This document is an executive summary of the strategy that the NNF Center for Basic Metabolic Research, at the University of Copenhagen, is pursuing between 2024 and 2028. Learn all about our research focus, our innovation efforts, our approach to education and outreach, and so much more.

Find contact information and resources on the last page.
The burden of cardiometabolic diseases continues to increase globally. Over the past 40 years, the number of people living with diabetes has quadrupled, while the rate of obesity has tripled. To prevent needless deaths and suffering, there is a demand for research into the biological pathways underpinning these diseases, to support new and effective approaches for their diagnosis, prevention and treatment.

In 2010, the Novo Nordisk Foundation Center for Basic Metabolic Research (CBMR) was established at the University of Copenhagen’s Faculty of Health and Medical Sciences. The Center’s uniquely multi- and interdisciplinary approach combines research in genetics, physiology and pharmacology, to better understand the complex interplay of the many factors that drive cardiometabolic disease.

The Center’s success is reflected in a strong publication record, patents and spinout companies, the training of hundreds of early-career scientists, as well as meaningful outreach and engagement activities that combine humanities perspectives with laboratory science to enrich public discourse about cardiometabolic disease. Thanks to a generous grant of up to DKK 1 billion from the Novo Nordisk Foundation and additional funding from other agencies, the Center can continue its activities for another five years from 2024 to 2028.

Learn more about CBMR in this document, which outlines our ambitious strategy for 2024 to 2028, whose ultimate goal is to transform the basic understanding of cardiometabolic health and disease and accelerate its translation into new prevention and treatment strategies.

Juleen R. Zierath
Professor, Executive Director
CBMR is an academic research center at the University of Copenhagen, located across three floors of the Maersk Tower, at the Faculty of Health and Medical Sciences, and at the Medical Museion. Fifty percent of the staff are drawn from outside Denmark and represent almost 40 different nationalities.

In 2023, the Center carried out an inclusion survey with the help of an impartial external consultant, which revealed that the Center is successfully operating as an inclusive workspace. Insights from the survey provided an effective resource for maintaining inclusivity and developing new initiatives to establish the Center as a beacon in this area, which will be reevaluated periodically.

Funding history
CBMR was established in 2010 based on a generous ten-year DKK 885M (€118M) grant from the Novo Nordisk Foundation (NNF). Since then, CBMR has applied for and secured two more rounds of strategic funding from the NNF, DKK 700M for 2018–2023 (€93M) and DKK 1BN for 2024–2028 (€134M), enabling our Center to excel in its cardiometabolic research, as well as educational and translational activities.

In addition to the core funding granted by the NNF, the Center has, since 2010, obtained an average of DKK 73.5 million (€9.8M) per year from various national and international funding agencies.

Leadership
The Center Leadership Team tracks and promotes scientific and operational performance and charts the Center’s overall research strategy. The Center Leadership Team is responsible for fostering a creative, interdisciplinary and collaborative culture with an international outlook to ensure that Center staff are committed to tackling challenging problems in cardiometabolic health and disease that could not be solved within a single research laboratory. The team meets twice a month and includes the Executive Leadership, research program coordinators, and faculty representatives.
Our Strategy

How CBMR makes an impact through research, education, translation and outreach

CBMR performs fundamental research into the mechanisms underlying cardiometabolic diseases. Our scientists are among the world leaders in human genetics, genomics, physiology and pharmacology, and their discoveries support new approaches to diagnosing, treating and preventing these cardiometabolic diseases.

While Group Leaders at CBMR each pursue their own research questions, they work in a collaborative and interdisciplinary research environment to address scientific challenges that no one research group can tackle alone. The Center also draws on skills, knowledge and techniques from research institutes around the world through research alliances and collaboration agreements.

Every year, CBMR scientists publish hundreds of peer-reviewed papers in top-tier journals and present their research at dozens of seminars and conferences. In addition to publications and presentations, the Center's researchers impact the scientific world and beyond through education, translation and public outreach.

