Longevity Industry Landscape Overview 2018

Volume I: The Science of Longevity

Volume II: The Business of Longevity

Science, Technology, Policy,
Business, Economics, Frameworks,
Society, Trends, Forecasting

“With some longer term, moonshot thinking around healthcare and biotechnology, I believe we can improve millions of lives” - **Larry Page, CEO of Google.**

“Death never made any sense to me.” **- *Larry Ellison, Founder of Oracle.***

“There will come an age when our average life expectancy will reach 200 years.” **- Masayoshi Son, CEO of SoftBank and Vision Fund.**

“Aging is the ultimate evil. To invest in Anti-Aging technologies is the most ethical business, and to donate to longevity research is the most effective form of altruism.” **- Dmitry Kaminskiy, Deep Knowledge Ventures.**

“Longevity is a blessing. And as an investor, it provides you opportunities to benefit from compounding and to have a longer investment horizon. But if you don’t prepare for it, you are left with two options: Work longer in life, perhaps much longer than you’d like, or hope you’ve been good to your children and that they’ll be willing to care for you in your old age. And, second, I hope you’ll speak out. Longevity is an issue of social justice that will have a more profound impact on your generation than on any generation before. If we don't start to address it – not just in this country but globally – we're going to see fewer job prospects for young people, higher unemployment, lower growth and many older people – maybe your parents – left without the means to support themselves.” **- Larry Fink, Chairman of Blackrock Capital.**

“The way we prioritize projects at Insilico Medicine is by looking at the number of quality-adjusted life years (QALY) each project can generate. It is the most altruistic cause and the most effective investment. If you add just one year of life to everyone on the planet, you generate over 7 billion QALY.” **- Alex Zhavoronkov, Chief Science Officer of the Biogerontology Research Foundation.**

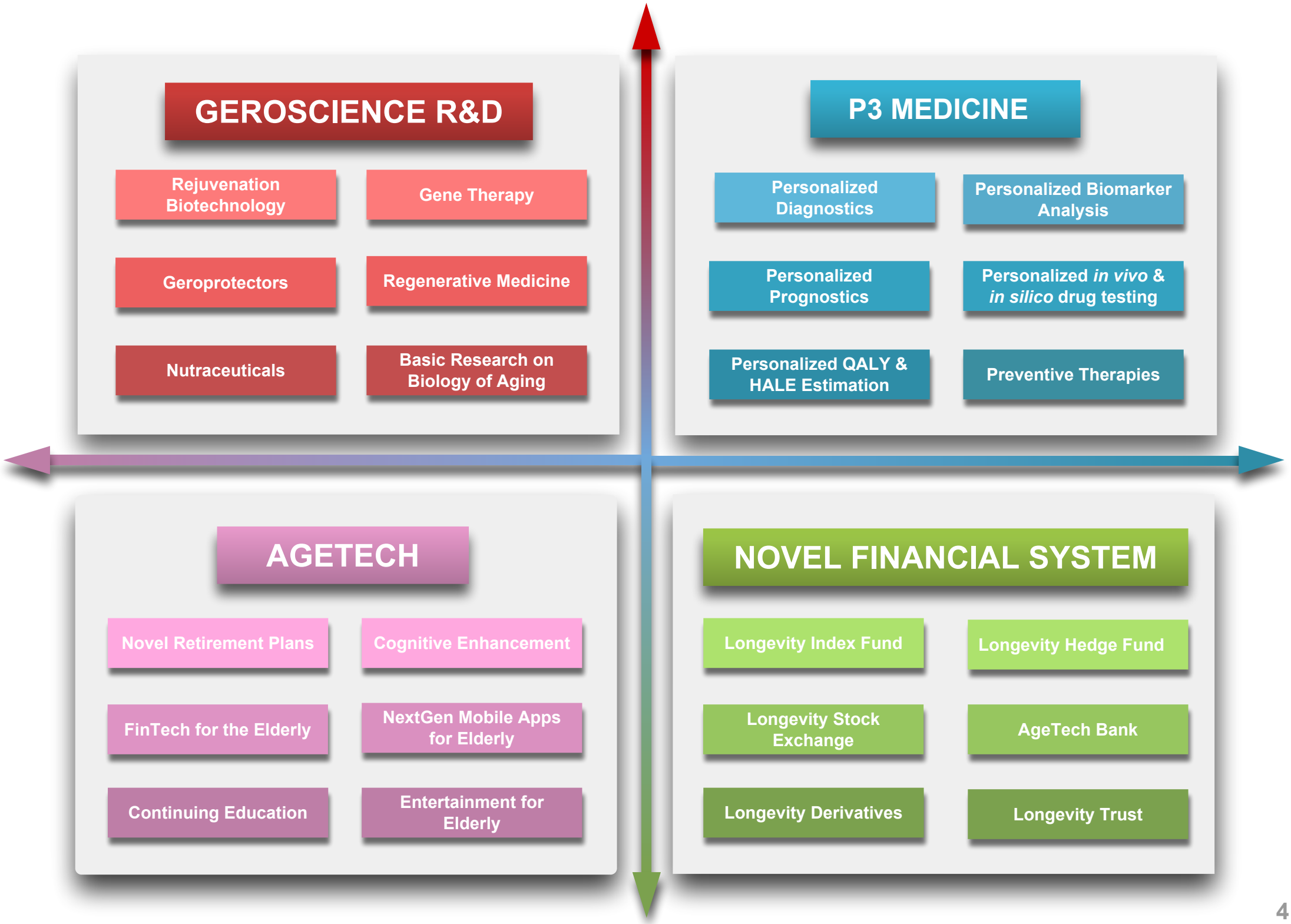
“The future of the longevity industry not only has the logical potential to become the wealthiest industry in all of history, but also represents the most ethical way of doing business.” **- Dmitry Kaminskiy, Deep Knowledge Ventures.**

Establishing a Framework for the Longevity industry

At present, there is no consensus on which of the various technologies touched upon in these documents falls under the umbrella of '**gerontology'**, and the more clearly defined terms such as '**P3 medicine'** have not been traditionally been associated with geroscience in general. We propose that they should be classified together, given their increasing relevance to extending healthy longevity. The 4 subdivisions of the industry that we propose are **Geroscience**, **P3 medicine**, **AgeTech** and **Novel Financial System**.

Geroscience (the science of aging) describes all areas of research and technology that directly recognize and address the issues of the ageing process. This includes both basic research into the biology of aging, as well as interventions designed to directly address the hallmarks of aging, and by virtue thereof the majority of chronic diseases that stem from the root causes of aging. **P3 medicine** describes the shift in medicine towards precision, personalisation and preventive rather than reactionary treatment. This report argues that it should be classified as cornerstone of the Longevity industry due to its focus on preventive treatment and maintenance of health via early diagnostics and the application of interventions as early as possible. **AgeTech** includes all non-biomedical technologies which help to preserve the quality of life, wellbeing and functional capacities of elderly demographics. While not traditionally considered as a part of the Longevity industry, this report argues that it is one of the industry's main four pillars because it can help preserve function and wellbeing up to the point where more advanced therapies reach practical application in the clinic. Chapter 7 of the report considers the creation of a **Novel Financial System** to simultaneously avoid economic stagnation in the face of demographic aging, while creating an infrastructure whereby governments and financial institutions can reap gains from maximizing not just population lifespan, but healthspan as well. Given the significant impact that societal ageing and Longevity have upon economies, pension funds and insurance companies have the potential to tie financial performance to quantitative measures of healthy longevity like HALY (health-adjusted life years) and QALY (quality-adjusted life years) in order to help economies thrive due to an increase in its citizens healthy longevity.

The Longevity report, the first of its kind, outlines the vast and multifarious Longevity industry, and formulates a preliminary foundation for classifying and systematizing the various strands of the industry into one coherent landscape, and establishing a standardized framework to unite the fragmented stakeholders of the industry, and to provide better tools and leverages for analyzing the vast and complex landscape of this emerging Longevity mega-industry.


GEROSCIENCE R&D
Rejuvenation Biotechnology
Gene Therapy
Geroprotectors
Regenerative Medicine
Nutraceuticals
Basic Research on Biology of Aging
P3 MEDICINE
Personalized Diagnostics
Personalized Biomarker Analysis
Personalized Prognostics
Personalized *in vivo* & *in silico* drug testing
Personalized QALY & HALE Estimation
Preventive Therapies
AGETECH
Novel Retirement Plans
Cognitive Enhancement
FinTech for the Elderly
NextGen Mobile Apps for Elderly
Continuing Education
Entertainment for Elderly
NOVEL FINANCIAL SYSTEM
Longevity Index Fund
Longevity Hedge Fund
Longevity Stock Exchange
AgeTech Bank
Longevity Derivatives
Longevity Trust

GLOBAL LONGEVITY INDUSTRY LANDSCAPE 2018

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COMPANIES

INVESTORS

SCIENCE HUBS

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LONGEVITY SCIENCE GLOBAL LANDSCAPE 2018

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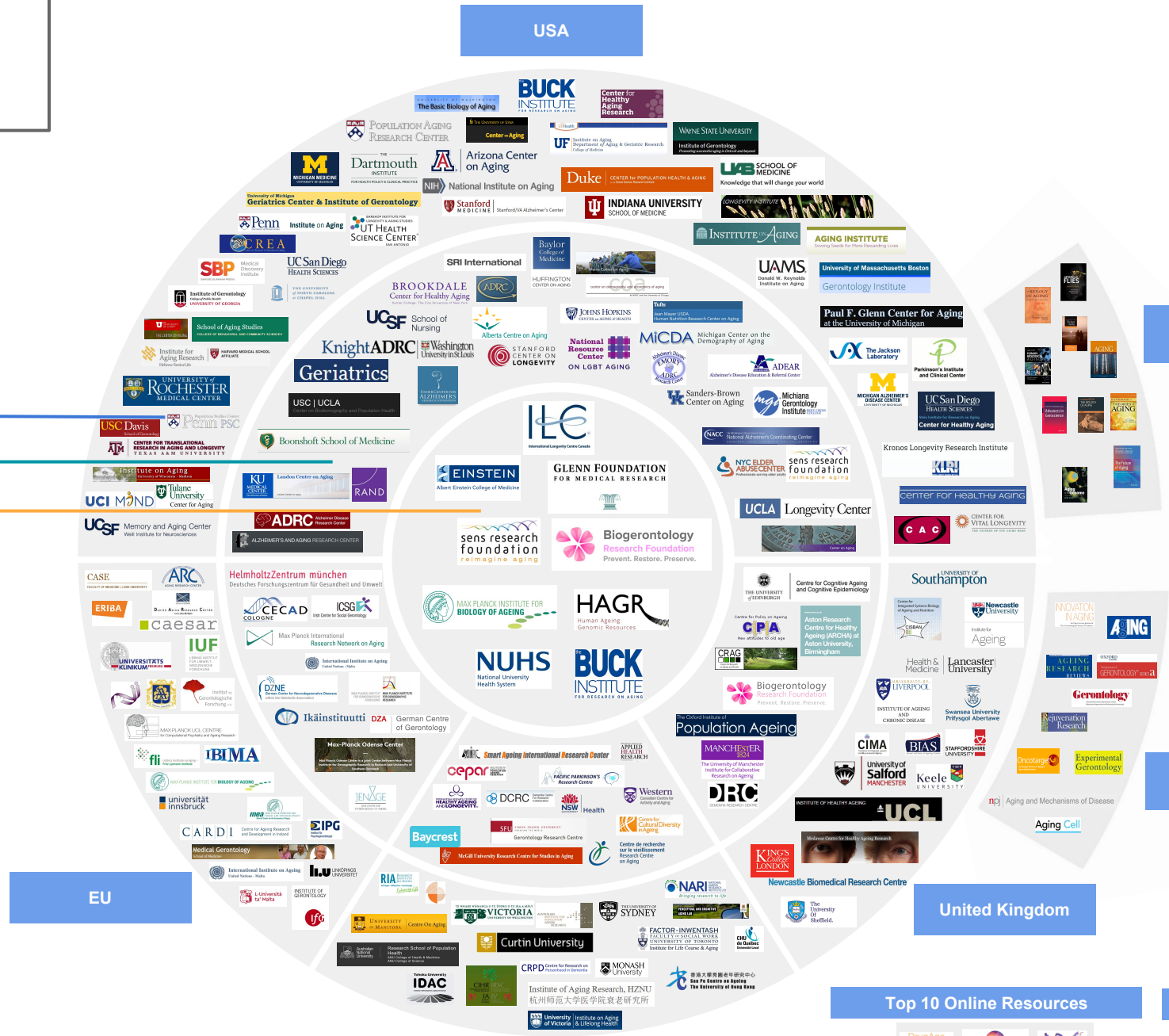
SCIENCE LABS

