2023 CELSIUS-LINNAEUS LECTURERS

February 9 09.00 – 16.15
Eva von Bahr, Ångström Laboratory

09.00 - Celsius-Lecturer Johan Rockström

Professor Earth System Science, University of Potsdam and Director
Potsdam Institute for Climate Impact Research

13.15 - Linnaeus-Lecturer John A. Rogers

Simpson Querrey Professor and Director of QSIB at Northwestern University

Each year the Faculty of Science and Technology arranges the Celsius-Linnaeus honorary lectures in memory of Anders Celsius (1701-1744) astronomer and physicist, and Carl von Linné (1707-1778), physician and botanist, who were professors at Uppsala University. The selected Celsius- and Linnaeus-lecturers are at today's forefront within their field.

The lectures are open for everyone to attend, no registration needed.

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Celsius-Linnaeus Lectures 2023

February 9, 09.00 - 16.15 at Eva von Bahr, Ångström Laboratory, Lägerhyddsvägen 1.

09.00: Welcome to the Celsius-Linnaeus Lectures 2023
Vice-Chancellor Anders Hagfeldt; Vice-rector Johan Tysk, Chairman of the Celsius-Linnaeus Committee Máté Erdélyi.

09.15: CELSIUS-LECTURER JOHAN ROCKSTRÖM

A safe and just future for humanity on Earth
Johan Rockström, Professor Earth System Science, University of Potsdam and Director Potsdam Institute for Climate Impact Research.

10.15: Coffee-break

10.30: Pivoting between loss and hope in governing a just future for humanity
Emily Boyd, Director of Lund University Centre for Sustainable Studies and Professor in Sustainability Science at Lund University.

11.00: Water in an interconnected world: A key enabler to reach energy and food security?
Claudia Teutschbein, *Associate Professor in Hydrology, Department of Earth Sciences, Uppsala University.*

11.30: Panel discussion
Professor Johan Rockström, Professor Emily Boyd and Associate Professor Claudia Teutschbein.
Moderator: Professor Giuliano Di Baldassarre, Department of Earth Science, Uppsala University.

13.15: LINNAEUS-LECTURER JOHN A. ROGERS

Soft, Skin-Interfaced Electronic and Microfluidic Systems.
John A. Rogers, Louis Simpson and Kimberly Querrey Professor of Materials Science and Engineering, Biomedical Engineering and Neurological Surgery at Northwestern University and Director of the Querry Simpson Institute for Bioelectronics.

14.15: Coffee-break

14.30: Combining Stem Cell and Device Engineering for In vitro Models of Human Psysiology.
Anna Herland, Associate Professor, Division of Nanobiotechnology, KTH.

15.00: Fat-Intra Body Communication: A new paradigm for intra-body communication technology enabling reinstatement of lost functionalities in human.
Robin Augustine, Associate Professor, Department of Electrical Engineering, Uppsala University.

15.30: Panel discussion
Professor John Rogers, Professor Molly Stevens, Associate Professor Robin Augustine.
Moderator: Professor Klas Hjort, Department of Materials Science and Engineering, Uppsala University.

16.00: Closing words
Chairman of the Celsius-Linnaeus Committee Máté Erdélyi.

**Prof. Dr. Johan Rockström**

Johan Rockström is Director of the Potsdam Institute for Climate Impact Research, Professor at the Institute of Earth and Environmental Science at Potsdam University, and Professor in Water Systems and Global Sustainability at Stockholm University. Rockström gained international recognition with the development of the Planetary Boundaries
framework, which has since become a standard of sustainability science. He is deeply involved in research activities covering a range of topics related to the Earth System and global sustainability in the Anthropocene, with the overarching research question: “What is the safe operating space for Humanity's future on Earth, and which sustainable transformations that can take us there?” Rockström’s research creates considerable impact. For example, he received the prestigious European Research Council (ERC) Advanced Grant, and is ranked as one of the most influential and most-cited scientists in the world by Clarivate Analytics.
In addition to his research endeavors, which have been widely used to guide policy,

Rockström provided strategic scientific guidance as a member of the European Commission’s Expert Group ‘Mission Board for Adaptation to Climate Change, including Societal Transformation’ and various scientific academies, including the Royal Swedish Academy of Sciences and the German National Academy of Sciences Leopoldina. He regularly acts as a speaker to high-level international meetings and organisations, such as the World Economic Forum (WEF), the General Assembly of the United Nations (UNGA), the United Nations Sustainable Development Solutions Network (SDSN) and the United Nations Framework Convention on Climate Change Conferences (UNFCCC). Moreover, he is the Chief Scientist of Conservation International, as well as chairing the advisory board for the EAT Initiative on Health, Food and Sustainability, the Earth League, Future Earth (co-chair), the United Nations Sustainable Development Solutions Network (SDSN) and the Earth Commission.