CBMR is embedded in an academic environment at the University of Copenhagen and in the process of doing science we educate students from the Bachelor to PhD level. They play a critical role in the Center's academic research, together with postdoctoral fellows in the early stages of their academic careers. These highly specialized scientific talents are in high demand in academia, the private sector and beyond. To support their future careers, the Center has a range of initiatives to ensure they make a positive contribution whether they choose to continue their careers within or beyond academia.

Through their research, CBMR scientists develop our understanding of the mechanisms underpinning cardiometabolic diseases. Sometimes, these discoveries can be translated into new approaches to preventing, treating and diagnosing these diseases. An Innovation Team is responsible for ensuring that the Center's scientists are equipped with the knowledge and tools to translate their discoveries – from filing a patent to starting a spinout company.

Finally, the Center's research affects society. Cardiometabolic diseases have wide-ranging social, cultural and economic consequences, which are not always fully appreciated. Through the Center's unique collaboration with Medical Museion, the University of Copenhagen's museum for the past, present, and future of medicine, the Center engages the public and key stakeholders in richer social and cultural explorations of cardiometabolic health and disease. These engagement activities are informed by the research of CBMR's Research Program 4 – which brings together historians, philosophers and sociologists with communication specialists and curators.

Vision

To pioneer groundbreaking research towards better cardiometabolic health.

Mission

To lead collaborative interdisciplinary research from single-cell genomics to whole-body systems, transforming the basic understanding of cardiometabolic health, and accelerating its translation into prevention and treatment strategies.
Fundamental Research into Cardiometabolic Health and Disease

Overall focus
At CBMR, 24 Research Groups each pursue their own research questions into the mechanisms that underpin cardiometabolic diseases. This includes the study of:

- genetics & genetic epidemiology
- appetite control
- energy homeostasis
- insulin sensitivity & resistance
- adipose tissue biology
- muscular function
- organ crosstalk

Research Groups also collaborate to answer broader thematic questions in three biomedical Research Programs. These promising areas of scientific investigation reflect the Center’s scientific strengths. Read more about Research Programs on the following pages.

CBMR scientists are further supported by six Enabling Biology and Technology Platforms. Turn to page 20 to read more.

Investments in Precision Health
The “average patient” is a poor representation of the heterogeneous patient population, hampering studies into the underlying causes, and limiting the prediction, prevention and treatment of disease. Our ambition is to stratify patients with cardiometabolic disease into subtypes and identify their distinct genetic and molecular markers, to enable more precise prognoses and treatment options.

Drawing on the humanities
Research Program 4, Cardiometabolic Research in Society and Culture, is an interdisciplinary program with humanities and social science scholars at Medical Museion. Program 4 collaborates with the Center’s biomedical scientists, communication specialists, and external stakeholders to help situate cardiometabolic research and enrich public dialogue. Read more about this program on page 18.

A complex mix of genetic, environmental and lifestyle factors influence a person’s risk of developing cardiometabolic diseases — such as obesity, type 2 diabetes and cardiovascular disease.

This complexity explains why so much about these diseases remains a mystery despite decades of intense research.

To produce a more complete picture of how and why humans develop these diseases, CBMR scientists collaboratively explore the underlying biology across many different levels — from molecules and cells to whole tissues and organs and to whole-body physiology and social context.

These interdisciplinary research projects hope to clarify the complexity and identify different types of patient groups who might benefit from different types of treatment.

To better understand cardiometabolic diseases, CBMR scientists carry out research across biological and societal levels and explore the influence of a range of environmental risk factors (represented by the outer ring of the diagram). In the process, they produce huge volumes of data. CBMR data scientists start to integrate this data to create a virtual (‘in silico’) model of metabolism (represented by the center of the diagram).
Research Program 1 – Human Variation and Functional Genomics

Variation in the human genome and its downstream molecular derivatives are a key driver of cardiometabolic disease. Research Program 1 sets out to identify this variation to help us understand the underlying mechanisms of cardiometabolic diseases and provide molecular insights that will support the Center’s overall purpose of enabling more precise diagnoses, prognoses and treatment options.