NON-PROFIT

GEROSCIENCE HUBS



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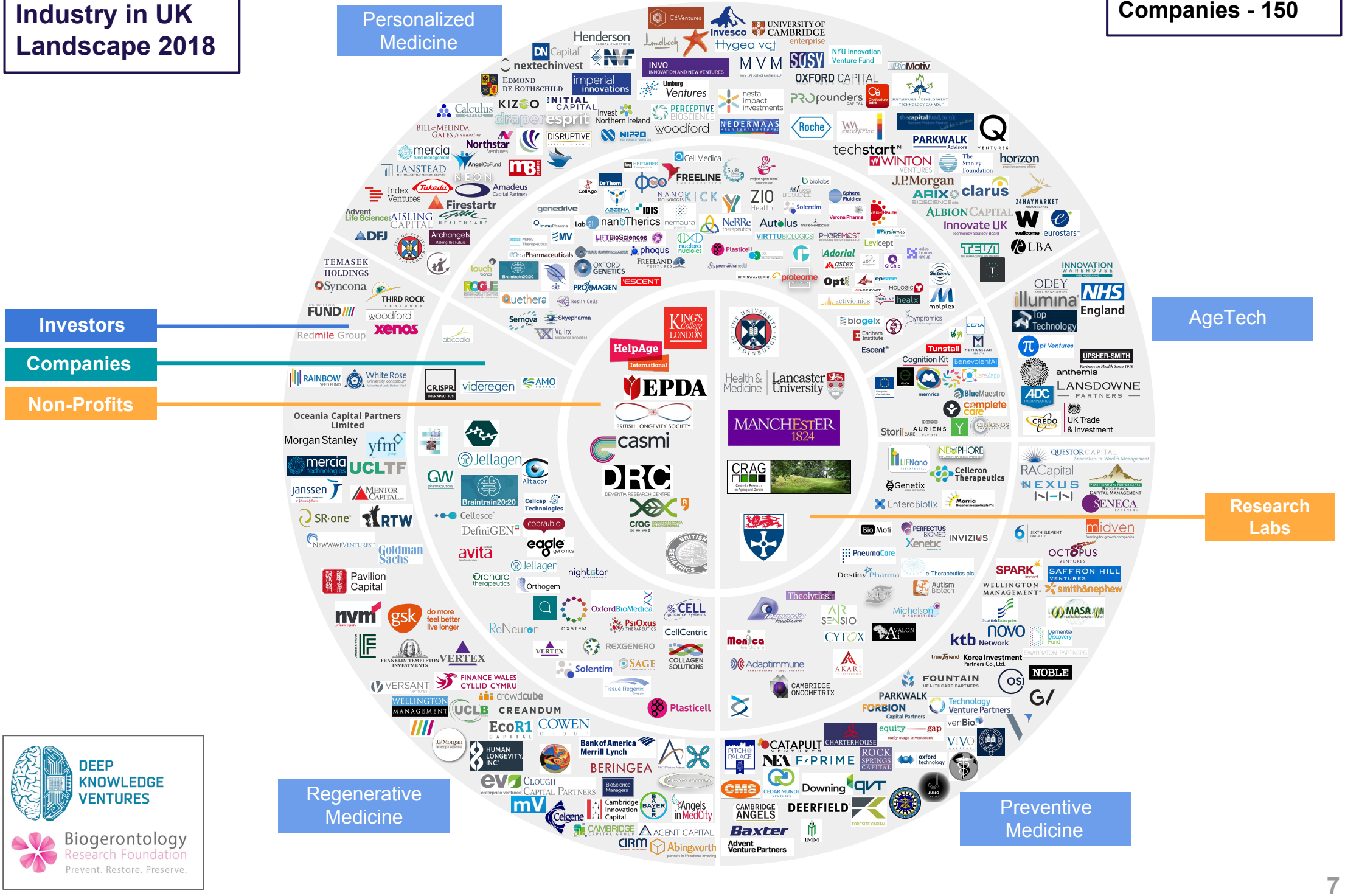
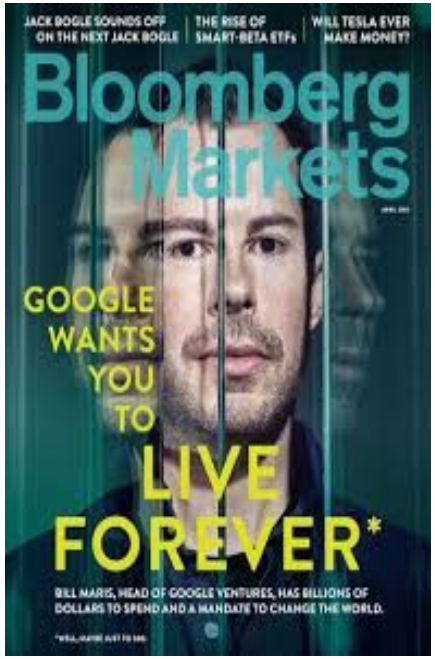
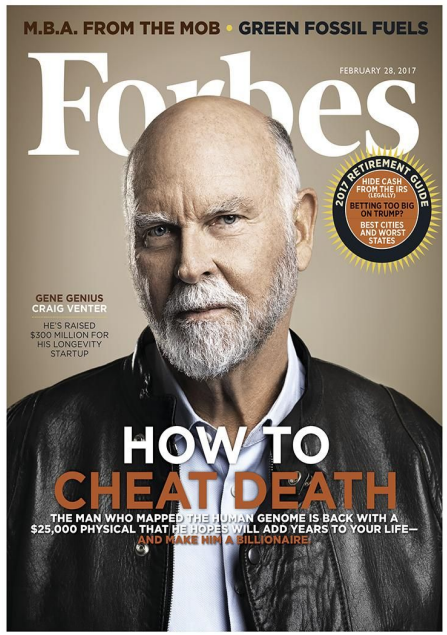
Longevity Industry in UK Landscape 2018

Investors - 200
Companies - 150



Top Media in Support of Longevity





Longevity at the Landmark Conferences

The Economist: ***The Business of Longevity and Ageing Societies***

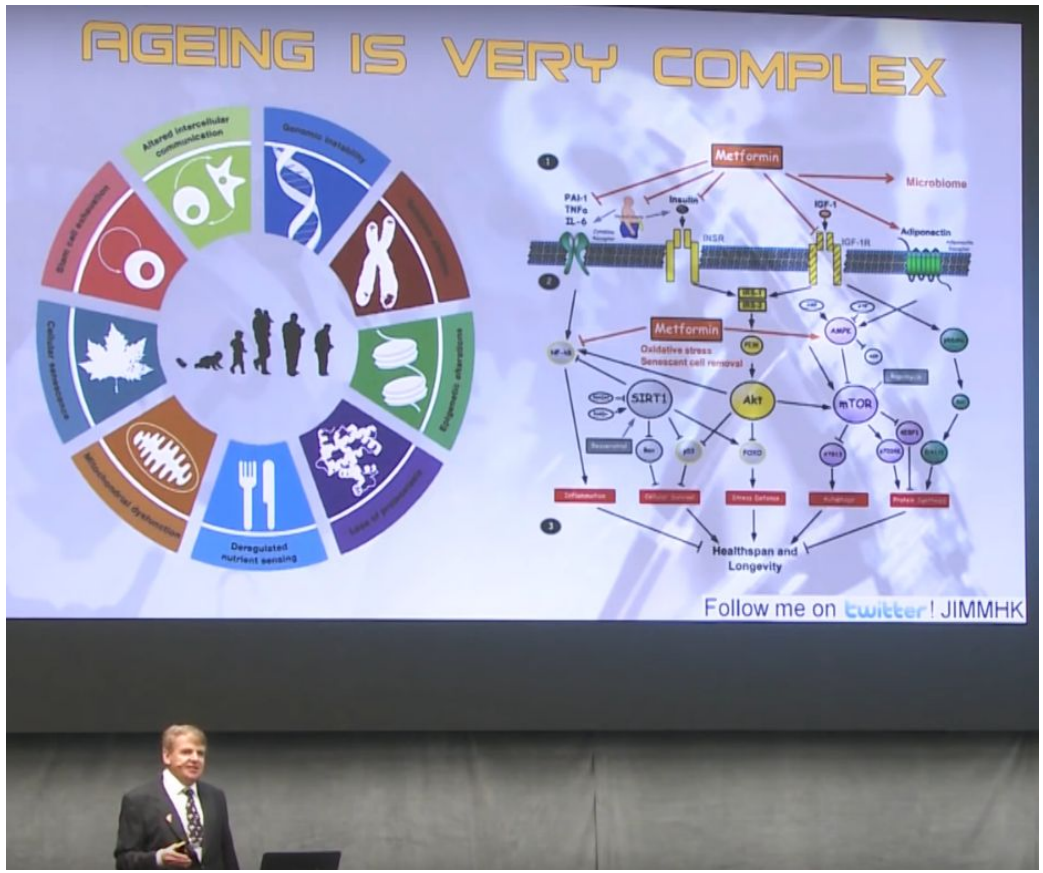
World Economic Forum

Leading Longevity Conferences

Basel Life Sciences Week
Aging Forum
AI and Blockchain for Healthcare

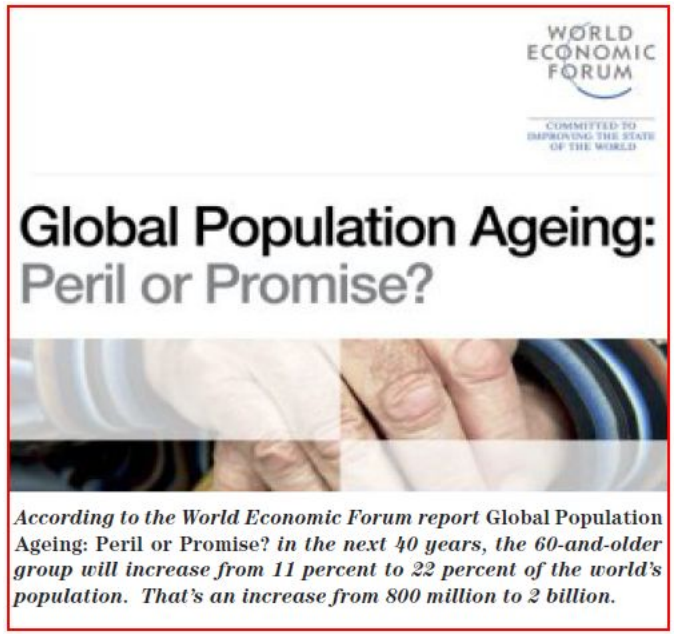
Master Investor Conference 2017 Organized by Jim Mellon & Mann Bioinvest in London

masterinvestor
RESEARCH • ANALYSE • INVEST



“We must develop a comprehensive and globally shared view of how technology is affecting our lives and reshaping our economic, social, cultural, and human environments. There has never been a time of greater promise, or greater peril.”

- Klaus Schwab, Founder and Executive Chairman, World Economic Forum

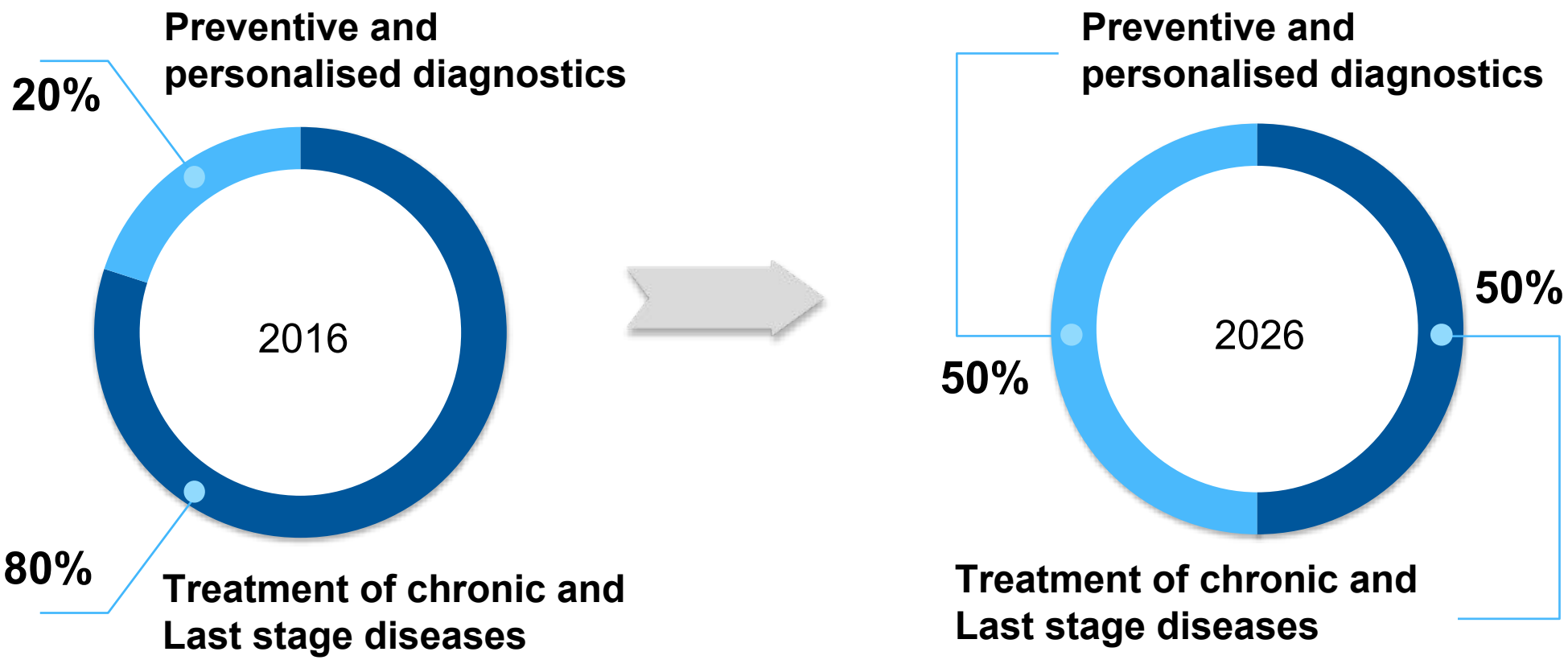


Here the history of the longevity industry is described as consisting of increasingly frequent paradigm shifts, each as disruptive as the last.

The overall direction of travel for longevity industry has been from techniques for treatment toward technologies for prevention.

A set of contingencies is described: cards that must fall in order for the next shift toward greater prevention to take place.

Paradigm Shift from Treatment to Prevention



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THE BUSINESS OF PROGRESSIVE MEDICINE *PRACTICAL APPLICATIONS*

Top 120+ Technologies & Therapeutics TRL 8-9

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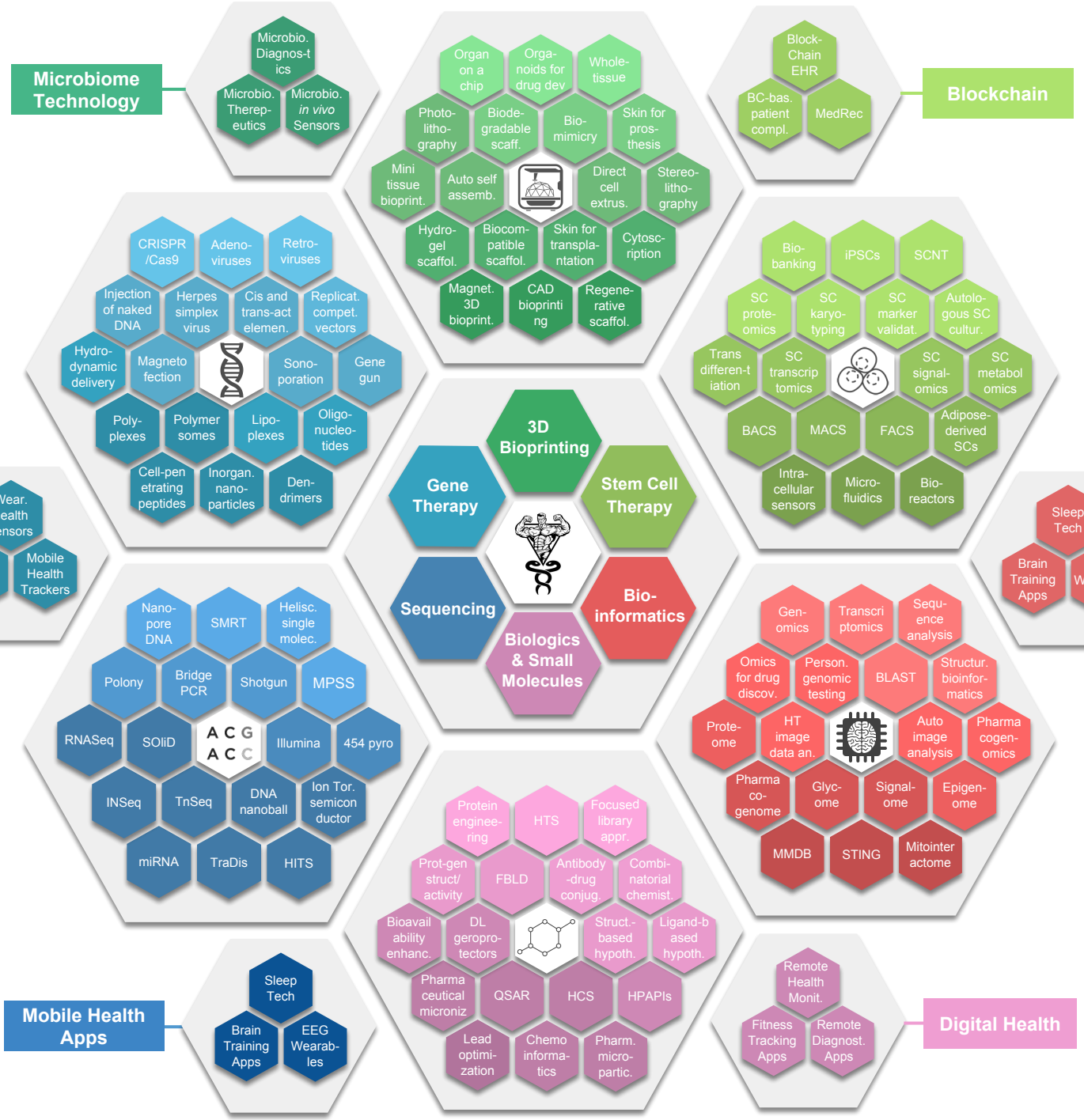

Technology Readiness Level (TRL)

9	Commercialized
8	Pre-Production
7	Field Test
6	Prototype
5	Bench/Lab Testing
4	Detailed Design

Technology Readiness Levels (TRL) are a common measure of how close a technology is for practical use, used in many engineering disciplines.
By applying it to progressive medicine, we can forecast how long it will take a given therapeutic or technology to witness practical applications in the clinic or home. The darkness of each hexagon represents its TRL, with darker colors indicating a low TRL and brighter colors indicating a high TRL.
All technologies and therapeutics shown here have a TRL between 8-9.