Rockström's work has been recognized with accolades, the most recent of which include the Prince Albert II of Monaco Climate Change Award (2020), the Hillary Laureate by the Hillary Institute of International Leadership (2017), the French distinction Knight of the Legion of Honour (2016), the German Environmental Award (2015) and the International Cosmos Prize (2015). Before becoming Director of the Potsdam Institute of Climate Impact Research, Rockström founded the Stockholm Resilience Centre at Stockholm University and was Executive Director at the Stockholm Environment Institute. He obtained a Master of Science (MSc) at the Swedish University of Agricultural Sciences, a Diplôme d'Agronomie Approfondie (DAA) at Institut National Agronomique Paris-Grignon, a Licentiate of Philosophy (PhLic) at Stockholm University, and completed a doctorate (PhD) in Natural Resources Management at Stockholm University.

A safe and just future for humanity on Earth

Science is today clear, we are facing multiple and interacting global environmental changes that together threaten the stability of the Earth system, and thereby the basis for world development. Six of nine planetary boundaries are today transgressed, providing ample evidence of a coupled global biosphere and climate crisis. The consequences are not only felt as rising frequency and amplitude of extreme events, causing massive social and economic loss and damage. We are rapidly approaching biophysical tipping points which, if crossed, will cause irreversible and self-amplifying impacts. Two key conclusions arise from the latest Earth system science with regards to climate safety. First, that 1.5°C is not a goal or target, it is a biophysical limit. Cross it, and we are likely to trigger multiple tipping points in the Earth system. Second, there is no safe landing for humanity, with regards to a manageable climate, unless we also bend the curves and return back to a safe operating space within Planetary boundaries, for land, water, biogeochemical flows and biodiversity. The Earth system, in a healthy state, has a remarkably high resilience, but we are seeing ample signs of cracks in the buffering capacity of the biosphere, and need to urgently act on all planetary boundary transgressions. This calls for setting scientific targets for a safe operating space on Earth, to keep the Earth system in a Holocene-like inter-glacial state. The talk also summarizes the multiple crisis we are facing – the climate crisis, the loss of biodiversity, the coronavirus pandemic, the energy crisis etc. A first attempt, based on the work of the Earth Commission, on defining safe and just Earth system boundaries is presented, as well as the "Earth for All" scenario analyses of pathways towards attaining the SDGs within Planetary Boundaries.

Emily Boyd

Emily Boyd is Professor in sustainability studies and a leading social scientist with a specialist focus on environment and climate change. Her unique focus has been on the interdisciplinary nexus of poverty, livelihoods and resilience in relation to global environmental change, focusing on issues pertaining to cities, sustainable land use, water and deforestation in Africa, Latin America, South-East Asia and Europe. Her work has been published across the social and sustainability sciences with notable publications on resilience, adaptation and the politics and practice of community participation in the new carbon economy.

Emily Boyd was previously a professor in resilience geography (2013-2016) and a reader in environment and development (2011-2013) at University of Reading. She has previously had a number of leadership roles as research division lead for global development at University of Reading, including departmental impact lead and research director in the School of Archaeology, Geography and Environmental Sciences (SAGES), Reading University. Her past research includes fieldwork in Mozambique where she was co-lead on a UN award-winning research project with informal settlements in Maputo, and on resilience and food security among coffee and cocoa producers in Ethiopia and Ghana as part of an ESPA, NERC-ESRC-DFID funded consortium project.

Pivoting between loss and hope in governing a just future for humanity

Climate justice (CJ) is experiencing a renaissance in the context of large-scale loss and damage (economic and non-economic) amid growing vulnerability among people across all corners of the planet. Globally societies are now confronted with climate loss and damage compounded by existing social vulnerabilities and multiple crises. These risks are projected to continue into the future. There is no question that loss and damage is a complex agenda in terms of who is responsible and who pays for creating a safe and fair future under climate change. Loss is critically about the limits to adaptation and results in costs to societies both in terms of lost dollars and negative consequences for cultures from territory and cultural heritage loss for example resulting from sea level rise. By no means is it easy to define, measure or govern these limits, as the talk will demonstrate. However, climate justice is also imbued with hope. Researchers demonstrate resurgence of ideals on redistribution of resources, fair procedures, and recognition of rights by mechanisms of inclusion and accountability. CJ also introduces hope through new (if not complex) ideas on compensation, degrowth, and vulnerability as an opportunity for agency. In evidence of this, mobilisation among civil society and youth has emerged in recent years, parallel with the science of attribution, and numerous court cases and climate litigation. Since climate change is longer merely abstract idea for some, but a growing reality for many, communities and leaders will mobilise over the coming year to define a new loss and damage financing regime for the very purpose of compensating the most vulnerable. It is an unprecedented and daunting task. It raises questions of what is development today? Who is vulnerable? And how are people on the frontline experiencing the effects of loss? Pivoting loss and hope are essential for collective willingness and restructuring to create new conditions for just transformations.

