

The Immortality Update: Deep Research on the Most Important Discoveries and News in Longevity Sciences from the Past 7 Days

I. Introduction: The Healthspan Horizon

This week's update marks a significant inflection point in longevity science, characterized by a clear transition from theoretical concepts to tangible clinical and technological advancements. The central theme resonating through the past seven days of research is the pursuit of *functional longevity*—a paradigm focused on developing interventions designed not merely to add years to life, but to add healthy, functional life to those years by preserving cognitive, physical, and cellular resilience.¹ The field is demonstrably maturing, moving beyond the prolongation of lifespan to the enhancement of healthspan, with a focus on maintaining quality of life, cognitive acuity, and physical capacity well into advanced age.¹

The past seven days have been dominated by four pivotal breakthroughs that form the core of this analysis:

1. **A Potential Paradigm Shift in Neuroprotection:** Unprecedented clinical data for an oral drug, blarcamesine, suggests the ability to stabilize cognitive decline in early Alzheimer's disease to a rate approximating that of normal, non-pathological aging. This finding challenges the current treatment landscape and offers a potentially more accessible and scalable therapeutic modality.
2. **A Foundational Leap in Gene Therapy Delivery:** A novel nanostructure developed at Northwestern University has overcome critical safety and efficiency bottlenecks for CRISPR gene editing. This technological advance dramatically increases the feasibility of deploying systemic genetic interventions to correct the root causes of age-related diseases.
3. **The Advent of Accelerated Research Models:** Groundbreaking research from two distinct fields provides new platforms for compressing the timeline of aging research. A framework from Insilico Medicine proposes using the rapidly progressing disease

idiopathic pulmonary fibrosis (IPF) as a "fast-track" clinical model for testing anti-aging drugs. Concurrently, a NASA-funded study on astronauts' hematopoietic stem cells provides a unique human model of stress-induced accelerated aging, offering deep insights into the molecular triggers of cellular decline.

4. **Convergence of AI, Biology, and Data:** A persistent undercurrent this week is the maturation of Artificial Intelligence (AI) platforms as indispensable tools. These technologies are no longer confined to drug discovery but are now integral to target validation, clinical trial design, and the delivery of personalized healthspan management, weaving a thread of computational power through every stage of longevity science.⁵

Together, these developments signal a strategic shift towards more practical, scalable, and foundational approaches to extending functional human life.

II. Key Findings: Breakthroughs in Functional Longevity

The interventions and technological platforms that emerged this week represent significant progress across multiple fronts of longevity science. The following table provides a high-level summary of these key developments, which are analyzed in detail in the subsequent sections.

| Intervention /Technology | Lead Institution/ Company | Mechanism /Principle | Development Stage | Key Finding This Week | Implication for Functional Healthspan |
|------------------------------------|---------------------------|---|------------------------------|---|--|
| Blarcamesine (ANAVEX® 2-73) | Anavex Life Sciences | Oral SIGMAR1 receptor agonist restoring cellular homeostasis via autophagy enhancement. | Phase IIb/III Clinical Trial | 84.7% reduction in cognitive decline vs. placebo in a precision medicine cohort, approximating normal aging profiles. ¹⁰ | Potential to preserve cognitive function and delay progression in early Alzheimer's disease with a safe, accessible oral |

| | | | | | |
|--|--|---|--|--|--|
| | | | | | therapy. |
| LNP-SNA Delivery System | Northwestern University | DNA-coated lipid nanoparticle (LNP) shell delivering CRISPR machinery (Cas9, gRNA, repair template). | Preclinical Platform Technology | Threefold increase in gene-editing efficiency and cellular uptake with significantly reduced toxicity compared to standard methods. ¹² | Enables safer and more effective <i>in-vivo</i> genetic repair for a wide range of age-related conditions by solving a critical delivery bottleneck. |
| IPF as an Aging Model | Insilico Medicine, Buck Institute, Duke University | Using idiopathic pulmonary fibrosis (IPF), a rapidly progressing disease, as a clinical proxy to test geroprotective drugs. | Conceptual Framework / Clinical Strategy | AI-driven analysis identified IPF as having one of the strongest mechanistic overlaps with the hallmarks of aging among 13 diseases. ¹⁴ | Accelerates the clinical testing of anti-aging therapies by "compressing time," potentially reducing trial duration and cost. |
| Spaceflight-Induced Stem Cell Aging | NASA / UC San Diego | Analysis of human hematopoietic stem cells (HSPCs) exposed to spaceflight | Foundational Research | Space-flown HSPCs showed accelerated aging hallmarks: DNA damage, | Provides a unique human model for studying the molecular drivers of |

| | | | | | |
|--|--|-------------------------------------|--|---|---|
| | | on the International Space Station. | | telomere shortening, mitochondrial stress, and reduced regenerative capacity. ¹⁵ | stress-induced aging and for testing potential countermeasures. |
|--|--|-------------------------------------|--|---|---|

