Northwestern Medicine®

Robert H. Lurie Comprehensive Cancer Center of Northwestern University

# Center for Molecular Aging and Cancer

## Using Human Population Data to Understand Aging-Related Diseases

# CENTER FOR MOLECULAR AGING AND CANCER

## Using Human Population Data to Understand Aging-Related Diseases

Age is a cause of cancer and many other diseases. However, each individual ages differently, leading to diversity in people's disease development. The Robert H. Lurie Comprehensive Cancer Center of Northwestern University has launched a new Center for Molecular Aging and Cancer (CMAC), a joint venture with the Department of Preventive Medicine at Northwestern University Feinberg School of Medicine.

The Center will unite Northwestern's experts in the new and exciting fields of population science, molecular biology, and "big data" technology to develop and expand new measures of human age at the molecular level, using:

- Cutting-edge laboratory technologies;
- Rich and in-depth lifelong data collected from large groups of men and women of diverse races and ethnicities living around the world;
- Advanced analytical approaches that integrate big data across multi "omic" measures to study your gene, gene regulators, metabolites, proteins, lipids, as well as your bacteria population in the gut to develop novel, precise molecular techniques for early diagnosis and precision prevention of cancer and its comorbidities (e.g., cognitive impairment, diabetes, and cardiovascular diseases);
- Integrated data from diverse molecular pathways with pre-clinical abnormalities in specific organ systems measured from modern diagnostic imaging to develop accurate predictors of organ-specific molecular aging using novel analytics, such as machine learning methods.

## CMAC: Potential for Evidence-based, Data-driven, and Scalable Population Studies

CMAC aims to expand the scope of Northwestern's current population research into more evidence-based, data-driven, and more importantly, scalable, molecular population studies by measuring human age at the molecular level and how accelerations in molecular aging can influence the development of cancers and other aging-related conditions and diseases. Through our innovative approaches, CMAC will establish a database of human molecular age by measuring our DNA, mitochondria, telomere length,and mutations. The long-term goal is to apply molecular age measures to the clinical setting to help early diagnosis of cancer, finding individuals who need a doctor's attention for screening, close follow-up, and inventive measures to prevent them from developing cancer.

This effort is led by Lifang Hou, MD, PhD, professor of Preventive Medicine and chief of the Division of Cancer Epidemiology and Prevention. Dr. Hou is a world-renowned scientist working at the forefront of efforts to develop new biological tools for cancer early detection and precision prevention. Dr. Hou is a member of the National Cancer Institute's Blue Ribbon Panel, providing scientific guidance to the White House's Cancer Moonshot Initiative, the nation's precision medicine program specifically targeting cancer prevention and early detection.

We know that our lives are filled with many powerful influences on how fast we age at the biological level. Every day, we are exposed to a variety of stressors that affect the way we grow, function, and live. These include not only what we breathe, eat, and drink but also our everyday lifestyles, communities, behaviors, and environmental and social stressors—even infections with bacteria, viruses, and fungi.

The molecular impact of these exposures can now be objectively measured in the laboratory via advanced high-throughput technologies, and accurately measuring human age at the molecular level is possible now. This offers several exciting potential applications for disease prevention, diagnosis, and treatment.

Dr. Hou has pioneered studies of molecular age and has already found that blood-based molecular age measurements predict several diseases such as cancer. We envision molecular aging being used in a simple blood test that will help doctors diagnose harder-to-cure but easier-to-prevent diseases.

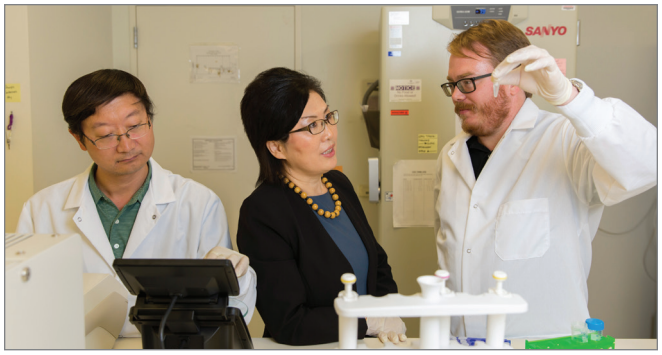
"Through the Center for Molecular Aging and Cancer, we aim to scale up our efforts to the level demanded by the sheer quantity of data represented by the new frontier of precision medicine."

Lifang Hou, MD, PhD, Director of the Center for Molecular Aging and Cancer, Chief of Cancer Epidemiology and Prevention in the Department of Preventive Medicine, and member of the National Cancer Institute's Blue Ribbon Panel for White House Cancer Moonshot Precision Medicine Initiative

Behaviors and exposures can affect our molecular aging by causing accelerated telomere shortening. Here you can see a representation of the shortening of telomere caps on chromosomes.

This is particularly important for cancers, due to their lethality and resistance to treatment if they are not detected early enough. Measuring molecular aging will find those who are likeliest to develop cancer or who have it when it is just a handful of cancerous cells hidden somewhere in the body, and guide prevention and treatment strategies personalized to individuals' biology and molecular age. Furthermore, molecular age changes in response to treatment, not just disease. Thus, the same blood test can also help doctors measure how effective a treatment is much faster than current methods—ensuring that it is successful before it is too late.

For example, one of cancer's defining characteristics is widespread dysfunction in the molecular controls of cell behavior, biology, and aging. These include telomeres, caps on the ends of our chromosomes that protect our genetic integrity and shorten with age. This process can be accelerated under environmental and behavioral influences, aggravating cancer risk. Dr. Hou's research team at CMAC found that the early transformation of cancer appears to first further accelerate, and then halt, this telomere shortening process. This dysfunction protects the malignant cancer cells from the human body's own defensive mechanisms. In-depth research on this early event will have extremely valuable clinical applications. We may be able to therapeutically target this dysfunctional "protection," inducing cancer cell death and providing a new, effective, safe, and targeted prevention and/or therapy for cancer. Thus, measures of molecular aging allow "precision medicine" strategies in cancer care, providing physicians with the tools to target cancer when it is most vulnerable and where it is most vulnerable.




