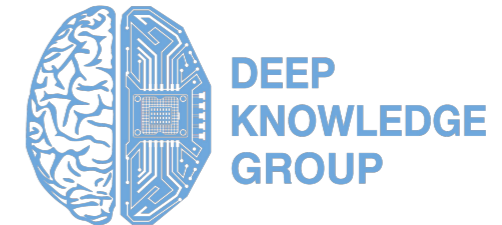


# AI for Longevity Overview

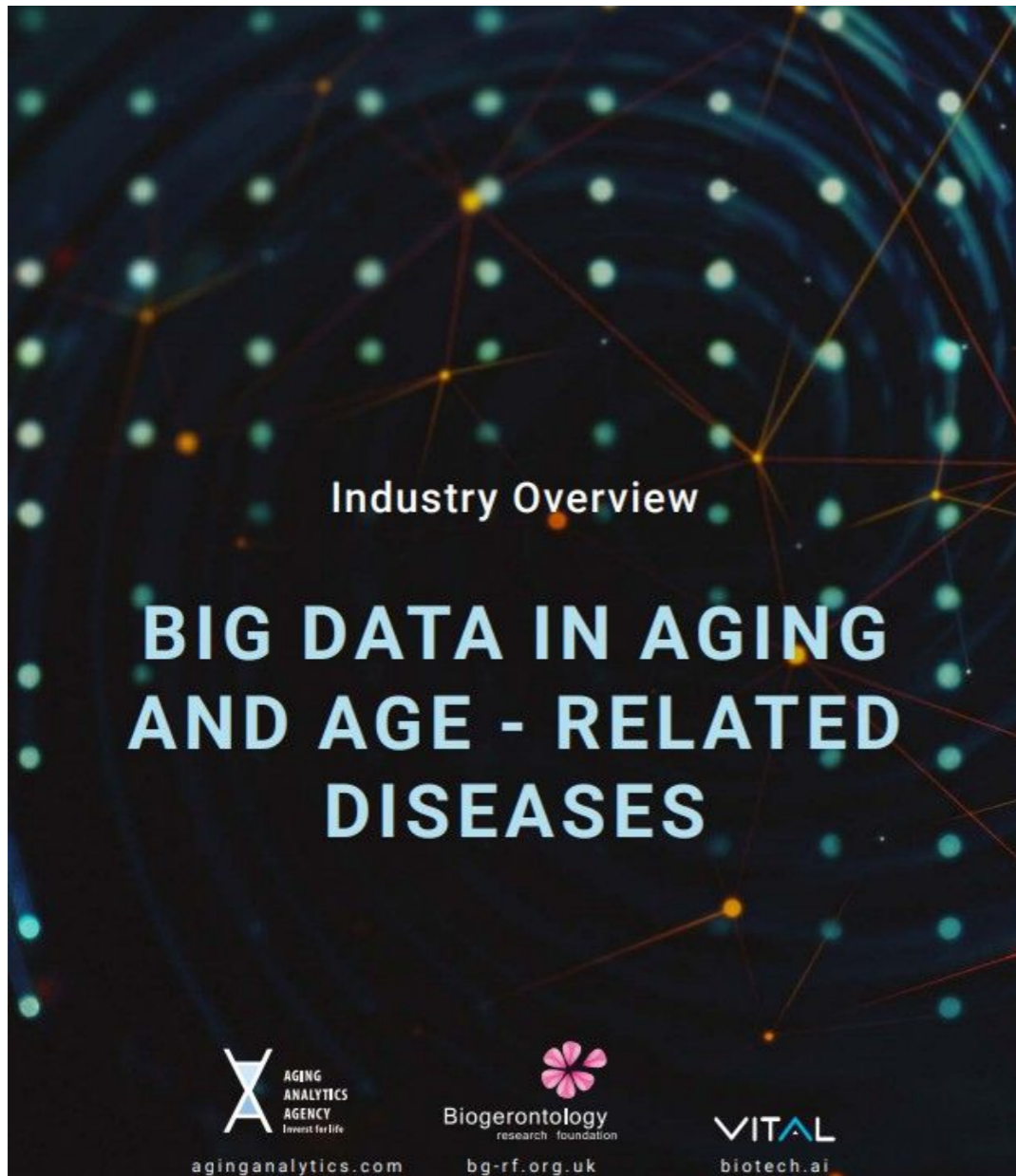
## Role of AI and Data Science for Healthy Longevity



**Dmitry Kaminskiy**  
*Aging Analytics Agency*



 **12 November, London**



**Data science and AI** are becoming the **central factors driving progress** in Longevity industry.

**Aging Analytics Agency** has recognized this for over 5 years, and began analyzing this sector in 2014 with its “Big Data in Aging and Age-Related Diseases” analytical report.



Martin Wood Lecture Theatre,  
20 Parks Rd,  
**Oxford**  
OX1 3PU  
15 September, 16:30 to 19:30

21st Century Medicine Forum:

**B**IG  
**D**ATA  
**S**CIENCE IN  
**M**EDICINE



Aubrey de Grey, SENS Research Foundation  
Avi Roy, Oxford University Scientific Society  
Geoffrey Furlonger, Aging Analytics Agency  
Dmitry Kaminskiy, Deep Knowledge Ventures  
Joao Pedro De Magalhaes, University of Liverpool  
Alex Zhavoronkov, InSilico Medicine  
Dr. Gordon Sanghera, Oxford Nanopore

[bdsmcongress.org](http://bdsmcongress.org)



The Second 2014 Symposium  
**Big Data Science in Medicine**  
*Accelerating Preventive Medicine*

8 December, 1:00pm – 7:00pm  
Saïd Business School, University of Oxford



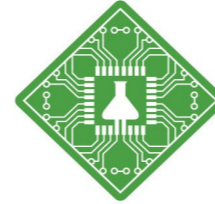
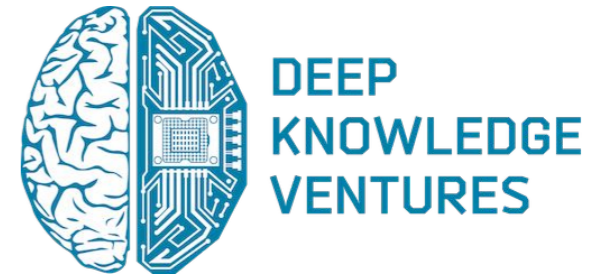
**Richard Barker** CASMI, Oxford & UCL  
**Olga Kovalchuk** University of Lethbridge  
**Thomas Wilckens** InnVentis  
**Alex Zhavoronkov** BGRF & InSilico Medicine  
**Anders Sandberg** Future of Humanity Institute  
**Gitte Pederson** Genomic Expression Inc  
**Maneesh Juneja** Health 2.0 and MJ Analytics  
**Dmitry Kaminskiy** Deep Knowledge Ventures



Register at: [bit.ly/oxfordmed](http://bit.ly/oxfordmed)

[bigdatamed.org](http://bigdatamed.org)

# Deep Knowledge Ventures: Investing in AI for Longevity Since 2014



英科智能  
Insilico Medicine



# Pharma's AlphaGo Moment: For the First Time AI Has Designed and Validated a New Drug Candidate in Days

## Insilico Medicine



The first in vivo active drug candidate developed from scratch (de-novo) using GENTRL system

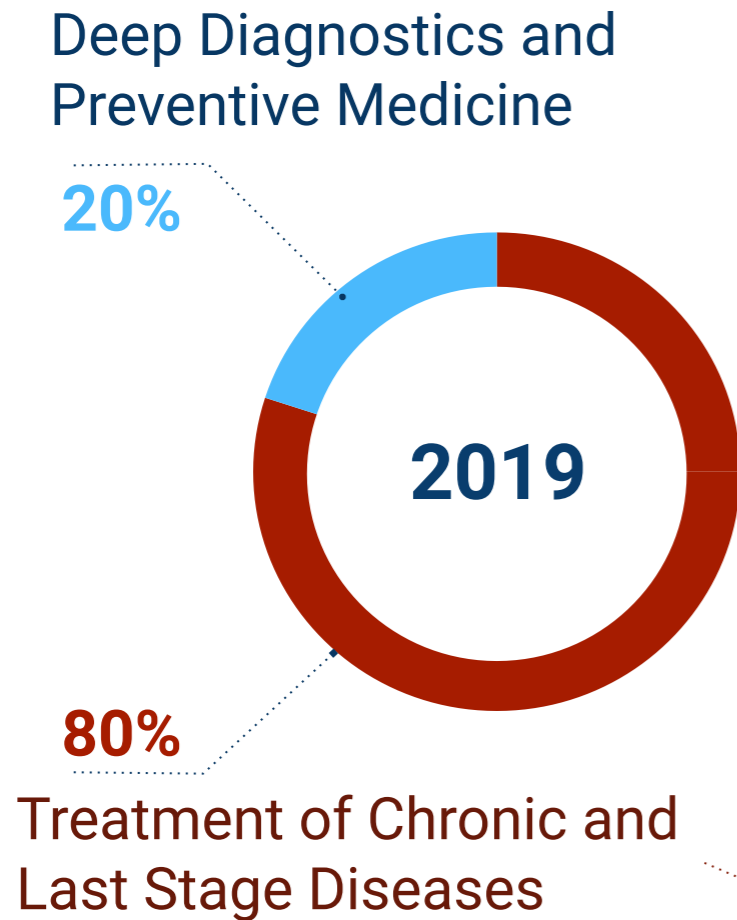
GENTRL system - a modular drug design platform based on generative adversarial networks (GANs) and other machine learning

A new candidate has been developed staggeringly quickly: in 46 days, including target selection

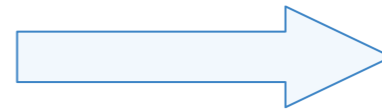
# The Role of Artificial Intelligence in Longevity Science

# Paradigm Shift from Treatment to Prevention

## Individual Patient Level



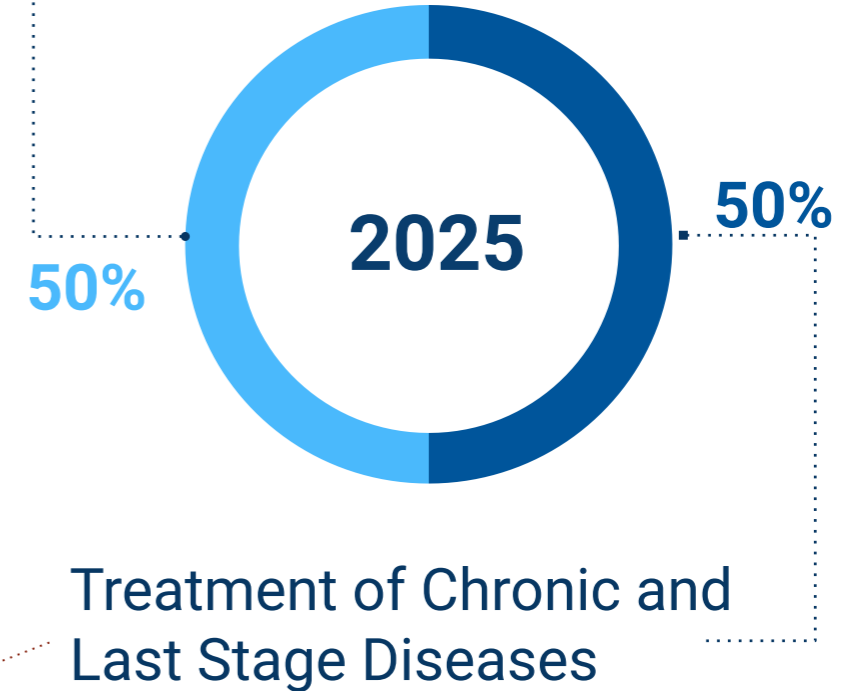
Personal Profile of Complex Biomarkers Networks