A. Neuroprotection and Cognitive Resilience: The Blarcamesine Phase IIb/III Data

On September 9, 2025, Anavex Life Sciences announced new clinical data from its Phase IIb/III trial of oral blarcamesine for early Alzheimer's disease (AD), presenting results that suggest a profound stabilization of cognitive function in a specific patient sub-population.¹⁰ This announcement stands out as a potentially pivotal moment for the treatment of age-related neurodegeneration.

The most striking finding emerged from a prespecified "Precision Medicine" cohort, which excludes carriers of a specific *SIGMAR1* gene variant and represents approximately 70% of the global population.¹⁷ In this group, the 30mg once-daily oral dose of blarcamesine demonstrated an

84.7% reduction in cognitive decline versus placebo over a 48-week period, as measured by the Alzheimer's Disease Assessment Scale-Cognitive Subscale 13 (ADAS-Cog13).¹⁰ The mean change from baseline in the treatment group was just 0.853 points, a figure that approximates the typical 1-point annual decline observed in prodromal (pre-dementia) aging adults.¹⁰ Similarly, on the Clinical Dementia Rating-Sum of Boxes (CDR-SB) scale, the change from baseline was 0.465, aligning with the 0-0.5 point annual range seen in prodromal aging.¹⁰ These results imply that the treatment did not merely slow disease progression but stabilized it to a rate nearly indistinguishable from non-pathological cognitive aging in this patient group.

Further bolstering these findings, long-term data from the open-label extension (OLE) trial, extending up to four years (192 weeks), demonstrated a sustained, disease-modifying effect. A delayed-start analysis showed a statistically significant and widening gap in cognitive and functional outcomes between patients who started treatment early versus those who switched from placebo after 48 weeks, underscoring the critical importance of early and

continuous intervention.²⁰

The mechanism of action for blarcamesine is fundamentally different from the prevailing anti-amyloid therapies. It is a sigma-1 receptor (SIGMAR1) agonist, a novel mechanism that operates *upstream* of the amyloid and tau pathologies that are the focus of most current AD therapies.²³ By activating SIGMAR1, blarcamesine is believed to restore cellular homeostasis, primarily through the enhancement of autophagy—the cell's intrinsic process for clearing damaged proteins and organelles.¹⁷ This action prevents the buildup of toxic protein aggregates and mitigates downstream consequences like mitochondrial dysfunction and oxidative stress, thereby providing a broad neuroprotective effect.²¹

The blarcamesine data represents more than just another drug in the development pipeline; it signals a potential strategic pivot in the entire approach to treating neurodegenerative disease. The current high-profile AD treatments, such as the anti-amyloid monoclonal antibodies lecanemab and donanemab, are intravenous biologics.²⁵ Their administration requires regular, time-consuming infusions in a clinical setting, presenting significant logistical burdens for patients and healthcare systems. Furthermore, they carry a notable risk of serious side effects, particularly amyloid-related imaging abnormalities (ARIA), which necessitates costly and intensive MRI monitoring.²³

In stark contrast, blarcamesine is an oral, once-daily small molecule with a favorable long-term safety profile and no association with ARIA.¹¹ The most common adverse event reported was transient, mild-to-moderate dizziness, which was further reduced with an extended titration period.²¹ This combination of efficacy, safety, and ease of administration positions blarcamesine not merely as a complementary therapy but as a potential first-line, disruptive alternative. An effective, safe, oral drug that targets a fundamental process of cellular aging (autophagy) would be vastly more accessible, scalable, and economically viable for global healthcare systems. It could reshape the AD market by shifting the therapeutic focus from the downstream clearance of a single pathological protein to the upstream preservation of foundational cellular health and resilience.

B. Unlocking Gene Therapy: The LNP-SNA CRISPR Delivery System

On September 5, 2025, researchers at Northwestern University, led by nanomedicine pioneer Chad Mirkin, published a study in the *Proceedings of the National Academy of Sciences* detailing a novel nanostructure that resolves one of the most significant barriers to the clinical application of CRISPR gene editing.¹² This breakthrough technology, termed a lipid nanoparticle spherical nucleic acid (LNP-SNA), addresses the critical "delivery dilemma" that has constrained the therapeutic potential of gene editing.