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THE SCIENCE OF PROGRESSIVE MEDICINE LANDSCAPE

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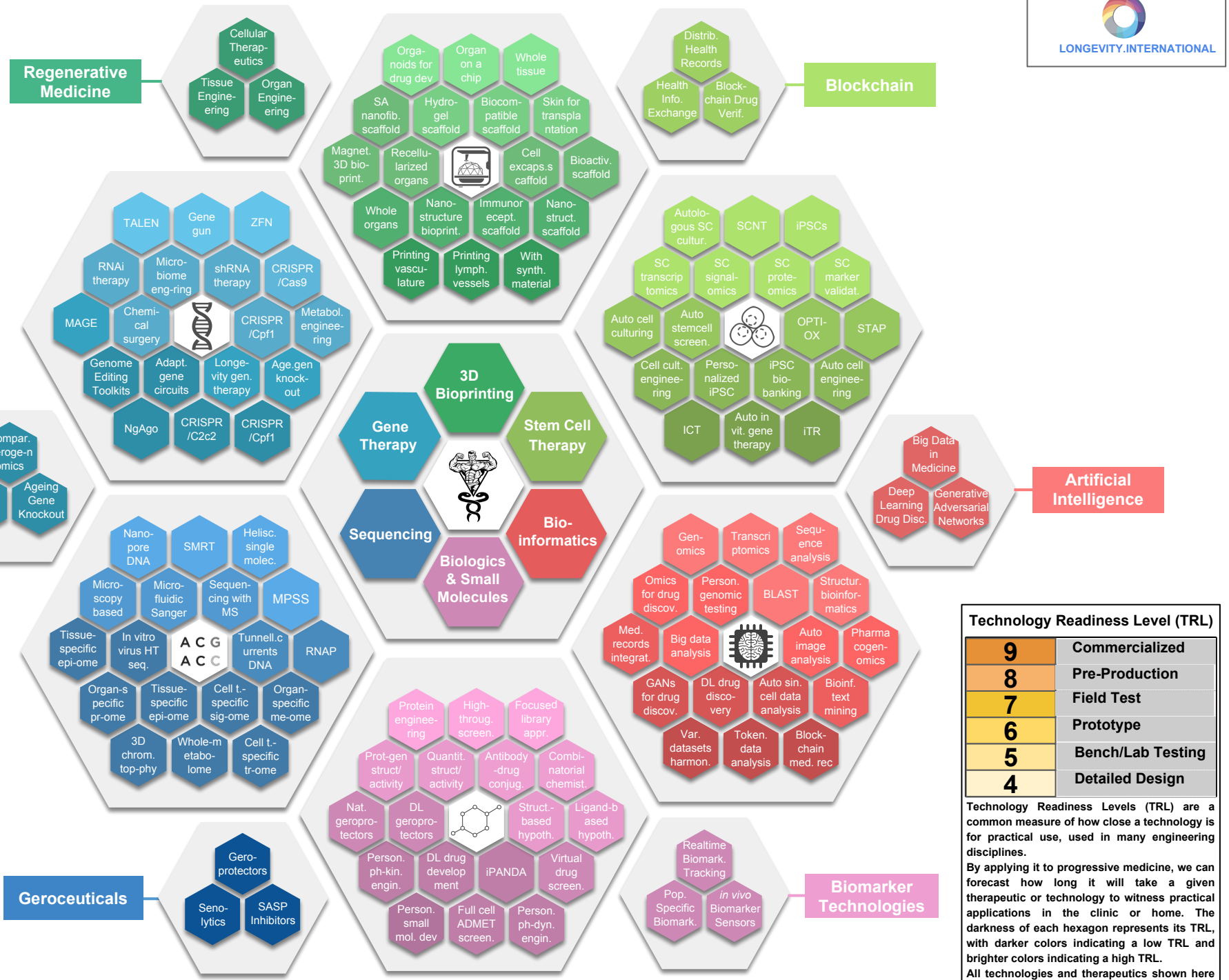
Top 120+
R&D Topics
TRL 4-7



Technology Readiness Level (TRL)

9	Commercialized
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By applying it to progressive medicine, we can forecast how long it will take a given therapeutic or technology to witness practical applications in the clinic or home. The darkness of each hexagon represents its TRL, with darker colors indicating a low TRL and brighter colors indicating a high TRL.
All technologies and therapeutics shown here have a TRL between 4 – 7. Technologies surpassing a TRL of 8 are transferred to the practical applications of progressive medicine landscape overview.

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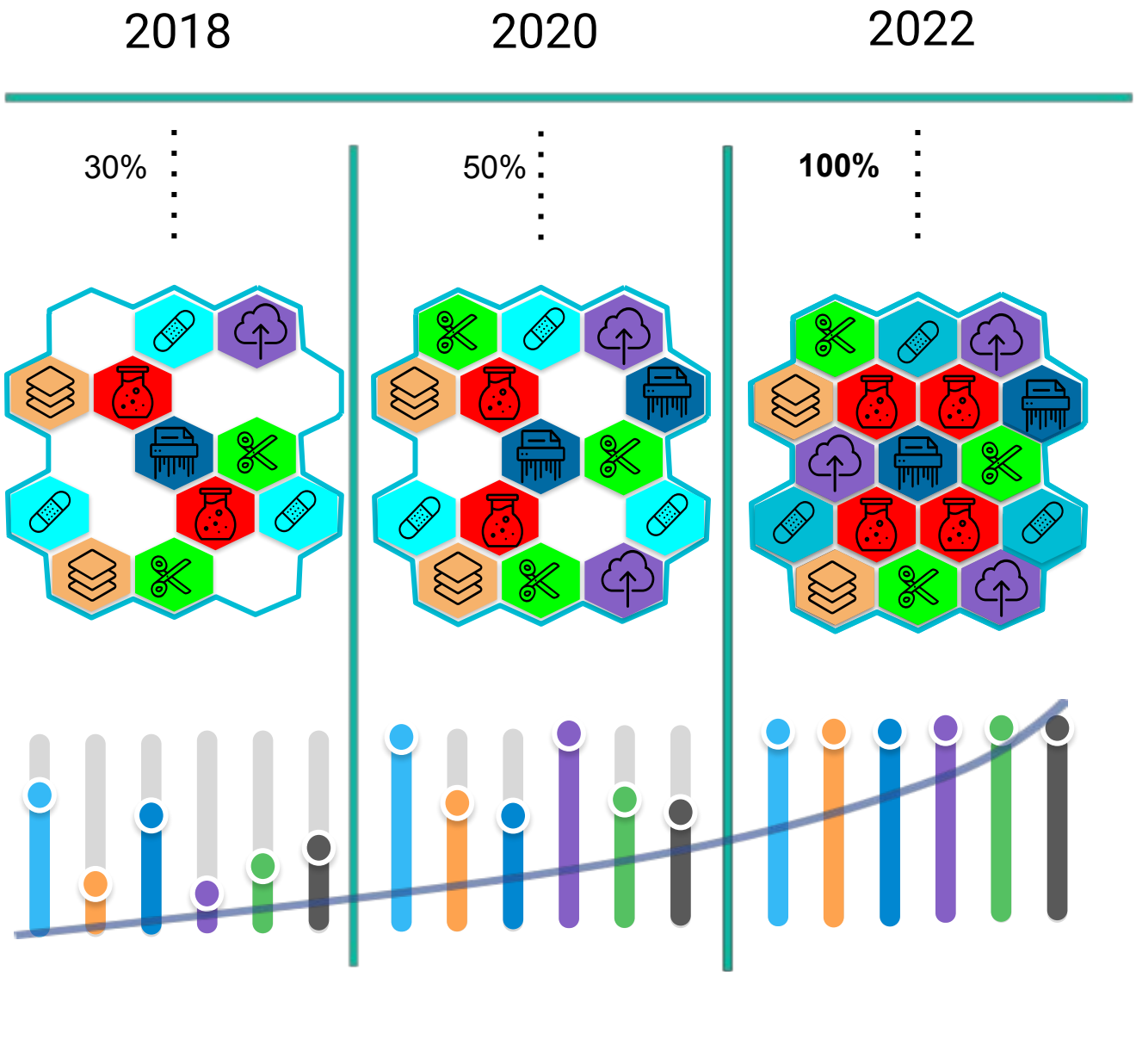
Timeline for Completion of Technologies for P3 Medicine Clinic Technology Readiness Level (TRL)



- Small Molecules and Biologics
- Next Generation Sequencing
- Stem Cell Therapy
- Bioinformatics
- Gene Therapy (CRISPR)
- 3D Bioprinting

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Key Longevity Industry Influencers

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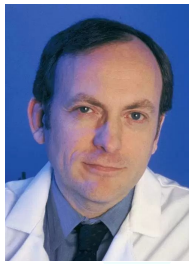
Longevity Scientists


Michael West


Eric Verdin


Cynthia Kenyon


Aubrey de Grey


Steve Horvath


Joao Pedro de Magalhães

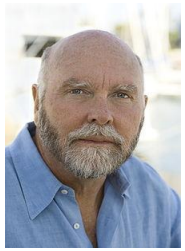

David Sinclair


Nir Barzilai


George Church


Brian Kennedy

Longevity Influencers


J. Craig Venter

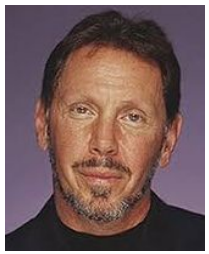

Larry Page


Sergey Brin


Ray Kurzweil


Alex Zhavoronkov


Nathaniel David


Larry Ellison


Martine Rothblatt

Longevity Investors


Dmitry Kaminskiy


Bryan Johnson


Peter Thiel


Jeff Bezos


Jim Mellon


Finian Tan


Sam Altman

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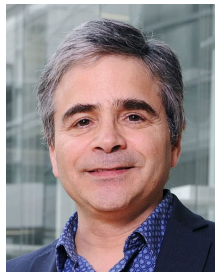
Top Longevity Scientists and Influencers


Anthony Atala


Joon Yun


Adam Antebi


Elizabeth Blackburn


Nursultan Nazarbayev


Bill Faloon

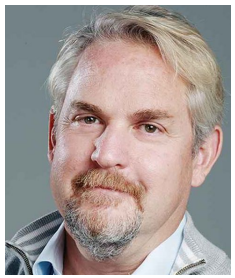

Peter Diamandis

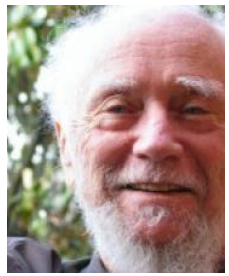

Sally Greengross


Michael Kope


Stephen Johnson

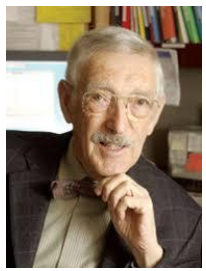

Maria Blasco

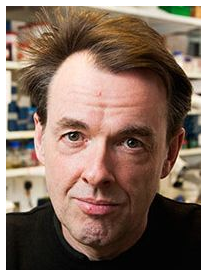

Andy Conrad


David Finkelstein

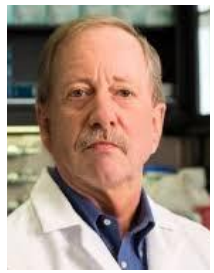

David Botstein


John D. Furber

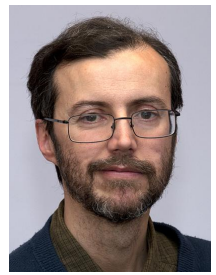

Bruce Ames


David Gems


Denham Harman


Steven Austad


Robert Freitas


Alex Freitas

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Longevity Influencers

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Top Longevity Scientists and Influencers


Vitalik Buterin


Alexey Moskalev


Ilia Stambler


Edwina Rogers


Robin Farmanfarmaian


Christine Peterson


Linda Partridge


Bill Maris


Michael Greve

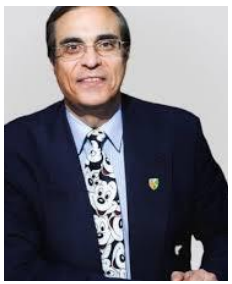

Maria Konovalenko


Calvin Harley

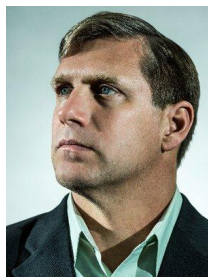

Leonard Guarente

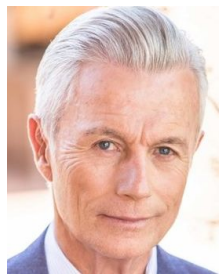

Thomas Langer


Nils-Göran Larsson


Jose Cordeiro


Dmitry Itskov


Zoltan Istvan


James Strole


Bernadeane


Robert Young


Kevin Perrott

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Top Longevity Scientists and Influencers