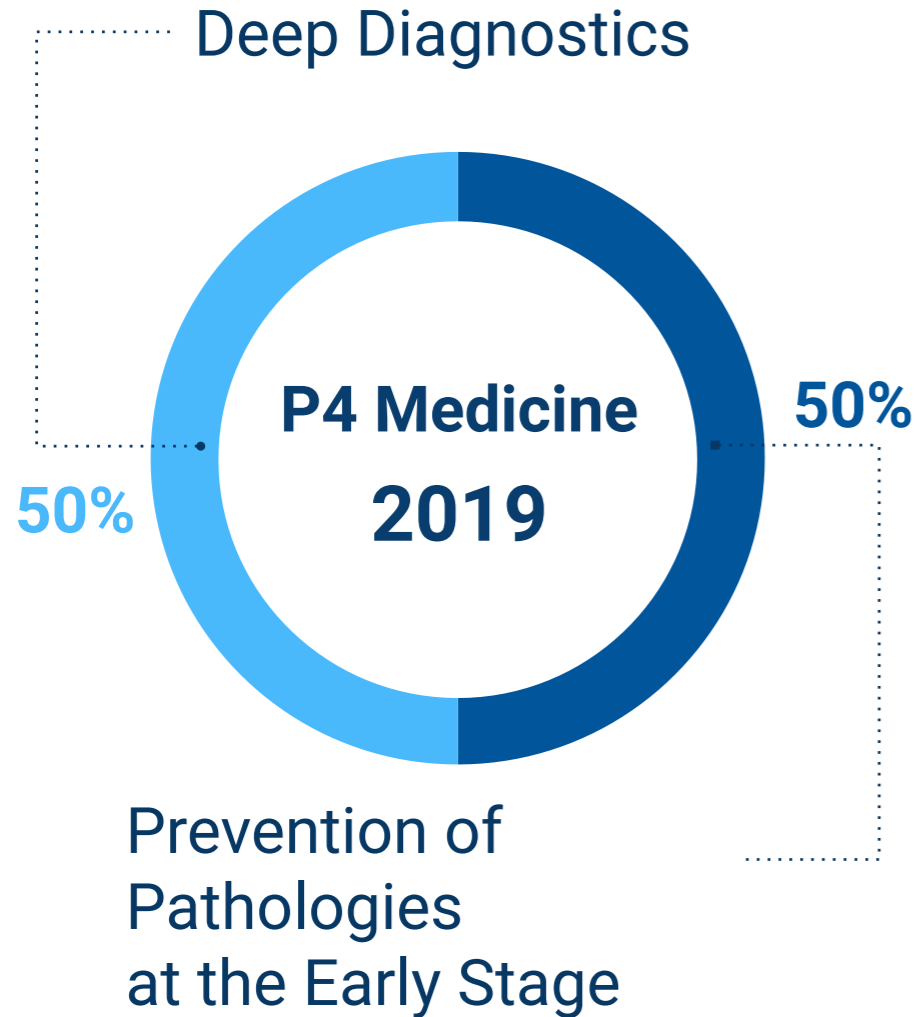
Data Science and AI application leading to the Biomarker discovery and implementation

Patients Grouping One-Size-Fit-All Biomarkers

Precision Preventive Personalized Medicine

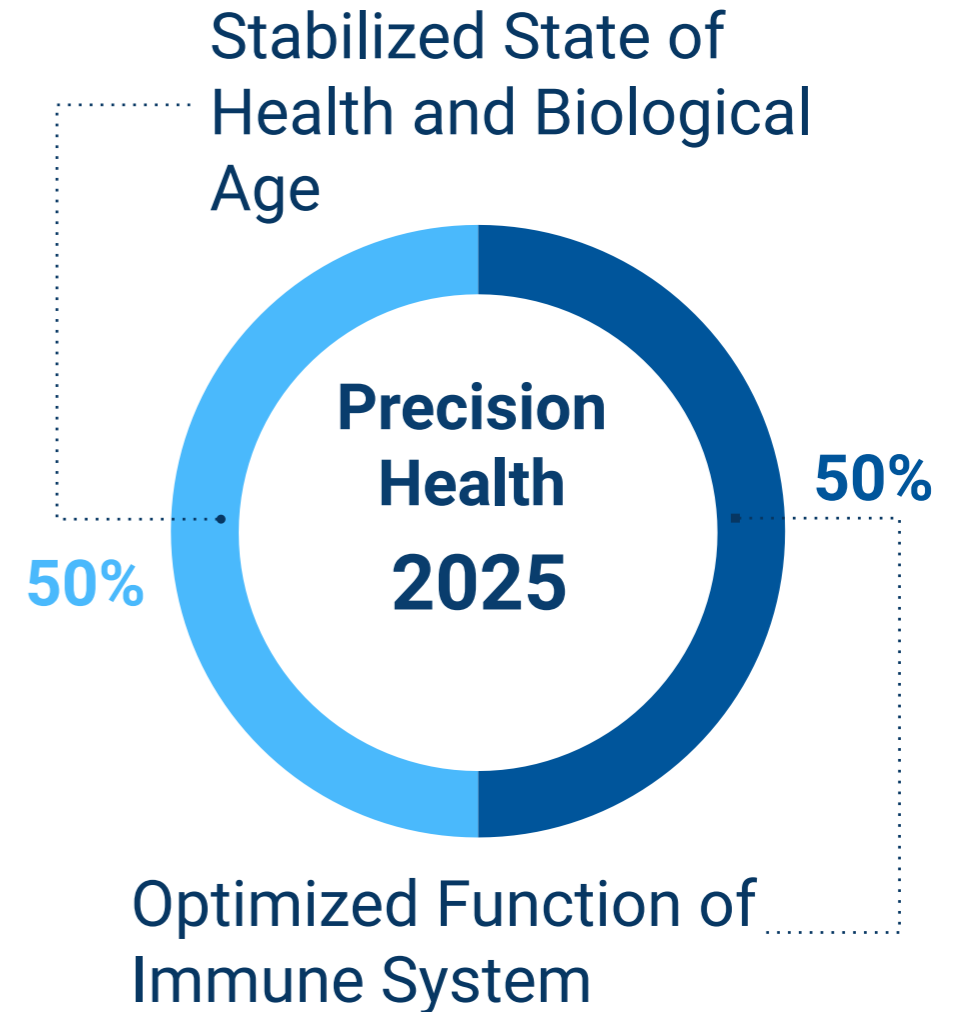


# The New Frontier - from Precision Medicine to Precision Health



➔

**Data Science and AI  
application leading  
to the Biomarker  
discovery and  
implementation**







# AI: Reshaping the Future of Longevity

AI for Drug Discovery,  
Biomarker Development  
and Advanced R&D  
Landscape / 2019 Q3