Theme 1: Discovery of human variation
Substantial progress has been made in identifying genetic variants associated with broad anthropometric traits. However, more targeted approaches are needed to understand the nuanced phenotypic variations. This theme will discover genetic and molecular variations that drive nuanced molecular heterogeneity among individuals living with, or at risk of progressing to, cardiometabolic traits and diseases.

Theme 2: Variant-to-function
Many genetic associations associated with cardiometabolic traits and diseases have been identified, however, little is known about how the molecular mechanisms exert their effect. This theme applies variant-to-function, single-cell and machine-learning approaches in relevant cell populations to map the genes, molecular processes and cell populations that underlie cardiometabolic disease.

Theme 3: Precision health
Cardiometabolic conditions are complex, multifactorial diseases that result from an intricate interplay between genetic and environmental factors. Despite their complexity, these diseases are typically defined by one simple metric. This theme will dissect the heterogeneity in cardiometabolic disease by identifying molecularly defined homogeneous subtypes.
Research Program 2 – Metabolic Dynamics and Organ Crosstalk

Streams of molecules are released from cells in response to energetic stressors like diet, exercise and temperature. These molecules then transmit signals within and outside tissue and organs, playing a crucial role in regulating metabolism. Research Program 2 sets out to understand what regulates these processes and how cellular and organ crosstalk is regulated during healthy and cardiometabolic disease conditions. The program also investigates how circadian rhythm controls metabolism and how energetic stressors affect the rhythm.

Theme 1: Energetic stress and metabolic dynamics
Exercise protects against the development of cardiometabolic diseases, but the molecular mechanisms behind these protective effects are poorly understood. This theme investigates how energetic stress, including exercise and temperature, interacts with circadian rhythm to regulate a healthy metabolism and counteract obesity and other cardiometabolic diseases.

Theme 2: Multiomics and computational framework
Cells release complex signatures of proteins, peptides and metabolites. Research Program 2 applies multiomics technologies across tissue types, cell types and body fluid samples, harvested during distinct metabolic conditions, to understand the complex metabolic crosstalk and how this is dysregulated during cardiometabolic disease. Disentangling the complexity of the data during organ crosstalk will help to identify new drug candidates.

Theme 3: Human in vitro models and high-content screening
To address organ crosstalk and candidate molecules identified within the multiomics screenings, Research Program 2 develops human in vitro models including 3D-cultures, co-culture systems and organoids, using primary cultures from clinical cohorts or human induced pluripotent stem cells. Examples of target cells are adipocytes, myocytes, hepatocytes, neurons and cardiomyocytes.
Research Program 3 – Physiological Control of Metabolic Homeostasis

Disturbances to energy homeostasis – the body’s processes that maintain a metabolic balance – lead to a range of diseases across different organ systems. Research Program 3 identifies the signaling networks that underly homeostatic control of metabolism at the molecular, cellular and tissue levels and determine how these mechanisms are integrated to shape whole-body energy balance. There is a specific focus on interactions between the central nervous system (CNS) and peripheral tissues that ensure coordination of systemic homeostasis. Finally, Research Program 3 will continue pursuing the development of innovative pharmaco-therapies for counteracting cardiometabolic diseases.

Theme 1: Nutrient and bioenergetic control of cellular homeostasis
The body can become metabolically dysfunctional if cells lose their ability to sense and communicate disruptions to the energy balance. This theme uncovers cell-specific nodes of metabolic control that would serve to expand the understanding of protective biological mechanisms and reveal novel targetable strategies to improve cardiometabolic health.

Theme 2: Coordination of homeostatic programs between the CNS and periphery
Mammalian body weight is regulated by biological mechanisms that match energy intake to energy expenditure. Often this involves bidirectional coordination between the periphery and CNS through ‘hard-wired’ efferent and afferent neuronal communication and via secreted factors, such as hormones and signaling metabolites and lipids.

Theme 3: Physiological defense of cardiometabolic homeostasis
This theme investigates the molecular underpinnings of the body’s metabolic adaptations, for example to nonambient temperatures or dietary challenges with excess calories. By understanding key regulatory nodes and mechanisms underlying these physiological responses, we can develop more targeted strategies for modulating energy balance and improving cardiometabolic health.