Arthur Bilger


Laura Carstensen


Henry Cisneros


Pinchas Cohen


Catherine Collinson


Joseph Coughlin


Fernando Torres-Gil


William Dow

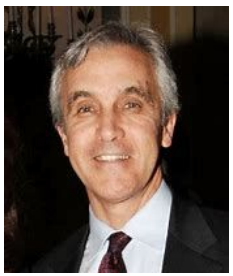

Ken Dychtwald


Marc Freedman


Linda Fried


Lynn Goldman


Christopher Herbert


Michael Hodin


Jo Ann Jenkins


Yves Joanette


Becca Levy


Freda Lewis-Hall


Robin Mockenhaupt


Philip Pizzo


Andy Sieg

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Youngsook Park


Keith Comito


Alexey Turchin


David Wood


Arielle Burstein


Rita Beamish


Paul Irving


Rodney Slater


Trent Stamp

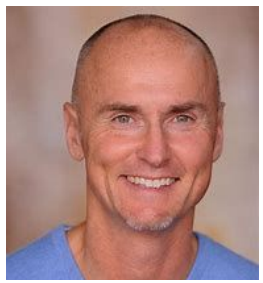

Dana Ardi


Errol Barnett


Arthur Bilger


Fred Jonske


Alexander Klabin


Chip Conley


Richard Eisenberg


Chris Farrell


Sherry Lansing


Campbell Gerrish


Taimur Hyat


Robert Johnson

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Baroness Sally Greengross OBE

David Sinclair

Helen Whately

Eric Kihlstrom

Linda Partridge

Leslie Arnold Turnberg

Charles Alessi

Maggie Throup

John Bell

Andrew Krentz

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Influencers: UK Longevity Industries

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David Amess


Narendra Patel


George P. Willis


Helen R. Griffiths


Martin Green


Paul Thornalley


Janet Thornton


Manlio Vinciguerra


Thomas von Zglinicki

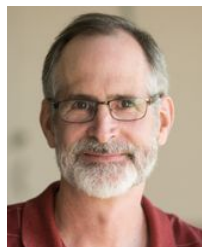

William Bains


Malcolm Jackson


Tom Kirkwood


Qing-Jun Meng

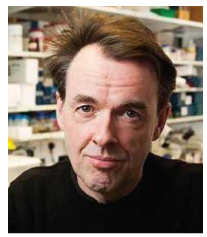

Ilora Gillian Finlay


Joel Parker


Richard Barker


Richard Faragher


Robert Freitas


David Gems


Aubrey de Grey


Joao Passos


David Kipling


Paul Keith Potter


Julia Neuberger


John Speakman


Aisling Burnand


J. P. de Magalhaes


Anne McArdle


Dr Richard Siow


John Pattison


Anders Sandberg

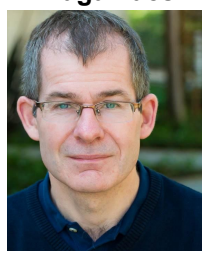

Dame Denise Platt


Suzanne Wait


Tim Spector


Philippa Whitford


Dmitry Kaminskiy


Peter Adams


Janet M. Lord


Colin Blakemore


Cleo Bishop

Leading Publications & Conferences

Top Scientific Journals in Geroscience

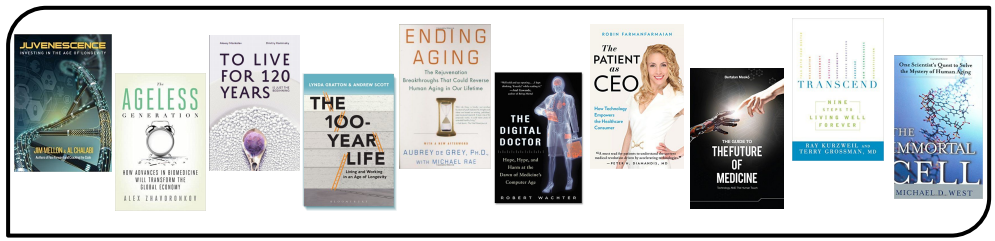
Experimental Gerontology
Ageing Research Reviews
Oncotarget
Gerotarget Section on Aging & Age-related disease
Innovation in Aging
An Open Access Journal of The Gerontological Society of America
Gerontology
International Journal of Experimental, Clinical, Behavioural, Regenerative and Technological Gerontology
Rejuvenation Research
Aging Cell
AGING
OXFORD ACADEMIC
The Journals of GERONTOLOGY SERIES a
npj Aging and Mechanisms of Disease

Top Longevity Conferences

BASEL LIFE
The Economist
masterinvestor
RESEARCH • ANALYSE • INVEST
WORLD ECONOMIC FORUM

Top Academic Books in Geroscience

Top Longevity Books



Top Scientific Meetings & Symposia

The 2017 Harvard / Paul F. Glenn Symposium on Aging June 26, 2017
The Ageing Cell
CSH Cold Spring Harbor Laboratory Mechanisms of Aging
2nd INTERNATIONAL CONFERENCE GENETICS OF AGING AND LONGEVITY
2nd International Conference on Aging & Gerontology June 26-27, 2017 | San Diego, CA, USA
Rejuvenation Biotechnology a SENS Research Foundation Conference
Disease Drivers of Aging: 2016 Advances in Geroscience Summit
BAAM BAY AREA AGING MEETING
2017 Barshop Symposium on Aging
The Buck Institute for Research on Aging
THE BURRILL & BUCK AGING MEETING innovation from discovery to delivery

Top Longevity Online Resources

Human Ageing Genomic Resources
GenAge: The Ageing Gene Database
DAA Digital Ageing Atlas
DrugAge
LONGEVITY.INTERNATIONAL
GenDR
AgingPortfolio.org Tracking International Progress in Aging Research
Fight Aging!
CellAge
LongevityMap
CTAGTCTATTGA
CTAGTCGATTGA

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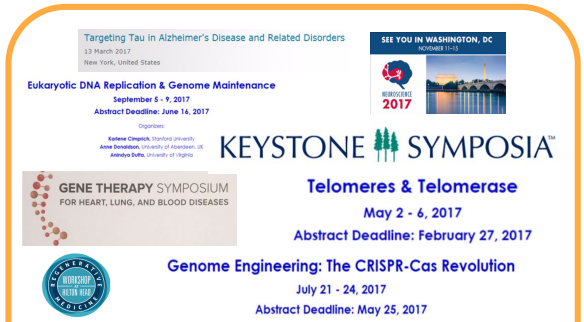
Top Longevity Conferences

	Palliative & Policy	Advanced Solutions	Basic Research
Europe			
USA			
Other			

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Top Longevity Journals

	Palliative & Policy	Advanced Solutions	Basic Research
Europe			
USA			
Other			

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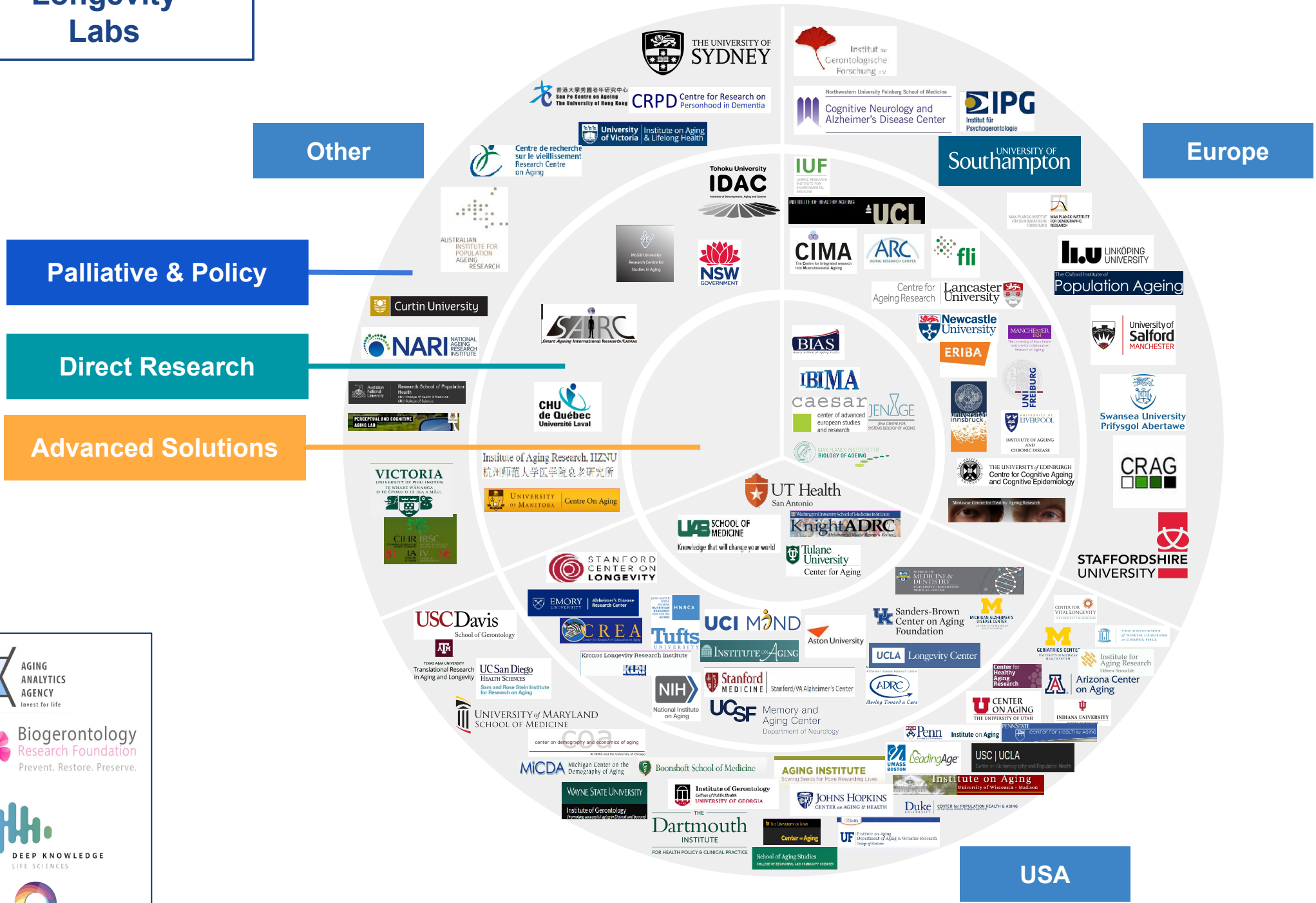
Longevity Labs



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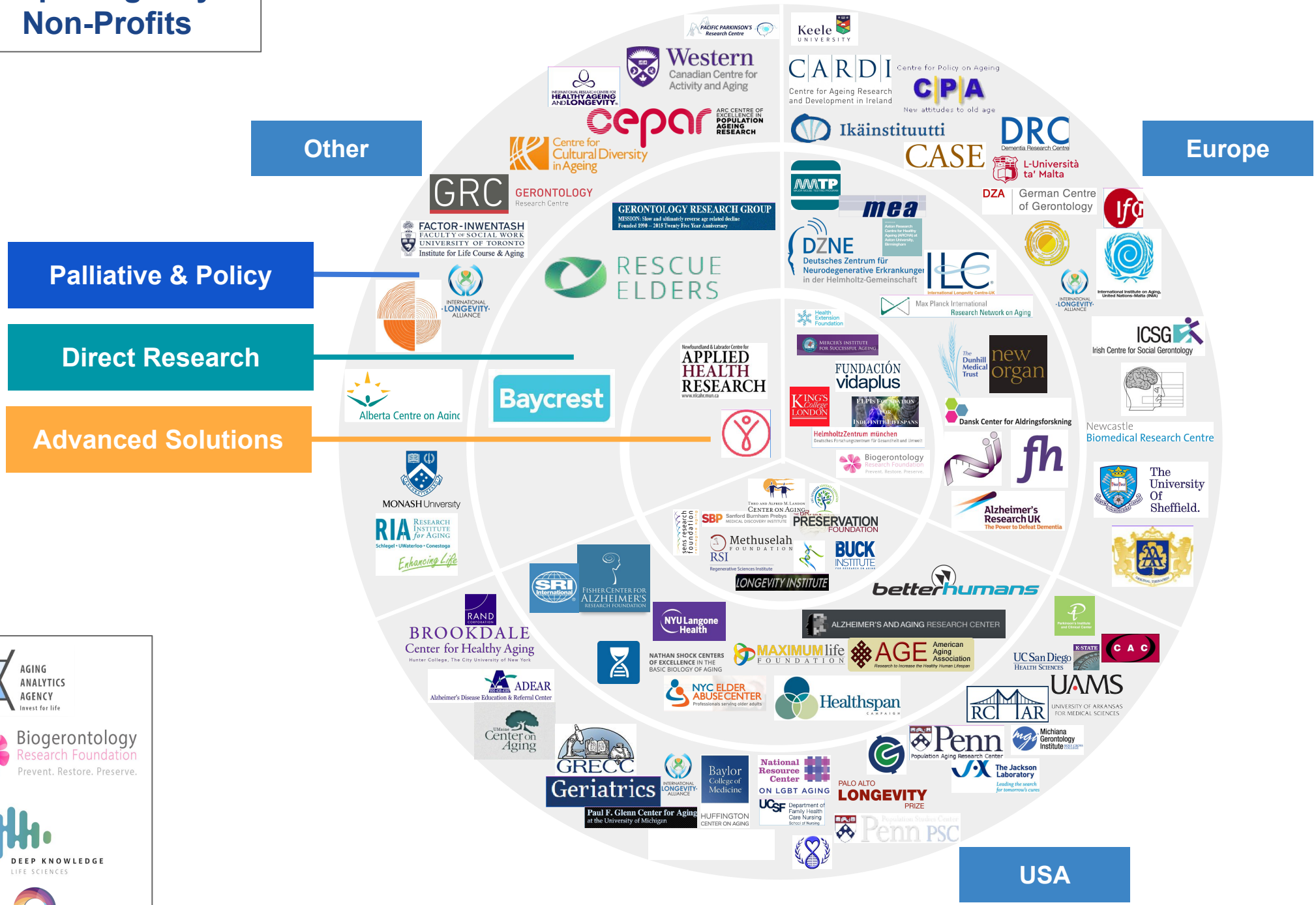
Top Longevity Non-Profits