AI Companies - 200  
Investors - 460  
Corporations - 70



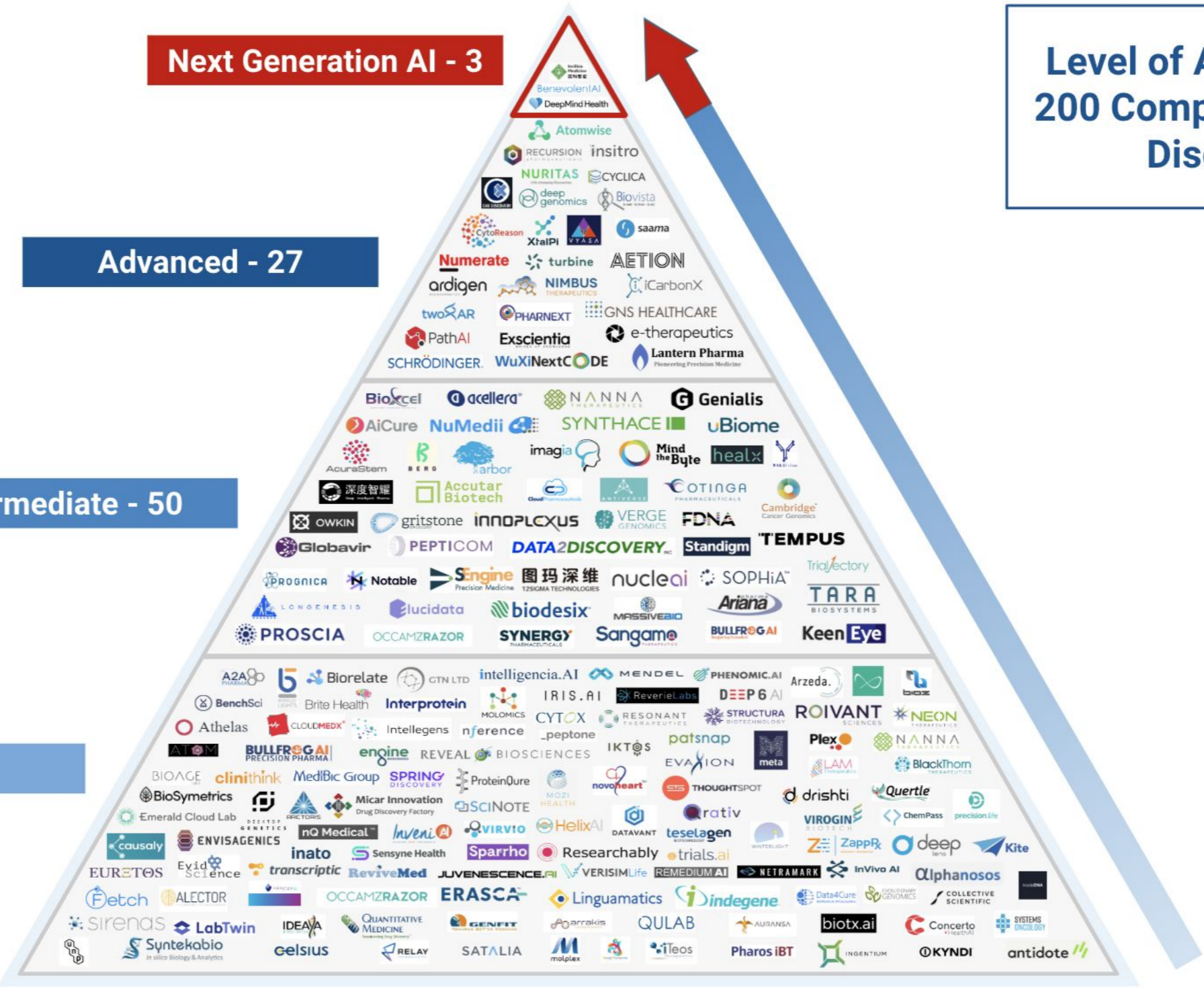
Next Generation AI - 3

Advanced - 27

Intermediate - 50

Basic - 120

Level of AI-Strength of 200 Companies in Drug Discovery Sector



# Rapid Industrialization of AI in the UK

AI in UK Industry Landscape 2018

1000 AI Companies  
25 AI Hubs





# The Business of Longevity 2019



**THE BUSINESS of LONGEVITY GLOBAL INDUSTRY LANDSCAPE**

**COMPANIES**  
**INVESTORS**  
**SCIENCE HUBS**



**Top 10 Longevity Companies**

**Top 10 Longevity Investors**



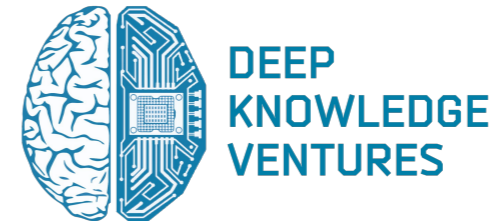
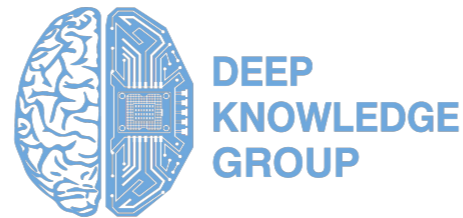
# Longevity AI Consortium at King's College London

*The UK's First Dedicated AI for Longevity Hub*



# Longevity AI Consortium

# Longevity AI Consortium at King's College London

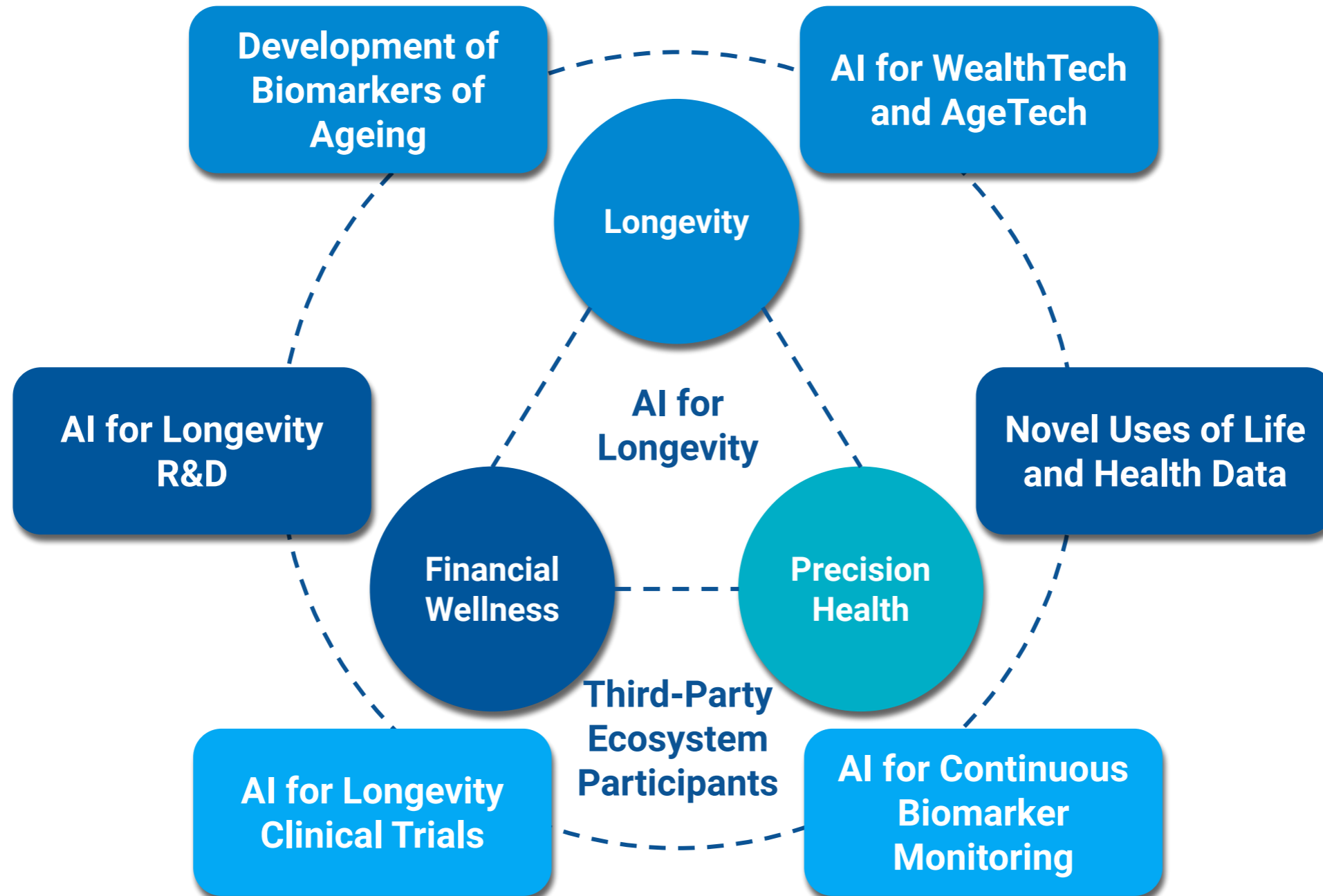


Ageing Research at King's (ARK) has developed World's first **Longevity AI Consortium** in 2019, building upon the foundation it has already established ageing and longevity research to turn scientific innovations into clinical realities.



# Utilizing AI Opportunities for Longevity

# Artificial Intelligence: the Game Changer for Precision Health and Longevity



# AI for Precision Health: Progress and Opportunities



Generate data from DNA sequence analysis and electronic patient health records

**Research  
Tool and  
Processing  
Technology**

Cost-efficiency of genome sequencing will enable genetic defects to be edited out of the genome

**Advances in  
Genetics**

**Meaningful  
Improvements  
in Clinical  
Care**

**Voluntary  
Data  
Contribution  
from  
Patients**

Genomics, transcriptomics, metabolomics, and microbiomics data can be generated in real time

# AI-driven Biomarkers and P4 Medicine

## AI-Driven Precision Biomarkers



- Continuous monitoring of health state based on changes in Biomarkers of aging

## AI-Driven Advanced Prognostics



- Advanced Biomarker-based prognostics
- AI-driven predictive prognostics based on personalized multi-omics

## Personalised Treatment Optimization



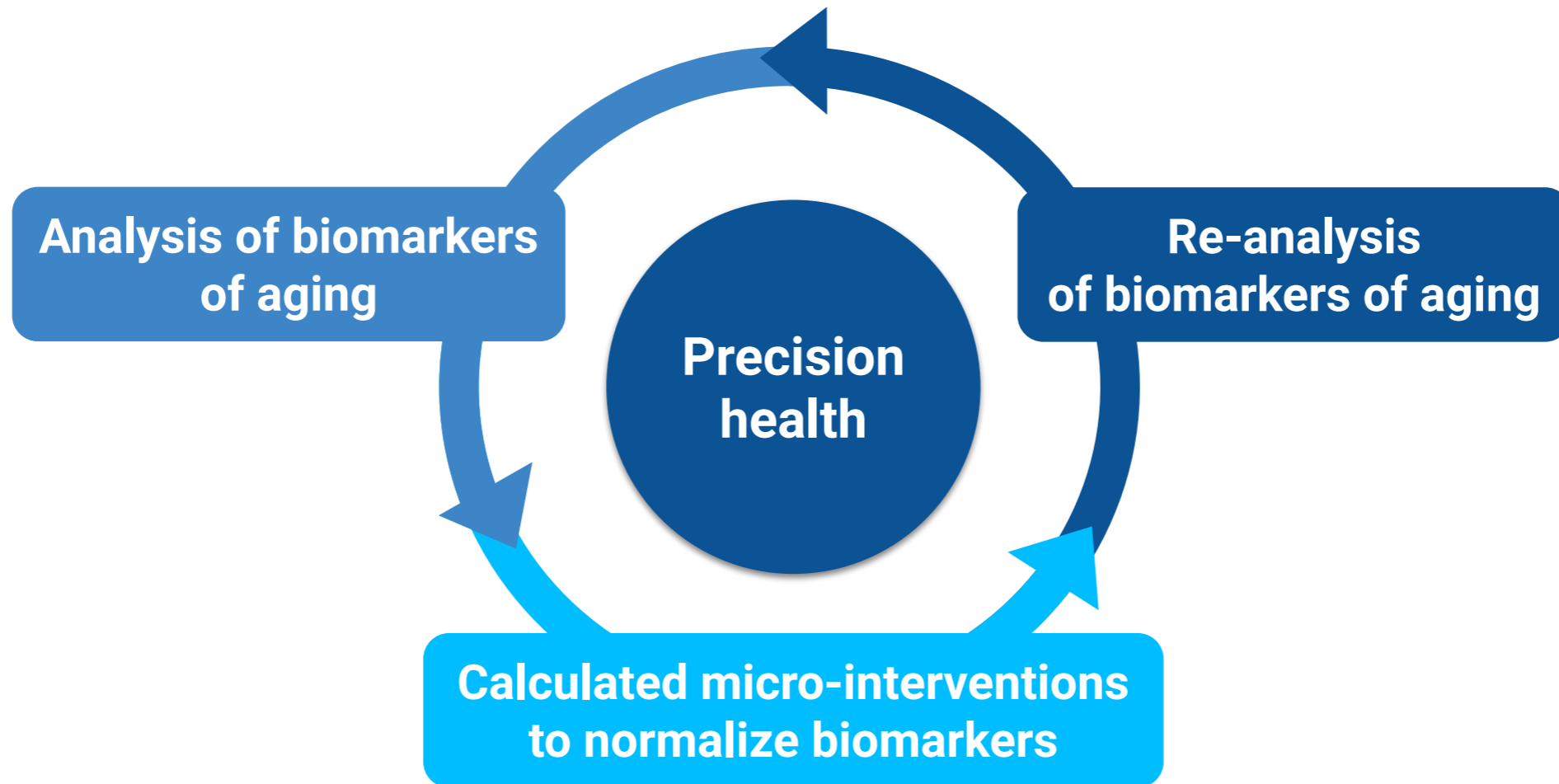
- AI-driven *in silico* personalised treatment optimization
- AI-driven personalised *in vivo* drug optimization

## AI-Driven Preventative Treatment



- Maintenance state of precision health through preventive medicine
- AI-based predictions of optimal drug combination

