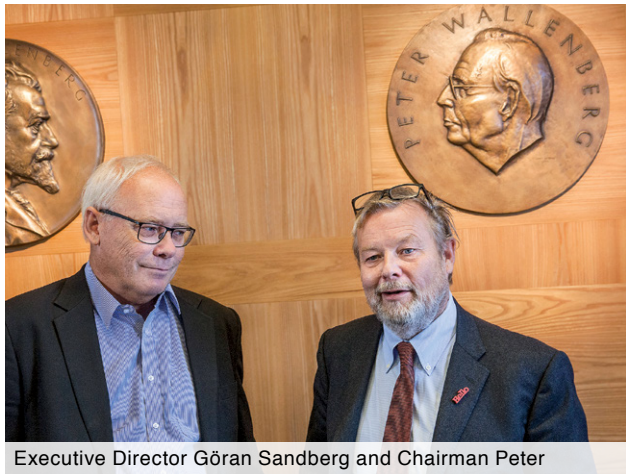
The Knut and Alice Wallenberg Foundation: 100 years of putting basic science first

In 2017, the Knut and Alice Wallenberg Foundation celebrates its 100-year anniversary. You might be familiar with the name, as it is one of the marquis sponsors of the Science for Life Laboratory (SciLifeLab) Awards, presented in partnership with *Science*/AAAS, to a select number of talented young researchers each year. Since its establishment in 1917, the foundation, one of the oldest and most prominent in Europe, has awarded SEK24 billion in grants (US$3 billion), including SEK1.7 billion (US$212 million) annually in recent years, to excellent basic research and education in Sweden. It is the largest private financier of research in Sweden and one of the largest private funders of scientific research in Europe. The foundation invests 80% of its earnings in basic research, mainly in medicine, technology, and the natural sciences. "We want young people to be able to build their careers in science," says professor Göran Sandberg, the foundation's executive director.



Executive Director Göran Sandberg and Chairman Peter Wallenberg Jr in the foundation's headquarters.

The foundation's primary aim is to "promote those domains that are for the betterment of Sweden." And yet, ever since André Oscar Wallenberg founded Stockholms Enskilda Bank over 160 years ago, the Wallenberg family has actively worked to support enterprise and research both in Sweden and internationally. "The foundation is very Swedish in the way that we think and how we act, but we also know that this means we are very global, because the research community is global," says Peter Wallenberg Jr, the foundation's chairman. Over 400 reviewers from across the world assist in the selection of the Wallenberg Academy Fellows, a program the foundation launched five years ago. More than 60% of Fellows have received their doctorates outside of Sweden. There is an international advisory board of eight Nobel laureates, and a national science council consisting of several previous chairmen of Nobel committees. Almost every Nobel Laureate and major scientific prize winner from Sweden over the last 100 years has received support in some form from the foundation.

Over the last century, the foundation has contributed in many ways to the growth and advancement of Swedish universities and research institutions and to the global research community. It has invested in a wide range of research efforts, including everything from exploring the connection between supersymmetry and dark matter, to discovering how people learn languages, to slowing the process of amyotrophic lateral sclerosis, to strengthening immune defenses after bone marrow transplants, to better visualizing ancient Egyptian architecture. It has supported innovations in nanotechnology, supercomputing, and microfluidics, and investigations in evolutionary biology, forestry, plant science, protein research, and genomics.

And the list will continue to grow, especially given the state of politics and economics across the world. "It is an absolutely necessary time to be supporting science—more than ever," says Sandberg. "If you consider the proposed cuts in research budgets, in the United States, Europe, and elsewhere—and also the tendency to fund more applied science—we think that the Wallenberg Foundation has a role to play in the development of knowledge."

Adds Wallenberg, "We are very fortunate to be able to work in a structure like the one we have. After 100 years, we feel a responsibility to see to it that it will continue to develop in the same way as it has for the next 100 years."

"The **most exciting** job in **Sweden**"

Ask Wallenberg what he likes most about his work, and he is very frank: "I have probably the most exciting job in Sweden," he says. "I am part of the fifth generation of the family, and together we engage in different roles with aim of ultimately providing for the beneficiaries of the foundation." He serves on the boards of a number of corporations and is chairman or vice chairman of many of the other 15 foundations that comprise The Wallenberg Foundations, which includes industrial holdings of some of Scandinavia's largest and most important blue-chip corporations.