The LNP-SNA's design is a hybrid of two powerful nanotechnologies. It consists of a lipid nanoparticle (LNP) core, similar to those used in mRNA vaccines, which carries the complete CRISPR machinery: the Cas9 enzyme, the guide RNA (gRNA), and a DNA repair template for precise edits. This core is then enshrouded in a dense, protective shell of spherical nucleic acids (SNAs)—globular forms of DNA invented in Mirkin's lab that can readily enter cells.¹³ This unique architecture synergistically combines the cargo-carrying capacity of LNPs with the superior cellular uptake and targeting capabilities of SNAs.¹²

The performance of this new system, tested across multiple human and animal cell types, demonstrated a transformative improvement over existing methods. The key performance metrics reported include:

- A **threefold increase** in both cellular uptake and overall gene-editing efficiency compared to standard LNP delivery systems.¹²
- Significantly **reduced cellular toxicity**, a major safety concern with other delivery vectors like viruses.¹³
- A greater than **60% improvement** in the success rate of precise DNA repair (homology-directed repair), the mechanism required to correct specific disease-causing mutations rather than simply disabling a gene.¹²

This development is not merely an incremental improvement but a foundational enabling technology that could de-risk and accelerate the entire field of *in-vivo* genetic longevity interventions. The primary obstacle preventing the translation of many promising genetic anti-aging strategies from the laboratory to the clinic has been the lack of a delivery vehicle that is both safe and efficient. Viral vectors, while effective, can provoke dangerous immune responses and have limitations on cargo size. Standard LNPs are safer but are often inefficient, with only a small fraction of their payload reaching the cell nucleus where gene editing occurs.¹³

Many of the most ambitious proposed longevity interventions are genetic in nature, such as enhancing the expression of protective genes like *TERT* (which encodes a component of telomerase) or *Klotho*, or performing partial cellular reprogramming using Yamanaka factors.²⁹ These strategies require safe and effective delivery of genetic material to multiple tissues throughout the body. The high risk and low efficiency of previous

in-vivo delivery methods have rendered such systemic treatments clinically unviable and unattractive for investment.

By providing a solution to this core delivery problem, the LNP-SNA platform makes the entire class of systemic genetic longevity therapies substantially more plausible. The platform's enhanced safety profile lowers the ethical barrier for using gene editing to treat non-lethal, age-related conditions. Its increased efficiency makes therapeutic effects achievable at lower, safer doses. This breakthrough fundamentally alters the risk-reward calculation for researchers, biotechnology companies, and investors. It has the potential to unlock significant

funding and accelerate the transition of numerous genetic healthspan extension therapies from preclinical concepts to human clinical trials, shifting the conversation from "if" to "when and how" these powerful tools will be deployed to combat aging at its genetic source.

C. Modeling Accelerated Aging: Spaceflight and Pulmonary Fibrosis

Two independent and seemingly disparate lines of research reported this week converge on a single, critical theme: the development of novel, human-relevant models to study aging in a compressed timeframe. These models address one of the most significant practical hurdles in geroscience—the impracticality of conducting decades-long clinical trials to validate anti-aging interventions.

First, a NASA-funded study from the University of California San Diego, published in *Cell Stem Cell*, used the extreme environment of space to model stress-induced aging.¹⁵ Researchers analyzed human hematopoietic stem and progenitor cells (HSPCs) from bone marrow donors that were flown on the International Space Station (ISS) for 30-45 days. Compared to identical ground-based controls, the space-flown stem cells exhibited a striking array of accelerated aging hallmarks. These included increased DNA damage, shortening of telomeres (the protective caps on chromosomes), heightened mitochondrial stress, and depleted regenerative reserves.¹⁶ The cells also showed increased inflammation and activation of the "dark genome," normally silent sections of DNA whose expression can destabilize cellular function.¹⁵ Critically, the space-flown cells accumulated single-base mutations associated with clonal hematopoiesis, a known age-related condition that can be a precursor to leukemia.³³

Second, a conceptual framework published in the journal *Aging* by researchers from Insilico Medicine, the Buck Institute for Research on Aging, and Duke University proposed using idiopathic pulmonary fibrosis (IPF) as a powerful clinical model for testing geroprotective drugs.¹⁴ Using AI-driven analysis, the researchers evaluated 13 common age-related diseases and determined that IPF has one of the strongest mechanistic overlaps with the fundamental biological hallmarks of aging.¹⁴ However, unlike the slow progression of normal aging, IPF is a devastating disease where lung function declines more than five times faster.¹⁴ This rapid progression creates a "compressed time" model, allowing researchers to observe the effects of a potential anti-aging therapy on aging-related pathways within a feasible clinical trial window of months, rather than decades.