# AI for P4 Medicine



# AI for Financial Longevity Wellness

**Adjusted  
AgeTech tools**

**Adjusted  
FinTech tools**

**Robo-advisors**

**Robo-retirement**

**AI-empowered  
WealthTech,  
FinTech,  
AgeTech**

**Adjusted  
WealthTech tools**

**Micro-investing**

**Financial services  
software**

**Digital brokerage**

# **Biomarkers of Longevity**



## **Analytical Report**

**Current State, Challenges and Opportunities  
Landscape Overview 2019**

**Increasing Role of Data Science and Artificial  
Intelligence in Biomarker Discovery and  
Monitoring**

# Biomarkers of Longevity 2019

Approved for Clinical Use - 41  
Healthcare-Ready - 33  
Research Use Only - 45

1st edition: Selection and Current Status, 2019

## Single Biomarkers

## Biomarker Panels

## Digital Panel Platforms

Approved for Clinical Use

Healthcare-Ready  
(waiting for clinical approval)

Research Use Only

ARUP LABORATORIES  
CD4+ T-Cell Recent Thymic Emigrants

ARUP LABORATORIES  
CD57+ NK Cells, Peripheral Blood by Flow Cytometry

ARUP LABORATORIES  
CD21 (Dendritic Cell) by Immunohistochemistry

InsideTracker Inner Age	InsideTracker Ultimate Plan	RGCC aCGH RGCC	RGCC Immune-Frame	GENOVA DIAGNOSTICS Comprehensive Adrenal Stress Profile	ARUP B-Cell Memory and Naive Panel	ARUP Natural Killer Cell and Natural Killer T-Cell Panel
Health + Ancestry Service	Carnitine Panel	Cytokine Panel, TH1	Hepatic Function Panel	Regulatory T-Cell Panel	Cytokine Panel	
GENOVA Oxidative Stress Analysis 2.0	FLUIDS IQ Adrenal Check	Adrenal Stress Profile	Advanced MethylDetox Profile	Advanced MethylDetox Profile + Thelomere Length	Diagnostix AGE-Reader mu Test	
Female/Male Saliva Profile II - Test Kit for 6 Hormone Level Imbalances	biobank Cytokine Panel	WellnessFX Premium	Aging Therapeutic 1.0	10 Hormone Saliva Test Kit	Anti-Aging + Comprehensive Blood and Urine Test Panel	
Healthy Aging Panel (Comprehensive)	GENOVA CardioGenomic Plus Profile	GENOVA DIAGNOSTICS ImmunoGenomic Profile		GENOVA NeuroGenomic Profile	PhysiAge Biomarkers of Aging Test	

babyon Babylon Health Platform

Health Reviser Platform

CarePredict Platform

Ada Symptom Checker app

Centers for Age Control AgeMeter

Google's DeepMind Health AI Platform

Cell Science Systems Telomere Length Test

ZYMO RESEARCH DNAge™ Epigenetic Aging Clock

CHRONOMICS EpiHealth

BioViva DNAge® Test

TELOYEARS TeloYears + Advanced Ancestry Tests

Epigenetic Age Analysis Version 2.0

EpiSocialpsych

Targeted Seq. for DNA Methylation Analysis

X LIFE LENGTH Telomere Length and Biological Age Testing

EpiLiver

EpiAging

EpiBreast

smartDNA smartGUT™ Microbiome Test

Microba Insight™

cerascreen Genetic Age Test

Viome Viome Gut Intelligence™ Test

GLYCANAGE GlycanAge Test

TFFAK Gut Microbiota Biohacker

toxiomiRTM biomarkers of toxicity

osteomiRTM validated bone biomarkers

thrombomiRTM biomarkers of platelet function

nourish balance bVive Blood Chemistry Calculator

zebro AI-Powered Radiology Assistant

edage MEDIAGE™ Biological Age Measurement System

kenSci KenSci Platform

enitic Enitic Platform

aging.AI Aging.AI

young.AI Young.AI

PathAI PathAI Platform

buoy Buoy Health Platform

HAUT.AI PhotoAgeClock

HAUT.AI Haut.AI Skin Health

zipongo Digital Nutrition Platform

Metabolism Panel	Immune Response Panel	Cardiovascular II Panel	Cell Regulation Panel
Organ Damage Panel	Neurology Panel	Inflammation Panel	Cardiovascular III Panel
Cardiometabolic Panel	Oncology III Panel	Oncology II Panel	HumanMAP v.2.0
CardiovascularMAP v.3.0	DiscoveryMAP v.3.3 Panel	AngiogenesisMAP v.1.0	NeuroMAP v.1.0
InflammationMAP v.1.0	CytokineMAP B	CytokineMAP A	ImmunoMAP v.1.0
LEGENDScreen Human PE Kit	LEGENDplex Human Th Cytokine Panel	Cytometry OMIP-004	Cytometry OMIP-018
		Cytometry OMIP-027	Cytometry OMIP-029

PROSCIA Proscia Platform

freonome Freonome Platform

BenevolentAI BenevolentAI Platform

Better Better Therapeutics Platform

Tempus Platform

ICabonX Platform





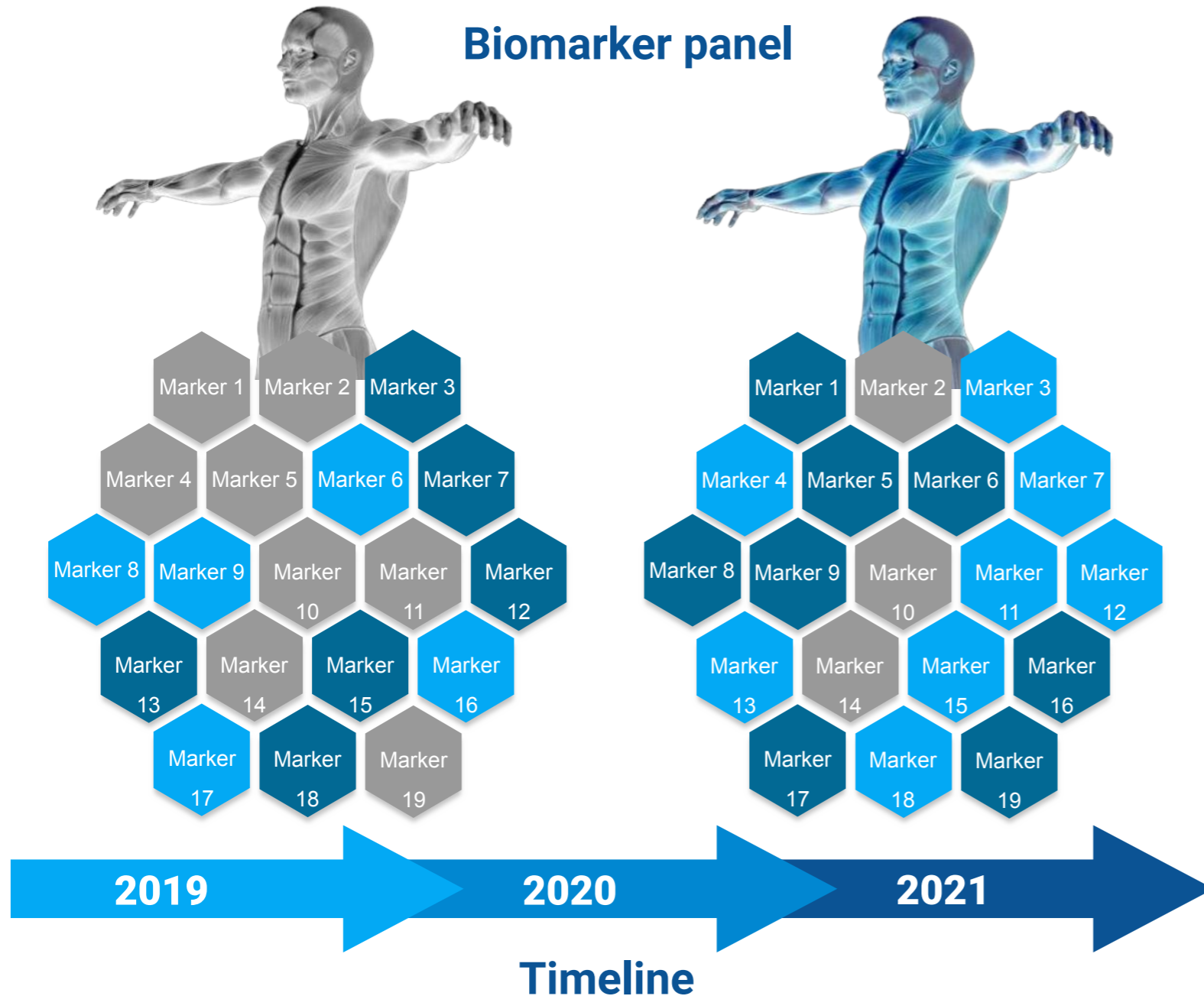
# Biomarkers of Longevity: Report Key Points




- ◆ A shift is needed towards maximally **actionable biomarkers of aging** that are not as accurate as possible but **precise enough** and **immediately implementable**
- ◆ As the **volume of data** on biomarkers of Longevity (and the complex ways they interact) continues to grow, AI will become a **completely essential component** of all Biomarkers of Longevity discovery, development and implementation
- ◆ Aging Analytics Agency's newest report presents an **MVP list** of biomarkers and biomarker panels with the **highest ratios of accuracy to actionability**, which are ideal for immediate practical implementation
- ◆ AI will enable the shift from preventive medicine to **Precision Health**, orchestrating a near **real-time cycle** of biomarker monitoring and therapeutic micro-adjustment

