

6. Longevity Science – S & T

Advances in biotechnology, geroscience, artificial intelligence, and preventive healthcare have revived global interest in human longevity.

Longevity Science (Geroscience)

Longevity science, also known as geroscience, is the interdisciplinary field that studies the biological mechanisms of aging and explores scientifically validated ways to delay, prevent, or reverse age-related decline. Rather than focusing only on extending how long humans live, longevity science prioritises improving the quality of life across the lifespan, integrating insights from biology, medicine, biotechnology, public health, behavioural sciences, and socio-economic policy. At its core, longevity science seeks to treat aging itself as a modifiable biological process, rather than an inevitable and irreversible outcome.

Core Concepts in Longevity Science

Healthspan vs Lifespan

Lifespan – Refers to the total number of years an individual lives. Advances in medicine have significantly increased lifespan globally over the past century.

Healthspan – Refers to the number of years lived in good physical, mental, and functional health, free from chronic disease and disability.

Central Objective – Modern longevity science aims to compress morbidity—that is, reduce the period of illness at the end of life—by extending healthspan rather than merely lifespan.

Biohacking

Definition – Intentional interventions in diet, lifestyle, environment, or biology to optimise health, performance, and aging outcomes.

Common Approaches

1. Continuous health tracking through wearables (sleep, glucose, heart rate variability).
2. Use of supplements, nutraceuticals, and personalised nutrition.
3. Advanced diagnostics such as genetic testing, epigenetic clocks, and metabolomics.
4. Experimental or semi-clinical therapies including cryotherapy, hyperbaric oxygen therapy, red-light therapy, and intermittent fasting protocols.

Concerns – Many interventions lack long-term clinical validation and raise ethical, safety, and equity issues.

Blue Zones

Definition – Regions with exceptionally high concentrations of centenarians and low prevalence of chronic diseases.

Classical Blue Zones

1. Okinawa (Japan)
2. Sardinia (Italy)
3. Nicoya Peninsula (Costa Rica)
4. Ikaria (Greece)
5. Loma Linda (USA)

Shared Characteristics – Plant-rich diets, regular physical activity, strong social networks, purpose-driven lives, and low chronic stress.

Indian Context – Kerala is sometimes discussed as a potential Indian blue zone due to higher life expectancy and social development, though robust longitudinal data is limited.

Policy Insight – Blue zones demonstrate that longevity is shaped more by social and lifestyle systems than by medical technology alone.



Global Longevity Trends and Innovations

Expansion of the Global Wellness Economy – The global wellness industry was valued at \$6.8 trillion in 2024 and is projected to reach \$9.8 trillion by 2029. Longevity-focused sectors include

1. Preventive healthcare
2. Personalised nutrition
3. Mental wellness
4. Anti-aging and regenerative medicine

Technology Integration

Artificial Intelligence – Used for early disease detection, personalised risk profiling, and predictive diagnostics.

Wearables and Neurotech – Brain-mapping devices and cognitive health trackers enable real-time monitoring.

Metabolic and Breath Analysis – Non-invasive testing to assess metabolic health, aging biomarkers, and inflammation levels.

Longevity Tourism – Growth of wellness travel focused on

1. Noctourism (sleep and circadian rhythm optimisation).
2. Luxury longevity retreats combining diagnostics, nutrition, and lifestyle interventions.

Raises questions about commercialisation versus evidence-based care.

Pharmaceutical and Biotech Advances

Research into repurposed drugs (e.g., GLP-1 agonists, senolytics) for healthspan extension. Focus on targeting hallmarks of aging such as inflammation, cellular senescence, and mitochondrial dysfunction.

Longevity Science in India

Demographic Transition – India is undergoing a rapid demographic shift and is projected to have the world's largest elderly population by 2067. This will place significant pressure on-

1. Healthcare systems
2. Pension frameworks

3. Social security and caregiving structures

Research and Institutional Efforts – The Longevity India Initiative at Indian Institute of Science is a landmark effort. The flagship BHARAT Study aims to

1. Develop India-specific aging biomarkers.
2. Create population-relevant health algorithms.
3. Reduce reliance on Western-centric medical and longevity data.

Economic Potential – The longevity economy—covering elder care, preventive healthcare, diagnostics, wellness services, and assistive technologies—is expanding rapidly. Preventive healthcare is emerging as a major growth segment in India's health economy.

Key Challenges for India

Curative-Centric Healthcare Mindset – Indian healthcare remains reactive rather than preventive. Low willingness to invest in wellness or screening before disease onset.

Data and Research Gaps – Poor quality age-related and health data, particularly in rural and informal populations. Limits the ability to

1. Identify Indian blue zones.
2. Design targeted longevity interventions.

Access and Equity Concerns – High costs of personalised longevity consultations (₹10,000–₹1 lakh). Advanced therapies remain accessible primarily to urban elites. Risk of longevity becoming a privilege rather than a public good.

Infrastructure Deficits – Inadequate geriatric care facilities. Limited integration of elderly care into primary healthcare systems.

Early Onset of Chronic Diseases – Indians develop lifestyle-related conditions (diabetes, cardiovascular disease) a decade earlier than Western populations. Shortens healthspan and increases long-term healthcare burden.

Way Forward- Building an Inclusive Longevity Framework

Socio-Economic Policy Redesign – Gradual extension of retirement age aligned with health capacity. Promotion of lifelong learning and re-skilling to keep older adults economically and socially engaged.

Development of AgeTech – Innovation in

1. Assistive devices
2. Smart homes
3. Remote health monitoring

Enable independent living for the elderly.

Public Health First Approach – Prioritise

1. Preventive care
2. Vaccination
3. Nutrition security
4. Geriatric services

High-tech biohacking should complement, not replace, foundational public health systems.

Cultural and Social Shift – Move away from ageist perceptions. Recognise older adults as contributors of experience and knowledge—often termed "Generation Experienced (Gen E)". Foster intergenerational integration in workplaces and communities.

Source– <https://www.thehindu.com/sci-tech/science/global-longevity-movement-india-ageing-science/article70448442.ece>