

HEALTHY LONGEVITY GLOBAL COMPETITION

2025 Catalyst Awardees

Sponsor: National Academy of Medicine

ACILIA

Principal Investigator	Tony Ma
PI Primary Affiliation	Benten Technologies, Inc.
Co-Investigator(s)	Katie Chang

PROJECT DESCRIPTION

ACILIA is an AI-powered smart speaker and mobile app platform that integrates with wearables and IoT devices to support informal care partners of individuals living with Alzheimer's disease and related dementias (ADRD). In the U.S., over 40 million unpaid caregivers provide essential support, including 1.5 million who care for individuals in the early stages of dementia. These caregivers often experience chronic stress, burnout, and social isolation, leading to negative health outcomes for both themselves and the individuals they care for. Existing solutions focus on professional care or occasional interventions, failing to offer continuous, personalized, and proactive support.

ACILIA transforms caregiving by combining artificial intelligence, natural language processing, and sentiment analysis to deliver real-time, just-in-time (JIT) education, emotional support, and stress reduction. The platform fosters social connectedness, enhances behavioral health, and empowers caregivers with AI-driven insights that improve care quality. By integrating into smart-enabled homes and healthcare systems, ACILIA simplifies access to support, reducing caregiving burden while promoting dignity, well-being, and aging in place.

With healthcare costs rising and policies shifting toward home-based care models like CMS GUIDE, ACILIA provides an innovative, scalable solution that enhances healthy longevity. It advances technology-enabled elder care services, aligning with behavioral health, healthcare delivery, and AI-driven interventions to extend the healthspan of caregivers and individuals with ADRD. By improving functioning, engagement, and mental well-being, ACILIA reimagines caregiving as a transformative, technology-enabled experience that enhances quality of life for aging populations.

Breaking the Inflammation-Senescence Cycle: A Targeted Multimodal Approach to Extend Healthspan

Principal Investigator	Yori Endo
PI Primary Affiliation	Mass General Brigham
Co-Investigator(s)	None

PROJECT DESCRIPTION

Breaking the Inflammation-Senescence Cycle: A Targeted Multimodal Approach to Extend Healthspan. As we age, our tissues accumulate senescent cells that secrete inflammatory factors, which in turn induce more senescence in neighboring cells. This self-perpetuating cycle of inflammation and senescence fundamentally drives the aging process itself and accelerates multiple age-related pathologies. Current interventions targeting either senescence or inflammation in isolation fail to break this cycle effectively.

We propose a novel multimodal nanoliposome delivery platform that simultaneously disrupts this cycle at three critical points: eliminating existing senescent cells, neutralizing inflammatory signals, and epigenetically rejuvenating pre-senescent cells. The platform features dual-targeting technology that specifically homes to both senescent cells and inflammatory microenvironments through antibodies against unique surface markers. Our innovative temporal release mechanism delivers each therapeutic component in a precisely timed sequence to maximize synergistic effects.

This approach directly addresses a fundamental mechanism of aging rather than treating individual symptoms or diseases. By simultaneously targeting multiple nodes in the inflammation-senescence network, we can potentially reverse biological age at the tissue level and restore youthful function.

The technology builds on established foundations in nanoparticle delivery and cellular reprogramming while innovating in their combined application. Initial testing will focus on adipose tissue and vasculature, with comprehensive measurements of senescent cell burden, inflammatory markers, epigenetic age, and physiological function. Success could transform how we approach aging, shifting from disease management to addressing the core drivers of biological decline.

