BESLUT

Datum för beslut: 2025-11-10

Diarienummer: KTH-RPROJ-0276016

Beslut om ett strategiskt forskningsinitiativ, KTH SUPREME

Detta beslut har undertecknats elektroniskt.

Beslutet

KTH:s vicerektor för forskning beslutar att:

- Finansiera *KTH Supreme* med 1 mnkr centrala medel under 2025/2026.
- Utse Christofer Lendel, CBH-skolan, som ansvarig forskningsledare för satsningen.
- Återrapportering enligt utvärderingskriterier, för dialog om fortsatt bidrag ska vara Forskningsberedningen tillhanda 10 november 2026.

Ärendet

KTH:s initiativ för forskningssatsningar inrättades enligt förslag från Översyn av KTH:s särskilda forskningssatsningar (Dnr: KTH-RPROJ-0276016). Förslaget innebär att centrala medel ska kunna användas till direkt finansiering av tre- till femåriga forskningsinitiativ med det huvudsakliga målet att dra in externa forskningsanslag.

Under föregående år har Forskningsberedningen arbetat vidare med att konkretisera förslaget, och kommit fram till ett antal kriterier för ett KTH Strategiskt initiativ samt kriterier för utvärdering (Protokoll 10/2024):

Kriterier för KTH Strategiskt forskningsinitiativ:

- Strategiska forskningsinitiativ är ett sätt för KTH att kraftsamla inom områden där det krävs nya samarbeten som är viktiga utifrån KTH:s vision och mål. Det kan dels vara att förstärka ett område som redan finns eller utveckla ett nytt.
- Strategiska forskningsinitiativ ska kunna initieras av både forskare, KTH:s ledning och forskningsberedningen.
- Strategiska forskningsinitiativ är satsningar med central finansiering på 0,5 - 3 mnkr per år i max fem år.
- Målsättningen för en beviljad satsning är att generera betydande externa bidrag till KTH om totalt minst 100 mnkr. Det kan vara externa bidrag från flera olika finansiärer som tillsammans stärker området för forskningsinitiativet. Utväxlingen blir den viktigaste indikatorn som följs upp årligen.

Kriterier för utvärdering av beviljat KTH Strategiskt forskningsinitiativ ska ske efter ett år enligt nedan:

- Projektansökan – En eller flera projektansökningar.
- Kraftsamling - Vilka PI´s är med i projektansökan/ansökningar?
- Förberedelsearbete inför utlysningar.
- Exempel på nya forskningssamarbeten.

Dessutom kommer behov av central finansiering, budgetutrymme och strategisk relevans att vägas in vid Forskningsberedningens bedömning.

Till Forskningsberedningens möte den 24 september inkom förslaget KTH SUPREME med professor Christofer Lendel, CBH-skolan, som ansvarig forskningsledare, se bilaga 1.

Baserat på Forskningsberedningens diskussion rekommenderas Vicerektor för forskning att stödja att förslaget beviljas sökt budget, 1 mnkr för år 2025/2026. En utvärdering ska ligga till grund för diskussion om fortsatt finansiering och i vilken omfattning. (KTH-RPROJ-0276016 Protokoll 8/2025).

Detta beslut har fattats av vicerektor för forskning Annika Borgenstam efter föredragning av forskningsrådgivare Johan Schuber.

Kungl. Tekniska högskolan

Annika Borgenstam, vicerektor för forskning KTH

Johan Schuber, forskningsrådgivare, avdelningen för forskningsstöd inom Verksamhetsstödet

Bilaga 1: projektförslag

Sändlista

<u>För åtgärd:</u>

Christofer Lendel, CBH-skolan

Kopia till:

Skolchef CBH-skolan

Controllergruppen, controller@kth.se

Chefen för avdelningen för forskningsstöd Maria Gustafson

Kommunikationschef Gunilla Iverfelt

Anna Aminoff

Sanna Pehrson, avdelningen för forskningsstöd

Expeditionsdatum:

YYYY-MM-DD

KTH SUPREME - KTH SUstainable PRotEin Materials Engineering

Name and title of PI, School: Associate Professor **Christofer Lendel**, CBH, Dept. of Chemistry

Name and title of co-PI´s, Schools:
Professor **My Hedhammar,** CBH, Dept. of Protein Science
Professor **Mikael Hedenqvist**, CBH, Dept. of Fibre and Polymer Technology
Professor **Paul Hudson**, CBH, Dept. of Protein Science
Dr. **Hanna Tegel**, CBH, Dept. of Protein Science

Funding, total direct funding requested for first year.