Claudia Teutschbein

Claudia Teutschbein is an Associate Professor in Hydrology at the Department of Earth Sciences, Uppsala University, Sweden. With a focus on modeling surface-water processes with emphasis on hydrological extremes, risks, nexus-thinking as well as interactions between humans and their environment in a changing climate, she conducts cutting-edge research to face current societal challenges in line with the Sustainable Development Goals.

Water in an interconnected world: A key enabler to reach energy and food security?

The availability and sustainable use of water, energy and food resources are essential for human wellbeing and development. The complex and interdependent connections between the supply and demand for these resources form an interconnected worldwide network, referred to as the water-energy-food nexus. This nexus is continuously evolving due to ongoing changes in population, environment, climate, land, political and socio-economic conditions. Abrupt alterations of these conditions (e.g., rapid climate change, a sudden policy change) may lead to unexpected non-linear impacts, which can threaten global economy and resource security. This presentation highlights the importance of taking a holistic systems perspective and showcases evidence of stress on our life-sustaining water, energy and food resources. With a focus on water as one of the most crucial resources for human civilization, societal progress and the achievement of the United Nations Sustainable Development Goals, the consequences of too little and too much water in an increasingly connected world will be discussed.

Professor John A. Rogers

Professor John A. Rogers obtained BA and BS degrees in chemistry and in physics from the University of Texas, Austin, in 1989. From MIT, he received SM degrees in physics and in chemistry in 1992 and the PhD degree in physical chemistry in 1995. From 1995 to 1997, Rogers was a Junior Fellow in the Harvard University Society of Fellows. He joined Bell Laboratories as a Member of Technical Staff in the Condensed Matter Physics Research Department in 1997, and served as Director of this department from the end of 2000 to 2002. He then spent thirteen years on the faculty at University of Illinois, most recently as the Swanlund Chair Professor and Director of the Seitz Materials Research Laboratory. In the Fall of 2016, he joined Northwestern University as the Louis Simpson and Kimberly Querrey Professor of Materials Science and Engineering, Biomedical Engineering and Medicine, with affiliate appointments in Mechanical Engineering, Electrical and Computer Engineering and Chemistry, where he is also Director of the recently endowed Querrey-Simpson Institute for Bioelectronics.

He has co-authored more than 850 papers and he is a co-inventor on more than 100 patents, more than 70 of which are in active use by large companies or startups that he has co-founded. His research has been recognized by many awards, including a MacArthur Fellowship (2009), the Lemelson-MIT Prize (2011), the Smithsonian Award for American Ingenuity in the Physical Sciences (2013), the Benjamin Franklin Medal from the Franklin Institute (2019) and a Guggenheim Fellowship (2021). He is a member of the National Academy of Engineering, the National Academy of Sciences, the National Academy of Medicine, the National Academy of Inventors and the American Academy of Arts and Sciences.

Abstract: Soft, Skin-Interfaced Electronic and Microfluidic Systems.
The skin is mechanically soft and curved; modern electronic and microfluidic technologies are rigid and planar. Eliminating this profound mismatch in physical properties will create vast
opportunities in man-made systems that can naturally integrate with the epidermis, for diagnostic, therapeutic or sensory function with important, unique capabilities relevant to fitness/wellness, sports performance, clinical healthcare and virtual reality environments.
Over the last decade, a convergence of new concepts in materials science, mechanical engineering, electrical engineering and advanced manufacturing has led to the emergence of diverse, novel classes of 'biocompatible' electronic and microfluidic systems with skin-like physical properties. This talk describes the key ideas and presents some of the most recent device examples, including (1) wireless, battery-free electronic 'tattoos', with applications in continuous monitoring of vital signs in maternal, fetal, neonatal and pediatric populations, including active deployments in the most advanced hospitals in the US and remote clinics in multiple countries in Africa, (2) microfluidic platforms that can capture, manipulate and

perform biomarker analysis on microliter volumes of sweat, with applications in cystic fibrosis and nutritional monitoring.