These two distinct approaches highlight the emergence of a crucial new trend in longevity research: the validation of human-relevant "accelerated aging" models to overcome translational hurdles. The primary obstacle in geroscience research and development is the

prohibitive cost and time required to test a true "geroprotector" in healthy humans.⁴ This barrier has historically stifled investment and slowed progress. The IPF model offers a solution by using a rapidly progressing human disease as a clinical proxy for aging, enabling shorter, more efficient trials that can still yield data on core aging mechanisms like inflammation, fibrosis, and cellular senescence.¹⁴ The spaceflight model offers a different, complementary solution: using an extreme environment to induce and study the

initiation of aging processes in primary human cells in a compressed timeframe, providing a clean system to understand cause and effect.

This trend represents a strategic maturation of the longevity field. By developing and leveraging these accelerated models, researchers can generate human-relevant data more quickly, de-risk therapeutic candidates earlier in the development process, and build a stronger evidence base for larger, longer-term trials. This could fundamentally change the economics and timeline of developing and validating geroprotectors, making the entire endeavor more tractable for both academic and commercial entities. Furthermore, the variability in resilience observed among different donors' stem cells in the spaceflight study suggests these models can also be used to discover novel biomarkers of biological age and identify the factors that confer resilience to age-related decline.¹⁵

III. From Bench to Bedside: Distinguishing Research Stages

A critical aspect of analyzing the week's developments is to accurately place each breakthrough within the research and development continuum. This distinction separates interventions with immediate clinical potential from foundational discoveries that will shape the therapies of the future.

Late-Stage Clinical Trials (Demonstrating Functional Benefit)

The standout example of a longevity-relevant intervention in late-stage clinical development this week is **blarcamesine** from Anavex Life Sciences. The announcement of new 48-week data from its Phase IIb/III trial, supplemented by long-term extension data up to four years, provides direct evidence of a functional benefit—the preservation of cognitive function—in a human population suffering from a major age-related disease.¹⁰ The results, particularly the

near-stabilization of cognitive decline in the precision medicine cohort, represent a tangible outcome that directly impacts healthspan. Furthermore, its oral formulation and favorable safety profile address key practical hurdles for widespread clinical adoption, positioning it firmly at the translational end of the R&D spectrum.

Preclinical and Platform Technologies (Enabling Future Therapies)

In this category are technologies that, while not yet therapies themselves, are critical enablers for future interventions.

- The **LNP-SNA CRISPR System** from Northwestern University is a quintessential example of an enabling platform technology currently in the preclinical validation stage. The reported experiments demonstrating its superior efficiency and safety were conducted *in vitro* in various human and animal cell lines.¹³ The immediate impact is not a functional benefit in humans today, but rather a dramatic expansion of the *potential* for developing a new class of genetic therapies. The crucial next step for this platform is to validate its performance and safety *in vivo* in animal models of genetic disease, which will determine its path toward clinical application.¹²
- The proposal to use **IPF as a Geroprotector Model** by Insilico Medicine and its collaborators is a conceptual framework and a novel clinical strategy, supported by extensive AI-driven bioinformatics analysis and a strong preclinical rationale.¹⁴ It is now being actively tested through the clinical development of Insilico's own AI-discovered TNIK inhibitor for IPF, which the company frames as a real-world test case for the model.³⁸ The success or failure of this and similar trials will serve as the ultimate validation for this innovative trial design strategy, potentially establishing a new paradigm for testing anti-aging drugs.

Foundational Research (Illuminating Core Mechanisms)

This category includes research that is furthest from direct clinical application but is essential for building our fundamental understanding of the aging process. The **NASA/UC San Diego study on spaceflight and stem cell aging** falls squarely into this domain. Its primary purpose was not to test a specific intervention but to use a unique environment to dissect the basic molecular mechanisms by which multifaceted stress accelerates aging in primary human cells.¹⁵ The findings—implicating mitochondrial stress, DNA damage, and inflammation—will inform the development of future interventions and biomarkers. This work

provides the "why" that will guide the "what" and "how" of future therapeutic development.

IV. The Longevity Toolkit: New Technological Platforms

This week's announcements highlight the rapid evolution of the technological platforms that underpin modern longevity research, with AI and advanced genetic engineering at the forefront.

A. AI-Driven Drug Discovery and Trial Design

The influence of Artificial Intelligence in the life sciences is expanding from a specialized tool to a comprehensive strategic engine.