PHOTOS: (ALL PAGES) MAGNUS BERGSTRÖM

As a race car driver in the Scandinavian Touring Car Championship, Wallenberg, 58, wants to drive as fast as possible in the most advanced, technologically fine-tuned vehicle available. And as the leader of the foundation, he does primarily the same thing: He wants to drive research in a singular way toward solving humanity's grand challenges and expanding our knowledge of the universe.

With degrees from the University of Denver, in Colorado, and the Leysin American School, in Leysin, Switzerland, Wallenberg, who succeeded his father as Chairman in 2015, sees no borders when it comes to science's promise for humankind. "In today's world, with alternative facts and unbelievable attitudes toward science, we believe it is even more important to support science," he says. "We feel that research is not about politics—it's about finding the unknown. It's about being curious, having long-term perspectives, and ideas and philosophies that are outside of the box."

David Seekell: Seeking to understand lake loss

When environmental degradation causes an ecosystem to pass a tipping point, the damage can be difficult or impossible to repair. This has adverse consequences for human well-being, including desertification, toxic algae blooms, and the collapse of fisheries. Wallenberg Academy Fellow David Seekell investigates these tipping points in forest lakes and seeks to know the answer to the question, "How much change is too much?"

David Seekell taking water samples from a local lake as part of his experiment.

CHRONOLOGICAL HISTORY OF THE FOUNDATION INCLUDING A FEW OF ITS HIGHLIGHTS

1917: The Knut and Alice Wallenberg Foundation is established

1921: First academic grants are awarded

1927: Support for Hans von Euler-Chelpin (1929 Nobel Laureate in Chemistry), Stockholm University College

1931: Support for plant-breeding research at the Swedish Seed Association

1933: Construction of Swedish National Museum of Science and Technology

1935: Royal Swedish Academy of Sciences establishes Research Institute for Experimental Physics, support for Manne Siegbahn (1924 Nobel Laureate in Physics)

1938: Death of Knut Wallenberg

1940: Establishment of Nobel Institute for Neurophysiology at Karolinska Institutet, support for Ragnar Granit (1967 Nobel Laureate in Medicine)

1950: Research on biochemical effects of radiation, support for George de Hevesy (1943 Nobel Laureate in Chemistry)

1951: Research on geomagnetic storms, support for Hannes Alfvén (1970 Nobel Laureate in Physics)

1956: Death of Alice Wallenberg

1960: Epilepsy Research

1965: Mass spectrometer developed at Lund University

1969: Support for marine water chemical component analysis, University of Gothenburg

1972: Underground particle accelerator at KTH Royal Institute of Technology

1970s: Research support in radio astronomy, nuclear physics, and space physics

1978: Hospital cyclotron and positron-emission tomography (PET) camera developed at Karolinska Institutet

1985: Uppsala Genetic Center established at Swedish University of Agricultural Sciences, Uppsala

1980s: Research and equipment in glaciology, supercomputing, biomedical sciences, genetics and developmental biology, and materials science

1990s: Research and infrastructure support in microelectronics, photonics, pharmaceutical chemistry, biotechnology, and genomics

2000s: Investment in major projects in genomics, neutrinos, the Human Protein Atlas, kidney research, distributed engineering, solar cells, humanities, nanoscience, regenerative medicine

2009: Foundation program for outstanding senior scientists established

2012: Wallenberg Academy Fellows established

2013: Grants for mathematics established

2015: Clinical Scholars program established

2015: Support for life sciences, autonomous systems, proteins, and biomedicines

2017: 100th anniversary of the foundation

Lakes encompass less than 1% of the planet's surface area, but their impact on human well-being is significant. Lakes have natural systems that deal with decaying organic material, thus keeping the water clear, which is important for maintaining their quality as sources of food and water, as well as their cultural and recreational value. In northern countries like Sweden, lakes figure heavily into both the environment and the culture: 10% of Sweden's forests consist of bodies of water, including lakes and streams, which could have a "huge influence in landscape-scale carbon balance or budget," says Seekell, now assistant professor in ecology and environmental science at Umeå University, where he moved to from the University of Virginia. "It's thought that lakes hold more carbon in their sediments than the oceans," he says. Furthermore, lakes are a major source of drinking water and, not surprisingly, are closely tied to Scandinavian culture. "Old coats of arms heavily feature fish," he notes. "It's a central part of the culture among peoples of these northern latitudes."