Salary costs for coordination:		650 kSEK.
KTH workshops (premises and food):	4x 30 kSEK	= 120 kSEK
International conference (additional funding will be applied):		80 kSEK
Pilot Masters projects:	5x 30 kSEK	= 150 kSEK
Total:		**1 MSEK**

After the first year, we plan to expand the activities to ca 3 MSEK per year.

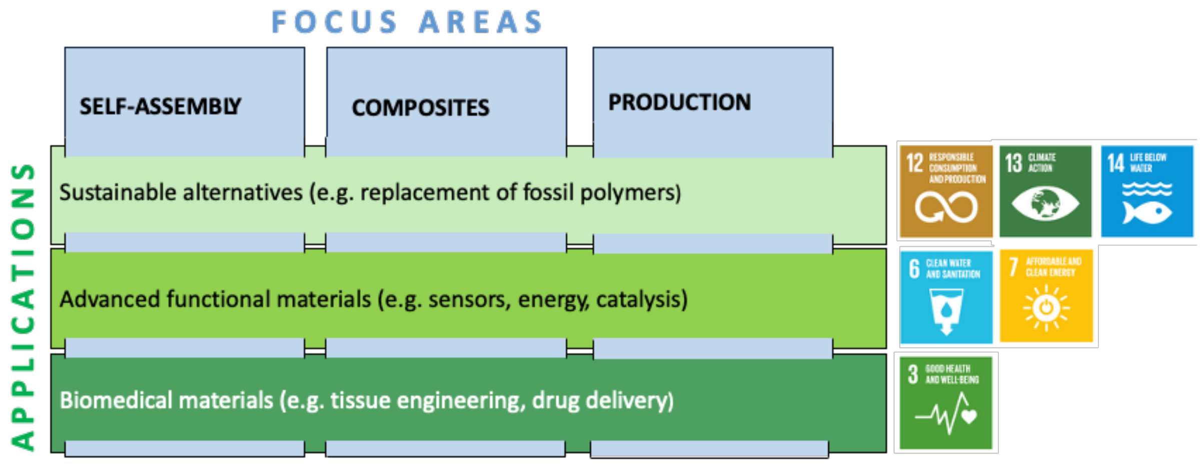

Figure 1. Outline of KTH SUPREME.

Purpose - *What will be achieved with the project? What´s the vision?*
Our vision is that KTH SUPREME will be an environment that advances KTH's unique spectrum of competences into a world-leading platform for the design of protein-based material solutions for a sustainable future. The proposed initiative will build the knowledge that is necessary to overcome the fundamental challenges in the field and thereby enable the development of novel technologies.

Proteins are unique polymers as they can be engineered at the single monomer level. This has made them the primary choice in Nature for advanced materials with intriguing properties and functionality. Proteins are also found as key components in new green technology, e.g. materials for efficient water purification developed by BlueAct technology (blueact.com) and renewable packaging from Xampla (xampla.com), both companies started from academic research (at ETH Zürich and Cambridge University, respectively). Moreover, proteins can be excellent chemical catalysts and protein materials are being explored in advanced functional materials, such as flexible electronics and photonic devices. Protein materials are also pivotal in biomedical technology, including tissue engineering and as nano-vehicles for drug delivery.

The primary question is how we can explore the endless design possibilities of proteins in the most efficient way? Nature has solved this by evolution and similar scientific approaches are indeed explored but technology development needs much faster progress than natural evolution. The recent breakthrough in AI for protein structure prediction (e.g. AlphaFold, that was rewarded the Nobel prize in chemistry last year) has fundamentally shifted what is within reach in this field and today. AI and machine learning is now becoming integrated tools in many research efforts. However, the power of AI relies on the availability of high-quality experimental data. The success of AlphaFold is based on the work to determine high-resolution structures of proteins and depositing them in an open database. The primary aim of KTH SUPREME will be to *enable* a similar transition into AI-assisted design of protein-based materials. To achieve this, we need to form a multidisciplinary team and work together to define key parameters of the materials and then design high-throughput experiments to explore how the protein architecture relates to these parameters. Notably, this represents a shift in the scientific approach as the goal of the work will be to produce high quality data rather than finding the "best" solution to a specific problem.