CAR-microglia for the treatment of Multiple Sclerosis

Principal Investigator	Lawson Brian
PI Primary Affiliation	The Scintillon Institute
Co-Investigator(s)	None

PROJECT DESCRIPTION

Multiple sclerosis (MS) is a debilitating autoimmune disease in which T and B lymphocytes infiltrate the central nervous system (CNS), attacking myelin sheaths and leading to progressive neurological decline. The disease becomes more prevalent and severe with age. While current therapies moderate relapses, they often suppress the peripheral immune system and do not selectively target pathogenic cells within the CNS. In this project, we propose a very novel, localized immunotherapy strategy that utilizes the resident immune cells of the CNS—microglia (MG)—to achieve targeted immune modulation without systemic toxicity. We will employ advanced chimeric antigen receptor (CAR) designs to engineer MG (CAR-MG) that specifically recognize and eliminate autoreactive T and B cells in the CNS. Additionally, we will develop “armored” variants that secrete neurotrophic and myelin repair factors to promote functional recovery. First, we will design a panel of CAR-MG constructs targeting pan-T/B cells and specific T-cell subsets, such as Th17 cells. These constructs will incorporate MG-specific promoters, safety switches, and inducible gene expression systems. Second, we will evaluate the therapeutic efficacy of CAR-MG in the well-established experimental autoimmune encephalomyelitis (EAE) mouse model of MS, assessing neuroinflammation, demyelination, and functional recovery. We will also confirm that CAR-MG can be rapidly ablated if necessary. This research can address critical gaps in MS treatment by confining CAR-based immunotherapy to the CNS and providing MG with neuroprotective capabilities. If successful, our platform will promote long-term immune tolerance in the CNS, preserve peripheral immunity, and enhance myelin repair, potentially revolutionizing MS care.

Decoding Resilience: AI-Driven Imaging to Extend Mobility and Strength in Aging

Principal Investigator	Rachel Surowiec
PI Primary Affiliation	Purdue University
Co-Investigator(s)	Stuart Warden

PROJECT DESCRIPTION

As people age, the ability to move, function, and remain independent is essential for quality of life. Yet musculoskeletal (MSK) health remains one of the most overlooked aspects of longevity, despite fractures and mobility loss leading to rapid declines in health, independence, and survival. Existing clinical tools fail to detect early skeletal fragility and muscle deterioration, leaving millions at risk for life-altering fractures without warning. Our goal is to shift the focus from merely predicting risk to identifying resilience—those who maintain function despite aging-related changes—allowing for personalized strategies that extend mobility and independence.

We will achieve this by applying artificial intelligence (AI)-driven radiomics to high-resolution bone imaging, transforming medical images into a powerful biomarker discovery tool. This approach extracts subtle, quantitative features invisible to the human eye, revealing early patterns of skeletal decline long before fractures occur. Our team has already demonstrated that radiomics can distinguish fragile from healthy bone with near-perfect accuracy in chronic kidney disease, a breakthrough now poised for a catalyst in aging populations.

To validate this approach, we will study individuals undergoing rapid weight loss treatments, a population experiencing accelerated MSK changes, allowing rigorous AI-model testing while addressing urgent gaps in understanding how these widely used interventions impact MSK health. If successful, this technology will seamlessly integrate into clinical workflows, enabling AI-driven screening for early intervention and personalized prevention. This work will transform MSK care from reactive treatment to proactive precision medicine, extending mobility, independence, and healthy longevity on a global scale.

Democratizing AI-Driven Biological Aging Insights via Routine Medical Imaging and Laboratory Biomarkers

Principal Investigator	Paul Yi
PI Primary Affiliation	St. Jude Children's Research Hospital
Co-Investigator(s)	None