# AI-Driven Development of Biomarker Panels of Aging, Longevity and Health

# AI-Driven Development of Biomarker Panels of Aging

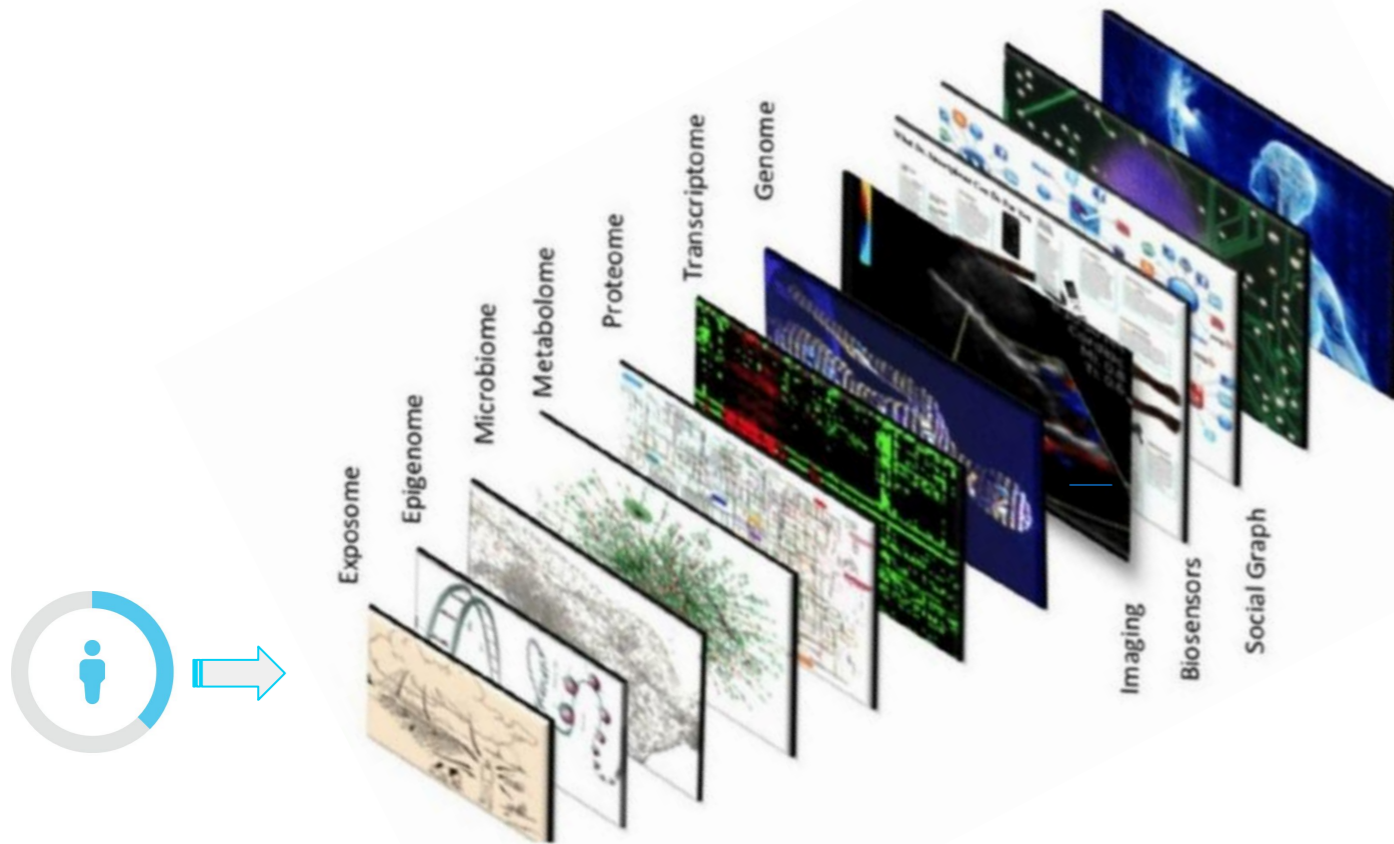
## Biomarker panel



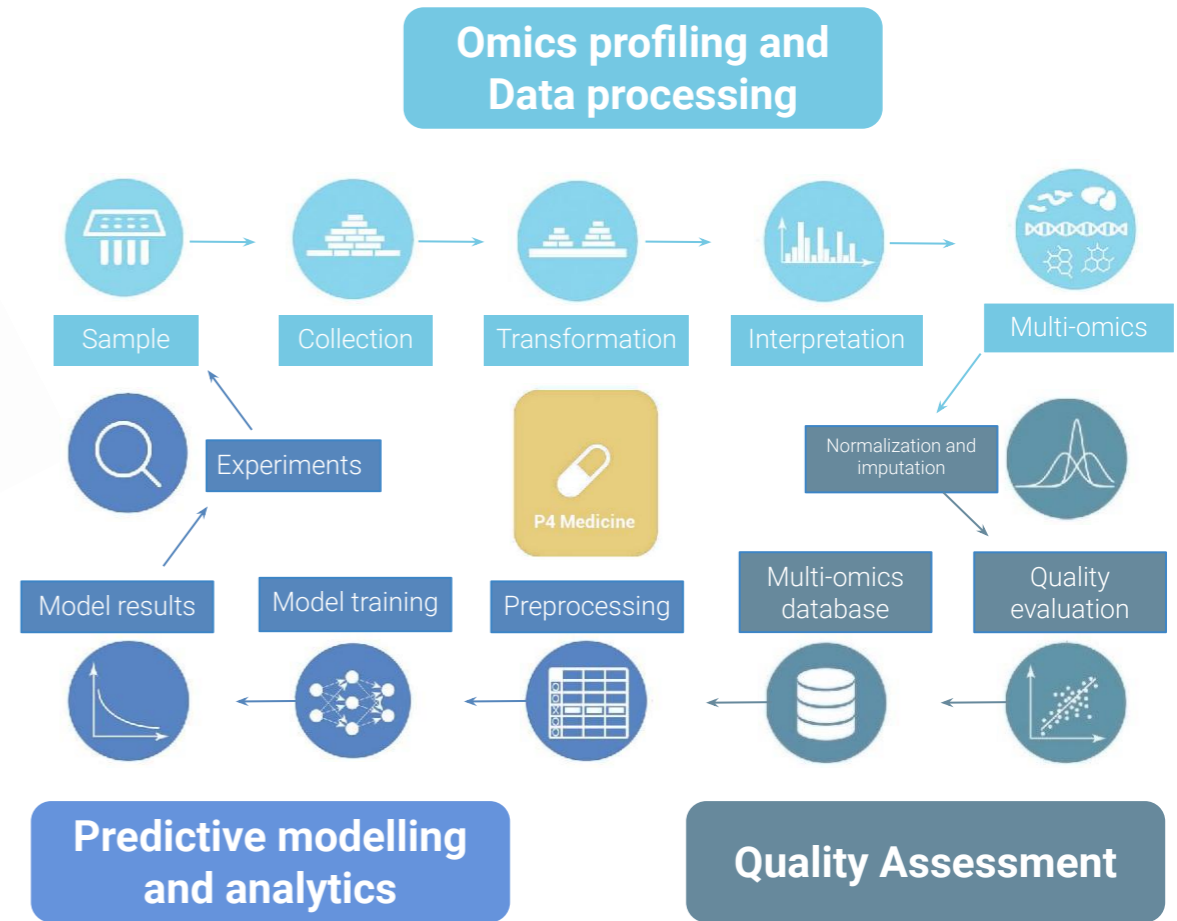
-  Unfulfilled Biomarkers
-  Validated Biomarkers adopted in practice
-  Experimental Biomarkers adopted in practice

Artificial Intelligence will use Digital Biomarkers to reality-check the proposed Longevity therapies and filter out inappropriate or impractical biomarkers from effective ones.

# Data Science and AI Making Complex Biomarkers Available



Creation of topological maps of health and disease



Data acquisition, multi-omics integration and predictive modeling

# Digital Biomarkers, Pharma Industry, and P4 Medicine



**Healthy lifespan extension and ageing processes reversal to a young state**

01

**Access to advanced preventive restorative medicine technologies**

02

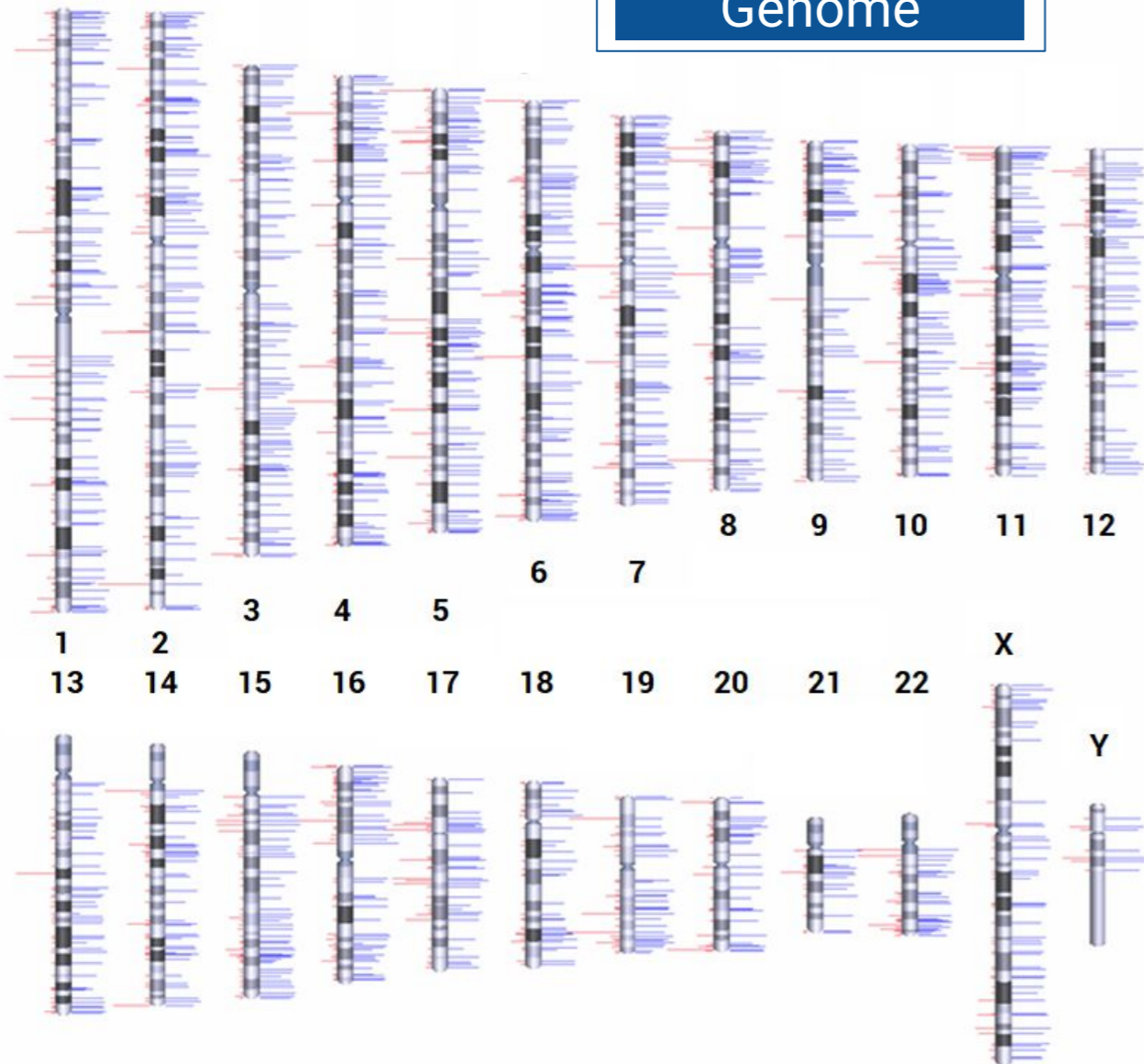
**Personalized Longevity programs**

03

**Health management by world leading experts**

# Biomarker Panels

## Genome



A **Biomarker Panel** is a group of biomarkers that reflect different interconnected processes or parameters of a disease or health status, creating complex networks of biomedical outputs.