There have been very few large-scale, long-term studies of lake systems, and yet the research is necessary. Lakes, which serve as a harbinger of climate change, are changing rapidly around the world. In some regions, lakes are drying up and threatening shoreline communities with food insecurity and economic uncertainty. In other regions, their water is getting darker, which signals potentially profound chemical and microbial disparities. We need to know if there is a limit at which lake systems suddenly collapse, how much lakes figure into overall climate science, and how lake dynamics will affect human and fish health.

ACADEMY FELLOWSHIPS

The Wallenberg Foundation has provided funds for outstanding scientists throughout its history, in the form of research and scholarship programs, project grants, and programs that support individual researchers. In recent years, however, providing individual grants—through programs such as the Wallenberg Scholars, Wallenberg Academy Fellows, and most recently Wallenberg Clinical Scholars—has become one of the foundation's top priorities.

In close cooperation with various Swedish Royal Academies, the Wallenberg Academy Fellows program provides resources for Sweden's most promising researchers. The program supports young researchers in medicine, natural sciences, engineering and technology, and humanities and social sciences, providing them with up to US$2 million to enable them to tackle difficult, long-term research questions. They are nominated by Swedish universities and research institutions, and the Swedish Academies evaluate and select the most promising candidates. The universities then take long-term responsibility for these individuals, providing them with permanent jobs.

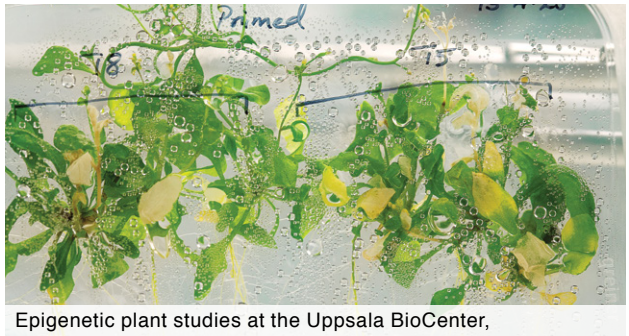
Seekell's ambitious research program will comprise multi-year experiments on entire lakes. This type of investigation is extremely expensive, but thanks to his fellowship, he will be able to proceed. "The foundation provides a generous amount of money with no strings attached," he says. "They are repeatedly encouraging us to try things that might fail or that won't get funded by other funding agencies. They want us to take risks."

When Seekell applied at age 28, he was the youngest applicant in the history of the fellowship. But the fact that he was also an emerging leader is emblematic of the type of researcher in which the foundation invests. "There were people who had much more experience than me," he says. "It just shows that the foundation puts their money where their mouth is in terms of the type of science and scientist they want to support."

As foundation representatives learned more about his aspiring research aims, they created additional avenues for his success. His home university is rather isolated, being located in Umeå, Sweden, about 400 km (249 mi) south of the Arctic Circle. They offered him travel funds, because "they knew it would be good for my research to speak with economists and social scientists who were down in Stockholm. So they just made it happen," he says.

Seekell, who was also honored with the *Science* and SciLifeLab Prize for Young Scientists in 2016 in the ecology and environment category, adds: "To get this fellowship is very prestigious. The whole thing has been like a dream!"

Ilona Riipinen's research is about understanding how clouds clean the air.



Epigenetic plant studies at the Uppsala BioCenter, Swedish University of Agricultural Sciences.

Charles Melnyk: Getting to grips with grafting plants

Charles Melnyk was pursuing a Ph.D. in plant sciences at the University of Cambridge, United Kingdom, when he had an epiphany. He had been examining the mobility of substances in plants, and had been using grafting between plants as a tool to measure the ability of RNA to migrate. When two plants, sometimes of different species, are cut and connected, they can join together into a chimeric organism and heal their vascular systems, which transport water, nutrients, and hormones. This healing process is called grafting. Humans have grafted plants for thousands of years, and it serves as a vital mechanism for advancements in agriculture and horticulture. Grafting's uses include cultivating ornamental plants and improving fruit and vegetable harvests. But a plant's ability to share vascular tissue also has a disadvantage: Parasitic plants can join their vascular tissue to a host plant, absorbing its nutrient supply.