PROJECT DESCRIPTION

Accurately assessing biological aging is essential for identifying individuals at risk for accelerated aging, enabling timely intervention. While epigenetic clocks provide an objective measure of biological age, their high cost and limited accessibility hinder widespread clinical adoption. We propose an AI-driven approach to extract aging biomarkers from routine medical imaging (CT, DEXA) and laboratory tests (e.g., CBC)—datasets already collected in clinical practice but underutilized for aging assessments. Using a unique cohort of over 6000 childhood cancer survivors, a population at high risk for accelerated aging, we will train AI models to predict biological age based on longitudinal imaging and lab data. To ensure generalizability, we will validate these models on both an independent hold-out set of cancer survivors and an external test set of age and sex-matched non-cancer controls, bridging insights from a high-risk group to the broader aging population. While epigenetic aging clocks will serve as our primary validation metric, we will cross-validate predictions against other established aging measures, including telomere length, frailty index, and cognitive function. Statistical validation will include correlation analyses to ensure biological and clinical relevance. To enhance interpretability, we will integrate deep learning for high-dimensional feature extraction, classical machine learning for explainability, and radiomics-based models for transparent biomarkers. This scalable, cost-effective framework can be immediately implemented in real-world settings, transforming routine clinical data into widely accessible aging biomarkers. By integrating AI with existing medical practice, our approach aligns with NAM's mission to advance healthy longevity through bold, innovative solutions.

Design of mitochondrial precision therapeutics through an AI-guided synthetic biology approach to enhance myocyte resilience and durability

Principal Investigator	Mariëlle van Kooten
PI Primary Affiliation	Powerhouse Biology, Inc.
Co-Investigator(s)	Rachel Jacobson

PROJECT DESCRIPTION

Mitochondrial dysfunction has been causally linked to aging and sarcopenia, yet current therapies fail to target mitochondria directly. Powerhouse Biology is developing AI-driven synthetic mitochondrial therapeutics to enhance cellular resilience and durability that will translate to improved human health outcomes. This project focuses on designing and validating synthetic mitochondrial assets, leveraging insights from resilient species and applying them to physiologically relevant human myocyte preclinical models.

Building on our expertise in sarcopenia and AI-guided drug discovery, we will computationally design mitochondria-targeted assets inspired by evolutionary adaptations. We will then test their effects on mitochondrial function in human skeletal muscle cells. Finally, we will optimize, and validate synthetic mitochondrial assets that enhance mitochondrial function to meet natural demands.

A successful outcome will validate synthetic mitochondrial enhancement in human cells, providing a foundation for novel therapeutics that prevent rather than cure muscle weakness. The NAM Catalyst Award will accelerate proof-of-concept development of novel AI-guided synthetic designs of mitochondria-centric precision therapeutics.

Design of wearable, non-invasive system for sleep enhancement

Principal Investigator	Huiliang Wang
PI Primary Affiliation	University of Texas at Austin
Co-Investigator(s)	Vincent Mysliwiec

PROJECT DESCRIPTION

As people age, deep, restorative sleep—called slow-wave sleep—declines significantly. This loss of deep sleep contributes to memory problems, cognitive decline, and increased risk for diseases like Alzheimer's. Poor sleep also weakens the immune system, increases inflammation, and accelerates biological aging. Despite the critical role of sleep in healthy aging, there are no safe, effective, and easy-to-use technologies that can actively enhance deep sleep at home.

We propose developing NEUSleep, a wearable, non-invasive sleep patch that uses real-time brain monitoring combined with focused ultrasound stimulation to enhance slow-wave sleep. The patch records brain activity using soft, long-lasting EEG electrodes and tracks sleep stages throughout the night. When deep sleep begins, the system delivers gentle ultrasound pulses to specific brain areas responsible for promoting sleep—the ventrolateral preoptic area (VLPO) and median preoptic nucleus (MnPO). These regions naturally help the brain shift into and maintain deep sleep, and scientific research has shown that stimulating them enhances slow-wave sleep.

NEUSleep's closed-loop system automatically adjusts stimulation based on each user's brain activity, providing personalized sleep enhancement without disrupting natural sleep cycles. The patch is designed to be comfortable, wireless, and suitable for long-term home use.

By enhancing deep sleep, NEUSleep could improve memory, cognitive function, and emotional well-being, while also supporting immune health and reducing age-related inflammation. If successful, this innovative technology could help older adults maintain brain health and resilience, extending healthy lifespan and improving quality of life.

