in carbon nano-materials to AIMES objectives. The biggest challenge for for me will be to translate my research activities into a real and affordable product/procedure that's out there in the market and people all over the world are using them in real-time.

*Sanhita Ray*

Post doc  
Team Agneta Richter-Dahlfors

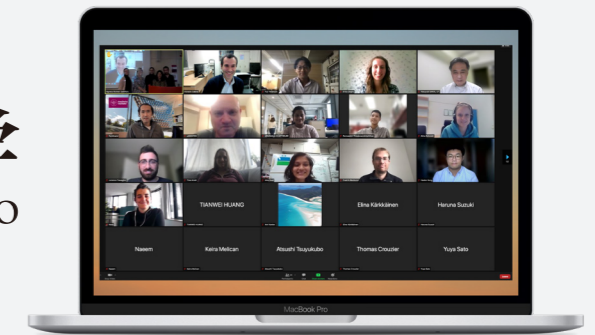
## THE STOCKHOLM TRIO AND UNIVERSITY OF TOKYO

The collaboration between the Stockholm Trio (Karolinska Institutet - KTH Royal Institute of Technology - Stockholm University) and University of Tokyo continued. AIMES was proud to once more host a session, this year on the theme

"Biomaterial for Biomedical Engineering". We opened up this session for an international audience and the 2-day hybrid session gathered around almost 100 participants from 21 countries with a common interdisciplinary interest.



東京大学  
THE UNIVERSITY OF TOKYO



"The strategic partnership between Stockholm Trio and the University of Tokyo (UTokyo) has contributed to a number of different initiatives. One of the activities includes workshops where researchers from AIMES have been active participants and engaged in the development of the partnership with UTokyo. AIMES plays an important role in the collaboration as facilitator of collaborative initiatives between our universities. A prolongation of the partnership agreement after 2022 is in preparation and the support and participation from AIMES in the next phase of the collaboration is important for the partnership."

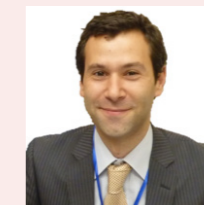
"The collaboration between The University of Tokyo and the Stockholm Trio has been a great opportunity to share cutting-edge research findings and discuss possibilities for collaboration within the framework of the strategic partnership since 2017. In particular, our groups share a mutual interest in biomaterials for medical application. Our discussions have focused on biomaterials-based bioengineering toward next generation therapies. We would like to continue this collaboration in the future. As one of our achievements, we will publish our collaboration work in the Focused Issue, "Frontline research on biomaterials-based bioengineering for future therapy", in the journal Science and Technology of Advanced Materials (STAM) (IF: 8.09)."



**Lennart Nilsson**, Professor KI's Academic representative in the steering committee for the strategic partnership between Stockholm Trio and UTokyo.



**Yuji Teramura**, Project Associate Professor, The University of Tokyo. Senior Researcher, National Institute of Advanced Industrial Science and Technology (AIST), Visiting Professor, Uppsala University



**Horacio Cabral** Associate Professor, The University of Tokyo

# The impact we envision

Answering the urgent call to action embodied by the 17 Sustainable Development Goals (SDGs), AIMES recognizes that our work needs to be both excellent, but also directed. As such, we have asked that our Team leaders to keep in mind specific goals in their work. Here are several narratives of the impact we envision our work to have.



My Team aims to use innovative science to tackle the United Nation's sustainable development goal number 3: Good Health/healthcare and well-being. We investigate the application of bioelectronics in medicine to develop novel devices for sustainable health and diagnostics. We are curious and very enthusiastic about using bioelectronic methods to address challenges in human health. We develop new technologies to combat healthcare challenges, design novel tools for early diagnostics, and solutions for digital medicine and remote monitoring.

– Onur Parlak

My projects aim at understanding mechanisms of bacterial persistency, and intrinsic antibiotic resistance, which fall under SDG 3. In the end, this will add to prevention of spread from carriers, and eventually to development of new treatment regimens.

– Mikael Rhen

My projects primarily address SDG 3, Good Health and Well Being, with a focus on addressing the rise of antimicrobial resistance and new ways to prevent and treat bacterial infections.

– Keira Melican

The integration of green routes for synthesis will contribute towards the targets to reduce waste and promote the manufacture of greener products. My Team is developing new materials to improve the performance of sensing technologies. We address SDGs 3 and 12.

– Erica Zeglio

New biohybrid systems are developed to mimic human physiology and pathophysiology outside the human body. We use these systems to increase understanding of the human body and aid in prediction of biodistribution, toxicology and efficacy of small molecules, nanomaterials and biologics. The systems, our design of them and the material we use relates to different SDGs.

– Anna Herland

Biofilm infections and biofouling impact a number of the SDGs; good health, food security, good manufacturing practices etc. My Team is studying biofilm physiology and pathogenicity while developing new strategies for treatment and removal. A novel optical sensing techniques for detection of polymeric materials in bacterial biofilm, is being expanded into renewable resources lignocellulose biomass and algae. This will aid in the optimization of current processes for a move towards a circular bio-economy. I am driving efforts to transform health, poverty and hunger globally, by developing collaborations with SIGHT and CESH.

– Ferdinand X. Choong

My team is continuing our efforts to demonstrate the multi-functionalities of a natural biopolymer: mucins. We believe that these molecules could be used as high value-added materials for biomedical purposes. We are continuing our efforts to demonstrate the applicability of mucins as a building block of new biomaterials, including using them to encapsulate pancreatic islets as well as demonstrating their antiviral and lubricating properties. Future project will aim at looking at the effect of mucin materials on bacterial biofilm, mucosal inflammation, and probiotic activity.

We also continue to focus on women's reproductive health. Cirql Biomedical is developing non-hormonal contraceptive, while at KTH we are developing methods to modify the properties of cervical mucus. Our aim is for these new technologies to offer radically better treatments and products to address unmet needs in women's reproductive health (infections, mucosal dryness, infertility, endometriosis), and help improve health and gender equality.

– Thomas Cruzier

The development of advanced sensors for real-time monitoring of infectious processes as well as bacterial colonization on biotic and abiotic surfaces is a major pre-requisite to tackle the rising problematic of antibiotic resistance. Controlling bacteria starts with monitoring how pathogenic species invade the natural microbiome. Specific detection of Staphylococci in a background of a mostly Gram-negative microbiome is a major goal of my research. As effective antibiotic treatments become scarce and novel antimicrobial medicines might be inaccessible to the most vulnerable populations, my team is also focusing on alternative strategies to impair growth or invasion of pathologic species. We do this by designing surfaces that can be addressed electronically to prevent bacterial growth or to act as barrier for bacterial contamination. The work of my team therefore focuses on the SDG goals promoting clean water and sanitation (6) as well as good health and well-being (3).

– Susanne Löffler

Building diagnostic capacity is critical to meeting global health priorities and achieving Sustainable Development Goal 3 by 2030. Accurate diagnostic techniques are the cornerstone of disease detection, clinical case management and control. The ongoing pandemic has exposed inequities in health care systems, especially in terms of access to quality diagnostics in resource limited settings. Team Russom is aiming to build sustainable diagnostics platforms using innovative nanotechnology based solutions for both COVID-19 and other infectious diseases. Our work is focused on Good Health and Well Being as well as Reduced Inequalities and Industry, Innovation and Infrastructure. In connection to the SDGs, PhD students of the Russom team won the prize for Best Poster at the 2nd KI Conference on Sustainable Development, presenting our Covid-19 Project.

– Aman Russom

# Making the change a reality

HOW CAN WE MAKE CHANGE A REALITY  
AS WE BRING SCIENCE TO SOCIETY?

The efficacy of scientific communication has become an issue during the COVID-19 pandemic. We as research scientists need to find better ways to interact with the general public and explain our work. One way to do this is through interaction with Learned Societies such as FEMS (Federation of European Microbiology Societies).