Despite grafting's wide use in plant biology, "we realized we had no idea how it works at a cellular level," says Melnyk. Questions abound regarding what happens when vasculature from different plants fuses together, either through grafting or during parasitic plant infection. So he set out on a vegetation investigation with a grant from Clare College, Cambridge, to conduct postdoctoral research on the subject. In 2016, he was named a Wallenberg Academy Fellow, and currently serves as associate senior lecturer in the Department of Plant Biology at the Swedish University of Agricultural Sciences (SLU) in Uppsala.

Melnyk has already had victories. He was the first to describe in detail the physiological dynamics of grafting processes and has identified specific genes that are necessary for grafting to take place. He is using the model plant *Arabidopsis thaliana* to examine how plants graft at the molecular, genetic, and developmental levels, and has developed a series of tools that allow him to monitor cell division, cell differentiation, and vascular connection at the graft junction.

The overall aim of his research is to make grafting more efficient and to expand the number of species that can be grafted. But his work has additional ramifications, as he endeavors to find methods for combating parasitic attacks on plants. "Parasitic plants are a huge global problem," he says. "They cause billions of dollars of losses in Asia and Africa, in particular. So we need to better understand how parasitic plants infect and affect the host." By having a better comprehension of grafting and what may actually halt grafting, "we can use the same technique to see how we can block parasitic plants."

FELLOWSHIP = FREEDOM

If there is one theme that encompasses the Wallenberg Foundation's funding goals for Academy Fellows, it is freedom. "We give them absolute freedom to explore whatever science they want, and we accept that they fail from time to time," says Peter Wallenberg Jr. "For us, failure is positive. You will always learn something from the research you do, even though you don't find what you thought you would. Failure is part of reality. You should not be afraid of it."

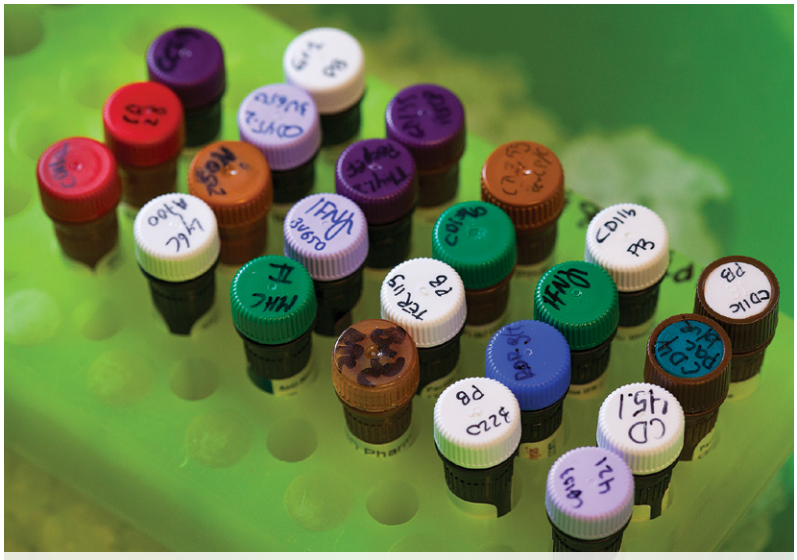
The Wallenberg Academy Fellows program was launched in 2012, with the goal of providing funding for up to 250 young researchers over a 10-year period. It grants up to US$2 million per Fellow. Although the Fellows are diversified in what scientific realms they have chosen to dwell, they agree that their funding provides them with an independence that is fairly scarce in science. "Having financial stability takes off some of the pressure and gives me time to be more creative," says Fellow Charles Melnyk. "I don't have to spend the next few years worrying about grant application outcomes."

David Seekell notes that because of his fellowship, he has had the opportunity to analyze subfields potentially related to his own research arena. "My view has shifted because I have had another year to think really deeply about it and explore the frontiers of my field," he says. "The fellowship gives a level of freedom I didn't know was possible or existed."

It's important to note that the Academy Fellows are not given a mandate on what they should do or how they should pursue their projects. "It's investment in the individual, and the forefront of research," says Fellow Ilona Riipinen. "There is the possibility that the first hypothesis will fail or that we will get something different than expected, and that's OK." And this freedom is an essential ingredient to the success of the foundation's funding philosophy. "It's about giving them the right conditions that allow them to develop," says Göran Sandberg, the foundation's executive director.