A graphical abstract for Research Program 3.
Research Program 4 – Cardiometabolic Research in Society and Culture

Research Program 4 connects CBMR’s fundamental scientific and innovation work to big questions about what it is like to live with cardiometabolic diseases, what impact scientific knowledge has on people’s understandings of their bodies and wellbeing, and even more broadly how these scientific ideas shift understandings of the human condition.

Theme 1: Research culture and communication
Contemporary science (particularly in biomedical fields) is taken up by different publics through different media. This theme investigates how efforts to disseminate ideas succeed, but also sometimes falter, and what can be learned from the relationship between promises and disappointments as well as misunderstandings, both in society and science.

Theme 2: Art and metabolism
Mutual illumination emerges at the intersections of science and art. But what understandings result from the occasional gaps of comprehension? And how can collaborations across this classic intellectual and temperamental divide engage broader parts of society, especially those with ‘lived experience’?

Theme 3: Diagnosis and disease categories
This theme asks how concepts and protocols of diagnosis move between the worlds of laboratory research, clinical analysis, and patient interaction. What role do instruments, techniques and practices play in each context, and how do they facilitate the translation of ideas and evidence between them?

Theme 4: Museums and stakeholder engagement
Research-led museums like Medical Museion are positioned between the ‘ivory tower’ of academic research and the public realm of a cultural venue. How has that situation evolved in the last couple of centuries? What are the range of ways in which such an institution today can be most effective at involving and listening to interest groups and the general public, as well as disseminating scientific knowledge to them?

The Stakeholder Engagement Platform brings together actors from multiple sectors to animate connections between science and society.

Public Engagement and Outreach

Obesity, diabetes and cardiovascular disease are pervasive and impact people in all sectors of society. This makes it essential that society is equipped to have nuanced discussions about how cardiometabolic diseases affect us, and the potential of scientific research and translation to improve things.

To engage diverse publics in richer social and cultural explorations of these topics, Medical Museion collaborates with Center scientists to produce award-winning, high-impact events and exhibitions, both in their own spaces and in collaboration with other cultural institutions. Medical Museion’s Stakeholder Engagement Platform also helps bridge fundamental research into society-at-large, by bringing together people from the multiple sectors who form and animate the big questions around this important research.

The World is in You
In 2021, Medical Museion curated the exhibition ‘The World is in You’ at Kunsthal Charlottenborg. The exhibition contained a mixture of pieces of art – from paintings to video installations, objects from Medical Museion’s collections and other scientific and historical objects. Moving through the themes of Space, Time, Microbes and Generations, this multidisciplinary display explored the entanglement of our bodies and minds with the environments that surround us. In the latter three themes, the exhibition drew directly on science conducted at CBMR. In 2022, Medical Museion won the communication award Formidlingsprisen for this exhibition.

The World is in You at Kunsthal Charlottenborg.
Photo: David Stjernholm
Enabling Biology and Technology Platforms

CBMR has six enabling biology and technology platforms to advance the Center’s basic research questions. These shared platforms, which are increasingly open to the regional research ecosystem, also encourage collaboration and aim to empower scientists to accelerate their impactful discovery and innovation efforts.

**Single-Cell Omics Platform**
Most tissues are inherently complex and require investigations at the single-cell level. To address this challenge, the Single-Cell Omics Platform (SCOP) was established to provide access to cutting-edge single-cell, spatial and standardized transcriptomics/epigenomics techniques. SCOP’s profound experience in laboratory work, programming, data visualization and machine learning enables CBMR researchers to address questions at the single-cell resolution through tailored guidance and support at all stages of a research project, from project planning, library preparation and sequencing to computational data analysis.

**Rodent Metabolic Phenotyping Platform**
The Rodent Metabolic Phenotyping Platform (RMPP) assists CBMR scientists in the planning, performance, and analysis of cardiometabolic in vivo experiments in rodents, using state-of-the-art procedures and technology. A major focus point of RMPP is to reduce stress in research animals. This is achieved by using catheters and implants to minimize handling, and through a strict focus on aseptic technique, when performing surgical procedures. Through the expertise provided by the RMPP staff, CBMR researchers can generate high-quality data while maintaining good animal welfare.