**Keira Melican**

Societal impact can be achieved through spin-out companies. My Team is focusing on delivering advanced, low-cost, diagnostics through our company Afiyet AB.

**Aman Russon**

Outreach to other hospitals and research centers in the Baltic Region has helped strengthen the quality and impact of our Stone Microbiome Project.

**Kalle Svennersten**

To increase our impact we can interact with politicians and the general public. I have lectured in Parliament (Riksdag) and found it a very rewarding experience.

**Anna Herland**

We have continued to develop our startup Cirqle Biomedical, developing a novel non-hormonal contraceptive for women.

**Thomas Crouzier**

Recognizing the key role of start-ups, SMES as well as large companies in delivering our work to society, AIMES continues to work closely with Ebba Biotech, Mölnlycke and Getinge, as well as new collaborations with Cellink AB. We are exploring opportunities with global networks like SIGHT to create positive impact globally and aid vulnerable populations. In 2021 I have begun developing projects aimed at improving food security with the NTU Chemical and Biomedical Engineering in Singapore.

**Ferdinand Choong**



The interactions of our Team Leaders with different elements of society are essential to facilitate the translation of our research results into societal use. These interactions include our industrial partner, other interested industry as well as political and regulatory bodies.

HOW DO WE AS RESEARCH LEADERS  
CHOOSE WHICH AREAS TO FOCUS OUR  
EFFORTS TO BRING ON A CHANGE?

We find it important to listen to the end-users as they are the ones closest to the challenge/problem. Through dialogue, we find the real needs and then we utilize our technical expertise to propose solutions.

**Aman Russon**

My team is positioned at the interface of medical and engineering sciences in line with AIMES goals. As PI of the team I guide each team member by introducing the right tools and right project to engage with.

**Onur Parlak**

Successful achievement of the SDGs requires intensive collaboration and co-operation between specialists in widely different areas. Good Health and Well-being builds on medical research which must be complemented by others.

**Agneta Richter-Dahlfors**

The SDG guidelines and ongoing discussions are a very good starting point to help direct our work towards the most critical needs.

**Keira Melican**

Knowledge of the research status, obtained through reading a wide-range of literature from many different fields, participation in conferences and other communication forums is essential to position our research at the cutting-edge.

**Anna Herland**

In my daily clinical work I see the needs that become the foundation of my research questions.

**Kalle Svennersten**

For the development of our non-hormonal contraceptives, feedback has been received through user research, direct interviews and surveys. Direct outreach to relevant companies involved in other projects has also helped guide our project design.

**Thomas Crouzier**

## GUIDED BY THE UN SUSTAINABLE DEVELOPMENT GOALS



Our work at AIMES is closely guided by the United Nations' Sustainable Development Goals (SDGs) outlined in Agenda 2030. While the 17 SDGs may appear independent, they are in fact closely interlinked. The SDGs cut across all layers of the biosphere, society, and economy.

The 6 broad research areas of AIMES encompass a number of the SDGs.

**Tissue microbiology Impact on 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 Impact on SDG 2, 3, 6, 12, 13, 17**

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 Impact on 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 Impact on 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 Impact on 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 Impact on SDG 1, 7, 8, 11, 12, 13, 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<sub>2</sub> emissions and ultimately a reduction in the fossil dependence.

## FERDINAND CHOONG IS PART OF THE SIGHT FELLOW PROGRAMME

Congratulations to Assistant professor Ferdinand Choong, who has been chosen to be part of the SIGHT Fellow Programme.

Swedish Institute for Global Health Transformation (SIGHT) was established at the Royal Swedish Academy of Sciences in January 2017 to transform global health. The SIGHT Fellows Programme empowers researchers to address health inequities globally. The immediate aim is to increase their contribution to solving the grand challenges in global health through a UN 2030 Agenda perspective.

Fellows build networks with global health actors from all sectors, bridging collaboration between sectors and informing policy development. They learn how diverse sectors can shape new ways of collaborating and learning to transform situations and achieve shared goals.

In February 2022, AIMES invited Göran Tomson, Scientific Director of the Fellows Programme, to present at their interdisciplinary seminar series "Crossing Borders" on Partnerships in Global Health - Lessons Learned.



"Being selected as one of the fellows of this program is a great opportunity to develop my research and figure out how to maximise the usefulness of new discoveries in the lab to make an impact in people's lives. Through this programme I aim to develop new interdisciplinary research and collaborations with an effort to achieve targets laid out in the UN's sustainable development goals", says Ferdinand Choong, Assistant professor."



SIGHT is a bridge-builder between different societal actors through dialogue on the importance of the Agenda for Global Health. SIGHT inspires, supports and contributes with a platform and an extensive network of national and international actors.

## SCIENTIFIC ACHIEVEMENTS AND AWARDS

**Team Zeglio**

Dr. Erica Zeglio, has been awarded the Marie Skłodowska-Curie Actions (MSCA) individual fellowship by the EU commission for her project on Bioresorbable Organic Electronic Devices. The project is expected to impact both the electronics and biomedical field, by providing new biodegradable materials and knowledge on their degradation and toxicity. This project is provided around 2 MSEK in funding and will be run in collaboration with Assoc. Prof. A. Herland and Prof. Anna F. Wistrand.



Together with Dr. Tiziana Fuoco, Assoc. Prof Anna Herland, and Prof. Anna F. Wistrand, Dr. Erica Zeglio has been awarded 50 kSEK by KTH Life Science Platform to enhance multidisciplinary collaborations in the Life Sciences domain.

**Team Herland**

Associate. Prof Anna Herland, has been awarded a position at division of Nanobiotechnology SciLife Lab, CBH, KTH.

Together with Dr. Erica Zeglio and Dr. Tiziana Fuoco, Assoc. Prof Anna herland has been awarded the Digital Futures Research Pair grant (KTH Digital Futures), Engineering biodegradable components for packaging digitalization, 2 MSEK. This is a first call for Research Pairs collaboration projects within KTH Digital Futures in the area Technologies for a digital transformation. Their project will provide biodegradable sensors to monitor meat and fish freshness. Such devices, if integrated as sensors in digital packaging, are expected to contribute to reduce food waste and promoting greener technologies.

With Karishma Jian and Dr. Leonardo Garma as co-applicants, Assoc. Prof Anna herland has been awarded 50 kSEK by the KTH Life Science Platform to enhance multidisciplinary collaborations in the Life Sciences domain for their project to develop cellulose-based bioelectronics platform for in-vitro electrophysiology. A goal of the project would provide a cheap and easy to fabricate interface for in vitro electrical monitoring.

**Team Edlund**

Prof Ulrica Edlund has taken up a new position as an Associate Editor of the journal Cellulose (Springer Verlag, IF 5.044)

She has also stepped up to a seat in the editorial board of the journals Polymer International (Wiley) and Journal of Bioactive and Compatible Polymers (SAGE).