**Professor Robin Augustine**

Graduated in Electronics Science from Mahatma Gandhi University, India in 2003. He received Master's degree in Electronics with Robotics specialization from Cochin University of Science and Technology India in 2005. Received Doctoral degree in Electronics and Optic Systems from Univerisité Paris Est Marne La Vallée, France in July 2009. His thesis topic was “Electromagnetic modeling of human tissues and its application on the interaction between antenna and human body in the BAN context”. He was the recipient of UGCRFSMS fellowship from Indian government and EGIDE Eiffel grant for excellence from French research ministry in 2006 and 2008 respectively. He served as Post Doctoral researcher at University of Rennes, 1, Brittany, France from 2009-2011. He joined Uppsala University as senior researcher in 2011. He is author or co-author of more than 180 publications including journals and conferences and has 3 patents. He is the editorial board member of IET Electronics Letters and Frontiers in communication. He became associate professor at Uppsala University on 2016. He is now Senior University Lecturer in Medical Engineering and Docent in Microwave Technology. He is the head of The Microwaves in Medical Engineering group comprising of 6 senior researchers, 4 PhD students and 2 Research Engineers. 2 PhD students graduated in 2019 under his supervision.

His current research field includes designing of wearable antennas, BMD Sensors, microwave phantoms, dielectric characterization, Bionics, mechatronics, Non-invasive Diagnostics, point of care sensors for physiological monitoring, clinical trials, animal trials, in and on body microwave communication. He has pioneered the Fat – Intra Body Communication technique. He is a regular sessions chair and convened session organizer in EuCAP. He has received Carl Trygger and Olle Engqvist Fundings for his Post-Docs. He has been invited at the Swedish Royal Academy of Sciences (Host of Nobel committee) to present his work on non- invasive physiological sensing. He is project coordinator for Indo-Swedish Vinnova project BDAS and for Swedish part of the bilateral (The Netherlands and Sweden) Horizon 2020 Eurostars project COMFORT. In February 2016 he became Associate Professor (Associate Professor) at UU. Recipient of Swedish research agency, Vetenskapsrådet's (VR) project grant 2017 for his project on A Novel Modality for Osteodiagnosis. He was part of Vinnova project on Skin cancer diagnostic tool based on micromachined interface for high-resolution THz spectroscopy (MTSSC). He is Co-PI of the EU project SINTEC , SSF framework grant LifeSec and Vinnova grant ' connect my body', 2018. He is the research lead on the Eurostars porject SenseBurn 2018. He is appointed as the board member of Department of Electrical Engineering from January 2020. He is the project leader for Eurostars project MAS 2020 and Co_PI for the SSF framework grant Zero-IoT 2020. He is parterning in the SSF 2022 grant Body Centric Operating System - BOS. He is the recipient of two Attractive Innovation Project 2020 awards from Uppsala University Innovation. He is the founder, chairman and CTO of the Swedish medtech company Probingon AB. He is currently coordinating EU HORIZON 2020 FET-OPEN Science Excellence project B-CRATOS, a visionary project in man machine interface.

Abstract: Fat-Intra Body Communication: A new paradigm for intra-body communication technology enabling reinstatement of lost functionalities in human. Intra body communication has been researched quite extensively for past couple of decades to serve the needs in real time monitoring, drug delivery, sensing for pre-emptive measures and to provide better quality of living to the population. The applications are not just limited to health care but also span the areas of recreation, sports and information technology. A handful of intra body, more specifically human body centric (HBC) communication modalities have been developed so far namely galvanic, capacitive and inductive methods. Human body or part is used as a communication channel in these technologies. Though they offer the possibility to connect devices and transfer data wirelessly from one part of the body to the other they suffer from one common drawback which is the low bandwidth hence lower data rates. Radio frequency communication has been regarded until recently as an improbable candidate for extensive HBC applications. In 2016 the Asan et. al from

the Microwaves in Medical Engineering Group, Uppsala University, Sweden published her first paper on the feasibility using the adipose tissue to transmit Microwave signals inside the body with significantly low loss(2dB/cm) [1]. Since then a number of articles have been published on different aspects of fat – intra-body communication (Fat-IBC) [2-6]. Considering the human anatomy, the fat tissue is found to be sandwiched between denser tissues such as skin and muscle. As it is known that the fat due to its very low water content has low permittivity and losses while muscle and skin do have almost an order of magnitude high permittivity and losses which is three to four times that of fat. This creates a natural wave guiding structure which we can utilize to transmit microwave signals at ISM frequencies. Fat-IBC pushes
further the current limits in intra-body data transfer by providing a higher bandwidth and enabling better power management to ensure longer implanted battery life. Fat channel communication will also help substantially the development of artificial limbs which require transfer of high-volume electrophysiological data, wirelessly.