# Single Biomarkers and Panels Classification Framework

		Osteoporosis	Arthritis									
		COPD	Sarcopenia									
Biological Age measurement	Ophthalmology	Aging-associated Metabolic Syndrome	Osteopenia							Drug Discovery and Development		
Alcohol/drug treatment	Gastroenterology	Type II Diabetes	Obesity							Drug Formulation		
Oncology	Orthopaedics	Cancer	Alzheimer's Disease	Locomotor function; Dexterity						Preclinical Trials		Genomic Instability
Cardiology	Hematology	Amyotrophic Lateral Sclerosis	Parkinson's Disease	Bone density; Bone mass hip						Clinical Trials		Telomere Attrition
Neurology	Rheumatology	Hypertension	Cerebrovascular Disease	Muscle mass; Body impedance; Abdominal fat	Digital biomarkers + AI	Biochemistry level	Genomics	Transcriptomics	Diagnostic	Efficacy - Pharmacodynamic		Loss of Proteostasis
Endocrinology	Sleep disorders	Atherosclerosis	Mild Cognitive Impairment	Blood pressure; Lipid profile; Glycated Hb	Human Biomonitoring	Genomic level	Epigenomics	Foodomics	Disease Risk Assessment	Efficacy - Predictive		Deregulated Nutrient Sensing
Maternal-Fetal medicine	Urogynecology	Cardiovascular Disease	Dementia	Lung capacities; Transpulmonary pressure	Imaging	Proteins and Cell Signalling level	Metabolomics	Nutritional genomics	Screening	Efficacy - Prognostic		Mitochondrial Dysfunction
Infectious diseases	Dentistry	Coronary Artery Disease	Multiple Sclerosis	Processing speed; Working memory; Visual memory	Laboratory procedures (Blood, Saliva, Biopsy)	Cellular level	Proteomics	Pharmacogenomics	P4 Medicine	Efficacy - Surrogate and Diagnostic		Cellular Senescence
Dermatology	Otolaryngology	Deep Vein Thrombosis	Coordination impairment	Endocrine profile; HPA axis	Pedigree and Family History	Tissue level	Lipidomics	Pharmacomicrobiomics	Regenerative Medicine	Validation		Stem Cell Exhaustion
Allergology	Immunology	Blindness	Age-related Macular Degeneration	Chronic inflammatory status	Routine and Comprehensive Physicals	Organs level	Glycomics	Toxicogenomics	Research	Safety		Altered Intercellular Communication
Clinical Outlook		Diseases and Conditions Outlook		Functional and Structural Outlook	Source Outlook	Focus Level Outlook	Omic Outlook		Application Outlook	Type Outlook	Age Mechanism Outlook	

# The Need for Maximally Actionable Biomarkers of Aging

- ◆ **Biomedical markers are able** to serve as the basis for building standard metrics for government programs and cost-effective healthcare policies, clinical implementations, and industrial output in global Longevity Industry.
- ◆ **Big Data analytics** is needed to develop optimal Panels of Biomarkers of aging and to determine how to optimize their implementation.
- ◆ Panels of less precise but **easily implementable biomarkers of aging** would be much better than an extremely precise and comprehensive panel of biomarkers of aging.



# Biomarkers of Longevity: *Second Edition* - Q1 2020

The next edition of the report will feature:

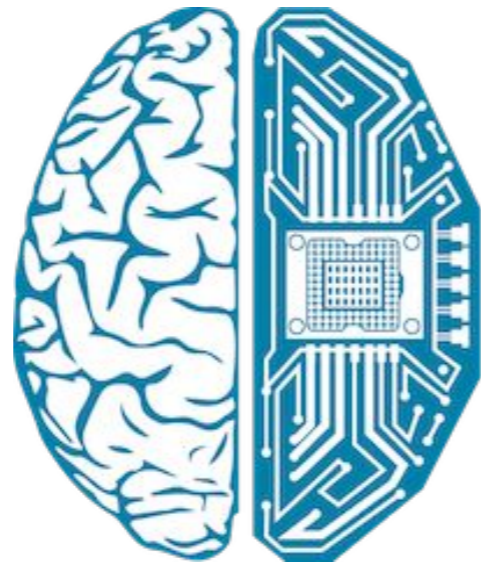
- ◆ Concrete deep analysis of which biomarkers and biomarker panels are available today.
- ◆ Estimation of which biological age biomarkers and implementations are consolidated, able to be used for human testing and monitoring
- ◆ The role of digital biomarkers and AI platforms and how they will become indispensable components of ageing and Longevity biomarker discovery, research, development and users daily use.

# Longevity AI Accelerator

# AI LONGEVITY ACCELERATOR

AT KING'S COLLEGE LONDON

KING'S  
College  
LONDON



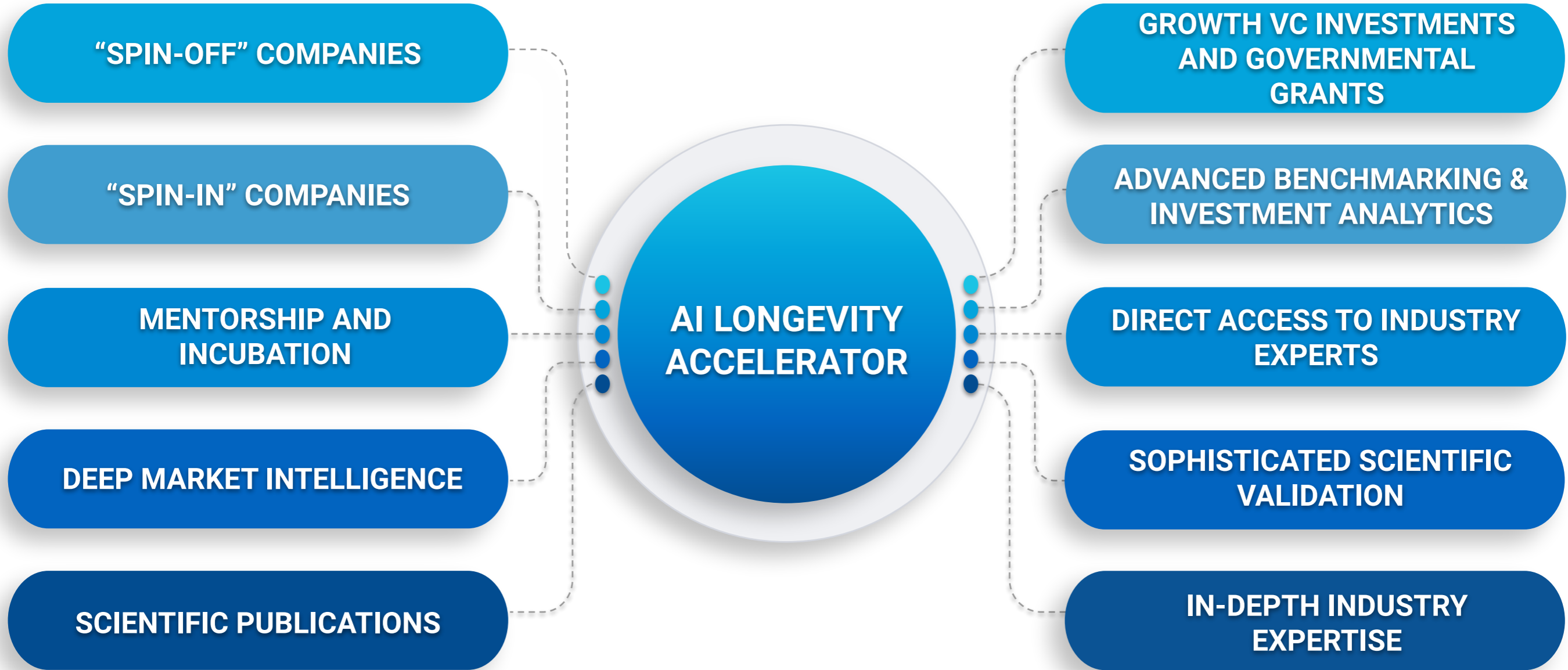
DEEP  
KNOWLEDGE  
VENTURES

KING'S  
College  
LONDON

Longevity AI  
Consortium

Ageing  
Research  
*at King's*

# AI Longevity Accelerator

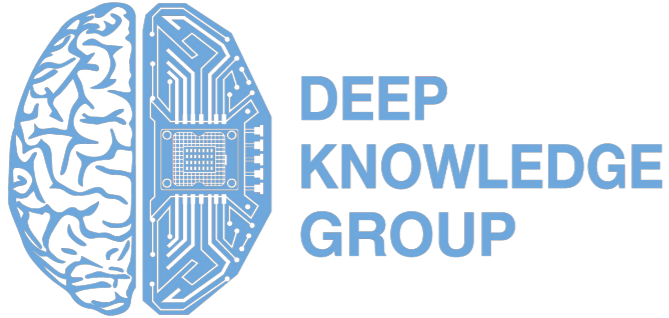


AI Longevity Accelerator is the World's First Specialised Accelerator, focused on the AI for Longevity Industry

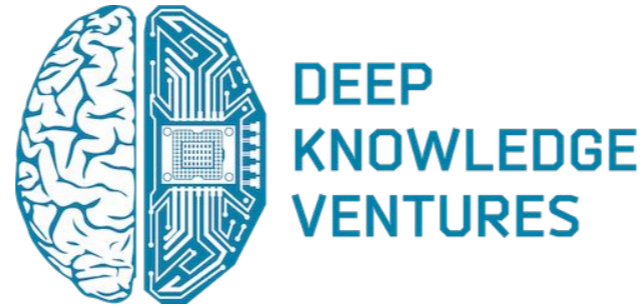
# AI Longevity Accelerator Global Aspect



# Funding by Deep Knowledge Group to the Longevity AI Consortium



Deep Knowledge Group is providing the Longevity AI Consortium with **£2 million** for non-profit activities over a 3-year period.



Deep Knowledge Ventures will provide the Longevity AI Consortium with **£5 million** for commercial activities over a 3-year period.