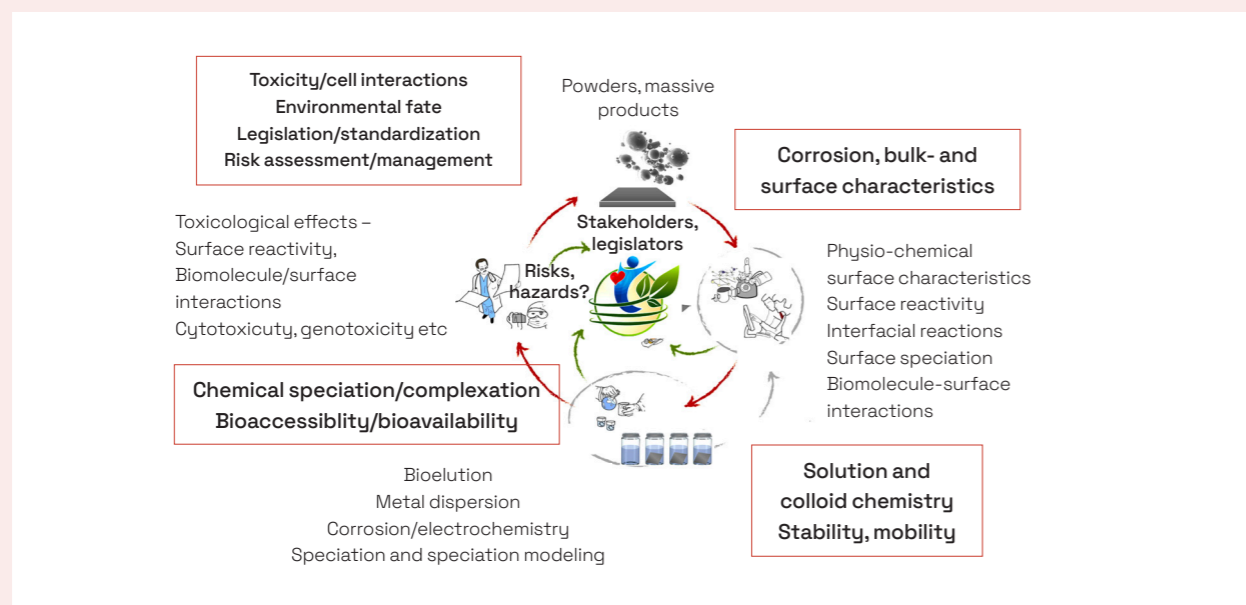
Prof. Ulrica Edlund served as a working group member at The Royal Academy of Engineering Sciences (IVA) in a project 2020-2021, on Sustainable water supply management and strategies in urban environments, aiming to map Swedish challenges, opportunities and elaborate an action plan for the future. She contributed to the final report released in 2021, and presented some findings at a public webinar in February 2021.

**Team Choong**

Dr Choong has been selected as a member of the 2nd cohort of the fellows program of the Swedish Institute for Global Health Transformation (SIGHT), and is 1 of 11 highly inspiring researchers selected nationally to promote an interdisciplinary approach, to strengthen and bridge Swedish research and education, and to provide a scientific basis for national and transnational collaborative policy work, in the field of global health.

Dr Choong has been selected to as a member of a focus group commissioned by the University director and the External Engagement Office map and strategize for ways and means to promote greater collaboration between KI researchers and industry.

# Sustainable use of metals in society



My team performs combined fundamental and applied research to gain an improved understanding of health- and environmental effects related to the use of and exposure to metals in different applications including metallic nanoparticles, i.e. tasks in close connection to the aims of several of the SDGs.

Academic research is done in close collaboration with international metal associations and enterprises, stakeholders and environmental and health risk assessment bodies. Novel methods and operational protocols have for example been elaborated to assess the extent of diffusely dispersed and migrated metals from a wide variety of metallic surfaces (as massive sheet and as (nano)particles) in different environments. The underlying mechanisms and relations to bioavailability, toxic effects and surface oxide characteristics have been elucidated. These studies are of societal and regulatory importance and were initiated in response to the increasing global environmental concern related to potential adverse effects induced by the release and dispersion of

metals from various sources in the society. These investigations were initially focusing on outdoor constructions and environmental aspects, later on adapted by the research team and via collaboration with toxicologists to conditions of relevance for e.g. food contact, high-touch surfaces, indoor hygiene, implant/medical materials and human exposure at occupational settings.

Bioaccessible data has been generated for different metals, alloys, metal oxides, pigments etc. and used by national and international industry within the mandatory framework of the European Chemicals legislation REACH regulating the use of chemicals (including metals). Generated data is also integrated in environmental and health risk assessments and managements worldwide. The generation of bioaccessibility data at in-vitro conditions limits e.g. the need for animal testing and enables a way forward to group, classify and label (CLP) chemicals, metals and alloys, aspects of importance also from a regulatory perspective.



Research studies aiming to estimate potential adverse effects on humans using only in-vitro testing have as an example been performed in collaboration with international industry represented by Eurometaux (European Non-ferrous Metals Association) and Nipera (International Nickel Institute). The bioelution results and protocol elaborated at KTH has formed the base for standardized bioelution testing operational protocols, initially implemented for the oral route

(the gastrointestinal tract). In 2016 ECVAM, the European Union Reference Laboratory for alternatives to animal testing, agreed to assess the bioelution protocol based on the work of the research team. In 2019 the submission assessment and the stage of validation were finalized, and the protocol is currently in its acceptance phase.

– Inger Odnevall

# Caring for the health of the people and the planet



A healthy bladder is crucial for maintaining kidney function, but also to have a functional social and active life.

As a Urologist it's my responsibility to ensure that my patients maintain a healthy urinary tract and kidney function. The ability to store and void urine is crucial to the maintenance of good kidney function. The urinary bladder and sphincter muscles enables this by a complex neuronal system involving the spinal cord, brain stem as well as the frontal cortex. Inability to store and void urine can be the result of pelvic injuries from childbirth, traumatic or immunological spinal cord injuries or local inflammatory disease of the bladder. Therefore, I study the physiology of the bladder with the aim to find affordable and efficient remedies to bladder associated disease.

In my practice I meet many patients suffering from kidney stone attacks which are one of the most painful conditions that we can experience and can also have life threatening or chronic complications. Kidney stone disease is especially prevalent in warm and dry locations of the world. It is also associated with dehydration which is more common in areas where access to clean water is limited. My team



Women are especially affected by bladder disorder because of childbirth and a higher incidence of inflammatory disease. Bladder disease is generally a neglected problem due to its stigmatizing nature and deeply afflicts women in developing countries due to lack of sanitation.

collects kidney stones for metagenomic analysis to study the microbiome associated with kidney stones. The aim is to understand how the natural microbial flora of the urinary tract contributes to stone formation and how we can use this knowledge to prevent recurrent kidney stone disease.

Many of my patients have diabetes. Fortunately, there are many new drugs on the market to treat diabetes. SGLT2 inhibitors is a new kind of antidiabetic medication for type 2 diabetes. It works by inhibiting the reuptake of glucose in the proximal tubule of the kidney thereby lowering blood glucose levels however by doing so it inevitably increases urine glucose levels. However, theoretically this increase in glucosuria may pose as a risk factor for the development of severe urological infections. In this project I conduct a systematic review and meta-analysis of current studies and literature to establish the current knowledge on SGLT2 inhibitors and urological infections we are also planning a prospective register study to follow patients on these medications over time to register if there is an increase in severe urological



Aquaculture of green algae does not only have low environmental impact but also provide a haven for spawning fish and other marine life.

infections associated with the glucosuria caused by SGLT2 inhibitors.

As a urological surgeon I use many different instruments and devices which often are disposables since that often is the most cost-efficient way to maintain sterility. I am always looking for suitable materials which are tissue friendly as well as affordable. Recently I have found out about Ulvan which is a polysaccharide with promising properties that is extracted from green algae. Ulvan has properties which make it very interesting as a raw material for urological devices. Ulvan is also interesting as a raw material since it can be produced in environmentally friendly aquaculture.

– Kalle Svennersten



COLLABORATION BETWEEN TEAMS

Research done by my team comprises of the synthesis, surface modification, characterization and materials design of polymers, with special focus on the design of renewable functional materials for a sustainable future from terrestrial and marine biomass including forestry biomass, algae and agricultural residues.

Materials are developed with the following targets:

- Enabling environmentally sound management of components and all wastes
- Made from renewable resources
- Produced with resource- and energy-efficient and clean technologies
- Property profiles that make them attractive and feasible substitutes to some of the non-sustainable material used today.

Projects include development of renewable films, coatings, microspheres, and hydrogel formulations based on more or less purified non-cellulosic oligo- and polysaccharide rich fractions generated in commercial wood processing operations such as pulping.