Digital Care Team for AD Risk Assessment: Integrating Retinal Biomarkers, RWD, and AI-Driven Analysis for Early Detection

Principal Investigator	Yu Huang
PI Primary Affiliation	Indiana University
Co-Investigator(s)	Jiang Bian

PROJECT DESCRIPTION

Alzheimer's Disease (AD) is the most common cause of dementia, yet early detection remains a significant challenge, leading to delayed interventions and poorer outcomes. Current diagnostic tools are often invasive, expensive, or inaccessible in primary care settings, contributing to widespread underdiagnosis. Existing evidence suggests that retinal changes, particularly in vascular structure, serve as early biomarkers for AD onset. Therefore, integrating retinal imaging biomarkers with personal characteristics (e.g., demographics, comorbidities, medications), powered by AI techniques, holds great potential for developing a non-invasive AD risk screening tool.

This project proposes an innovative AI-driven screening tool that combines retinal imaging biomarkers with real-world data to enable early AD risk assessment. The tool can automatically extract retinal information from non-invasive imaging techniques, such as Optical Coherence Tomography, and integrate it with patient history from electronic health records to create a personalized risk profile. Additionally, this tool is supported by a digital care team composed of AI agents specializing in ophthalmology, neurology, and other related fields. These AI agents collaborate to assess risk factors and generate personalized AD risk reports, assisting clinicians in early diagnosis and intervention.

In this project, we will conduct a large-scale study utilizing patient data from IU Health and Yale University. If successful, this tool could enhance AD risk screening by making it more accessible and cost-effective. Future developments will focus on integrating it into clinical workflows. By enabling early detection, this project has the potential to improve patient outcomes and reduce the burden of AD on individuals and healthcare systems.

Large Scale Foodborne pathogen surveillance system

Principal Investigator	Digvijay Singh
PI Primary Affiliation	Drizzle Health
Co-Investigator(s)	Bonolo Mathekga

PROJECT DESCRIPTION

CDC estimates 48 million people get sick, 128,000 are hospitalized, and 3,000 die from foodborne diseases each year in the United States. Expectedly, it also disproportionately threaten older adults, whose weakened immune systems lead to 3-10 times higher hospitalization rates and increased mortality. We propose a paradigm-shifting pathogen detection system that transforms food safety from selective, reactive testing to continuous, proactive surveillance at a food supply chain level (right at the production plants). Our innovative three-part approach integrates: (1) a polymer-based millifluidic capture system that concentrates bacteria without reagents or external power, (2) a vertical polarimetric scanning system that analyzes bacterial light scattering patterns to provide species-specific signatures within seconds, and (3) machine learning algorithms that enable automated pathogen recognition with continuously improving accuracy. By eliminating the need for specialized training and time-consuming procedures, our technology makes comprehensive monitoring economically viable throughout entire food supply chains. We hypothesize this system will long-term reduce pathogen-induced illness in adults by at least 30%.

Piloting Social Prescribing for Elderly Patients Experiencing Loneliness

Principal Investigator	Alan Siegel
PI Primary Affiliation	Social Prescribing USA
Co-Investigator(s)	None

PROJECT DESCRIPTION

As the U.S. population ages (it is expected to surpass 80 million individuals aged 65 and older by 2040), loneliness among older adults has become a public health crisis.

We propose a rigorous pilot implementing social prescribing, an innovative care model by which primary care providers connect patients with community-based activities to treat loneliness and improve quality of life. Social prescribing has shown promise globally, particularly in the United Kingdom, which has scaled nationally over the past six years. However, its implementation in the U.S. remains limited.

Our proposal aims to fill this gap through a well-defined, single-site pilot study built into the primary care setting, in partnership with a large US not-for-profit health plan. This study will involve a sample of older adults at risk for loneliness, depression or anxiety, and high healthcare utilization, who will be prescribed community-based activities for 6-12 weeks. The intervention will be implemented using the traditional link worker model for social prescribing, with that link worker facilitating connections between patients, primary care providers, and community organizations. The pilot will assess the impact of social prescribing on patient outcomes through quantitative measures (mood states, wellbeing scale, loneliness scale, healthcare visits) and qualitative feedback from patients and providers.