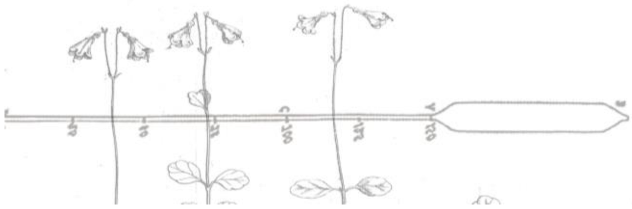
Anna Herland

Anna Herland is an Associate Professor in Nanobiotechnology at SciLifelab, the Department of Protein Science at KTH Royal Institute of Technology and the Department of Neuroscience at Karolinska Institute Sweden. She is in the management group of AIMES, Center for the Advancement of Integrated Medical and Engineering Science at KTH and Karolinska Institutet and the vice-director of KTH Life Science Platform. Herland received a PhD in Organic Bioelectronics from Linköping University with Professor Olle Inganäs as a supervisor. She did postdoc fellowships at Karolinska Institutet in stem cell engineering with Associate Professor Ana Teixeira and at Wyss Institute, Harvard University in tissue engineering with Professor Donald Ingber. She is a Wallenberg Academy Fellow and has > 60 peer-reviewed journal publications and 10 patents. Her research group focuses on creating microphysiological models of tissue, especially the central nervous system. She develops human primary and stem cell-derived systems combined with microfluidics and uses organic electronics or bioelectronics stimuli and read-outs for real-time assessment of biological functions.

Combining Stem Cell and Device Engineering for In vitro Models of Human Physiology

Mammalian cell in vitro studies have traditionally had poor translation to human in vivo processes and treatment outcomes. The low resemblance between classical cell culture—a monolayer, static, monoculture of cell lines and the dynamic, three-dimensional, and multicellular *in vivo* environment is a major reason for this gap. The demand to accurately model human physiology and pathophysiology has, however, risen with the insights into inter-species differences in animal models and with the increasing development of human-specific treatments.

Engineered human microfluidic Organ-on-Chip models have emerged as a promising new pre-clinical technology to fill this demand. In Organ-on-Chips, cells are cultured in connected microcompartments and with perfusion. Recent studies have shown that physiological processes related to pharmacokinetics and pharmacodynamics (PK/PD) as well as toxicology can be replicated in these systems. We have developed a 10-organ Organ Chip automated platform to recapitulate a full human Body-on-Chip with physiological vascular coupling to combine multiple organ models (Herland *Nature Biomedical Engine*ering 2020). This Body-on-Chip system allowed studies of intestinal (oral) uptake, intravenous (IV) injection, first-pass metabolism and excretion, organ-specific responses, and accurate *in vitro-to-in vivo* extrapolation (IVIVE). We are currently developing these systems from three perspectives: first, to increase human physiological relevance through stem cell engineering and relevant three-dimensional microenvironment, second, to incorporate non-disruptive real-time monitoring of cellular functions, and third, to make them user-friendly and cost-effective (Kavand, Advanced Materials 2022). Our specific focus is the neurovascular unit (NVU), the restrictive barrier that lines the capillaries that course through the brain and spinal cord. We are using micro-engineering to create vascular-mimicking, fluidic Organ-on-Chip models of NVU. These models are populated with human pluripotent stem cell-derived vascular and neural cells. The design and material of the NVU-on-Chip have been tailored to study barrier penetration of small drugs and biopharmaceuticals, as well as cellular interactions and inflammatory responses in real-time (Matthiasen Small 2021).



CELSIUS LECTURER

09.00 – 10.15

A safe and just future for humanity on Earth

Johan Rockström

Professor Earth System Science, University of Potsdam and Director Potsdam Institute for Climate Impact Research.

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SYMPOSIE LECTURERS

10.30 – 11.00

Pivoting between loss and hope in governing a just future for humanity

Emily Boyd

Director of Lund University Centre for Sustainable Studies and Professor in Sustainable Science at Lund University.

11.00 – 11.30

Water in an interconnected world: A key enabler to reach energy and food security?

Claudia Teutschbein

Associate Professor in Hydrology, Department of Earth Sciences, Uppsala University

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PANEL DISCUSSION

11.30 – 12.00

Professor Johan Rockström, Professor Emily Boyd and Associate Professor Claudia Teutschbein

Moderator: Professor Giuliano Di Baldassarre, Department of Earth Science, Uppsala University

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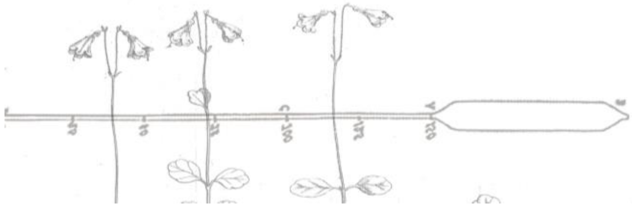