Bio-based polymer materials contribute to achieve at least a partial transition from the use of oil-based resources in the biomedical materials industry (SDG#12). To conserve and sustainably use the oceans, seas and marine resources for sustainable development is also targeted in SDG#14 and water purification is an essential part of reaching SDG#6. Replacing fossil-based products with bio-based alternatives also help to reduce CO<sub>2</sub> emissions with a long-term positive contribution to SDG#15. Developing processes according to green chemistry principles is important by adoption of clean and environmentally sound technologies and industrial processes as explicitly targeted in SDG#9.

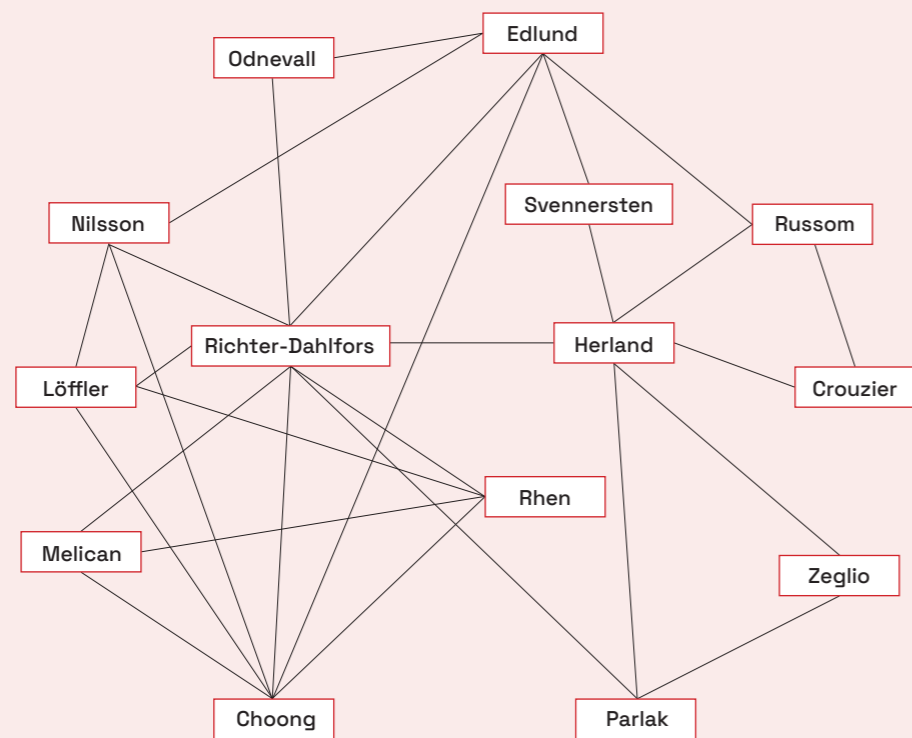
– Ulrica Edlund

# Research

A core mission of AIMES is to conduct interdisciplinary research of highest standard. In 2021, AIMES scientists published 44 scientific articles in 37 different leading and high-impact factor journals spanning across a wide range of disciplines.

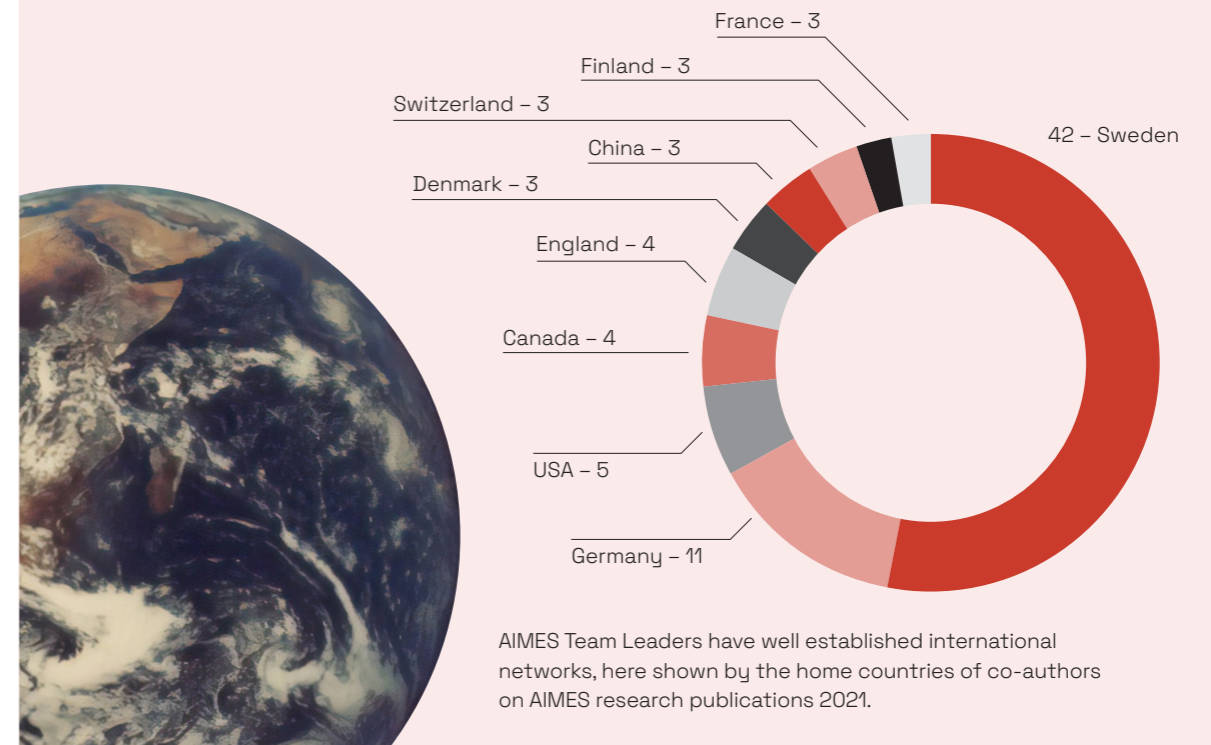
The interdisciplinarity of AIMES research is clearly witnessed from the assortment of journals presenting our work. These includes Nature Physics, Nature Communications, Advanced Functional Materials, ACS Nano, Advanced Healthcare Materials, Cell Reports Biofabrication, Lab on a Chip, PLOS Pathogens and NPJ Biofilms and Microbiomes.

## INTERDISCIPLINARY COLLABORATIONS WITHIN AIMES



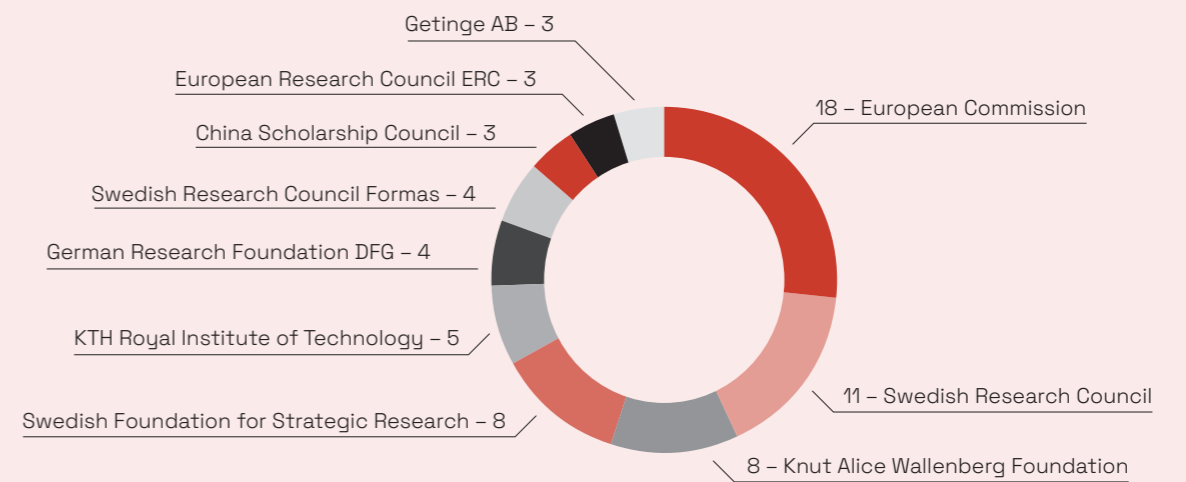
AIMES interdisciplinary environment aims to stimulate new collaborative interactions. The spider web illustrates how new and ongoing interdisciplinary collaborations have been established between the Team leaders.