If successful, the findings from this pilot could be rapidly implemented and scaled through our large partner institution and hold high potential to transform how we care for our aging population across the United States.

Precision Nutrition for Longevity

Principal Investigator	Angela Zivkovic
PI Primary Affiliation	UC Davis
Co-Investigator(s)	None

PROJECT DESCRIPTION

HDL is more than just “good cholesterol”—it’s a key to long, healthy lives. While early research linked low HDL cholesterol to heart disease, the story has become more complex. Extremely high HDL levels are now associated with increased mortality and dementia, revealing that total cholesterol transport alone doesn’t capture HDL’s true role. These particles are essential for brain health, metabolism, immunity, and protection against chronic and infectious diseases. Centenarians tend to have high HDL concentrations, suggesting their importance in longevity. However, HDL’s complexity and small size have made them difficult to study—until now.

We’ve developed an innovative method to isolate and analyze HDL with unprecedented precision, unlocking their potential to transform health. HDL reflect fundamental biological processes like oxidative stress and inflammation, making them powerful indicators of overall health. More importantly, harnessing HDL’s natural potency offers an alternative to expensive medications, which are not accessible to everyone and often come with side effects. Instead, dietary and lifestyle interventions can optimize HDL function in a way that is both cost-effective and equitable.

By understanding HDL’s role in disease prevention, we can create targeted solutions that don’t rely on pharmaceuticals but rather empower individuals to take control of their health. Revolutionizing disease prevention starts with unlocking HDL’s full potential—paving the way for sustainable, personalized strategies that improve health outcomes and promote longevity for all.

Rejuvenating the Aging Immune System by Targeting Aged Hematopoietic Stem Cells

Principal Investigator	Siddhartha Jaiswal
PI Primary Affiliation	Stanford School of Medicine, Department of Pathology
Co-Investigator(s)	Christopher Maximilian Arends

PROJECT DESCRIPTION

As we age, our blood and immune systems gradually decline, increasing the risk of infections, blood cancers, and chronic diseases like heart disease. A key driver of this process is the aging of hematopoietic stem cells (HSCs), which are responsible for producing all blood and immune cells. In older adults, these stem cells shift toward producing more myeloid cells (the body's first line of immune defense) at the expense of lymphoid cells (long-term immunity), leading to inflammation and weakened immune responses.

This project aims to understand why this shift happens and whether it can be reversed. Using genetic data from large biobanks, we will identify genetic variants that may influence the balance between myeloid and lymphoid cells. We will refine this list to focus on genes that are active in HSCs and could serve as potential drug targets. Next, we will use gene-editing techniques to study how these genes affect blood stem cell function in the lab. Finally, we will explore whether blocking or enhancing their activity can restore a healthier immune cell balance.

By combining human genetic discoveries with cutting-edge experimental methods, this study aims to uncover new ways to slow immune aging and reduce the risk of age-related diseases. If successful, it could pave the way for therapies that help people stay healthier for longer by targeting aging blood stem cells at their root cause

Resolving the combinatorial and cumulative human blood virome

Principal Investigator	Caleb Lareau
PI Primary Affiliation	Memorial Sloan Kettering
Co-Investigator(s)	None

PROJECT DESCRIPTION

The human body is not entirely 'human'. Instead, the composition of our body includes trillions of bacteria and viruses that co-exist with us and in turn change as we age. This project will focus on the human virome, meaning the composition of viruses that live in and on our bodies but usually do not make us sick.

Current estimates of the human virome indicate that for every one human cell, there are ~10 viral particles (or 380 trillion total) within the human body. Despite the ubiquity of these viruses, our knowledge about the commensal (or 'tolerated') virome, tolerogenic mechanisms, and response to pathogenic infection is in its infancy. Critically, approximately 1 in 30 individuals in our aging population are immunocompromised in the United States. Exemplified in organ/tissue transplants, immunodeficiencies yield dramatically different responses to otherwise tolerated infections, meaning the intersection of our aging population and the virome will continually increase the risk of life-threatening complications from viral infections normally controlled in homeostasis.