- **Insilico Medicine's End-to-End Platform** exemplifies this evolution. The proposal to use IPF as a model for aging is a direct output of their AI-driven approach. The platform leverages AI for initial target identification (PandaOmics) and novel molecule generation (Chemistry42).⁴⁰ The IPF framework extends this capability into the realm of AI-driven *clinical strategy*, using computational analysis to identify diseases with high alignment to aging hallmarks, thereby creating more efficient and impactful clinical trials.¹⁴ This represents a fully integrated AI stack, guiding the process from the earliest stages of target discovery through to the design of human validation studies.
- The launch of **Corsera Health** highlights a different but equally important application: the use of causal AI for preventative medicine. Their platform is designed to predict an individual's lifetime risk of atherosclerotic cardiovascular disease (ASCVD) and identify those who would benefit most from early intervention, such as their planned once-annual RNAi therapeutic.⁶ This represents a shift towards a proactive and highly personalized model of healthspan extension, powered by predictive modeling.
- This trend is further reflected in the launch of consumer-facing and clinical-support AI platforms. **Rejuve.AI** aims to democratize access to longevity insights by analyzing users' personal health data from wearables and self-reported information, using AI to generate personalized recommendations and reward data contribution with cryptocurrency tokens.⁸ Similarly, **Longevity AI** offers a platform for clinicians to integrate lab results, biomarker data, and lifestyle metrics to create personalized health plans, using an AI "co-pilot" trained on vast datasets to accelerate analysis and improve care.⁴²

Collectively, these developments show that AI is no longer just a tool for finding drug targets. It is now being strategically deployed across the entire research, development, and healthcare value chain: identifying novel biological connections (IPF and aging), designing innovative clinical strategies (accelerated trials), predicting individual disease risk (Corsera), and delivering personalized interventions (Rejuve.AI).

B. Advanced Genetic Engineering Platforms

Parallel to the advances in AI, the "hardware" of therapeutic intervention is also undergoing a revolution. Northwestern University's **LNP-SNA system** represents a significant leap forward in the technology of gene therapy delivery. The platform is a prime example of "structural nanomedicine," a field predicated on the principle that the physical architecture of a delivery vehicle is as important as its chemical payload.¹³ The hybrid LNP-SNA structure is not simply a passive container; its design actively facilitates cellular uptake, protects its cargo, and reduces toxicity. By creating a modular, safe, and highly efficient delivery vehicle, this platform provides the essential tool needed to execute the "software" of CRISPR-based genetic edits for extending healthspan, moving these powerful therapies from theoretical possibility to practical reality.¹²

V. Ethical and Practical Considerations

As the science of longevity advances with unprecedented speed, it brings to the forefront complex ethical and practical considerations that demand careful navigation by researchers, clinicians, regulators, and society at large.

A. Accessibility and Equity in Neuroprotection

The potential of an oral drug like blarcamesine for Alzheimer's disease highlights a critical issue of accessibility and equity. Compared to intravenous monoclonal antibody therapies, which require regular visits to specialized infusion clinics and extensive monitoring, a safe, self-administered oral pill could be distributed far more widely and equitably.²⁶ This could dramatically reduce the treatment burden on patients and caregivers and improve access for

those in underserved or rural communities. However, the "precision medicine" aspect of blarcomesine's efficacy introduces a new ethical layer. The finding that its benefits are most profound in the ~70% of the population with the wild-type

SIGMAR1 gene raises important questions.¹⁰ Widespread implementation would likely necessitate genetic screening to identify optimal candidates, creating potential disparities in access and raising concerns about how to manage treatment for the remaining 30% of patients who may derive less benefit.

B. Safety and Governance of Gene Editing

The LNP-SNA platform's significantly reduced toxicity is a major step toward addressing the primary ethical imperative in medicine: "first, do no harm." By making CRISPR-based interventions safer, it lowers the ethical barrier for their potential use in treating non-lethal, chronic age-related conditions, where the risk-benefit calculation is more stringent than for terminal genetic diseases.¹² However, as the technology becomes more powerful and accessible, it intensifies the need for robust societal and regulatory frameworks. Clear governance will be required to oversee its application, particularly to maintain the critical ethical line between somatic (non-heritable) cell therapy, which affects only the individual patient, and germline (heritable) editing, which would alter the human gene pool for future generations.

C. Human Subjects in Accelerated Aging Research

The innovative use of accelerated aging models also carries unique ethical responsibilities.