## PUBLICATIONS IN INTERNATIONAL COLLABORATION



AIMES Team Leaders have well established international networks, here shown by the home countries of co-authors on AIMES research publications 2021.

## FUNDERS OF AIMES RESEARCH



The interdisciplinary research performed by AIMES Team Leaders is financed by a range of national and international funding bodies. In our publications for 2021 we acknowledge the following funding sources.

Each publication also acknowledges AIMES and the support of Karolinska Institutet, The Royal Institutet of Technology and Getinge as primary funders.”



## SCIENTIFIC PUBLICATIONS

**Optotracing for selective fluorescence-based detection, visualization and quantification of live *S. aureus* in real-time**  
NPJ BIOFILMS AND MICROBIOMES

**A semi high-throughput method for real-time monitoring of curli producing *Salmonella* biofilms on air-solid interfaces**  
BIOFILM

**UPEC kidney infection triggers neuro-immune communication leading to modulation of local renal inflammation by splenic IFN gamma**  
PLOS PATHOGENS

**An Organic Electrochemical Transistor to Monitor *Salmonella* Growth in Real-Time**  
ADVANCED MATERIALS INTERFACES

**The interplay between atmospheric corrosion and antimicrobial efficiency of Cu and Cu<sub>5</sub>Zn<sub>5</sub>Al<sub>1</sub>Sn during simulated high-touch conditions**  
CORROSION SCIENCE

**Bacteria Detection at a Single-Cell Level through a Cyanotype-Based Photochemical Reaction**  
ANALYTICAL CHEMISTRY

**Lectin-Functionalized Polyethylene Glycol for Relief of Mucosal Dryness**  
ADVANCED HEALTHCARE MATERIALS

**Distinct conformers of amyloid beta accumulate in the neocortex of patients with rapidly progressive Alzheimer's disease**  
JOURNAL OF BIOLOGICAL CHEMISTRY

**Portable and wearable real-time stress monitoring: A critical review**  
SENSORS AND ACTUATORS REPORTS

**Tau Protein Binding Modes in Alzheimer's Disease for Cationic Luminescent Ligands**  
JOURNAL OF PHYSICAL CHEMISTRY B

**Knowing more from less: miniaturization of ligand-binding assays and electrophoresis as new paradigms for at-line monitoring and control of mammalian cell bioprocesses**  
CURRENT OPINION IN BIOTECHNOLOGY

**High resolution and rapid separation of bacteria from blood using elasto-inertial microfluidics**  
ELECTROPHORESIS

**Sorption of Neuropsychopharmaca in Microfluidic Materials for In Vitro Studies**  
ACS APPLIED MATERIALS & INTERFACES

**Rapid prototyping of heterostructured organic micro-electronics using wax printing, filtration, and transfer**  
JOURNAL OF MATERIALS CHEMISTRY C

**Toward Rapid Detection of Viable Bacteria in Whole Blood for Early Sepsis Diagnostics and Susceptibility Testing**  
ACS SENSORS

**Colonization of dermal arterioles by *Neisseria meningitidis* provides a safe haven from neutrophils**  
NATURE COMMUNICATIONS

**Immune-Modulating Mucin Hydrogel Microdroplets for the Encapsulation of Cell and Microtissue**  
ADVANCED FUNCTIONAL MATERIALS

**All-cellulose functional membranes for water treatment: Adsorption of metal ions and catalytic decolorization of dyes**  
CARBOHYDRATE POLYMERS

**The large-scale cultivation potential of *Ulva fenestrata*: a case study from a Scandinavian off-shore seafarm**  
PHYCOLOGIA

**A novel 4D cell culture mimicking stomach peristalsis altered gastric cancer spheroids growth and malignance**  
BIOFABRICATION

**Continuous Monitoring Reveals Protective Effects of N-Acetylcysteine Amide on an Isogenic Microphysiological Model of the Neurovascular Unit**  
SMALL

**Thiophene-Based Optical Ligands That Selectively Detect A beta Pathology in Alzheimer's Disease**  
CHEMBIOCHEM

**Flex Printed Circuit Board Implemented Grapene-Based DNA Sensor for Detection of SARS-CoV-2**  
IEEE SENSORS JOURNAL

**Sample-to-answer COVID-19 nucleic acid testing using a low-cost centrifugal microfluidic platform with bead-based signal enhancement and smartphone read-out**  
LAB ON A CHIP

## SCIENTIFIC PUBLICATIONS

**RNA atlas of human bacterial pathogens uncovers stress dynamics linked to infection**  
NATURE COMMUNICATIONS

**Bisphenol A Inhibits the Transporter Function of the Blood-Brain Barrier by Directly Interacting with the ABC Transporter Breast Cancer Resistance Protein (BCRP)**  
INTERNATIONAL JOURNAL OF MOLECULAR SCIENCES

**Circle-to-circle amplification coupled with microfluidic affinity chromatography enrichment for in vitro molecular diagnostics of Zika fever and analysis of anti-flaviviral drug efficacy**  
SENSORS AND ACTUATORS B-CHEMICAL

**Adsorption of bio-organic eco-corona molecules reduces the toxic response to metallic nanoparticles in *Daphnia magna***  
SCIENTIFIC REPORTS

**Improved L-Type amino acid transporter 1 (LAT1)-mediated delivery of anti-inflammatory drugs into astrocytes and microglia with reduced prostaglandin production**  
INTERNATIONAL JOURNAL OF PHARMACEUTICS

**A beta 43 aggregates exhibit enhanced prion-like seeding activity in mice**  
ACTA NEUROPATHOLOGICA COMMUNICATIONS

**Vancomycin-Loaded Microneedle Arrays against Methicillin-Resistant *Staphylococcus Aureus* Skin Infections**  
ADVANCED MATERIALS TECHNOLOGIES

**Influence of preservation methods on biochemical composition and downstream processing of cultivated *Saccharina latissima* biomass**  
ALGAL RESEARCH-BIOMASS BIOFUELS AND BIOPRODUCTS

**High throughput viscoelastic particle focusing and separation in spiral microchannels**  
SCIENTIFIC REPORTS

**Influence of the microenvironment on modulation of the host response by typhoid toxin**  
CELL REPORTS

**Structural Alterations of Mucins Are Associated with Losses in Functionality**  
BIOMACROMOLECULES

**Fluid interfacial energy drives the emergence of three-dimensional periodic structures in micropillar scaffolds**  
NATURE PHYSICS

**Accumulation of alpha-synuclein within the liver, potential role in the clearance of brain pathology associated with Parkinson's disease**  
ACTA NEUROPATHOLOGICA COMMUNICATIONS

**3D printing of a bio-based ink made of cross-linked cellulose nanofibrils with various metal cations**  
SCIENTIFIC REPORTS

**Multiplexed Microfluidic Cartridge for At-Line Protein Monitoring in Mammalian Cell Culture Processes for Biopharmaceutical Production**  
ACS SENSORS

**Hybrid Filaments from *Saccharina lattissima* Biomass: Engineering of Alginate Properties with Maleic Anhydride Grafted Linseed Oil**  
POLYMERS

**DNA Strands Trigger the Intracellular Release of Drugs from Mucin-Based Nanocarriers**  
ACS NANO

**Microglia control small vessel calcification via TREM2**  
SCIENCE ADVANCES

**Modulating the Bioactivity of Mucin Hydrogels with Crosslinking Architecture**  
ADVANCED FUNCTIONAL MATERIALS

**Metal bioaccessibility in synthetic body fluids - A way to consider positive and negative alloying effects in hazard assessments**  
MATERIALS & DESIGN