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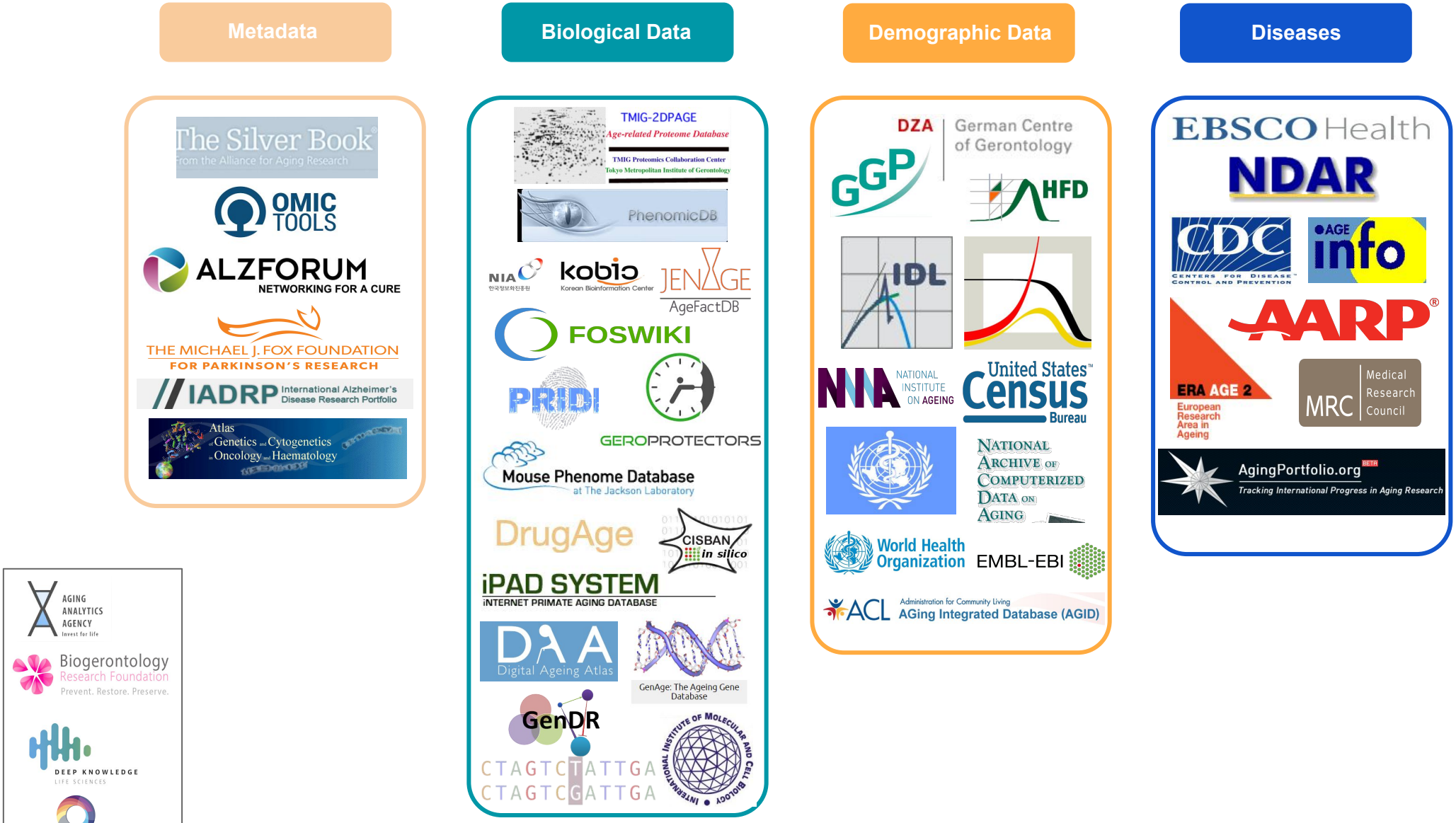
Longevity Databases By Category



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Longevity Scientific Articles

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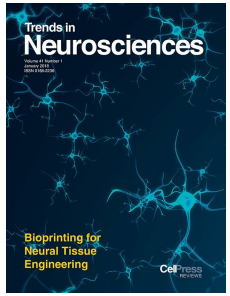
The diagnosis of mild cognitive impairment due to Alzheimer's disease

The age distribution of cancer and a multi-stage theory of carcinogenesis

The role of oxidative stress

The association between quantitative measures



Interactions between glutamatergic and monoaminergic systems

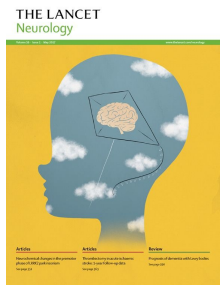
Early-onset Alzheimer's disease

Folate, vitamin B12, and serum total homocysteine levels

A DNA damage checkpoint response in telomere-initiated senescence

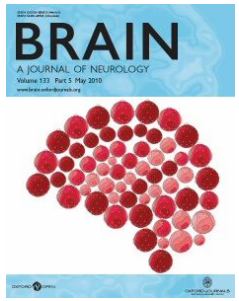
Selective loss of central cholinergic neurons in Alzheimer's disease

Basal lipid peroxidation in substantia nigra is increased in Parkinson's disease



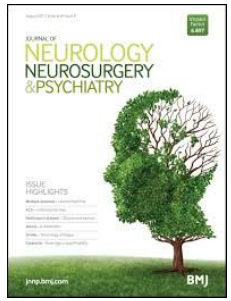
Research criteria for the diagnosis of Alzheimer's disease

Body fat assessed from total body density and its estimation from skinfold thickness



Ageing and Parkinson's disease

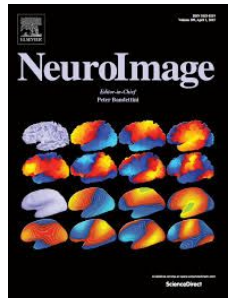
Global prevalence of dementia



The relevance of the Lewy body

Segregation of a missense mutation

Multiple isoforms of human microtubule-associated protein tau



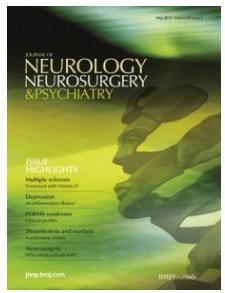
A voxel-based morphometric study of ageing in 465 normal adult human brains

Effect of age and high blood pressure on baroreflex sensitivity in man

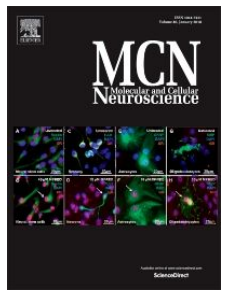
Cerebral blood flow in dementia

The moulding of senescence by natural selection

Telomere reduction in human colorectal carcinoma and with ageing



Accuracy of clinical diagnosis of idiopathic Parkinson's disease



Identification of a novel aspartic protease (Asp 2) as beta-secretase

Oxidative stress in Parkinson's disease

Why do we age?

Age-specific relevance of usual blood pressure to vascular mortality

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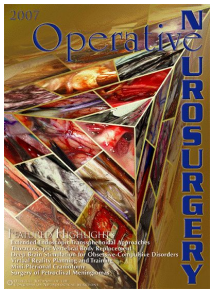
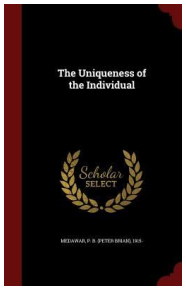


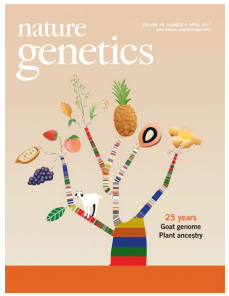
Electrical stimulation of the subthalamic nucleus in advanced Parkinson's disease.

Instability and decay of the primary structure of DNA

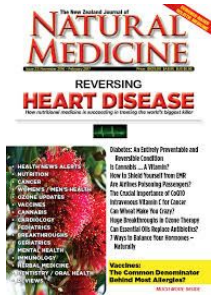
Consensus guidelines for the clinical and pathologic diagnosis



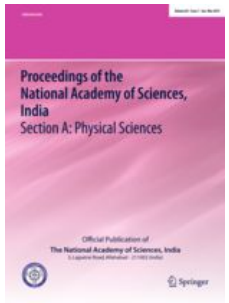
An unsolved problem of biology



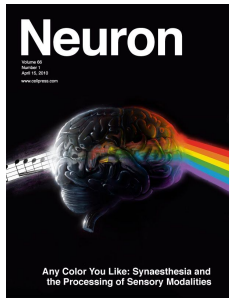
A pathogenic mutation for probable Alzheimer's disease



Neuropathology of human Alzheimer disease



The maintenance of the accuracy of protein synthesis and its relevance to ageing



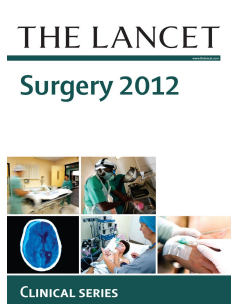
Cloning of the gene containing mutations

Selective loss of central cholinergic neurons in Alzheimer's disease

Macrophage phagocytosis of aging neutrophils in inflammation

Mitochondrial complex I deficiency in Parkinson's disease

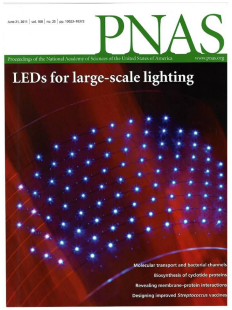
Increased amyloid beta-peptide deposition



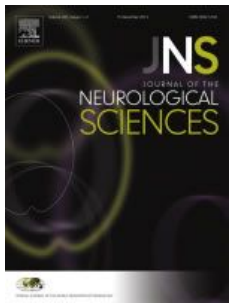
Pravastatin in elderly individuals at risk of vascular disease

alpha-Synuclein in filamentous inclusions

Alpha-synuclein in Lewy bodies



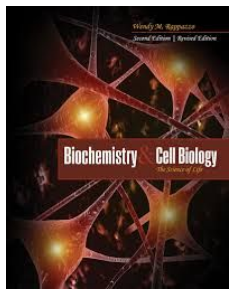
Binding of human apolipoprotein E to synthetic amyloid beta peptide



Observations on the brains of demented old people

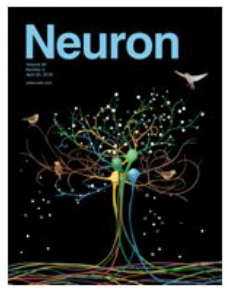
p53 mutant mice that display early ageing-associated phenotypes

Hereditary early-onset Parkinson's disease caused by mutations in PINK1

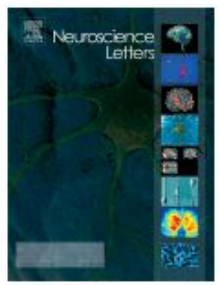


Free radicals and antioxidants in normal physiological functions and human disease

Questioning Macular Pigment Measurement Methods and Genetic Risk of Age-Related Macular Degeneration.



Tau proteins of Alzheimer paired helical filaments: abnormal phosphorylation of all six brain isoforms



Sequencing of exons 16 and 17 of the beta-amyloid precursor protein gene in 14 families with early onset Alzheimer's disease fails to reveal mutations in the beta-amyloid sequence.

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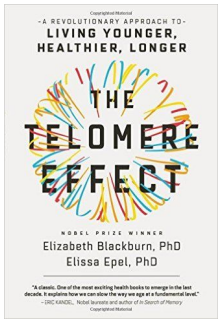
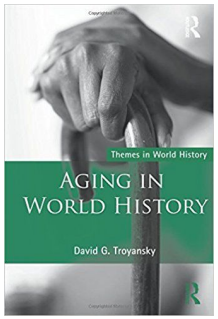
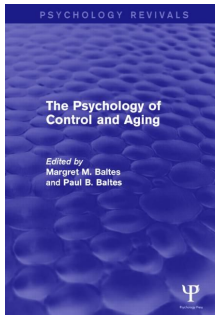


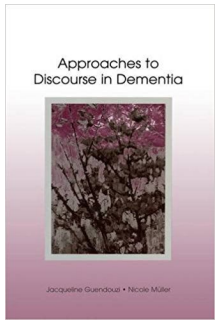
The Telomere Effect



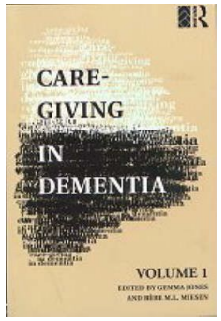
Aging in World History



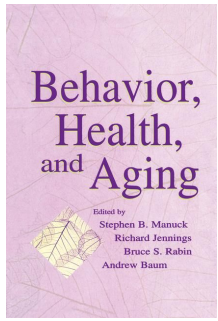
The Psychology of Control and Aging



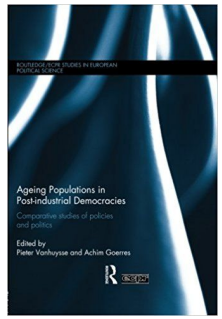
Approaches to Discourse in Dementia



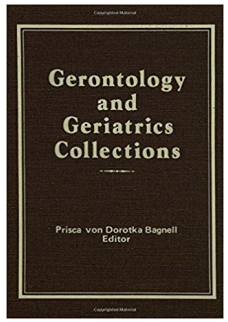
Care-Giving in Dementia



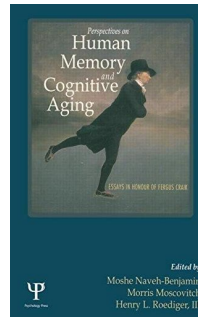
Behavior, Health, and Aging



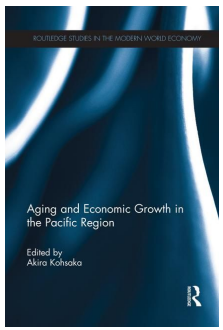
Ageing Populations in Post-Industrial Democracies



Gerontology and Geriatrics Collections

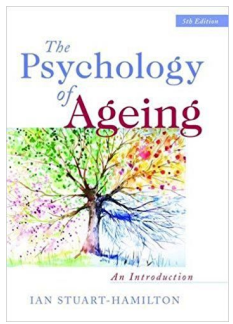


Perspectives on Human Memory and Cognitive Aging



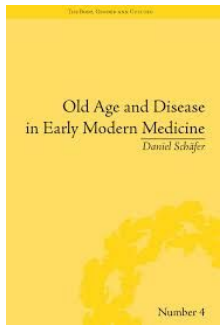
Aging and economic growth in the pacific region

Researching later life and ageing

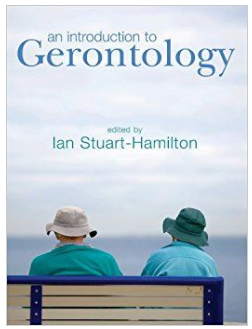


The psychology of ageing: an introduction

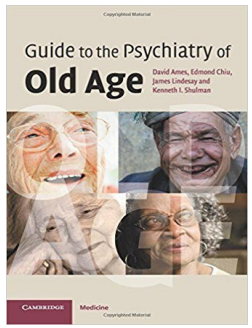
Representing ageing: images and identities



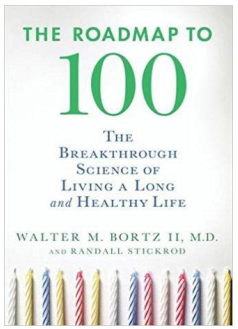
Old age and disease in early modern medicine



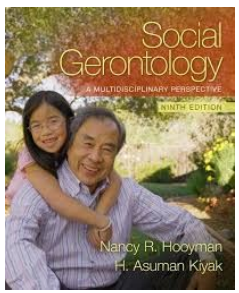
An introduction to gerontology



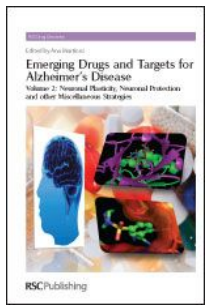
Guide to the psychiatry of old age



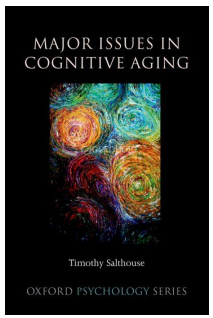
The roadmap to 100



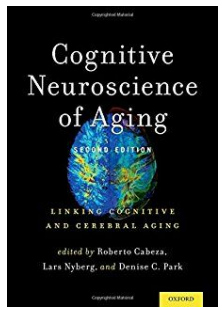
Social Gerontology



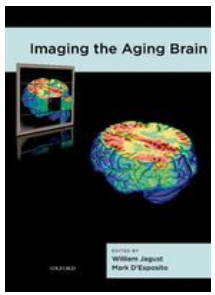
Emerging drugs and targets for Alzheimer's disease