**Metabolomics Platform**
The ambition of the Metabolomics Platform is to support the development of analytical strategies for metabolomics-driven systems biology in personalized health strategies through cutting-edge and tailored metabolomics techniques. The platform provides access to advanced analytical instrumentation, consultation with regards to experimental design and analysis, conducts targeted and untargeted metabolomics and lipidomics analyses and is developing expertise in tracer and flux analysis studies. The platform also provides advanced bioinformatics and statistical analyses.

**Computational Chemistry Unit**
A major challenge in drug discovery and development is to transform early-stage projects into valuable assets through robust target validation studies. The Computational Chemistry Unit (C3U) develops and implements computational technologies to accelerate structure-based discovery and medicinal chemistry synthesis of innovative pharmaceutical tool compounds and drug candidates. These compounds are crucial for investigating the physiological roles of newly identified metabolic target proteins and their connection to treating cardiometabolic diseases. The compounds lay the groundwork for innovative translational research, enabling out-license agreements and the formation of spinout companies.

**Data Analytics Platform**
The Data Analytics Platform (DAP) is being established during this grant period to allow scientists to seamlessly integrate multidimensional, high-resolution data from diverse sources in a state-of-the-art supercomputing environment. The Platform is designed to facilitate data-driven research among scientists locally, nationally and internationally. Seemingly disparate data can be connected into coherent analysis environments thereby allowing scientists to model molecular and phenotypic variations driving nuances in individuals at risk of developing, or living with, cardiometabolic traits and diseases.

**Genetic Perturbation Platform**
Scalable and causal models are required to systematically link genetic variations to genes and genes to specific molecular phenotypes. CRISPR-based perturbation screens are essential for understanding how genetic variations contribute to complex trait heterogeneity by revealing causal relationships between variants, genes and phenotypes. The Genetic Perturbation Platform (GPP) will allow CBMR scientists and collaborators to dissect the genetic basis of complex traits through providing large-scale CRISPR-based genetic perturbation screening tools for cell lines and primary cells derived from Danish cohorts.
Translation Strategy

Cultivating an Entrepreneurial Mindset
CBMR takes a proactive approach in translating fundamental research discoveries into transformative treatments and therapies. Our proven record includes patent applications and successful spinout companies. An Innovation Team has been appointed to strengthen the entrepreneurial mindset across the Center and to connect researchers to support structures that drive innovation.

Transforming Discovery to Therapy
The CBMR Innovation Team supports innovation processes across the center. This includes support with securing of intellectual property rights, proof-of-concept/pre-seed fundraising, guidance on industry partnerships and the development of spinout companies.

The CBMR Innovation Summit
Starting in 2024, the CBMR Innovation Summit will bring together global leaders from academia, biotech, pharma and the healthcare sector to focus on next-generation prevention and treatment strategies for cardiometabolic disease. The Summit will address thematic issues revolving around the pressing global challenges as well as opportunities connected with cardiometabolic science and innovation.

In the autumn of 2023, the Center held its first Innovation Workshop. Among the speakers was Trine Wintere, Vice Dean for Innovation and External Relations at the Faculty of Health and Medical Sciences.

CBMR scientists have lodged 19 invention disclosures since 2018 and established a number of successful spinout companies.

Embark Laboratories
CBMR co-founders: Associate Professor Zach Gerhart-Hines, Professor Thue W Schwartz.

Originally founded as Embark Biotech, the spinout was established to identify novel cell surface receptors that physiologically regulate fat tissue calorie-burning and glucose and lipid uptake. In 2023, Novo Nordisk A/S acquired Embark Biotech in a deal worth up to €456 million. The founders continue their work in the newly formed Embark Laboratories.

Ousia Pharma
CBMR co-founders: Associate Professor Christoffer Clemmensen, Postdoc Jonas O Petersen, Staff Scientist Anders Bue Klein.

Ousia Pharma is developing next-generation weight loss therapies. Their clinical lead candidate (OP-216), a first-in-class triple-acting peptide-drug conjugate, targets hypothalamic neuroplasticity to drive a potent and sustained weight loss.