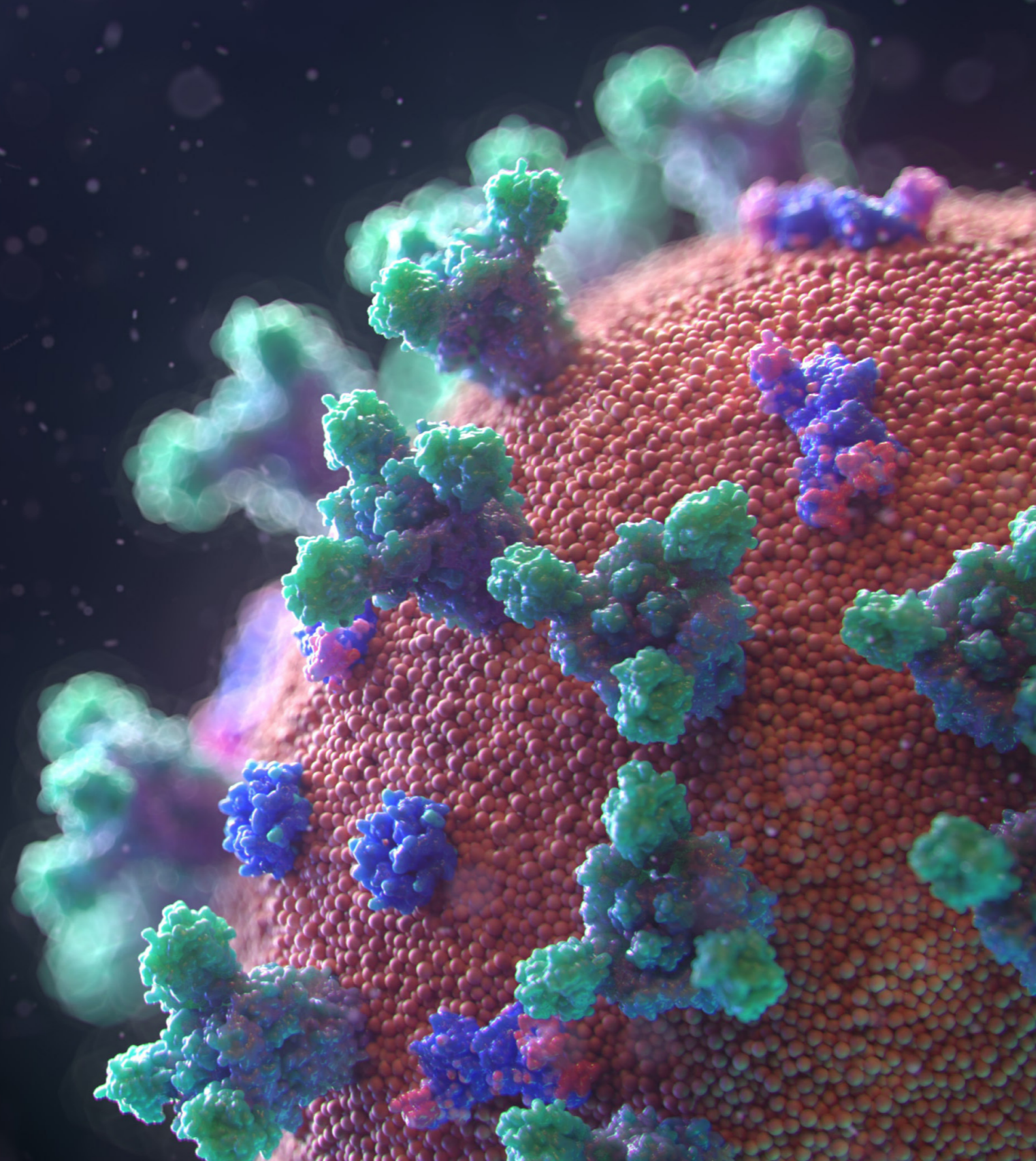
# Pandemic Challenges

The COVID-19 pandemic has affected many aspects of our lives both personally and professionally. While it was an exciting time to be working in medical research with scientists (and epidemiologists) becoming household names and sought after media guests, many challenges were encountered. The enforced social distancing and facility shutdowns dramatically curtailed in-person meetings, interactions with colleagues and even the ability to work in the facilities. Research science is a social activity, one of the driving forces of AIMES is to be a meeting hub where we can come together and discuss and brainstorm our science. Without these interactions many of our Team Leaders felt their work, and particularly that of their team members suffered. Many of our international students returned home in the face of uncertain borders and travel restrictions, the lack of students is still sorely felt as many are not confident to travel again. Post-doctoral researchers and incoming doctoral students were also affected and there is still many empty benches waiting for people to arrive. Education activities were severely affected and with little notice many courses were switched to online learning. This was a significant learning curve for those of us who teach and organize PhD and Masters courses, with much time needing to be dedicated to adaptation of our teaching material.

Colleagues at AIMES with clinical affiliations were called up to support the health care system as it battled the waves of COVID-19, many of them losing months of research time. Those of us not working in the clinic

subsequently lost the input of these critical partners. The pressure on the hospitals was also felt in indirect ways. The cancellation of elective surgeries meant some teams lost access to important clinical samples and tissues. Without this material, their projects ground to a halt. Personal protective equipment including gloves and face masks were diverted into the clinics, meaning many of us could not continue our work without appropriate PPE. Beyond PPE, the supply chain issues have affected almost every aspect of our work. Significant delays in delivery of chemicals, equipment or even machine services has delayed many projects. The frustrations of this are still felt today with long and everchanging delivery times leading to planning difficulties.

As we start to see the light at the end of the long tunnel, we hope we can move forward with the positives we have learnt. We appreciate our time together now, we make better use of in-person meetings. We have all become experts at Zoom lectures and webinars which has opened up many international opportunities. There is an increased awareness of the importance of our role as communicators, how can we ensure that science is communicated correctly and effectively? We also learnt how amazingly effective research science can be when focused on a single goal with many of the economic and administrative restrictions taken away. The achievements of the medical research scientists over the past 2 years in incredible and further confirms what we already knew – we can achieve anything if we put our collective minds to it.



# Education

INTERDISCIPLINARY COURSES  
– A CHALLENGE NOT ONLY FOR THE STUDENTS



To further establish the AIMES vision, we are also actively developing interdisciplinary educational courses at all levels. These courses are designed to establish the interdisciplinary way of thinking early in the education as a pre-requisites to build the respect and understanding for different kind of knowledge and how to combine them. We have encountered a number of set-backs and challenges when seeking to establish new courses and particularly a new Masters Program but we are determined to resolve these challenges in order to find an interdisciplinary way forward for students at all levels. Many of these set-backs have been related to a level of obstructionism from the monodisciplinary culture to allow interdisciplinary educations to take its place in the curriculum. We have now made the connections we hope are needed to further develop this work over the coming 12 months.

In 2021 we have continued to develop and run a number of courses. The pandemic has continued to make education a difficult concept during 2021 with the majority of courses still being run remotely.

During 2021 we have set the ground work for a new **Masters in Integrated Medical and Engineering Sciences**. We have developed the baseline curriculum and are seeking collaborations with the appropriate parties at KI and KTH to help make this program a reality within the next 24-36 months.

A new AIMES developed PhD course, **Advances in Biomaterials for Biomedicine and Clinical Applications (#5565)**, has been established and will run in Autumn 2022. Many of the team leaders at AIMES will be involved in teaching this course.

Team leaders at AIMES are also responsible for a number of other PhD and Masters levels courses at both KI and KTH. This includes **Clinical and Molecular Bacteriology and Biomimetic Systems**.