- **For IPF Patients:** The proposal to use patients with a terminal illness like IPF as a "testbed" for broader anti-aging therapies requires scrupulous ethical oversight. The primary endpoint of any such clinical trial must be a clear and meaningful benefit for the IPF patient, such as improved lung function or quality of life. The potential for the therapy to be validated as a more general geroprotector must remain a secondary, albeit significant, outcome.¹⁴ The informed consent process for these trials must be exceptionally clear about this dual purpose to ensure patients fully understand the research context.
- **For Astronauts:** The definitive finding that spaceflight accelerates biological aging in human stem cells places a profound ethical responsibility on NASA and other space agencies.¹⁵ It is no longer a theoretical risk but an observed phenomenon. This

necessitates the urgent development and implementation of effective countermeasures to protect astronaut health on long-duration missions, such as those planned for Mars. It also raises complex questions about long-term health monitoring, healthcare provisions, and potential liability for astronauts after they have completed their service.

VI. Future Directions and Strategic Outlook

The developments of the past week not only represent immediate progress but also set the stage for the next phase of innovation in longevity science. The strategic outlook for these key areas is becoming clearer.

- **The Evolving Alzheimer's Landscape:** The next 12 to 18 months will be critical for blarcamesine. Following the presentation of this compelling data, regulatory filings with the U.S. Food and Drug Administration (FDA) are anticipated, building on the marketing authorization application already accepted by the European Medicines Agency (EMA) in late 2024.²³ If approved, blarcamesine's oral administration, novel upstream mechanism, and favorable safety profile could trigger a major market shift. It would force a re-evaluation of the commercial viability and therapeutic positioning of the current generation of anti-amyloid antibodies. The key questions will be how payers, clinicians, and healthcare systems integrate this new class of therapy and whether it becomes a first-line treatment for early AD, fundamentally changing the standard of care.
- **Validation of Next-Generation Platforms:** The trajectory for the week's key platform technologies is now focused on validation. The LNP-SNA system must move from *in vitro* success to proving its safety and efficacy for systemic delivery in *in vivo* animal models. This is the crucial next step for its application in treating systemic age-related diseases. For the IPF aging model, the ongoing clinical trials of TNIK inhibitors and other targeted therapies will serve as the first real-world test of this accelerated trial paradigm.³⁸ The results of these trials will determine if this innovative approach becomes a new industry standard for developing geroprotective drugs.
- **From Observation to Intervention in Stress-Induced Aging:** The NASA/UC San Diego spaceflight study has successfully identified key molecular pathways of accelerated cellular aging. The logical next step is to use this unique experimental model to *test interventions*. Future missions to the ISS will likely involve treating hematopoietic stem cells in space with candidate compounds—such as senolytics, autophagy enhancers, or mitochondrial stabilizers—to determine if the age-related damage can be prevented or mitigated. This will provide invaluable data on which biological pathways are most critical for building cellular resilience against multifaceted stressors.
- **Overarching Trend:** The convergence of these disparate fields—neuroscience, gene editing, AI, and space medicine—points toward a future where healthspan interventions are increasingly **systemic, personalized, and preventative**. The focus is shifting away

from treating single, end-stage diseases and toward maintaining youthful function at a fundamental cellular level. This new paradigm will be guided by predictive AI and enabled by powerful new therapeutic platforms like advanced gene delivery systems. The rapid and substantive progress observed this week suggests this future is arriving faster than previously anticipated, heralding a new and more pragmatic era in the science of functional longevity.

Works cited

1. Too well to die; too ill to live: an update on the lifespan versus health span debate - PMC, accessed September 10, 2025, <https://pmc.ncbi.nlm.nih.gov/articles/PMC12068195/>
2. Stem Cell Rejuvenation Therapies: Extending Healthspan and Pushing the Boundaries of Longevity - Open Access Journals, accessed September 10, 2025, <https://www.openaccessjournals.com/articles/stem-cell-rejuvenation-therapies-extending-healthspan-and-pushing-the-boundaries-of-longevity-18356.html>
3. The \$1 billion wager riding on whether a human will live to 150, accessed September 10, 2025, <https://www.washingtonpost.com/science/2025/09/05/aging-experts-respond-putin-xi-longevity/>
4. McKinsey Health Institute outlines how to advance biomedical healthspan science | spaopportunities.com news, accessed September 10, 2025, <https://www.spaopportunities.com/spa-news/McKinsey-Health-Institute-outlines-how-to-advance-biomedical-healthspan-science/357741>
5. The Future of Longevity: 5 Breakthroughs Redefining Aging Right Now | Super Age, accessed September 10, 2025, <https://superage.com/the-future-of-longevity-5-breakthroughs-redefining-aging-right-now/>
6. Startup Looks to Extend Healthspan by Predicting, Preventing Cardiovascular Disease, accessed September 10, 2025, <https://www.dicardiology.com/content/startup-looks-extend-healthspan-predicting-preventing-cardiovascular-disease>
7. Targeting Senescence: A Review of Senolytics and Senomorphics in Anti-Aging Interventions - PMC - PubMed Central, accessed September 10, 2025, <https://pmc.ncbi.nlm.nih.gov/articles/PMC12190739/>
8. Rejuve.AI Launches App for Longevity Advice and Treatments - Lifespan.io, accessed September 10, 2025, <https://www.lifespan.io/news/rejuve-ai-launches-app-for-longevity-advice-and-treatments/>
9. AI and Longevity: Can Artificial Intelligence Help Humans Live Longer?, accessed September 10, 2025, <https://trendsresearch.org/insight/ai-and-longevity-can-artificial-intelligence-help-humans-live-longer/>
10. Anavex Life Sciences Announces Oral Blarcamesine Cognitive ..., accessed September 10, 2025,