Here, we will develop new bioinformatic methodologies to study the composition, evolution, and impact of the virome on human health as a function of aging and development. Specifically, we will aggregate data from 1,000,000 individuals to study the blood virome with rich annotations of genetics, human phenotypes, and disease states. Our association analyses will resolve the virome's impact on age-associated diseases, including autoimmune diseases and cancers. The result of this catalyst project will be the identification of specific viral species that could be targeted to improve human healthspan

Reversing Muscle Atrophy and Metabolic Decline with Multi-active Secretomes

Principal Investigator	Hans Keirstead
PI Primary Affiliation	Immunis, Inc.
Co-Investigator(s)	None

PROJECT DESCRIPTION

The current medical approach to manage chronic conditions in aging is to treat individual manifestations of aging in isolation using single active ingredients, with little focus on prevention, and without addressing the underlying age-related biological changes that drive health dysfunction and increase the risk of chronic conditions. A treatment that could prevent or reverse the underlying age-related biological drift would improve health in aging, reduce risk of chronic conditions, reduce medical costs, and improve quality of life. We propose that such a therapeutic can be made from defined, high purity stem cell derivatives, which can essentially be used as factories to produce defined cocktails of pro-regenerative biologics that have the capacity to restore health across diverse biological systems. Defined progenitors derived from stem cells secrete a broad range of bioactive factors that play crucial roles in maintaining tissue homeostasis, regeneration, and immune modulation, all biological functions that show impaired function in aging. These secreted molecules, collectively known as the secretome, include a broad range of growth factors, cytokines and chemokines (immune signaling molecules), tissue remodeling enzymes and other signaling molecules. The biologics in the secretome are key regulators of many biological functions that undergo age-related dysfunction including tissue regeneration and wound healing, inflammation and immune modulation, and maintenance of cardiovascular, metabolic and musculoskeletal health. Restoring health to these diverse biological systems would be enormously impactful to improve health longevity and quality of life in the aging population and would reduce medical and financial burden.

Smart Assisted Geriatric Encounters (SAGE): An AI-Powered Home Visit Companion to Assist Aging in Place

Principal Investigator	Yijung Kim
PI Primary Affiliation	Health Economics and Aging Research Institute, MedStar Health Research Institute
Co-Investigator(s)	Allan Fong

PROJECT DESCRIPTION

More than 4-million U.S. adults aged 70 and older are homebound, facing limited access to quality health care despite their multiple chronic conditions and higher acute care utilization rates. Without timely medical care, these individuals face worsening health outcomes and quality of life, leading to escalating costs and strains on the U.S. health care system. Home-based primary care (HBPC), led by geriatricians, has proven to improve outcomes and reduce costs, yet its reach is severely constrained by a national shortage of geriatricians. Compounding this challenge, home visits require significant time spent researching and coordinating community resources—time that could otherwise be devoted to direct medical care. As the homebound population grows, innovative solutions are urgently needed to maximize the efficiency and impact of HBPC. To address this challenge, we propose Smart Assisted Geriatric Encounters (SAGE), an AI-powered smartphone application designed to enhance resource coordination during geriatric home visits. Drawing on Retrieval-Augmented Generation (RAG) technology, SAGE would create a dynamic knowledge repository of community resources and common patient needs, providing real-time, location-specific recommendations. Through a conversational interface, geriatricians could quickly access this information, addressing resource needs immediately rather than through time-consuming follow-up work. As the system learns from each interaction, it would evolve into a powerful knowledge repository, improving decision-making and optimizing resource utilization. We will pilot SAGE through an established house call program serving low-income communities in a large metropolitan area,

laying the groundwork for a scalable solution to enhance HBPC and extend the reach of limited geriatric care resources.