The intention for 2022 is to be able to bring all teaching back 'on site' and to start gaining recognition and increasing the interest in AIMES from the student populations through the courses we will run and outreach to promote those we have in the pipeline.

## PhD STUDENTS



**Alina Schmidt**

PhD student

Team Ulrica Edlund & Team Agneta Richter-Dahlfors

How can we use the valuable resource of polymers that plants produce as their stabilizing building materials? Plants in agriculture and algae in mariculture offer nutrients but also an enormous mass of organic "waste", that is yet largely unexploited. The focus of my research is to explore new ways on how to convert these natural resources sustainably into high-value compounds for new materials. Therefore, we design extraction processes for macromolecules and further explore their potential usages as renewable sources for biomedical materials. In future sustainable, biobased as well as biodegradable polymers are expected to be of growing demand. The key to achieving this, is by working together to understand what nature's, society's and medical needs are. For these actions, AIMES enables me to engage in multidisciplinary collaborations and provides a scientific infrastructure where we all can meet and take on new challenges together.



**Kun Jian**

PhD student

Team Thomas Crouzier

There are more than 400 m<sup>2</sup> epithelial surfaces in the human body covered by a viscous gel, called mucus. Mucins are the matrix components of mucus providing functions that keep us alive, such as barrier, hydration, lubrication and bioactivity. However, many details in how these functions are related to the many structural features of mucins are still unknown. My PhD project is aiming to explore and control the structure-function relationship of mucin materials. 2021 is the last year of my PhD study within AIMES and I just passed my PhD defense in early 2022. The multidisciplinary research in AIMES lifted the barrier for collaborations and the seminars organized by AIMES got me to know the world-leading research.



**Nazanin Poursharifi**

Visiting PhD student

Team Onur Parlak

I am Nazanin Poursharifi from Isfahan University of Technology, Iran. I have recently started in Team Parlak, AIMES, Karolinska Institutet and as a visiting PhD student. I am very interested in conducting my PhD thesis in the electrochemical biosensor for cancer diagnostics. My educational major is in textile engineering and I really would like to carry out my research in an interdisciplinary environment, especially like KI and AIMES where world-leading experts work together. For this aim, I applied to work with Team Parlak and we are developing fibre-based sensor technology for medical applications. So far, I am very happy to be here and be part of AIMES.



**Sebastian Buchmann**

PhD student, Dual PhD

Team Anna Herland

"In my PhD project, we use conjugated polymers with the help of microfluidic tools to investigate and modulate electrophysiological properties of neural in-vitro models and bacterial biofilm communities. In contrast to conventional inorganic electrodes made, for example from gold, conjugated polymers are made out of organic materials, are flexible, and provide an improved interface with cells. In 2021 I transferred freshly into the joint PhD program Medical Technology from KTH and KI supervised by Anna Herland and co-supervised by Erica Zeglio and Agneta Richter Dahlfors. This allows me to profit from available knowledge and facilities at both universities. When working on such an interdisciplinary projects this brings great advantage when expertise in microfluidic chip fabrication but also cell culture work is needed."

## PhD STUDENTS

**Tianqi Zhang**

PhD student

Team Keira Melican &amp; Team Agneta Richter-Dahlfors

COVID-19 might not be the only pandemic that we're living in. With the growing antibiotic resistance among pathogenic bacteria and consequently fewer options to treat the potential infections, our world might face another challenge from the emergence of 'superbugs'. Here at our lab at AIMES, we focus on the host-bacterial interaction of several human pathogens. By identifying the mechanism of how bacteria attach to human tissue and how they establish initial colonies, our research aims to provide insights into novel prevention strategies. Despite the many challenges in the previous year, I'm satisfied that with the support from AIMES and my supervisors, I was able to achieve my study goals and make steady progress in my research.

**Svava Steiner**

PhD student

MD

Team Agneta Richter-Dahlfors

In 2021 I entered my last year as a PhD student in AIMES, and during this year I finished my PhD thesis. This thesis, titled "The Dynamics of Intra- and Inter-organ Communication During an Acute Kidney Infection", includes works on how bacteria and the host interact during infections. Specifically I have studied how the nervous and coagulation systems are involved during kidney infections. As a clinician with an interest in bridging pre-clinical and clinical research, my PhD in AIMES has allowed me to work with projects ranging from the lab bench, to advanced *in vivo* studies, and a clinical epidemiological study. Being a center where researchers from many different disciplines meet and collaborate, AIMES has offered me this unique opportunity to work with such a broad range of studies while constantly having the support of and being inspired by colleagues with different backgrounds.

**Tharagan Kumar**

PhD student

Team Aman Russom

Microfluidics is emerging as an essential technology for high-throughput cell isolation applications. My work focuses on developing microfluidic devices for sample preparation and the isolation of rare cells for improved cancer diagnostics. Circulating tumor cells (CTCs) are rare cells shed into the circulatory system from its primary tumor site through the metastasis process. The isolation and detection of CTCs from peripheral blood samples is minimally invasive and can allow for early cancer diagnosis.

AIMES provided me with 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 capture and release cancer cells efficiently. At AIMES, I managed to find collaborations from which both parties benefitted. It allowed me to expand my research field, which I could not have thought about.

## PhD STUDENTS

<b>Svava Steiner</b> KI	<b>Ahmad Saleem Akhtar</b> KTH
<b>Karen Butina</b> KI	<b>Sebastian Buchmann</b> KTH and KI Joint PhD programme
<b>Kun Jiang</b> KTH	<b>Nazanin Poursharifi</b> Isfahan University of Technology, Iran, Visiting PhD student
<b>Amanda Kessler</b> KTH	<b>Surangrat Thongkorn</b> Chulalongkorn University, Thailand, Visiting PhD student
<b>Tharagan Kumar</b> KTH	<b>Abby Weston</b> King's College, UK, Visiting PhD student
<b>Alina Schmidt</b> KI / KTH	
<b>Dimitris Voulgaris</b> KTH	
<b>Tianqi Zhang</b> KI	

## MASTER STUDENTS

**Ana Benavente**

NOVA School of Science and Technology, Portugal

**Sneha Bangalore**

Uppsala University

**Farzad Elhami**

Politecnico di Milano, Italy

**Rick Heszen**

Radboud University, Netherlands

**Muriel Holzreuter**

ETH Zürich, Netherlands

**Elina Kärkkäinen**

KI

**Yunfan Lin**

KTH

**Saskia Ludwig**

Maastrich University, Netherlands

**Violetta Nikiforova**

KI

**Vasiliki Patsaki**

KTH

**Sagar R. Maleyur**

Uppsala University

**Kim Roekevisch**

Netherlands

**Denis Roots**

KTH

**Mariam Shehata**

KI

**Vivek Srikumar**

KTH

**Eleni Stergiou**

Uppsala University

**Alessandra Tamashiro Orrego**

KI

**Xueyu Wen**

KTH

**Felix Falk**

KI Erasmus+, International Master in Innovative Medicine

**Jolin Maanja**

KI Medical School

## BACHELOR STUDENTS

**Vilma Grönvall**

KTH

**Dinh Nguyen**

KTH

**Jonathan Samuelsson**

KTH

# 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:



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



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

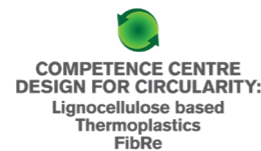
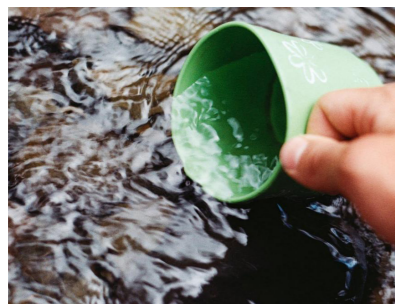


Offers living platforms that emulate the complexities of human biology to enable unprecedented insights into human biology and health



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.