- <https://www.anavex.com/post/anavex-life-sciences-announces-oral-blarcamesine-cognitive-resilience-results-approximating-normal-a>
11. Anavex Life Sciences Announces Oral Blarcamesine Cognitive Resilience Results Approximating Normal Aging in New Precision Medicine Clinical Data from Phase IIb/III Alzheimer's Disease Trial - Stock Titan, accessed September 10, 2025, <https://www.stocktitan.net/news/AVXL/anavex-life-sciences-announces-oral-blarcamesine-cognitive-s1js28v26b9h.html>
 12. New nanostructure makes CRISPR edits safer and three times faster - Drug Target Review, accessed September 10, 2025, <https://www.drugtargetreview.com/news/186004/new-nanostructure-makes-crispr-edits-safer-and-three-times-faster/>
 13. CRISPR's efficiency triples with DNA-wrapped nanoparticles ..., accessed September 10, 2025, <https://news.northwestern.edu/stories/2025/09/crisprs-efficiency-triples-with-dna-wrapped-nanoparticles/>
 14. Scientists spotlight lung disease as fast-track model for ageing drugs - Drug Target Review, accessed September 10, 2025, <https://www.drugtargetreview.com/news/186449/scientists-spotlight-lung-disease-as-fast-track-model-for-ageing-drugs/>
 15. Spaceflight increases aging: NASA study finds blood-forming stem cells at risk, accessed September 10, 2025, <https://timesofindia.indiatimes.com/science/spaceflight-increases-aging-nasa-study-finds-blood-forming-stem-cells-at-risk/articleshow/123805597.cms>
 16. Spaceflight Accelerates Human Stem Cell Aging, UC San Diego ..., accessed September 10, 2025, <https://today.ucsd.edu/story/spaceflight-accelerates-human-stem-cell-aging-uc-san-diego-researchers-find>
 17. Anavex Life Sciences Announces Oral Blarcamesine Cognitive Resilience Results Approximating Normal Aging in New Precision Medicine Clinical Data from Phase IIb/III Alzheimer's Disease Trial - Investing News Network, accessed September 10, 2025, <https://investingnews.com/anavex-life-sciences-announces-oral-blarcamesine-cognitive-resilience-results-approximating-normal-aging-in-new-precision-medicine-clinical-data-from-phase-iib-iii-alzheimer-s-disease-trial/>
 18. Newsroom | Anavex Life Sciences, accessed September 10, 2025, <https://www.anavex.com/newsroom>
 19. Positive Phase 2b/3 Open-Label Extension Trial Results: Blarcamesine for Treatment of Early Alzheimer Disease - Psychiatric Times, accessed September 10, 2025, <https://www.psychiatrictimes.com/view/positive-phase-2b-3-open-label-extension-trial-results-blarcamesine-for-treatment-of-early-alzheimer-disease>
 20. Anavex Life Sciences Announces Positive 4-Year Blarcamesine Results, accessed September 10, 2025, <https://www.clinicaltrialvanguard.com/news/anavex-life-sciences-announces-positive-4-year-blarcamesine-results/>