Solid Therapeutics
CBMR co-founders: Professor Thue W Schwartz, Associate Professor and Head of the Computational Chemistry Unit Thomas M Frimurer, Postdoc Mette Trieu Larsen.

Solid Therapeutics is working on novel and innovative therapeutic principles focused on inhibition of tumor-cell metabolism and immune-evasion by targeting receptors for oncometabolites. It builds on the discovery that cancer cells only survive in the harsh microenvironment inside a tumor by upregulating cellular sensors for key metabolites secreted by stressed cancer cells.
External Collaborations

Cardiometabolic research covers an enormous span of knowledge and disciplines and requires a well-equipped toolbox of techniques and approaches, as well as access to clinically relevant materials.

CBMR cannot investigate the entire cardiometabolic research field alone — that’s why the Center has forged strategic external collaborations/alliances with research institutes and hospitals that have unique expertise in approaches, techniques, skills and tools the Center lacks and which complement and advance the Center’s work.

The Center already has several successful collaborations/alliances in place, which support more impactful discoveries, publications and public dialogue. Examples of research alliance partners include, University of Michigan (USA), the Weizmann Institute of Science (Israel), University of Dundee (UK), University of Oxford (UK), Karolinska Institutet (Sweden), and the Swedish University of Agricultural Sciences (Sweden).

To identify fundamental cardiometabolic research questions related to diseases and to translate discoveries into improved health, CBMR has initiated a number of collaborative studies with clinical centers across Denmark and Greenland. Examples of clinical questions and translation of discoveries are:

1. non-autoimmune diabetes and complications related to diabetes
2. children and adolescents living with obesity and early detection of obesity-related complications
3. early detection and characterization of steatotic liver disease
4. the role of brown fat in cardiometabolic health
5. defining the effects of nicotinamide riboside (NR) treatment on aging skeletal muscle regeneration and stem cell function.

Novo Nordisk Foundation Center for Genomic Mechanisms of Disease

In 2021, CBMR established a strategic collaboration with the Novo Nordisk Foundation Center for Genomic Mechanisms of Disease at the Broad Institute, USA, to strengthen its ability to translate human genetic discoveries into cardiometabolic disease mechanisms. The aim of the Novo Nordisk Foundation Center for Genomic Mechanisms of Disease is to accelerate our understanding of how human genetic variants affect risk of common complex diseases, such as type 2 diabetes, obesity and other cardiometabolic outcomes. Its approaches complement those used at CBMR.

Education and Training

Scientific education
CBMR is committed to educating the next generation of scientists, regardless of whether they remain at the Center or go on to make an impact elsewhere — in academia, industry, biotech, the clinics or beyond. We have educated hundreds of PhD students, a group that comprise a third of our overall staff numbers, and many Master students choose a CBMR Research Group to carry out a project. CBMR scientists also contribute to Bachelor, Master and PhD courses at the Faculty of Health and Medical Sciences, both through research-based teaching and design of specialized courses.

Curious about doing a Master project at CBMR? Scan the link to see what projects are available.

The CBMR International PhD and Postdoc Program
The program supports competitive national and international recruitment of PhD and Postdoc fellows to CBMR. The fellowships are aimed at early-career researchers with a basic science background or clinicians who aspire to a career in biomedical sciences. We are particularly interested in candidates who are familiar with integrative research approaches within the broad area of basic research with an application towards cardiometabolic diseases.

Developing talent
It is essential for research leaders to acquire and develop strong leadership skills to manage the challenges of scientific work, support a productive environment for diverse staff groups, and communicate with a range of stakeholders. CBMR, therefore, offers a comprehensive and holistic talent development program for scientific staff of all levels. This includes mentoring, peer coaching, leadership and management training, pedagogical training and career development.

The Center’s annual conference Metabolism Day offers early-career researchers an opportunity to practice their poster presentation skills.
Stay in Touch

You can stay in touch with CBMR in a variety of ways. Our social media platforms are regularly updated, and our latest job listings and educational opportunities can be found on our website.

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