Science parks and incubators interacting with AIMES scientists



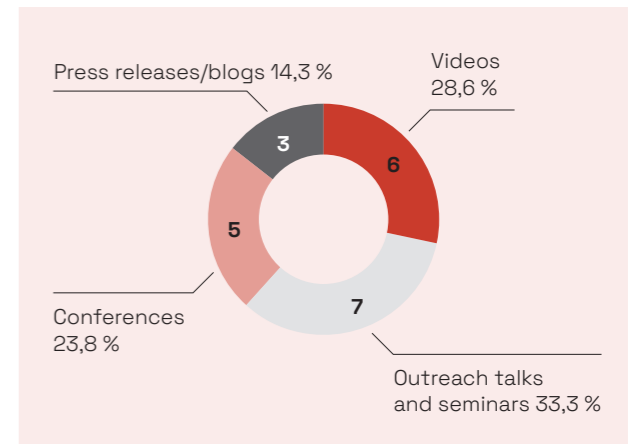
# Media impact

## 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, in 2021 AIMES has continued to make strategic use of online and digital media to traverse lockdowns and geographical distances to connect with society. We continue to make significant effort in developing and publishing a wide variety of media types, including press and social media channels.

In 2021, Center scientists and their research have been featured in physical-, digital- and hybrid conferences, TV interviews and podcasts, press releases, webinars, symposium, and video abstracts.



## HIGHLIGHTS OF 2021



Team leaders Agneta Richter-Dahlfors, Ulrica Edlund and Ferdinand X. Choong were invited speakers to the 2nd hybrid conference on Sustainable Development at KI, an event that inspires scientists to reflect on how health is linked to climate change and to learn examples of how KI research relates to specific SDGs.

### OUTREACH EVENTS

Wearable Bioelectronics in Medicine, A student initiative for talks on career and science, September 2021

Wearable Technologies in Medicine, organized by Ankara University Neuroscience Student Society, December 2021

Korrosion och ytkemi-studier av metalliska material kopplat till hälsa och miljöeffekter – ett axplock av pågående tvärvetenskapliga aktiviteter”.

I. Odnevall, Occupational and Environmental Medicine, Linköping University Hospital, March, 2021

NanoMed North Focus Seminar, June, 2021

Corrosion Awareness day, Swerim, on-line, April, 2021

Seminar on R&D project Health and Environmental Aspects of Additive Manufacturing and Challenges for a Sustainable Product 2 (HÄMAT2), Sandvik Additive Manufacturing, June, 2021

Sisäympäristöjen hygieeninen turvallisuus -seminaari, On-line, April 22, 2021

## WEB PUBLICATIONS

Women in research (<https://womeninresearchblog.wordpress.com/2021/06/27/erica-italy/amp/>)

<https://www.kth.se/en/aktuellt/nyheter/human-stem-cells-enable-model-to-test-drug-impact-on-brain-s-blood-barrier-1.1088594>

<https://www.kth.se/en/aktuellt/nyheter/3d-model-of-living-brain-cancer-points-to-possible-future-for-drug-screening-1.1145429>

## CONFERENCES

2nd hybrid conference on Sustainable Development at KI, November 2021

Sensors in Medicine (Online event), November 2021

New Ideas for Medicine, May 2021, Munich.

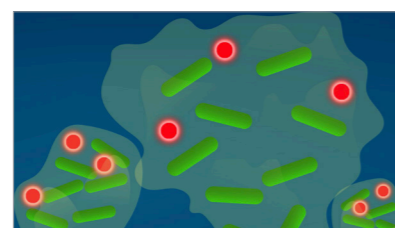
1st Corrosion and Materials Degradation Web Conference, May 2021

Eurocorr September 2021

## VIDEOS



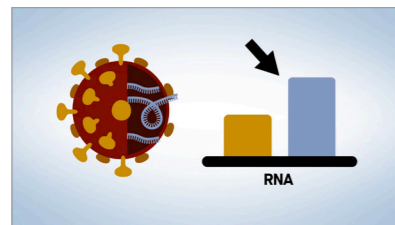
Transfer of Cobalt Nanoparticles in a Simplified Food Web.



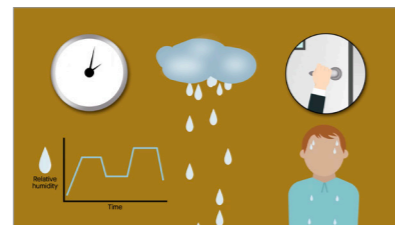
Chemical sensors enable scientists to watch bacterial cities grow.



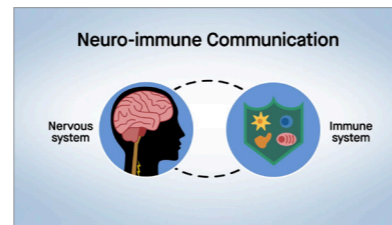
Optotracer illuminates live bacteria in real time.



Improving coronavirus testing for resource-limited countries.



New method for studying antimicrobial properties of high-touch metal surfaces.



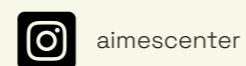
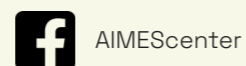
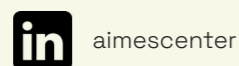
Nerve signaling explains spleen's fast, long-distance response to kidney infection.

## SOCIAL MEDIA ENGAGEMENT

In 2021, the best social networks were Facebook, Instagram, Twitter, Pinterest, LinkedIn and Snapchat. AIMES continues to maintain a prominent social media presence on LinkedIn, Facebook and Instagram. While conducting exciting research, the AIMES communications team continues to maintain and grow 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, South Asia and the Americas. 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'. As AIMES increases its activities in line with KI's agenda 2030 and the UN's sustainable development goals, we are also noticing a growing pool of followers from 'Global Health' and 'Government Administration'. 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.

[www.aimes.se](http://www.aimes.se)



## AIMES 2021

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NOVA School of Science and Technology, Portugal, Master student

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**Tingru Chang**  
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**Ferdinand Choong**  
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**Thomas Cruzier**  
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Professor emerita in Neurochemistry, University of Gothenburg, President of IAU, International Association of Universities, Chair of the Steering Group

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KTH, Bachelor student

**Violetta Nikiforova**  
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**Agneta Richter-Dahlfors**  
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**Denis Roots**  
KTH, Master student

**Aman Russom**  
KTH, Professor

**Ahmad Saleem Akhtar**  
KTH, PhD student

**Jonathan Samuelsson**  
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**Sivakoti Sangabathuni**  
KI, Postdoc

**Ulrike Schimpf**  
KTH, Postdoc

**Alina Schmidt**  
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KI, Master student

**Vivek Srikumar**  
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**Svava Steiner**  
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**Nazmun Sultana**  
KTH, Postdoc

**Helén Svahn**  
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**Karl Svennersten**  
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**Linda Thörn**  
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**Dimitris Voulgaris**  
KTH, PhD student

**Xueyu Wen**  
KTH, Master student

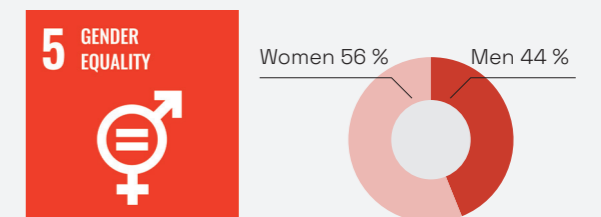
**Abby Weston**  
KTH, Visiting PhD student

**Honji Yan**  
KTH, Postdoc

**Erica Zeglio**  
KTH, Researcher

**Tianqi Zhang**  
KI, PhD student

**Xuying Zhang**  
KTH, Researcher



UN sustainability goals #5, Achieve gender equality and empower all women and girls, is a goal that is constantly in focus at AIMES. 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. The type of interdisciplinary environment that AIMES provides has proven to be very attractive for female researchers coming from both engineering and medical backgrounds and we look forward to continuing to contribute to growing equality in research and development.

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**AIMES Annual Report 2021**

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