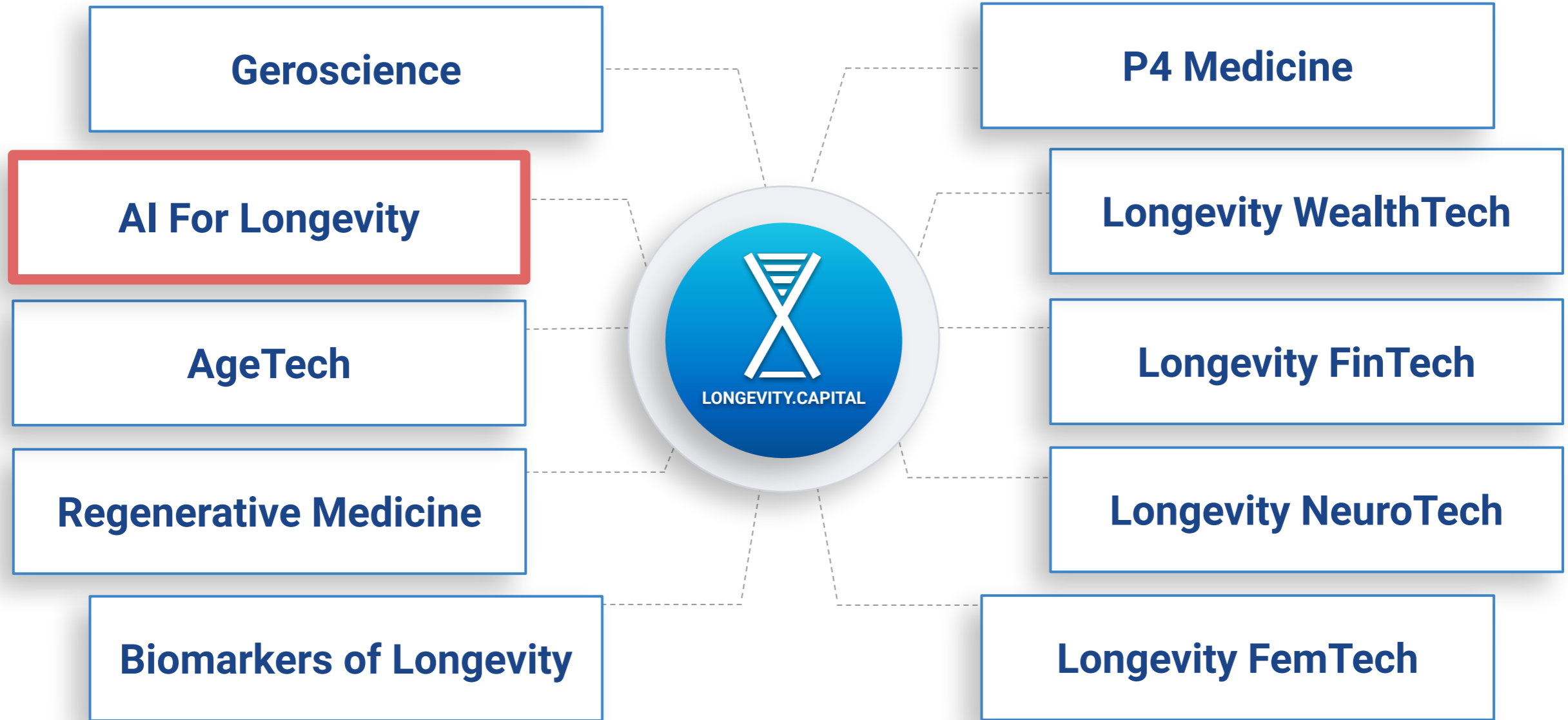
The further liquidity and syndication of the investment rounds will be provided and supported by Longevity.Capital



# Longevity.Capital

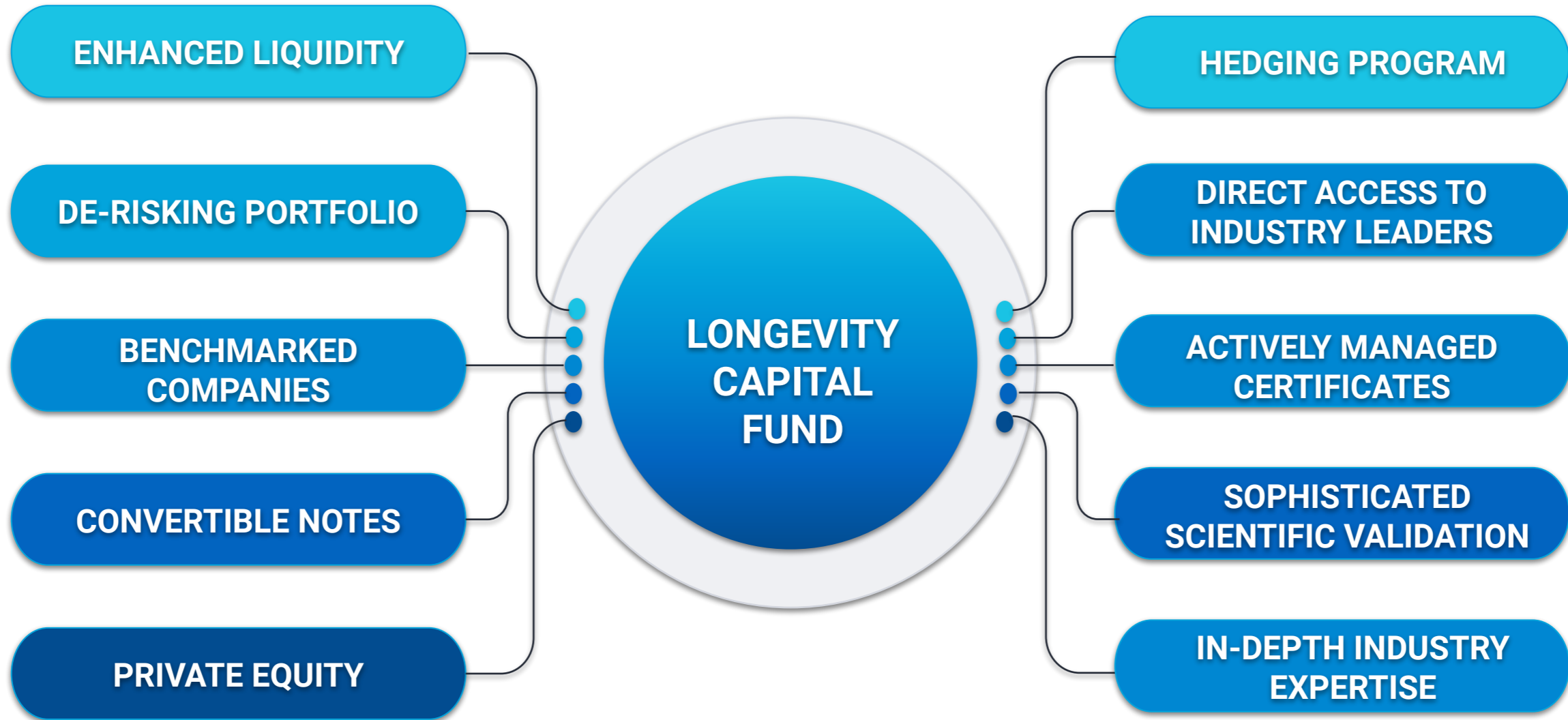
***Specialized Longevity-Focused  
Hybrid Investment Fund***

# Portfolio Diversification over 10 of Longevity Industry Subsectors





# Longevity.Capital Fund Architecture



Longevity Capital Fund is a Novel InvestTech Solution: Specialised Investment Fund focused on the Longevity Industry

# The Future of AI for Longevity

# The Future of AI for Longevity

- ◆ AI will exponentially **accelerate** the rate of **Longevity R&D** and the pace of the practical implementation of Longevity technologies and therapeutics
- ◆ This will accelerate the shift from **treatment to prevention** and from preventive medicine to **Precision Health**
- ◆ We will witness a shift in the collection of health data away from hospital patients and towards the **collection of life data** from of **millions of healthy** individuals

# The Future of AI for Longevity

- ◆ Explosion of activity in developing **actionable biomarkers of aging** that have very high **ratios of accuracy to implementability**
- ◆ **FinTech, AgeTech and WealthTech**, AI will enable **financial wellness** over extended periods of Healthy Longevity
- ◆ Novel methods of AI to optimize **psychological wellness, social activity, neuroplasticity**, and to combat **loneliness and social isolation**

@Longevity\_Intl  
#livelongerbetter

# INTERNATIONAL LONGEVITY POLICY AND GOVERNANCE SUMMIT 2019

*Living longer, healthier and productively for global prosperity*

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November, 12th

Longevity uk

# Global Longevity Governance Landscape

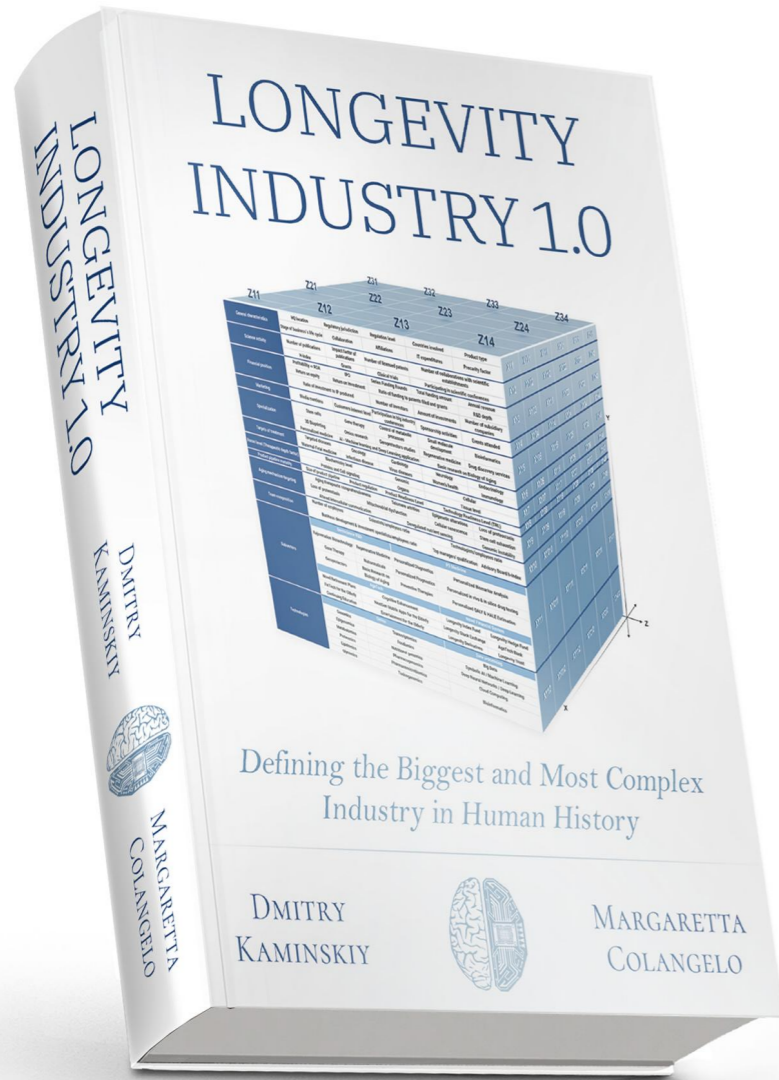
50 Countries Big Data  
Comparative Analysis of  
Longevity Progressiveness



