Theme 1: Neurodegenerative diseases in an aging population

1. **'The Missing Link: Unravelling the Role of Genetic Variation of Beneficial Arthropods in Agro-ecosystems', DKK 59.1 million**

   Main applicant: Trine Bilde, Professor, Department of Biology, Aarhus University

   Co-applicants:
   Marjo Saastamoinen, Associate Professor, Helsinki Institute of Life Science, University of Helsinki, Finland

   Greta Bocedi, Royal Society University Research Fellow, School of Biological Science, University of Aberdeen, UK

   Philip Francis Thomsen, Associate Professor, Dept. of Bioscience, University of Aarhus, Denmark

   Brief description:
   The grant will enable an ecological genetics research centre to be established that will investigate whether the dramatic decline observed in insect populations also contributes to loss of genetic diversity. The project will also examine how the interaction between the habitat needs of the insects and the use of natural land areas influences the genetic diversity of the insect populations. The research will investigate whether less genetic diversity threatens the biological functions of species and renders these populations especially vulnerable to environmental changes and outbreaks of disease.

   "Insects are extremely important in both natural and cultivated ecosystems and we are apparently seeing large declines in their populations. However, we know little about how this affects genetic diversity, the loss of which can also accelerate the loss of species diversity, which is one of the important ecosystem services that insects provide such as pollination and natural pest control. Understanding how we can maintain genetic diversity in natural populations is therefore important. Our research, which will use major genome analysis, will examine the interaction between animal biology and the intensity of the use of their habitats and how this affects the maintenance of healthy and diverse populations," says Trine Bilde.

Theme 2: Quantum simulators for unravelling complex processes in nature

1. **'Quantum for Life', DKK 48.6 million**

   Main applicant: Matthias Christandl, Professor, Department of Mathematical Sciences, University of Copenhagen

   Co-applicants:

   Markus Reiher Professor, Dept. Physical Chemistry, ETH Zürich

   Eugene Polzik, Professor, Niels Bohr Institute, University of Copenhagen

   Anders Krogh, Professor, Dept. Biology & Center for Health Data Science, University of Copenhagen

   Brief description:
   The project aims to develop algorithmic strategies for the quantum simulation of biomolecules and thus enable the researchers to study, for example, long-range electron interactions. To achieve this, the research team will simultaneously develop an experimental quantum simulator platform comprising levitating atoms over a two-dimensional dielectric membrane.

   "Electron interactions are crucial in biochemical processes in drug design, such as docking two molecules. Since the interaction is quantum mechanical, it is very difficult to calculate with today's classical computers and even supercomputers. Quantum computers, in contrast, are naturally suited to tackle such problems. Quantum for Life will develop and use tailor-made quantum algorithms, providing an opportunity to open a new chapter in the computational life sciences in Denmark. With the new centre, I am pleased that the quantum mathematics we are developing can be used to solve important problems related to fundamental biological processes," says Matthias Christandl.

2. **'Solid-state quantum simulators for biochemistry (Solid-Q)', DKK 60 million**

Main applicant: Peter Lodahl, Professor, Niels Bohr Institute, University of Copenhagen

Co-applicants:
Jesper Nygård, Professor, Niels Bohr Institute, University of Copenhagen

Anders S. Sørensen, Professor, Niels Bohr Institute, University of Copenhagen

Ferdinand Kuemmeth, Associate Professor, Niels Bohr Institute, University of Copenhagen

Gemma C. Solomon; Professor, Department of Chemistry, University of Copenhagen

Brief description:
The project is based on using and integrating two types of quantum simulation hardware to perform quantum mechanical calculations related to complex biomolecules.

"Our starting-point is new quantum hardware, which we have developed through decades of dedicated basic research. Today, these quantum building blocks are good enough that we can scale up and address complex chemical problems. This requires an interdisciplinary team, and we are very pleased to gather leading research groups in Denmark in Solid-Q. We hope to be able to design and fabricate quantum simulators that will help us to understand and optimize protein-folding problems or energy transport in photosynthesis, which will open new perspectives for developing drugs or energy-efficient materials. I am very grateful that the Novo Nordisk Foundation has decided to invest heavily in this field, which hopefully in the long term will also lead to new business opportunities in Denmark," says Peter Lodahl.