21. New 3-Year Data Highlight Continued Treatment Effects of Blarcamesine in Slowing Alzheimer Disease - NeurologyLive, accessed September 10, 2025, <https://www.neurologylive.com/view/new-3-year-data-highlight-continued-treatment-effects-blarcamesine-slowing-alzheimers>
22. Anavex Life Sciences Announces Positive Precision Medicine Results from up to 4-Years of Oral Blarcamesine Treatment in Phase IIb/III Open-Label Extension Trial in Early Alzheimer's Disease, accessed September 10, 2025, <https://www.anavex.com/post/anavex-life-sciences-announces-positive-precision-medicine-results-from-up-to-4-years-of-oral-blarca>
23. AD/PD 2025: Long-term data shows Anavex's Blarcamesine benefits in early Alzheimer's, accessed September 10, 2025, <https://www.clinicaltrialsarena.com/analyst-comment/ad-pd-2025-anavex-blarcamesine-early-alzheimers/>
24. Blarcamesine for the treatment of Early Alzheimer's Disease: Results from the ANAVEX2-73-AD-004 Phase IIb/III trial - PubMed, accessed September 10, 2025, <https://pubmed.ncbi.nlm.nih.gov/39800452/>
25. Executive summary: The biotech revolution and longevity - RBC Wealth Management, accessed September 10, 2025, <https://ca.rbcwealthmanagement.com/sean.fraser/blog/4639995-Executive-summary-The-biotech-revolution-and-longevity>
26. Anavex Life Sciences Reports Fiscal 2025 Third Quarter Financial Results and Provides Business Update, accessed September 10, 2025, <https://www.anavex.com/post/anavex-life-sciences-reports-fiscal-2025-third-quarter-financial-results-and-provides-business-updat>
27. Northwestern University Develops Novel Nanostructure to Triple CRISPR Gene Editing Efficiency - MedPath, accessed September 10, 2025, <https://trial.medpath.com/news/dd9041de55ded067/northwestern-university-develops-novel-nanostructure-to-triple-crispr-gene-editing-efficiency>
28. Research & Innovation - Northwestern Now, accessed September 10, 2025, <https://news.northwestern.edu/research-and-innovation/>
29. New Anti-Aging Gene Therapy Extends Lifespan by up to 20% - SciTechDaily, accessed September 10, 2025, <https://scitechdaily.com/new-anti-aging-gene-therapy-extends-lifespan-by-up-to-20/>
30. Gene Therapy and Longevity: Transforming the Future of Healthy Aging - Mewburn Ellis, accessed September 10, 2025, <https://www.mewburn.com/news-insights/gene-therapy-and-longevity-transforming-the-future-of-healthy-aging>
31. Spaceflight accelerates the aging of human blood-forming stem cells - DD India, accessed September 10, 2025, <https://ddindia.co.in/2025/09/spaceflight-accelerates-the-aging-of-human-blood-forming-stem-cells/>
32. NASA-Backed Study Finds Space Travel Drastically Accelerates Aging In Cells, accessed September 10, 2025, <https://hothardware.com/news/nasa-study-finds-space-accelerates-aging-cells>

33. Stem Cells Age Faster in Space | The Scientist, accessed September 10, 2025, <https://www.the-scientist.com/stem-cells-age-faster-in-space-73357>
34. Insilico employs AI-driven tools to uncover the link between idiopathic pulmonary fibrosis (IPF) and accelerated aging, accessed September 10, 2025, <https://insilico.com/tpost/5t5cdcvdj1-insilico-employs-ai-driven-tools-to-unco>
35. Idiopathic pulmonary fibrosis identified as a model for anti-aging ..., accessed September 10, 2025, <https://www.eurekalert.org/news-releases/1097126>
36. Idiopathic Pulmonary Fibrosis Identified as a Model for Anti-Aging Drug Development, accessed September 10, 2025, <https://www.aging-us.com/news-room/idiopathic-pulmonary-fibrosis-identified-as-a-model-for-anti-aging-drug-development>
37. AI-Driven Tool Links Lung Fibrosis to Accelerated Aging in IPF and Aging Research, accessed September 10, 2025, <https://www.managedhealthcareexecutive.com/view/ai-driven-tool-links-lung-fibrosis-to-accelerated-aging-in-ipf-and-aging-research>
38. Insilico Medicine Reports Positive Phase IIa Results for ISM001-055, a Novel First-in-Class Drug Treatment for Idiopathic Pulmonary Fibrosis (IPF) Designed Using Generative AI - PR Newswire, accessed September 10, 2025, <https://www.prnewswire.com/news-releases/insilico-medicine-reports-positive-phase-ii-a-results-for-ism001-055-a-novel-first-in-class-drug-treatment-for-idiopathic-pulmonary-fibrosis-ipf-designed-using-generative-ai-302251732.html>
39. Insilico Medicine announces positive topline results of ISM001-055 for the treatment of idiopathic pulmonary fibrosis (IPF) developed using generative AI, accessed September 10, 2025, <https://insilico.com/news/tnik-ipf-phase2a>
40. IPF – Phase 1 | Insilico Medicine, accessed September 10, 2025, <https://insilico.com/blog/ipf-phase1>
41. AI Models Demonstrate Links Between IPF, Aging Processes, accessed September 10, 2025, <https://www.ajmc.com/view/ai-models-demonstrate-links-between-ipf-aging-processes>
42. Longevity AI, accessed September 10, 2025, <https://www.longevity-ai.com/>