A preliminary outline of the project is shown in Figure 1. The three focus areas will be *1) self-assembly, 2) composites* and *3) production & circularity*. *Self-assembly* refers to how protein molecules (the same or different) can come together into specific structures at the nano- or micro- scales. C*omposites* is about the use of proteins as connectors or scaffolds for materials built from e.g. cellulose, traditional polymers or inorganic matter. Finally, *production & circularity* relates to how well the protein can be produced in heterologous expression systems or if it could be extracted from agricultural resources. Notably, there is a strong synergy between these questions since industrial waste streams could also serve as feed for microbial expression systems. Such single cell protein production systems can even use air as nitrogen source, as demonstrated by the Finish company Solar Foods (solarfoods.com). Industrial approaches for recycling protein materials is today an unexplored area although this is done continuously in Nature (this is how proteins are used as nutrition in living organisms). We also see three prioritized areas of applications: *sustainable alternatives* (meaning materials that can replace less sustainable alternatives that are used today), *functional materials (*where the protein structure provides novel functionalities to the material, e.g. in energy harvest/storage, adhesion or water purification) and *biomedical materials* (where the protein origin of the materials is important due to its biocompatibility).

The implementation of KTH SUPREME will proceed in the following steps: **I.** Gather competence within KTH. In a series of workshops, we will define and elaborate the specific goals of the projects. We will also explore machine learning strategies and involve external experts in this area. **II.** Support pilot Master's degree projects aiming at generating data for training of machine learning algorithms. The data-collection approach is highly suitable for such projects and KTH SUPREME will offer a small financial support for them. **III.** Organize recurring international meetings about protein materials hosted by KTH. This will establish KTH as an international node in the field. **IV.** Coordinate common applications for major project grants (e.g. VR, Vinnova, KAW) and facilitate participation in relevant consortia (e.g. Horizon Europe).

Strengthen KTH and fulfil KTH:s vision and goals
Protein materials is an inherently interdisciplinary field of research, bridging biotechnology, chemistry, and material engineering. KTH SUPREME will provide a platform that will foster and develop the collaboration between disciplines. By doing so, KTH can take the lead in this research area in global perspective and become a key actor in international research and education initiatives. In particular, the education aspect

will be central in cultivating a new generation of young scientists equipped with the tools to design our future materials. KTH should be the first choice for students with a desire to develop bio-inspired solutions.

Protein materials open new avenues for addressing many of our global challenges. Advanced materials for biomedical applications, as sustainable alternatives to synthetic polymers and in materials with novel functionality, showcasing the potential of protein materials to redefine technological boundaries. The potential for local production can stimulate economic development in underprivileged regions, contributing to a sustainable and equitable society. Proteins also represent a promising platform for translating groundbreaking ideas into tangible solutions. Their unique design properties allow for the customization of materials tailored to specific needs, enabling the rapid prototyping and commercialization of innovative products. Hence, KTH SUPREME will catalyse innovation across various industries.

Finally, cooperative solving of the challenges in designing protein materials offer a fertile ground for outstanding basic research, pushing the boundaries of scientific understanding of the principles of molecular self-assembly, biomolecular recognition, and materials science.

Contributions to society, industry and education

The goals of KTH SUPREME are well aligned with the Swedish research agenda, as described in 'Regeringens forskningsproposition 2024'. Bioeconomy is highlighted as a prioritized area of research and the combination of biotechnology and materials engineering opens for innovative solutions for our future society. KTH is a leading environment in the utilization of cellulose biomass. Expanding this endeavour to include protein resources will add a new dimension to the valorization of domestic biomass, since the agricultural and forest sector have many protein-rich side streams that could be exploited.

The projects connected to KTH SUPREME will give the students a unique combination of biotechnology and material science. The acquired knowledge will be important for many aspects of the green transition, from non-polluting plastics to active materials for renewable energy or environmental remediation. Moreover, the acquired skills will be pivotal in working with biomedicine and biomaterials. We also anticipate that students with a fundamental understanding for data-driven, machine learning approaches will be very attractive in the industry.

Why at KTH

KTH has an extraordinary potential to establish a world-class environment for research on protein materials. Two groundbreaking research environments provide the pillars upon which the proposed initiative will be built. First, KTH has a leading role in the Wallenberg Wood Science Centre. Within this platform, KTH has built an extremely strong competence about how to reform forest-derived components into innovative bio-based materials. Second, in the field of molecular biotechnology, KTH has been leading the Human Protein Atlas work for more than 20 years. The aim of this large-scale project is to map all human proteins in cells, tissues and organs. To do that, a large number of scientists with expertise in design, production and characterization of proteins have been engaged.