As a fellow at SLU, he is pursuing remarkably distinctive research. "For the university, it's great to have the fellowship, funding, and expertise to come here and to help advance this research that no one else is doing in Sweden," he says. Now, he focuses on why certain plant species readily graft whereas others do not. Self/nonself-recognition may be key to understanding how parasitic plants infect their hosts, and has relevance for improving graft formation and combating parasitic plant infections. "How do two unrelated species come together and fuse?" he ponders. "How does the plant know there is something there and whether it is a friend or foe? If I can describe that, it would be amazing."

As the only Fellow who is a plant biologist, Melnyk recognizes he is in a special role. "There are different ways to improve global health and food security, and studying plants is one way to do so," he says. "I'm incredibly grateful to the foundation."



Large biobanks, combined with Sweden´s demographic databases, provide unique resources for analysis.

Sidinh Luc studies how stem cells differ from each other.

Sidinh Luc: Solving cellular formation in the blood

Researchers have long believed that the stem cells found in our bone marrow are all the same, but extensive investigation has shown that assumption to be premature. Sidinh Luc, an assistant professor in the Department of Medicine at the Karolinska Institutet (KI), will now make detailed studies of this mixed bag of blood stem cells. The talented biologist launched a laboratory at KI in 2017, when she received her Wallenberg Academy Fellowship, to help us understand how stem cells in our bone marrow differ from each other and whether there are different types of stem cells involved in different types of blood cancer. “The blood stem cells are the only self-renewing cells in the body’s blood system,” she explains. “It’s why we can have continuous blood production for life.”

Our red and white blood cells are continually renewed. Stem cells in the bone marrow divide and give rise to all the specialized cells found in our blood: monocytes, macrophages, neutrophils, basophils, eosinophils, erythrocytes, dendritic cells, T cells, B cells, and natural killer cells.

To better understand this basic process, Luc wants to isolate different types of blood stem cells and mark them using genetechnology tools, in order to reveal which specialized blood cells originate from which stem cells. She also plans to investigate how epigenetic differences govern the development of different blood stem cells, and how levels of various stem cells in the bone marrow change throughout our lifespan. The hope is that more detailed knowledge of blood formation will increase our understanding of how different forms of blood cancer develop and how they can be treated.

Chief among her efforts is her investigation of epigenetics as it relates to blood cancers. “Previously, we thought genetic mutations were the most important mutations for cancer development,” she says. “Here, we are looking at the role of the epigenetic processes in normal cell development. If we can understand how these cells normally behave, then we can understand cancer.” Luc is also looking at whether there is a correlation between stem cell origin and the type of leukemia that could develop in the body.

Her research is risky. “It has always been difficult to study hematopoietic stem cells because they are few in number, and there are very few techniques to examine cells so low in number,” she says. “But the injection of capital from the Wallenberg Foundation will potentially transform her investigations into innovations that can save lives. “If I had received a smaller grant, we would be limited in the types of questions we could explore,” she notes.

Luc grew up in Sweden, and received her Ph.D. from Lund University, although she spent the majority of her graduate school period at the University of Oxford, United Kingdom, since her lab had moved there. She then went to the Dana-Farber Cancer Institute in Boston, Massachusetts, to further her expertise. She is thrilled that the fellowship has allowed her to return to her native land and contribute to medical knowledge both in Sweden and in the larger scientific community. And interestingly, she sees a link between her own motivation—a combination of imagination, creativity, and the desire to pursue big, bold ideas—and the mission of the foundation. “It was clear during the application process that the foundation promotes free thinking,” she says. “You don’t need to pursue a specific research question. And if it doesn’t work out, it’s OK to pursue a different path. The idea is simply to do the best science.”

Ilona Riipinen: Clarifying how clouds clean the air

Clouds are nature's vacuum cleaner. Together with the rain they produce, clouds serve as the most important removal mechanism for the pollutants that clutter our atmosphere. This is important to know, as the air we breathe does not consist only of gas molecules: Each cubic centimeter of atmospheric air typically contains thousands of small aerosol particles. These liquid or solid airborne particles originate from natural sources (e.g., forests, oceans, and deserts) as well as human activities (e.g., combustion processes, traffic), and their diameters span from nanometers to hundreds of micrometers.