Theme 3: Biodiversity & productivity of managed ecosystems

1. **'Silva Nova – Restoring soil biology and soil functions to gain multiple benefits in new forests', DKK 60 million**

   Main applicant: Per Gundersen, Professor, Department of Geosciences and Natural Resource Management, University of Copenhagen

   Co-applicants:
   Inger Kappel Schmidt, Professor, Dept. of Geosciences and Natural Resource Management, University of Copenhagen, Denmark

   Leho Tedersoo, Research Professor, Natural History Museum, Estonia

   T. Martijn Bezemer, Professor, Institute of Biology, Leiden University, Netherlands

   Brief description:
   The research will focus on how to use afforestation as an instrument in combatting climate change by sequestering carbon in trees but also how to use the resulting forests as habitats for species that can help to strengthen biodiversity. The project will investigate whether inoculating former arable land with soil from old forests will make establishing new forests on agricultural land faster and more efficient. The hypothesis is that microorganisms that benefit tree growth are not present in agricultural land and that transplantation can establish the right microbiome to support and accelerate forest restoration.

   "When we plant trees in a field, a forest eventually grows. However, soil processes, the microbiome and plant communities continue to resemble fallow land. Regenerating the soil to support forests may thus take centuries. Our project will explore the transition from field to forest and find methods to turbocharge this development to benefit biodiversity and the environment. In Denmark, we have a plan to double the forest area. This is a massive project that will change the landscape. This generous grant for research on afforestation will ensure that, if all goes well, society will reap additional benefits from the plan," says Per Gundersen.

2. **'SustainScapes – Sustainable Solutions for Maintenance of Biodiversity and Production across Landscapes', DKK 60 million**

Main applicant: Signe Normand, Professor, Department of Biology, Aarhus University

Co-applicant:
Tommy Dalgaard, Professor, Department of Agroecology, Aarhus University, Denmark

Brief description:
The research will help us to understand how changes in land use and climate conditions have historically affected biodiversity across Denmark. Based on the new knowledge, the project will develop tools to predict how and in which land areas restoring ecosystems in relation to agricultural production will most strongly affect biodiversity in the future.

"SustainScapes will rethink how to use the Danish landscape and explore nature-based solutions for protecting biodiversity and bio-based production. We will provide new knowledge about where – and how quickly – we can expect biodiversity to be restored and use data observed from space to track the changes. The project will strive to deliver local, sustainable solutions that benefit biodiversity, the climate and production by linking local and global models that will place local choices in a globalized context. Action requires locally based knowledge. We want to make it easier for the general public and decision-makers to launch local initiatives for a sustainable future," says Signe Normand.

Theme 4: The microbial secretome and the plant cell wall

1. **'Oxygen Constraints on Microbial Secretomes during Plant Cell Wall Turnover (OxyMiST)', DKK 59.9 million**

   Main applicant: Katja S. Johansen, Professor, Department of Geosciences and Natural Resource Management, University of Copenhagen

   Co-applicants:
   Jean-Guy Berrin, Theme Leader, Fungal Biodiversity and Biotechnology Lab, INRAE, France

   Paul Dupree, Professor, Dept. of Biochemistry, University of Cambridge, UK

   Brief description:
   The project will investigate how oxygen contributes to the enzymatic breakdown of carbohydrate in the plant cell wall, thus enabling fungi to absorb nutrients. Specifically, the research will be based on two selected ecosystems: peat soil and wood. These ecosystems are especially interesting because much of the Earth's carbon is stored in them and because the amount of available oxygen varies significantly in these conditions. The project provides an opportunity to improve understanding of an important process in nature. In addition, the results can strongly influence our use of enzymes in other contexts, such as in industry, in which enzymes are used to produce a wide range of products such as fuel, materials and food.

   "The OxyMiST consortium will investigate how oxygen influences the secretion of enzymes by fungi and the enzymatic processes. So far, we have only seen a snippet of what appears to be a rather complicated picture. This will be really exciting!" says Katja S. Johansen.