AGING  
ANALYTICS  
AGENCY

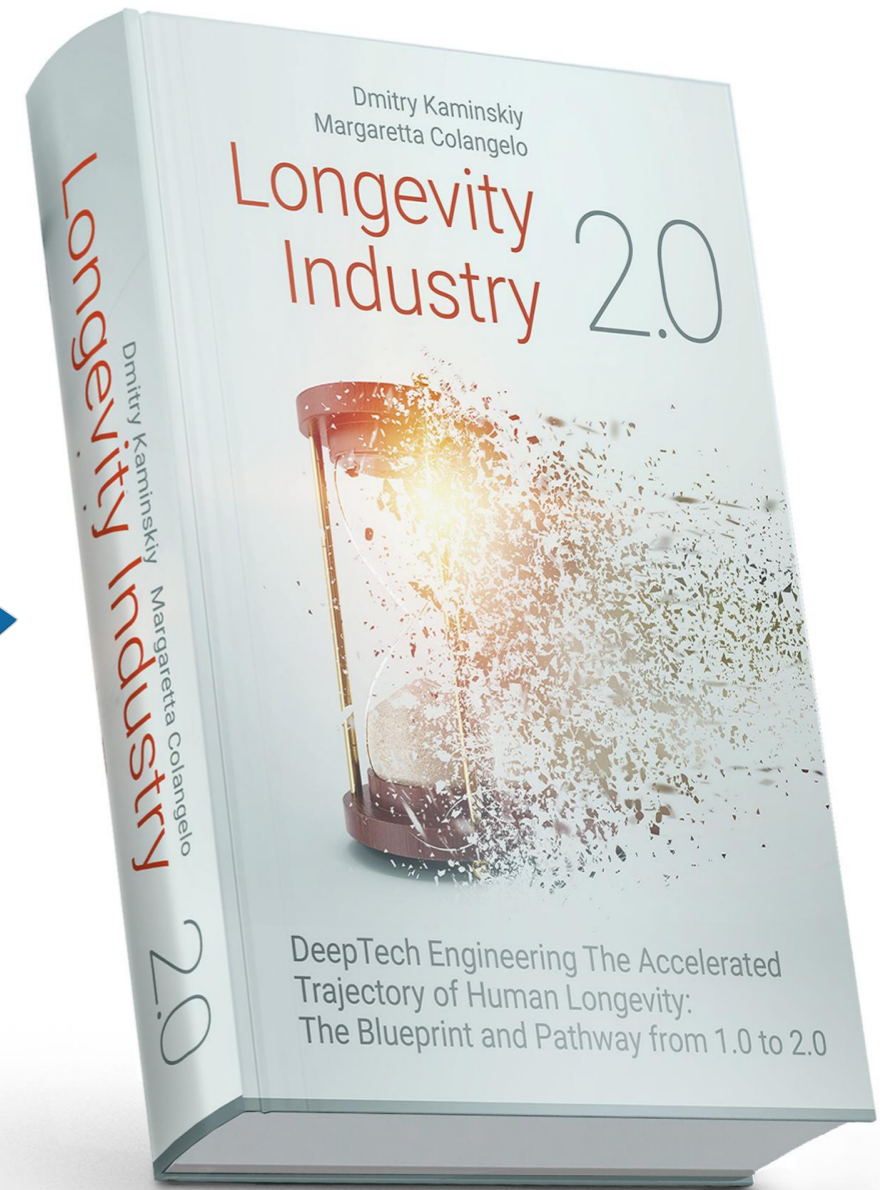
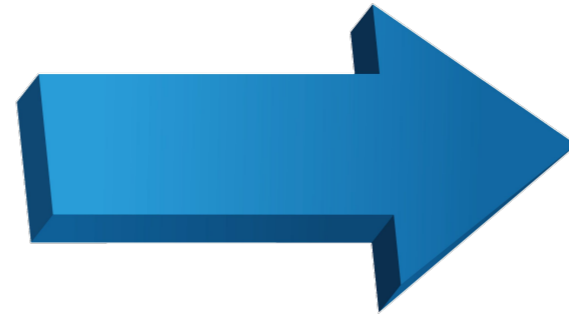
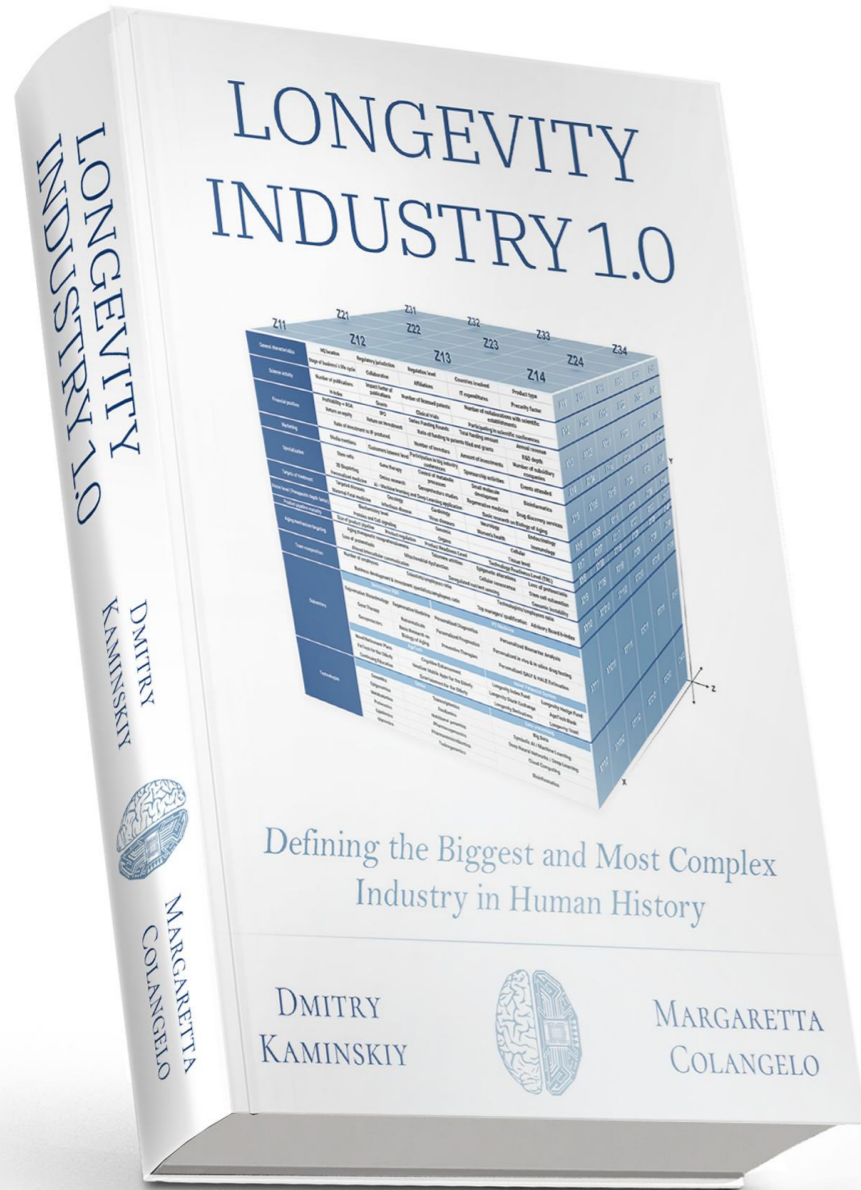
[www.aginganalytics.com](http://www.aginganalytics.com)

# Longevity Industry 1.0: Evolution of the Longevity Industry from Zero to 1.0



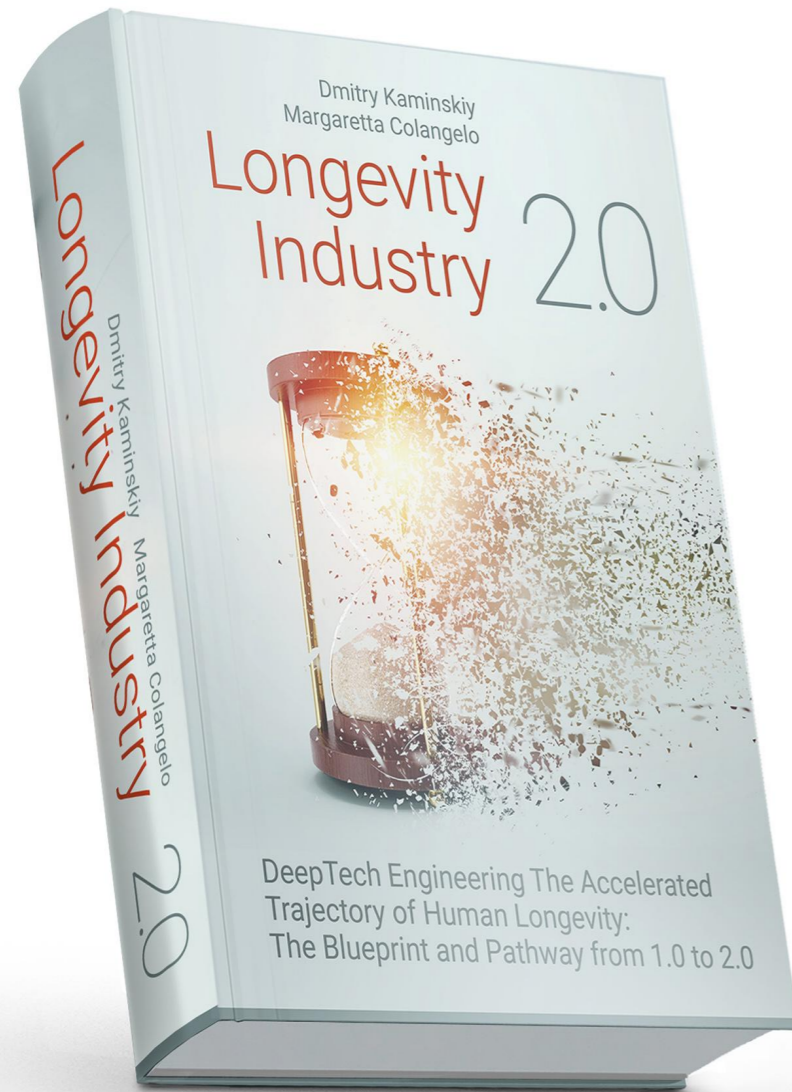
- ◆ The Industrialization of Longevity
- ◆ The Current State of Longevity Science, Business, Finance, and Practical Applications
- ◆ Longevity Becomes National Priority Item for the Strategic Agenda of Progressive Governments
- ◆ Transforming the Challenge and Deficit of Aging into the Opportunity and Asset of Longevity
- ◆ Defining and De-Risking: Hype vs. Reality

# Longevity Industry 2.0: DeepTech Engineering the Accelerated Trajectory of Human Longevity - The Blueprint and Pathway from 1.0 to 2.0





# Longevity Industry 2.0: DeepTech Engineering the Accelerated Trajectory of Human Longevity - The Blueprint and Pathway from 1.0 to 2.0



- ◆ **Global Industrialization of Longevity to Scale**
- ◆ **The Evolution from Longevity Start-ups to Multi-Trillion Dollar Longevity Corporations**
- ◆ **How AI Will Replace Doctors by 2025**
- ◆ **The Disruption of BioTech and Healthcare by Novel AI-Driven InvestTech Solutions**
- ◆ **The Rise of Progressive Longevity MegaHubs**

**Formula of 21st Century**

**Most Progressive Country =**

**Ministry of AI + Ministry of Longevity**



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ANALYTICS  
AGENCY**

**[www.aginganalytics.com](http://www.aginganalytics.com)**

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