A safe and just future for humanity on Earth

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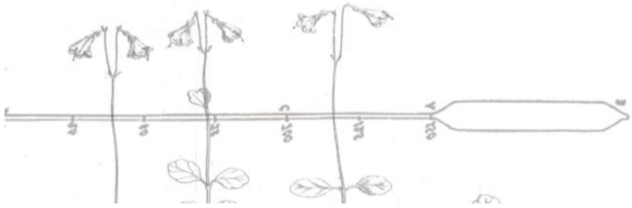

Pivoting between loss and hope in governing a just future for humanity

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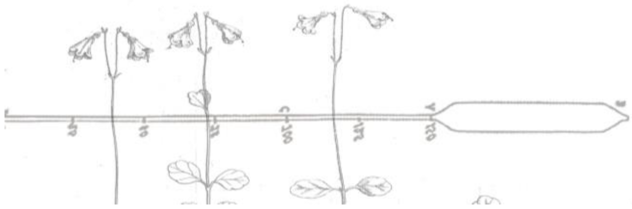

Water in an interconnected world: A key enabler to reach energy and food security?

Claudia Teutschbein

The availability and sustainable use of water, energy and food resources are essential for human wellbeing and development. The complex and interdependent connections between the supply and demand for these resources form an interconnected worldwide network, referred to as the water-energy-food nexus. This nexus is continuously evolving due to ongoing changes in population, environment, climate, land, political and socio-economic conditions. Abrupt alterations of these conditions (e.g., rapid climate change, a sudden policy change) may lead to unexpected non-linear impacts, which can threaten global economy and resource security. This presentation highlights the importance of taking a holistic systems perspective and showcases evidence of stress on our life-sustaining water, energy and food resources. With a focus on water as one of the most crucial resources for human civilization, societal progress and the achievement of the United Nations Sustainable Development Goals, the consequences of too little and too much water in an increasingly connected world will be discussed.

Claudia Teutschbein is an Associate Professor in Hydrology at the Department of Earth Sciences, Uppsala University, Sweden. With a focus on modeling surface-water processes with emphasis on hydrological extremes, risks, nexus-thinking as well as interactions between humans and their environment in a changing climate, she conducts cutting-edge research to face current societal challenges in line with the Sustainable Development Goals.

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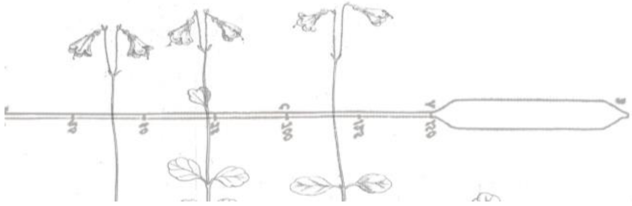

LINNAEUS LECTURER

13.15 – 14.15

Soft, Skin-Interfaced Electronic and Microfluidic Systems

John A. Rogers

Simpson Querrey Professor and Director of QSIB at Northwestern University

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SYMPOSIE LECTURERS

14.30 – 15.00

Combining Stem Cell and Device Engineering for In vitro Models of Human Physiology

Anna Herland

Associate Professor, Division of Nanobiotechnology, KTH.

15.00 – 15.30

Fat – Intra Body Communication: A new paradigm for intra-body communication technology enabling reinstatement of lost functionalities in human

Robin Augustine

Associate Professor, Head of The Microwaves in Medical Engineering Group, Solid State Electronics Division, Department of Electrical Engineering, Uppsala University

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PANEL DISCUSSION

15.30 – 16.00

Professor John Rogers, Associate Professor Anna Herland and Associate Professor Robin Augustine.

Moderator: Professor Klas Hjort, Department of Materials Science and Engineering, Uppsala University

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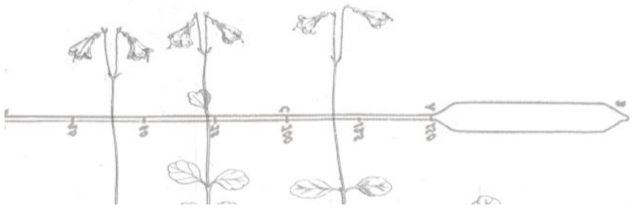


Soft, Skin-Interfaced Electronic and Microfluidic Systems

John A. Rogers

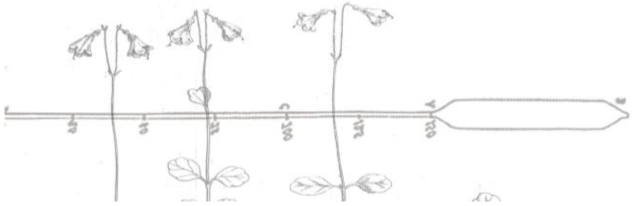
The skin is mechanically soft and curved; modern electronic and microfluidic technologies are rigid and planar. Eliminating this profound mismatch in physical properties will create vast opportunities in man-made systems that can naturally integrate with the epidermis, for diagnostic, therapeutic or sensory function with important, unique capabilities relevant to fitness/wellness, sports performance, clinical healthcare and virtual reality environments.