Cancer is particularly susceptible to molecular aging changes, making it an ideal disease to study. However, molecular aging can be used to measure one's susceptibility to a variety of aging-related diseases like cardiovascular disease, Alzheimer's disease, and diabetes. Dr. Hou's team at CMAC has conducted research on a number of molecular and biological aging biomarkers using lifelong exposure, lifestyle, and medical data, and successfully applying them to predictive models of several diseases. The research findings have been related to several aging-related diseases. Dr. Hou's team is currently developing organ-specific aging measures by combining blood molecular aging measures with clinical and imaging data of specific organs for accurate organ-specific aging prediction and disease diagnosis.

## Our Lives, Our Age, Our Health

Lifestyle recommendations made by professional societies, such as AHA, ACS, and ADA, to help prevent cardiovascular disease, cancer, and other aging-related diseases were first introduced decades ago, yet these diseases still remain potent killers today. Currently we have no way to measure the full biological impact of activities such as smoking, losing weight, or even the passage of time. We have no way to know why lifestyle changes prevent disease in some people but not others, and we don't know how quickly we need to act to prevent diseases. Molecular aging has potential of answering all of these questions, providing us with, for the first time, a biological measurement to quantify the impact of behaviors and environments on human health. This can help all of us understand the biological impact of our efforts to live healthier lives.

Investigations into molecular aging and its biomarkers offer us the opportunity to identify the ways in which nutrition, exercise, and other everyday activities can alter cells, and which parts of them are most susceptible to disease-promoting changes. For example, in the case of cardiovascular

"The new Center for Molecular Aging and Cancer at the Lurie Cancer Center will have a big impact on our efforts to prevent cancer by detecting malignant diseases, identifying individuals susceptible to cancer, and ultimately developing strategies to effectively intervene early in the process."

Leonidas Platanias, MD, PhD, Jesse, Sara, Andrew, Abigail, Benjamin, and Elizabeth Lurie Professor of Oncology and Director, Robert H. Lurie Comprehensive Cancer Center of Northwestern University

aging the transition from optimal to poor cardiovascular health appears to occur over many years before doctors can detect clinical changes. By better understanding these molecular changes, we can intervene during this critical period more intensely, potentially preventing cardiovascular disease. By understanding the full trajectory of molecular aging, we can understand the optimal age at which lifestyle changes are needed to prevent disease.

Beginning to understand the molecular aging processes by linking lifestyle and social exposures to disease development will create the potential for precision disease prevention recommendations, with a tremendous capacity to save lives and improve quality of life through tailored treatments. For instance, think of daily nutritional allowances designed specifically with your molecular age, gender, and race in mind. A better understanding of how these exposure-induced molecular processes interact will also open the door to the development of newer drugs, based on the foods you eat and things you do every day, to give us effective new options for preventing cancer and other diseases.

## Vision for the Future

Beyond targeting age-related diseases, we aim to target the underlying aging process. In order to do so effectively, we need large amounts of data ("big data") from real people. The larger and more diverse these populations are, the more powerful and sophisticated analyses population scientists can perform. Dr. Hou has already developed a worldwide reputation as a specialist in the unique challenges of studying molecular aging as a predictor of disease risk and an indicator of disease progression. A fully supported center will offer a greatly enhanced ability to conduct more powerful, larger-scale population-based research on molecular aging and facilitate powerful new discoveries. A dynamic and dedicated team at CMAC will foster collaborations with researchers around the world.

We aim to scale up our efforts to the level demanded by the sheer quantity of data represented in the new frontier of precision medicine to achieve three goals:

- Develop molecular aging as a simple blood test useful for the early diagnosis of cancer and other aging-related diseases.
- Use molecular aging to target precision prevention initiatives at the right age, tailored to every person's lifestyle, genetics, and disease risk and thus stopping aging-related diseases from developing before they can become fatal or debilitating.
- Apply molecular aging to guide the treatment of aging-related diseases—making it safer and more effective, and improving quality of life in patients after they complete treatment.

Our mission through these goals is to help current and future aging populations not only live longer but do so happily, independently and healthily.

## A Call for Support

Northwestern Memorial HealthCare and Northwestern University Feinberg School of Medicine are seeking to impact the health of humankind through Northwestern Medicine. Our commitment to transform healthcare and to be among the nation's top academic medical centers will be accomplished through innovation and excellence. At the Lurie Cancer Center and medical school, we recognize that every positive contribution we have made to cancer care, research, and education has been made possible by generous donors who have entrusted us with their philanthropic support.

We invite loyal donors and interested friends to join Dr. Hou and her colleagues in advancing the **Center for Molecular Aging and Cancer**. Your gifts of outright support and endowment will provide the resources we need to introduce breakthroughs that will improve the diagnosis and treatment of people living with cancer today and in the future.

## For information about supporting the Center for Molecular Aging and Cancer, please contact:

Terri Dillon
Northwestern University Feinberg School of Medicine
Development & Alumni Relations
420 E. Superior Street Rubloff Building-9th Floor
Chicago, IL 60611
Phone: 312-503-4837
Email: terri-dillon@northwestern.edu

Learn more about the Lurie Cancer Center's patient care, services and programs, research and education, clinical trials, and faculty at cancer.northwestern.edu

Northwestern Medicine®

Robert H. Lurie Comprehensive Cancer Center of Northwestern University