Not surprisingly, because of their abundance and size, these atmospheric pollutants contribute to global climate change and have negative effects on air quality. What is surprising is that relatively little is known about exactly how clouds maneuver and suck out waste particulates. Thanks to the bright mind of atmospheric physicist Ilona Riipinen, we may now have answers to this puzzle. Riipinen is studying how aerosol particles form in the atmosphere, and she has recently turned her attention to an exciting new field: self-cleansing processes in the atmosphere, and cloud formation in particular.

"My research often deals with fundamental phenomena, so many findings may be of use from both a climate and a health perspective," she says. "Interaction between aerosol particles and clouds has a bearing on both these issues. I think there is great potential to find something new and interesting, and perhaps a little surprising."

As a Wallenberg Academy Fellow, Riipinen's goal is to leverage the insights she gains about atmospheric self-cleansing processes to craft methods for making more exact forecasts and historical comparisons of particulate concentrations in the atmosphere. She serves as professor of atmospheric science and head of the Atmospheric Science Unit at the Department of Environmental Science and Analytical Chemistry (ACES) at Stockholm University.

The novelty of her work is that she is focused on the complex organic mixtures that reside in the atmosphere: How they are distributed between the gas phase and the condensed phase, what their properties are, and how we represent these processes in a way that can be incorporated into climate models that don't allow for this type of complexity. "I'm interested in scaling and simplifying the complex," she says.

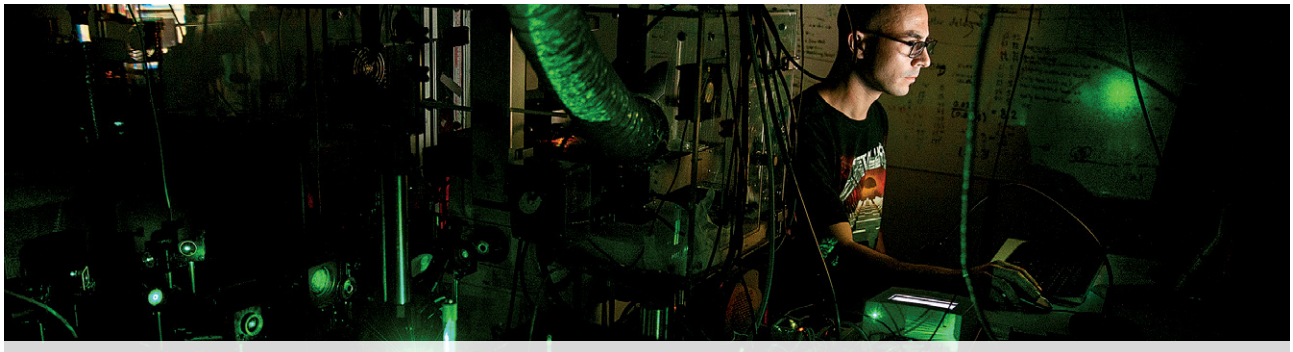
Using a combination of experimentation and modeling, she seeks to enhance global climate models with strategic information about cloud action. Her funded enterprise is a big project, with years of intensive work ahead, but Riipinen can't wait. "I'm a sucker for learning. I love the feeling when you sometimes say, 'How did I not realize this before?'" she says with a chuckle. "I'm interested in how we communicate and disseminate our findings so it becomes something that others will grasp. I want to share my intellectual process in such a way that it is useful to others."

Riipinen sees the value of her fellowship in terms of the foundation's willingness to look beyond quick fixes, invest in the future, and make a permanent commitment to addressing scientific and social problems. "It does a great service to Sweden and to the world through longevity. It's the long-term support that inspires such intellectual and creative freedom," she says. "When you see this dedication and the people who are given the freedom to pursue what they think is interesting, you know it will make an impact."

THE WALLENBERG ECOSYSTEM

The Wallenberg sphere comprises 15 nonprofit foundations—the Wallenberg Foundations—and the industrial holding companies Investor AB and FAM AB, and their respective holdings.

Dividends from these long-term holdings enable the continuous funding of foundation grants for research and education.



Studying the physics of living cells in a laboratory at Uppsala University.