Over the last decade, a convergence of new concepts in materials science, mechanical engineering, electrical engineering and advanced manufacturing has led to the emergence of diverse, novel classes of 'biocompatible' electronic and microfluidic systems with skin-like physical properties.

This talk describes the key ideas and presents some of the most recent device examples, including (1) wireless, battery-free electronic 'tattoos', with applications in continuous monitoring of vital signs in maternal, fetal, neonatal and pediatric populations, including active deployments in the most advanced hospitals in the US and remote clinics in multiple countries in Africa, (2) microfluidic platforms that can capture, manipulate and perform biomarker analysis on microliter volumes of sweat, with applications in cystic fibrosis and nutritional monitoring.

Professor John A. Rogers obtained BA and BS degrees in chemistry and in physics from the University of Texas, Austin, in 1989. From MIT, he received SM degrees in physics and in chemistry in 1992 and the PhD degree in physical chemistry in 1995. From 1995 to 1997, Rogers was a Junior Fellow in the Harvard University Society of Fellows. He joined Bell Laboratories as a Member of Technical Staff in the Condensed Matter Physics Research Department in 1997, and served as Director of this department from the end of 2000 to 2002. He then spent thirteen years on the faculty at University of Illinois, most recently as the Swanlund Chair Professor and Director of the Seitz Materials Research Laboratory.

In the Fall of 2016, he joined Northwestern University as the Louis Simpson and Kimberly Querrey Professor of Materials Science and Engineering, Biomedical Engineering and Medicine, with affiliate appointments in Mechanical Engineering, Electrical and Computer Engineering and Chemistry, where he is also Director of the recently endowed Querrey-Simpson Institute for Bioelectronics. He has co-authored more than 850 papers and he is a co-inventor on more than 100 patents, more than 70 of which are in active use by large companies or startups that he has co-founded. His research has been recognized by many awards, including a MacArthur Fellowship (2009), the Lemelson-MIT Prize (2011), the Smithsonian Award for American Ingenuity in the Physical Sciences (2013), the Benjamin Franklin Medal from the Franklin Institute (2019) and a Guggenheim Fellowship (2021). He is a member of the National Academy of Engineering, the National Academy of Sciences, the National Academy of Medicine, the National Academy of Inventors and the American Academy of Arts and Sciences.



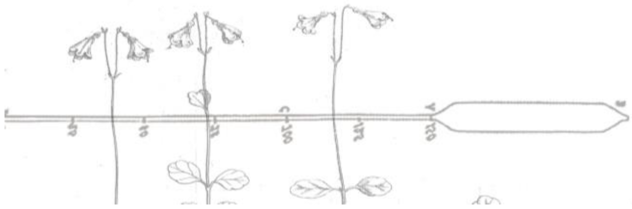
Combining Stem Cell and Device Engineering for In vitro Models of Human Physiology

Anna Herland

Mammalian cell in vitro studies have traditionally had poor translation to human in vivo processes and treatment outcomes. The low resemblance between classical cell culture—a monolayer, static, monoculture of cell lines and the dynamic, three-dimensional, and multicellular in vivo environment is a major reason for this gap. The demand to accurately model human physiology and pathophysiology has, however, risen with the insights into inter-species differences in animal models and with the increasing development of human-specific treatments.

Engineered human microfluidic Organ-on-Chip models have emerged as a promising new pre-clinical technology to fill this demand. In Organ-on-Chips, cells are cultured in connected microcompartments and with perfusion. Recent studies have shown that physiological processes related to pharmacokinetics and pharmacodynamics (PK/PD) as well as toxicology can be replicated in these systems. We have developed a 10-organ Organ Chip automated platform to recapitulate a full human Body-on-Chip with physiological vascular coupling to combine multiple organ models (Herland *Nature Biomedical Engine*ering 2020). This Body-on-Chip system allowed studies of intestinal (oral) uptake, intravenous (IV) injection, first-pass metabolism and excretion, organ-specific responses, and accurate *in vitro-to-in vivo* extrapolation (IVIVE). We are currently developing these systems from three perspectives: first, to increase human physiological relevance through stem cell engineering and relevant three-dimensional microenvironment, second, to incorporate non-disruptive real-time monitoring of cellular functions, and third, to make them user-friendly and cost-effective (Kavand, Advanced Materials 2022). Our specific focus is the neurovascular unit (NVU), the restrictive barrier that lines the capillaries that course through the brain and spinal cord. We are using micro-engineering to create vascular-mimicking, fluidic Organ-on-Chip models of NVU. These models are populated with human pluripotent stem cell-derived vascular and neural cells. The design and material of the NVU-on-Chip have been tailored to study barrier penetration of small drugs and biopharmaceuticals, as well as cellular interactions and inflammatory responses in real-time (Matthiasen Small 2021).