KTH also hosts leading research groups within different subfields of protein-based materials: *My Hedhammar* is developing recombinant spider silk into biomaterials; *Mikael Hedenqvist* is a leading expert in processing of naturally proteins into materials and *Christofer Lendel* designs hierarchical protein materials based on self-assembly principles. These groups, and others, were part of the initiative to build a Swedish Protein Material Network, started at KTH in 2015. In this effort we realized that we had a unique niche in bringing together scientist from materials sciences and molecular biotechnology and we have received very positive response on the two international meetings we arranged. To the best of our knowledge, no similar meetings exit today.

A preliminary review has identified several research groups at KTH that could contribute important elements to the KTH SUPREME environment even though they are not focusing on protein materials today (e.g. photochemistry, physical characterization techniques, surface-related phenomena, industrial bioprocess technology, modelling of materials and processes). The intention is to build an inclusive platform that could spark new ideas that would not have emerged otherwise.

Importantly, KTH is in the forefront of the AI transition in our society. This will be of central impact for guiding the activities within KTH SUPREME. A close collaboration with the KTH strategic initiatives within this area will be established.

National and international competition

Although Sweden has many excellent research groups working with biobased materials, the field of protein materials is eclipsed by the efforts related to wood-derived resources and cellulose. In comparison with other Swedish universities, KTH has a strong connection between the fields of molecular biotechnology, computational biology and materials engineering. This put us in a unique position to step forward and take the national lead in this area of research.

The potential of protein materials is recognized internationally with leading research groups at e.g. Aalto, ETH, MIT and Cambridge Universities. A few strategic initiatives have been launched, including HYBER and then LIBER initiatives (Aalto), the Bringing Materials to Life Consortium (ETH) and SUPRALIFE (a Horizon Europe project led by University of Aveiro). There is also a centre for protein design at Copenhagen University that was just launched with funding from Novo Nordisk foundation. All these initiatives are *either* focusing on materials or molecular design while the aim of KTH SUPREME will be to *connect* molecular biotechnology with bio-based materials and to building data resources for machine learning applications. Hence, KTH now has an excellent opportunity to impact the international development of the field.

Research team

The core team represents several perspectives of protein-based materials, and their competences are highly complementary.

Christofer Lendel (CBH, Dept. of Chemistry) has been driving the initiative to establish a Swedish network for protein materials research since 2015. His scientific background provides a link between the two fundamental pillars of the proposed cluster: materials science and biotechnology.

My Hedhammar (CBH, Dept. of Protein Science) is a leading authority in recombinant spider silk production and development of biomaterials. She is also the head of R&D for Spiber Technologies AB, a knowledge-driven company working with synthetic spider silk for biomaterials.

Mikael Hedenqvist (CBH, Dept. of Fibre and Polymer Technology) is an expert in biopolymer materials with a special focus on proteins. He has an extensive network of academic and industrial contacts and is a member of the Wallenberg Wood Science Center and the board of Nordic Bioplastics Association.

Paul Hudson (CBH, Dept. of Protein Science) uses metabolic engineering, synthetic biology, and systems biology to develop biologcial approaches for CO_2 fixation. Protein engineering and design are central tools and his group has now started to explore the possibilities offerred by machine learning.

Hanna Tegel (CBH, Dept. of Protein Science) is one of the most experienced persons at KTH when it comes to recombinant protein production with key roles in the Wallenberg Center for Protein Research (WCPR), the Human Protein Atlas project and Protein Production Sweden (PPS).

Strategy for funding

Research related to bioeconomy and biobased solutions will be the target of substantial national funding according to 'Regeringens forskningsproposition 2024' (>260 MSEK between 2025 and 2028). A new research and innovation program in circular bioeconomy will be established through Formas, which should fit KTH SUPREME very well. We also aim to take part in the planned call for a research school in bioeconomy. Another goal is to form competitive teams for the VR and VINNOVA calls for excellence clusters (applications for planning grants have already been submitted). The excellence centres will have a budget of at least 40 MSEK/year (VR). The VINNOVA program has a total budget of ca 1000 MSEK during the next four years. We will also develop collaborative projects suitable for strong applications for KAW project grants (up to 40 MSEK per project). These opportunities are all within short- to medium term and will define the frames for the work within KTH SUPREME.

Another side of the funding strategy will be to support the participation in Horizon Europe calls, primarily within pillar II, global challenges, cluster 6 (Food, bioeconomy, natural resources, agriculture and environment). For this, the establishment of an international networks linked to the initiative is needed and the conferences we will arrange will open opportunities to form international teams for these applications.

In addition, we hope that the collaborative environment within KTH SUPREME will seed new project ideas for applications to national and international funding, including VR, Formas, Novo Nordisk foundation and ERC. For these opportunities we hope to see the long-term effects of the initiative.