Anna Herland is an Associate Professor in Nanobiotechnology at SciLifelab, the Department of Protein Science at KTH Royal Institute of Technology and the Department of Neuroscience at Karolinska Institute Sweden. She is in the management group of AIMES, Center for the Advancement of Integrated Medical and Engineering Science at KTH and Karolinska Institutet and the vice-director of KTH Life Science Platform. Herland received a PhD in Organic Bioelectronics from Linköping University with Professor Olle Inganäs as a supervisor. She did postdoc fellowships at Karolinska Institutet in stem cell engineering with Associate Professor Ana Teixeira and at Wyss Institute, Harvard University in tissue engineering with Professor Donald Ingber. She is a Wallenberg Academy Fellow and has > 60 peer-reviewed journal publications and 10 patents. Her research group focuses on creating microphysiological models of tissue, especially the central nervous system. She develops human primary and stem cell-derived systems combined with microfluidics and uses organic electronics or bioelectronics stimuli and read-outs for real-time assessment of biological functions.



Fat – Intra Body Communication: A new paradigm for intra-body communication technology enabling reinstatement of lost functionalities in human

Robin Augustine

Intra body communication has been researched quite extensively for past couple of decades to serve the needs in real time monitoring, drug delivery, sensing for pre-emptive measures and to provide better quality of living to the population. The applications are not just limited to health care but also span the areas of recreation, sports and information technology. A handful of intra body, more specifically human body centric (HBC) communication modalities have been developed so far namely galvanic, capacitive and inductive methods. Human body or part is used as a communication channel in these technologies. Though they offer the possibility to connect devices and transfer data wirelessly from one part of the body to the other they suffer from one common drawback which is the low bandwidth hence lower data rates. Radio frequency communication has been regarded until recently as an improbable candidate for extensive HBC applications.

In 2016 the Asan et. al from the Microwaves in Medical Engineering Group, Uppsala University, Sweden published her first paper on the feasibility using the adipose tissue to transmit Microwave signals inside the body with significantly low loss(2dB/cm) [1]. Since then a number of articles have been published on different aspects of fat – intra-body communication (Fat-IBC) [2-6]. Considering the human anatomy, the fat tissue is found to be sandwiched between denser tissues such as skin and muscle. As it is known that the fat due to its very low water content has low permittivity and losses while muscle and skin do have almost an order of magnitude high permittivity and losses which is three to four times that of fat. This creates a natural wave guiding structure which we can utilize to transmit microwave signals at ISM frequencies. Fat- IBC pushes further the current limits in intra-body data transfer by providing a higher bandwidth and enabling better power management to ensure longer implanted battery life. Fat channel communication will also help substantially the development of artificial limbs which require transfer of high-volume electrophysiological data, wirelessly.

Prof. Robin Augustine graduated in Electronics Science from Mahatma Gandhi University, India in 2003. He received Master's degree in Electronics with Robotics specialization from Cochin University of Science and Technology India in 2005. Received Doctoral degree in Electronics and Optic Systems from Univerisité Paris Est Marne La Vallée, France in July 2009. His thesis topic was "Electromagnetic modeling of human tissues and its application on the interaction between antenna and human body in the BAN context". He was the recipient of UGCRFSMS fellowship from Indian government and EGIDE Eiffel grant for excellence from French research ministry in 2006 and 2008 respectively. He served as Post-Doctoral researcher at University of Rennes, 1, Brittany, France from 2009-2011. He joined Uppsala University as senior researcher in 2011. He is author or co-author of more than 180 publications including journals and conferences and has 3 patents. He is the editorial board member of IET Electronics Letters and Frontiers in communication. He became associate professor at Uppsala University on 2016. He is now Senior University Lecturer in Medical Engineering and Docent in Microwave Technology. He is the head of The Microwaves in Medical Engineering group comprising of 6 senior researchers, 4 PhD students and 2 Research Engineers. 2 PhD students graduated in 2019 under his supervision. His current research field includes designing of wearable antennas, BMD Sensors, microwave phantoms, dielectric characterization, Bionics, mechatronics, Non-invasive Diagnostics, point of care sensors for physiological monitoring, clinical trials, animal trials, in and on body microwave communication. He has pioneered the Fat – Intra Body Communication technique.