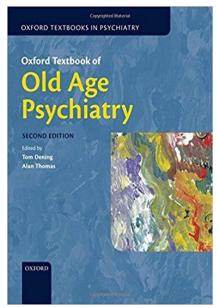
Major issues in cognitive aging



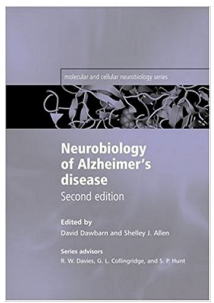
Cognitive Neuroscience of Aging



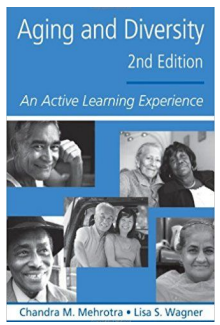
Imaging the Aging Brain



Oxford textbook of old age psychiatry



Neurobiology of Alzheimer's disease



Aging and Diversity

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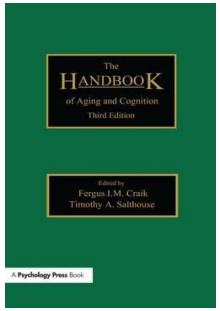
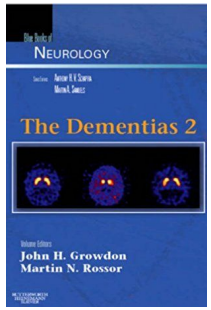
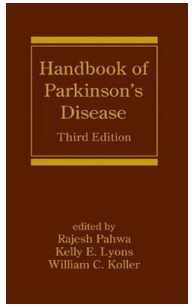


The Handbook of Aging and Cognition

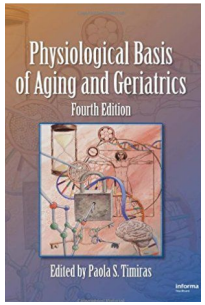
Ageing in Asia



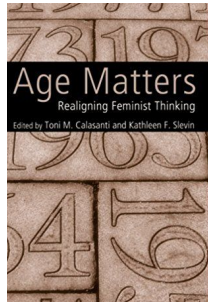
Blue Books of Neurology Series



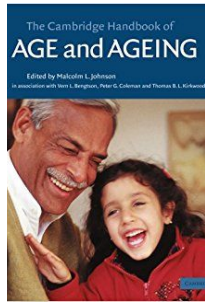
Handbook of Parkinson's disease



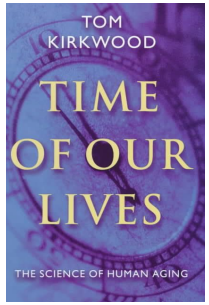
Physiological basis of aging and geriatrics



Re-Aligning Feminist Thinking

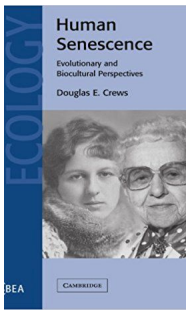


The Cambridge handbook of age and ageing

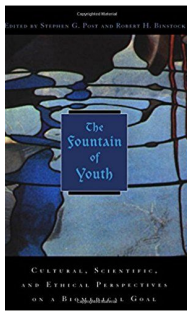


Time of our lives: the science of human aging

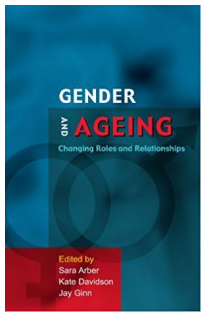
Successful Aging



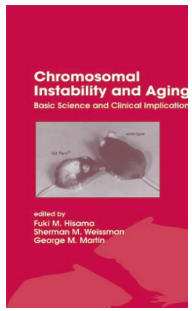
Human senescence



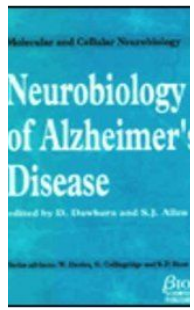
The fountain of youth



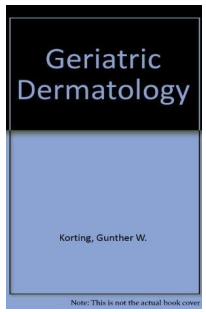
Gender and Ageing



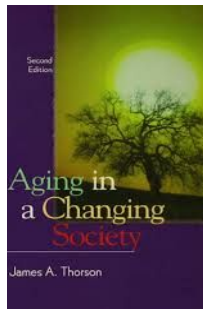
Chromosomal instability and aging



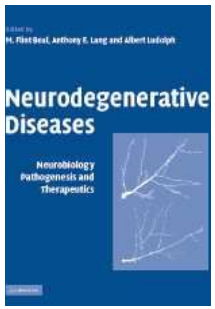
Neurobiology of Alzheimer's disease



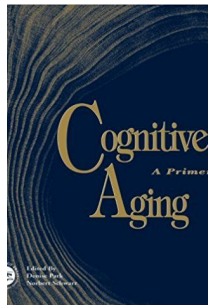
Geriatric dermatology



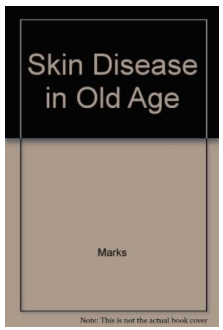
Aging in a Changing Society



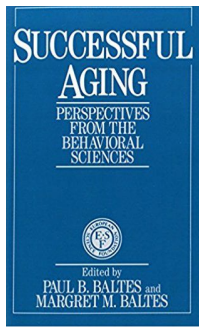
Neurodegenerative diseases



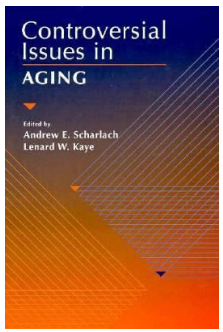
Cognitive Aging: A Primer



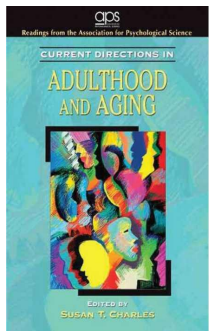
Skin disease in old age



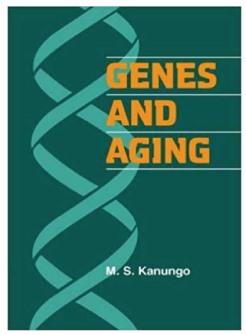
Successful Aging



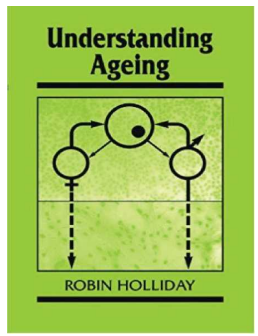
Controversial issues in Aging



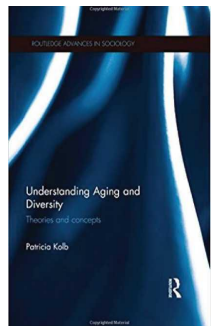
Current Directions in Adulthood and Aging



Genes and aging



Understanding ageing



Understanding aging and diversity

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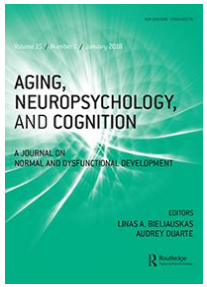
Longevity Journals

LONGEVITY.INTERNATIONAL

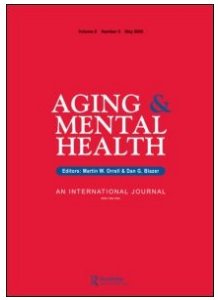


Aging, Neuropsychology and Cognition

International Journal of Education and Ageing

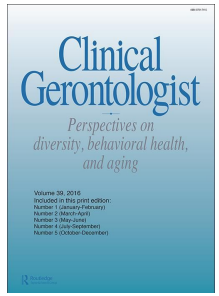
Age and Ageing

Ageing & Society



Aging & Mental Health

Aging Health



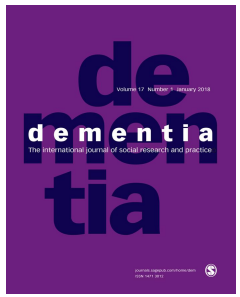
Clinical Gerontologist

Journal of Aging, Humanities, and the Arts

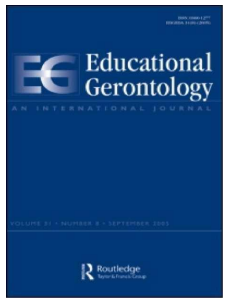
Ageing Horizons

Alzheimer's Research & Therapy

Canadian Journal on Aging



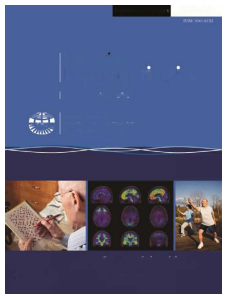
Dementia



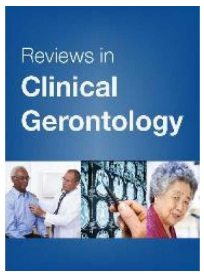
Educational Gerontology

Experimental Aging Research

Immunity & Ageing



International Psychogeriatrics

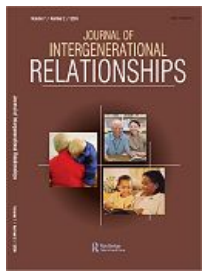


Reviews in Clinical Gerontology

The Aging Male

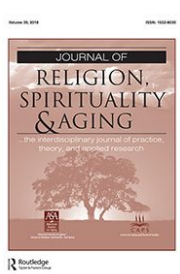
The Journals of Gerontology,Series A: Biological Sciences

Molecular Neurodegeneration



Journal of Intergenerational Relationships

The Journals of Gerontology, Series B: Psychological Sciences



Journal of Religious Gerontology

Work, Aging and Retirement

British Medical Journal

The Application of AI for Advanced R&D

Generate Novel Drug Candidates

- Analyze data sets, form hypotheses and generate novel insights
- Identify novel drug candidates
- Analyze data from patient samples in both healthy and diseased states to generate novel biomarkers and therapeutic targets
- Predict binding affinity and other pharmacological properties of molecules
- Allow filtering for drug-like properties of molecules
- Reduce complexity in protein design

Aggregate and Synthesize Information

- Extract knowledge from literature
- Generate insights from thousands of unrelated data sources
- Improve decision-making
- Eliminate blind spots in research
- Identify competitive whitespace

Repurpose Existing Drugs

- Rapidly identify new indications for many known drugs
- Match existing drugs with rare diseases
- Conduct experimental biology at scale by testing 1000+ of compounds on 100+ of cellular disease models in parallel
- Generate novel biomarkers and therapeutic targets

Design and Run Preclinical Experiments

- Reduce time, money, and uncertainty in planning experiments
- Decode open- and closed-access data on reagents and get actionable insights
- Automate selection, manipulation, and analysis of cells
- Expedite development of cell lines and automate manufacturing of cellular therapeutics
- Automate sample analysis with a robotic cloud laboratory

Clinical Trials

- Optimize clinical trial study design
- Transform diverse streams of biomedical and healthcare data into computer models representative of individual patients
- Deliver personalized medicine at scale, by revealing optimal health interventions for individual patients
- Analyze medical records to find patients for clinical trials
- Automate matching cancer patients to clinical trials through personal medical history and genetic analysis
- Improve pathology analysis
- Identify patients that would benefit from novel therapies

AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape / 2018 Q1

Companies - 80
Investors - 180
Corporations - 25

Drug Discovery

Advanced R&D

Investors

AI Companies

Corporations

DEEP KNOWLEDGE VENTURES

AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape / 2018 Q1

Companies - 80
Investors - 180
Corporations - 25

USA

Investors

AI Companies

Corporations

UK

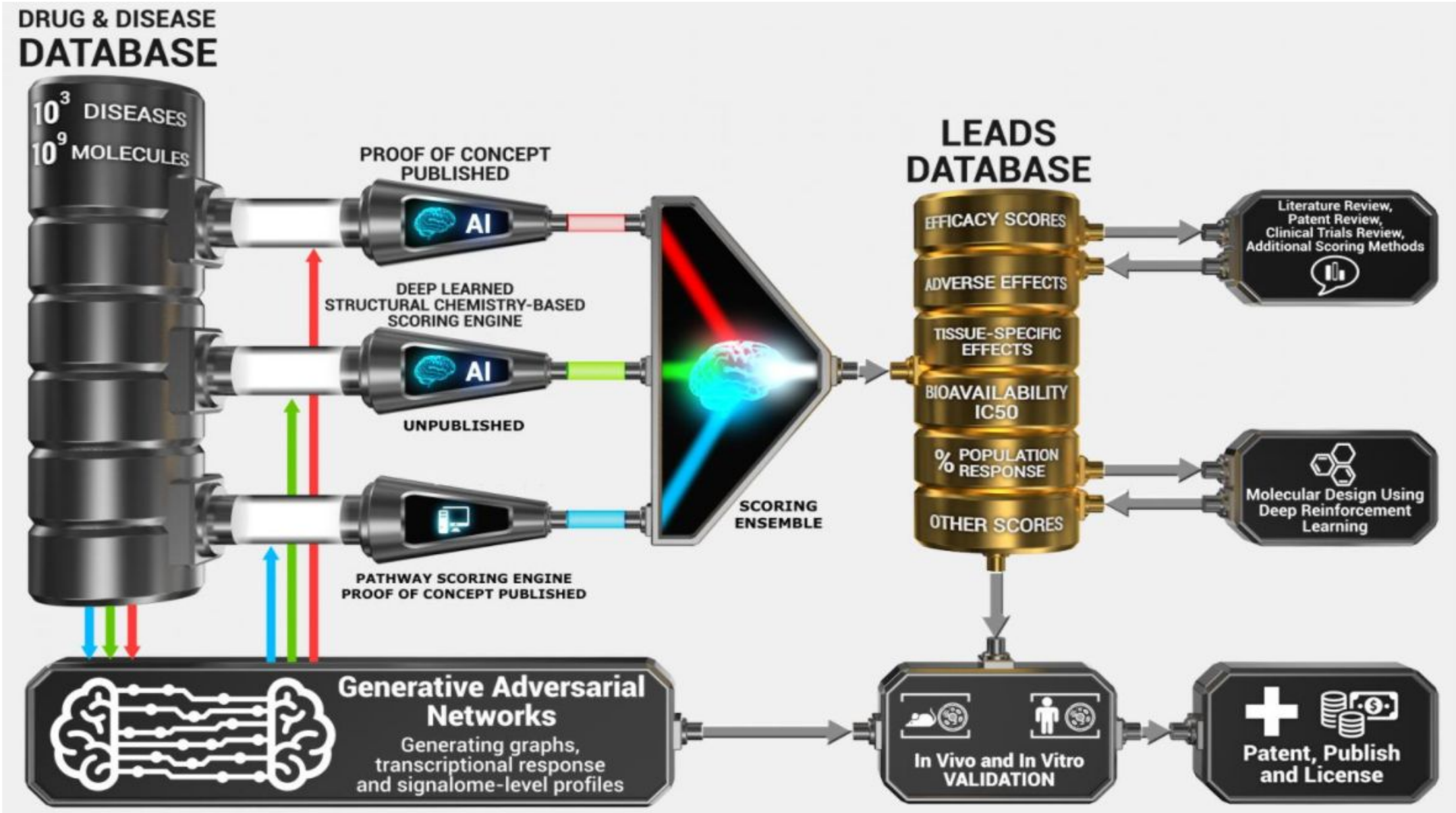
Other Regions

EU

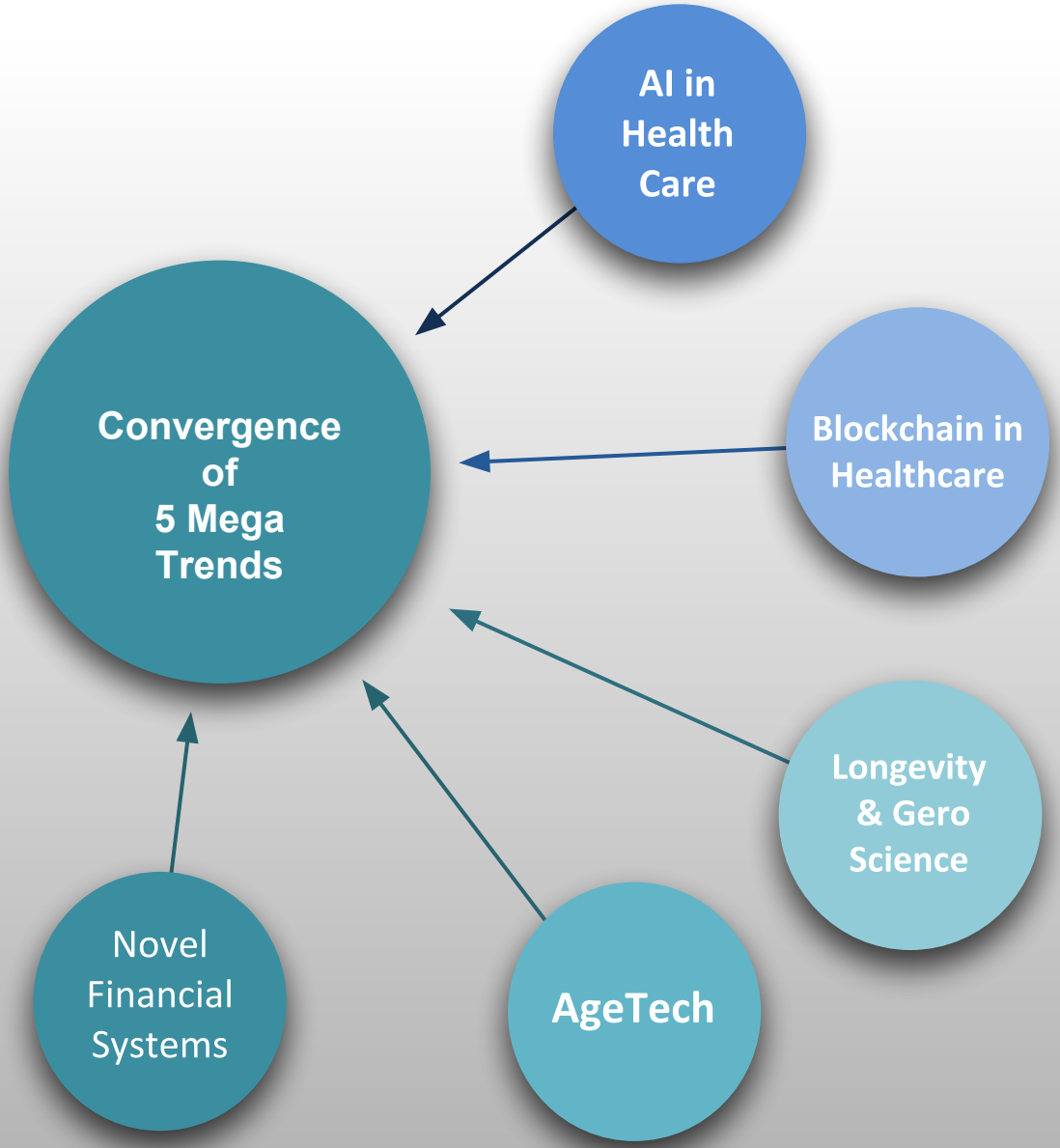
Asia

DEEP KNOWLEDGE VENTURES

INSILICO MEDICINE / DRUG DISCOVERY ENGINE



5 Mega Trends to Disrupt the BioTech & BioMedicine Industries in the next 5 Years



I AI in Healthcare

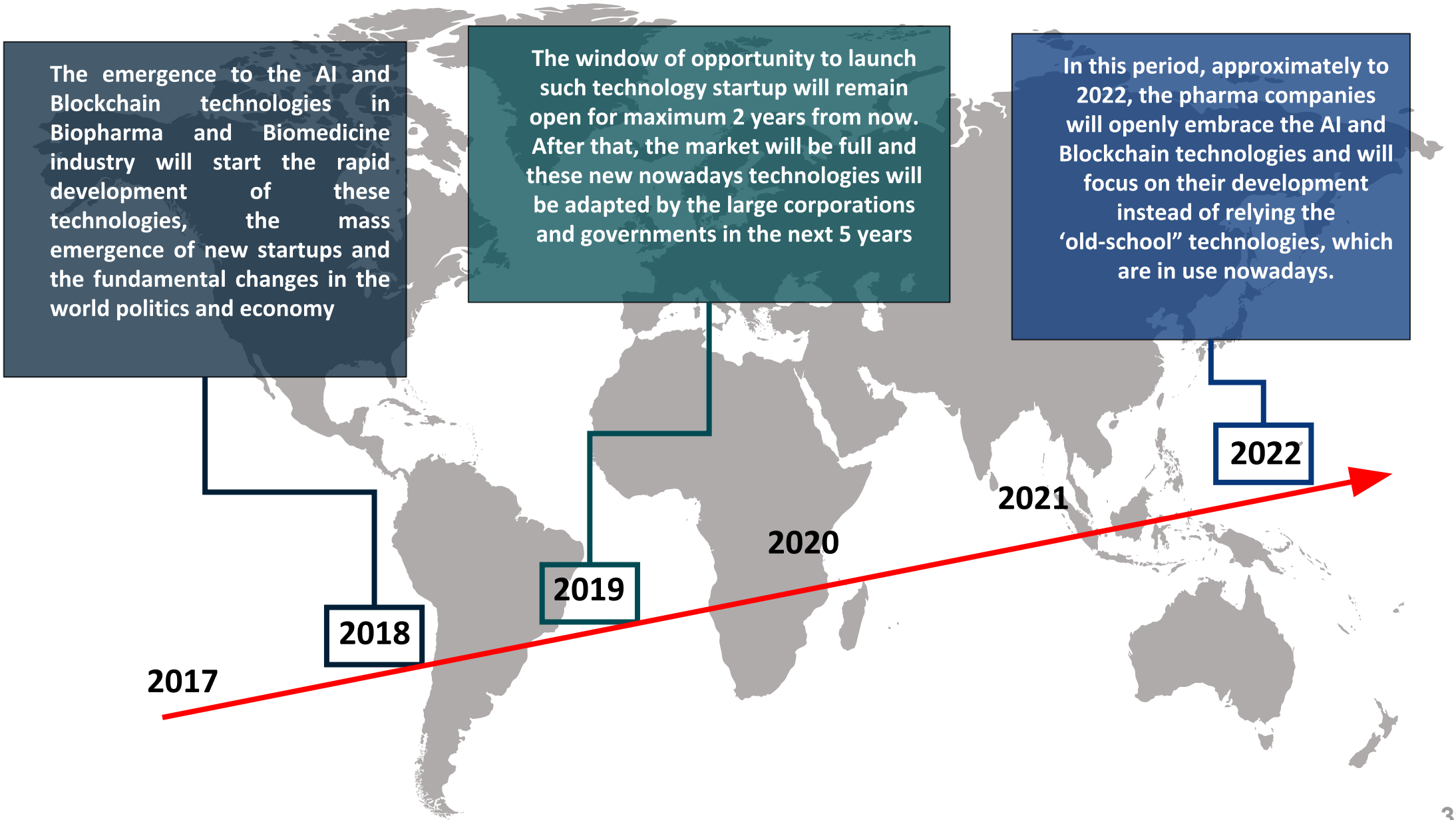
II Blockchain in Healthcare

III Longevity & Geroscience

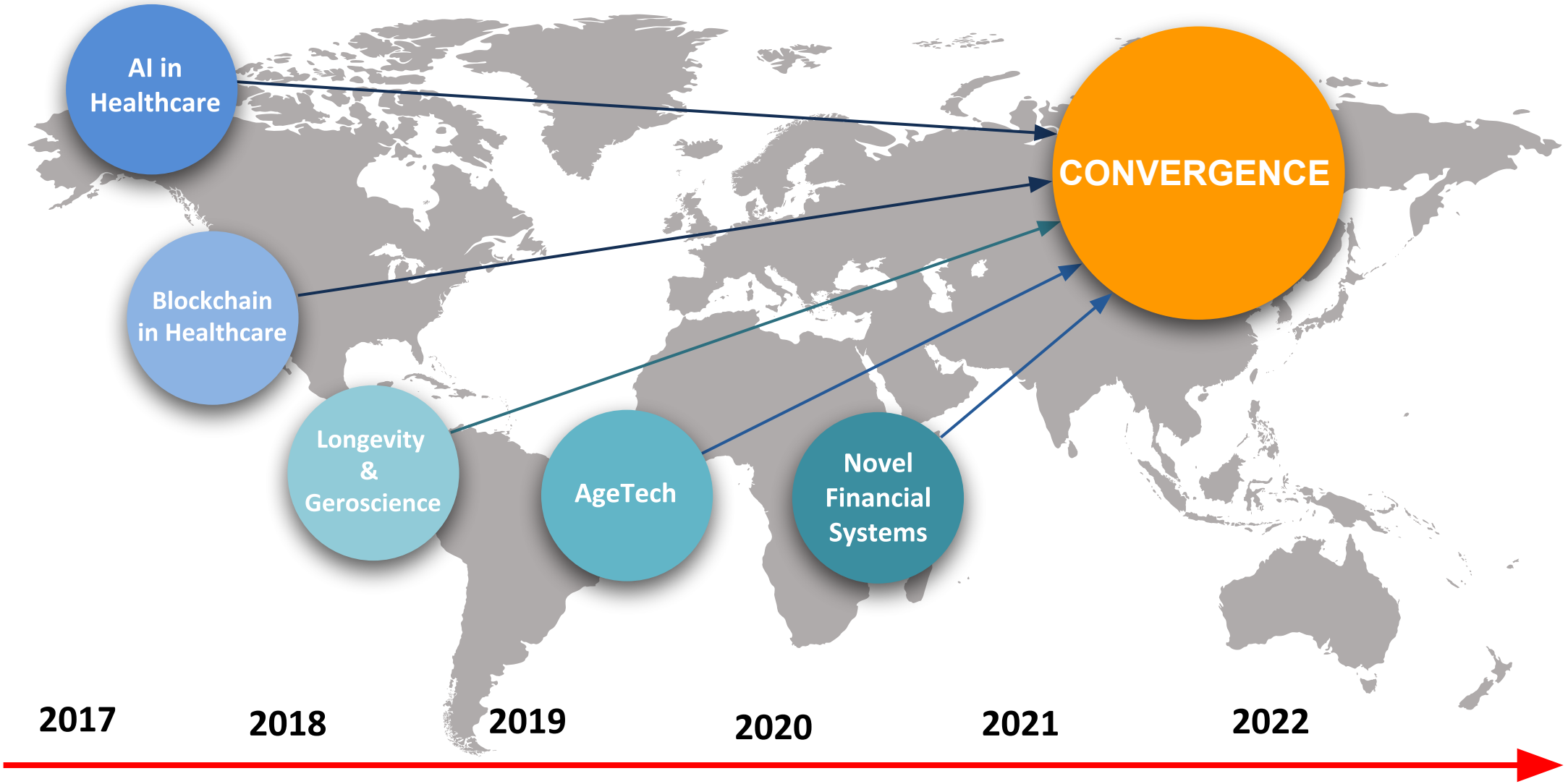
IV AgeTech

V Novel Financial Systems

Consequence:
The Major Shift in the BioMedicine Industry



Convergence of 5 Mega Trends



Overview of the Progressive Model of P3 Medicine Platform

Personalisation and precision of diagnostics, prognostics and treatment for individual patients

01 Exclusive access to advanced restorative medicine technologies

- Exclusive safe testing of novel therapies on individual`s stem cells, skin and other organs

02 Personalized longevity programs

- Personalised diagnostics, prognostics and therapeutics
- Virtual human body for health monitoring

03 Health management by world leading experts

- Continuous health monitoring by the world leading experts

Healthy lifespan extension and ageing processes reversal to a young state

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Pipeline for the Progressive Model of P3 Medicine Platform

Precision Diagnostics

- Multi-Omic Sequencing
- Non-invasive continuous monitoring
- Total-body imaging

Advanced Prognostics

- Virtual Human Prognostics
- Personalised *in vitro* Prognostics
- AI & Deep Learning-based prognostics

Personalised Experimentation

- Intelligent *in silico* Experimentation
- Personalised *in vivo* experimentation on human skin
- AI & Deep learning-based biomarker development

Preventative Treatment

- Gene therapies
- Cell therapies
- Tissue engineering
- Small molecules & biologics

Precision Diagnostics

Digital avatar visualizes a combination of biomarkers and other diagnostic results

Collect your data today:

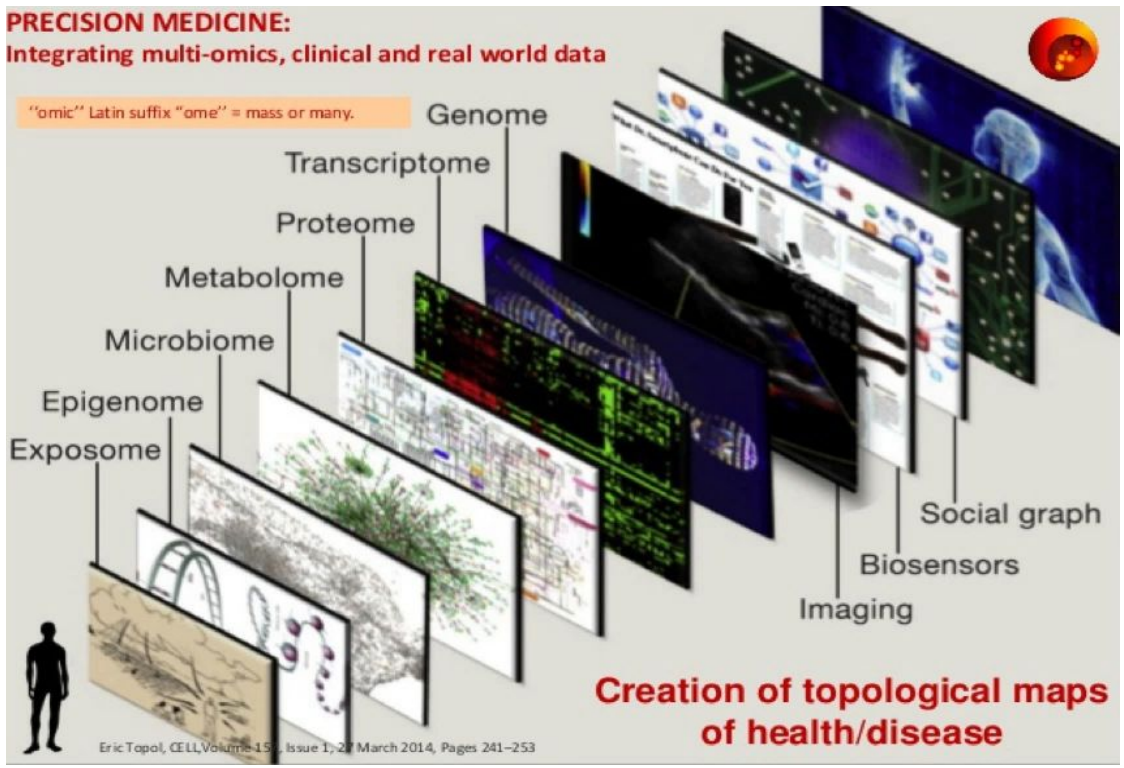
- Blood samples
- Biomarker analysis
- Database of personal biomedical data stored on blockchain

Future benefits:

- Data driven analysis of biomarkers dynamics over time
- Analyse the changes in your digital avatar
- Personalized interventions

Precision Diagnostics

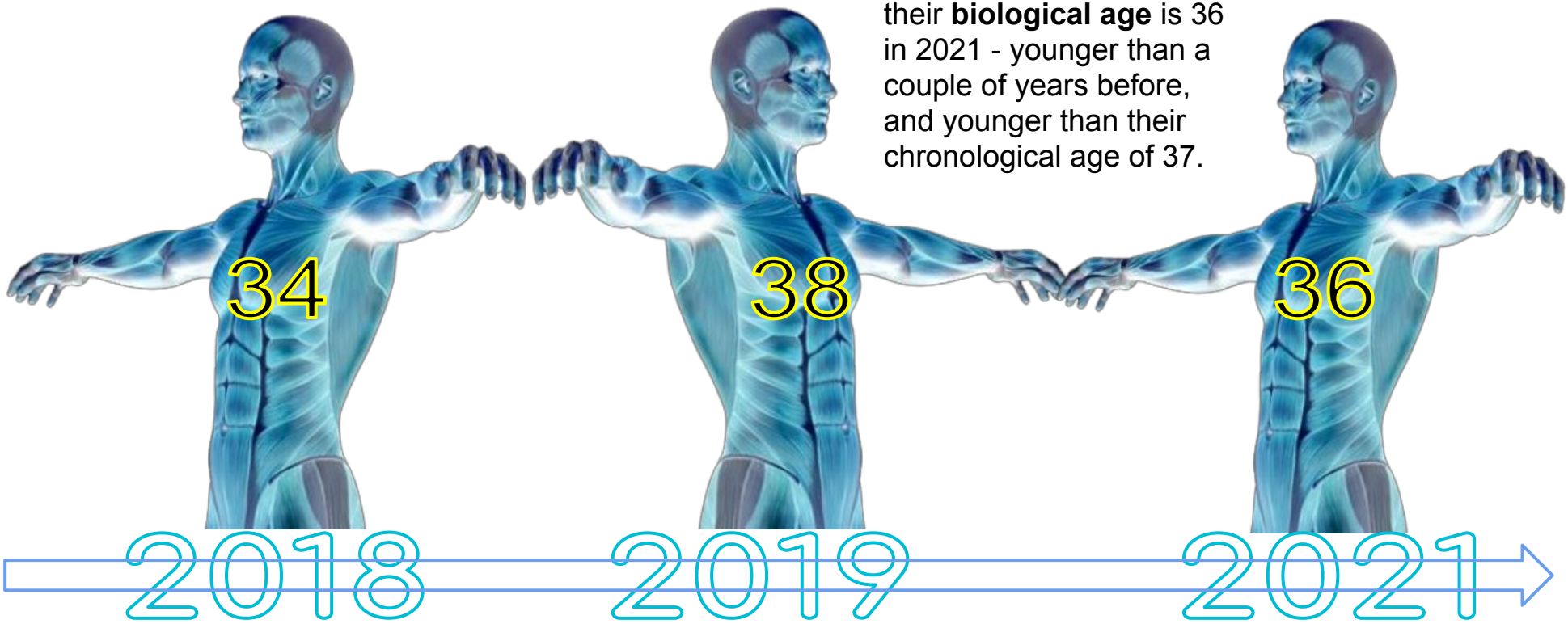
- Multi-Omics Sequencing
- Non-invasive continuous monitoring of biomarkers
- Multi-modal total-body imaging
- Qualitative functional tests
- Whole-body and organ specific biological age calculation based on biomarkers
- 3D integration of cross-sectional tissue and organ imaging



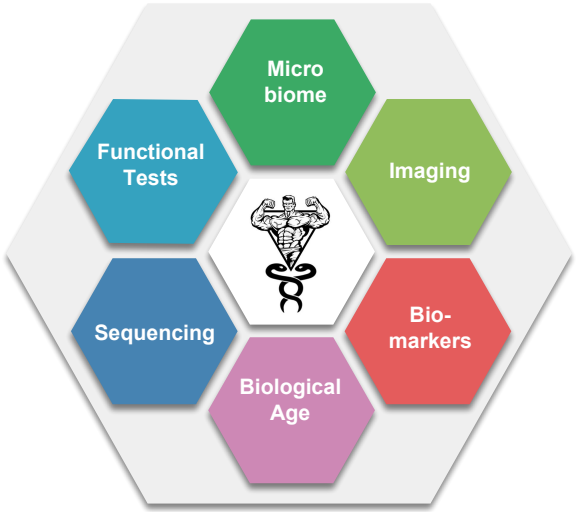
Young.AI is one such digital avatar, powered by AI to take biological data and assess patient health and age. The power of taking patient information and plugging into an AI-driven, digital environment is that not only does it enable insights impossible to obtain otherwise, but it allows for a powerful analysis of all these layers of data **over time**.

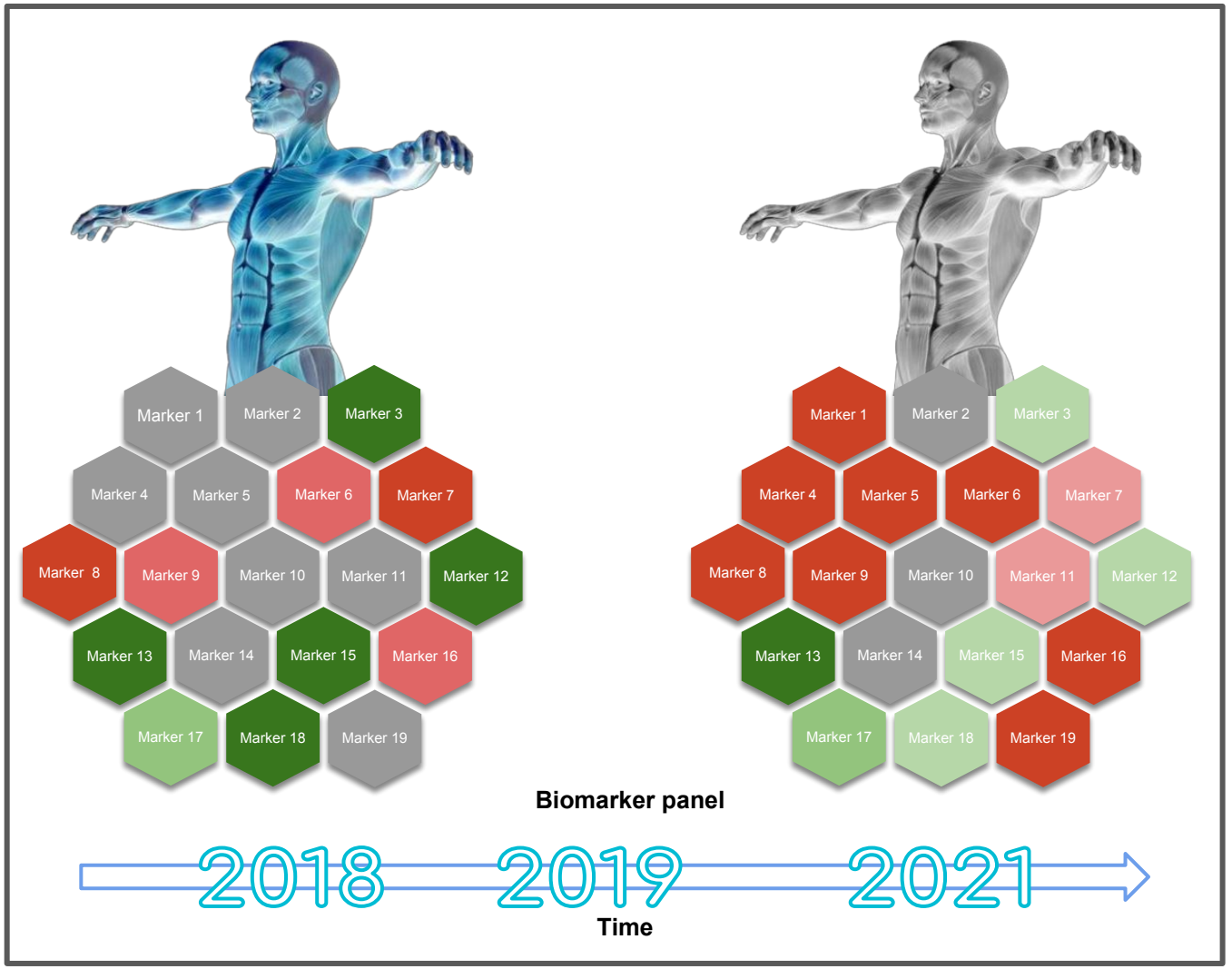
A truly 3D visualisation of patient health includes time, and follows not only deteriorations but also improvements over custom timeframes that allow interpretation based on personal circumstances including changing lifestyle, trialling treatments, etc. As such, a patient may be able to see how their body has been changing over 5 years in terms of health, function, biological age, etc.

A patient may see that their **biological age** is 36 in 2021 - younger than a couple of years before, and younger than their chronological age of 37.

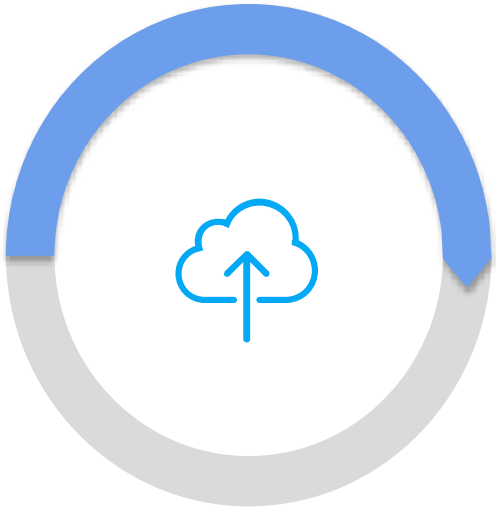


Diagnostics Panel for Digital Avatar

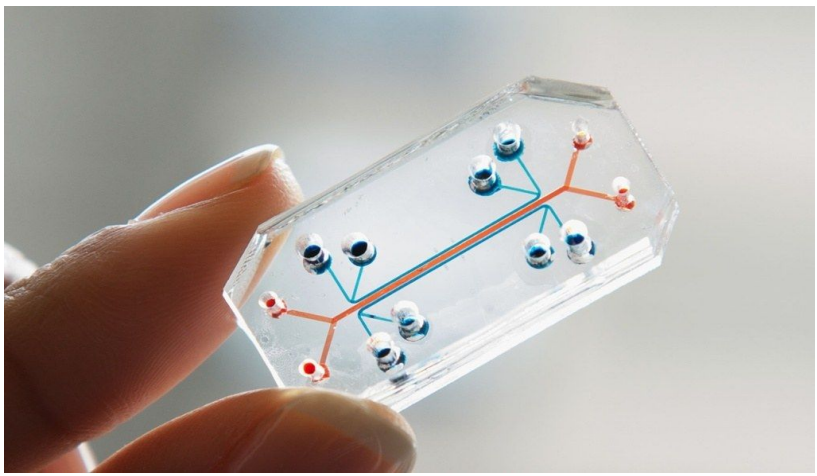


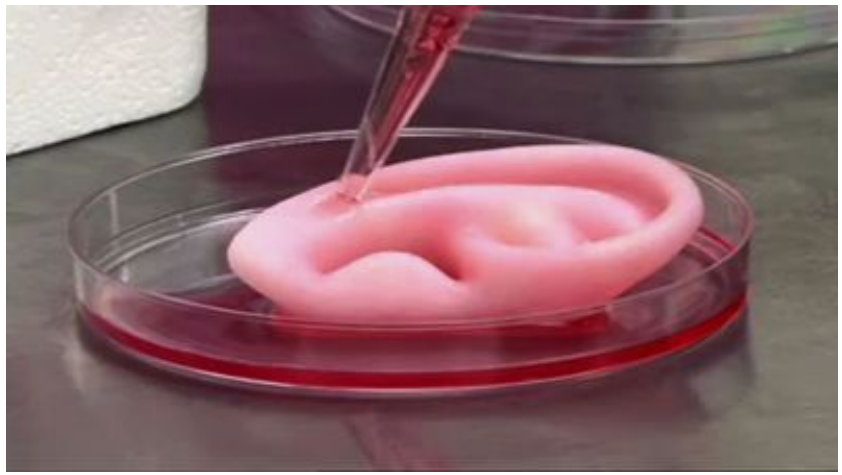


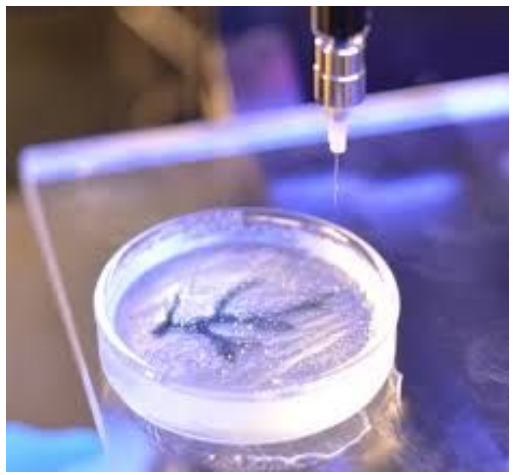
Personalized Experimentation

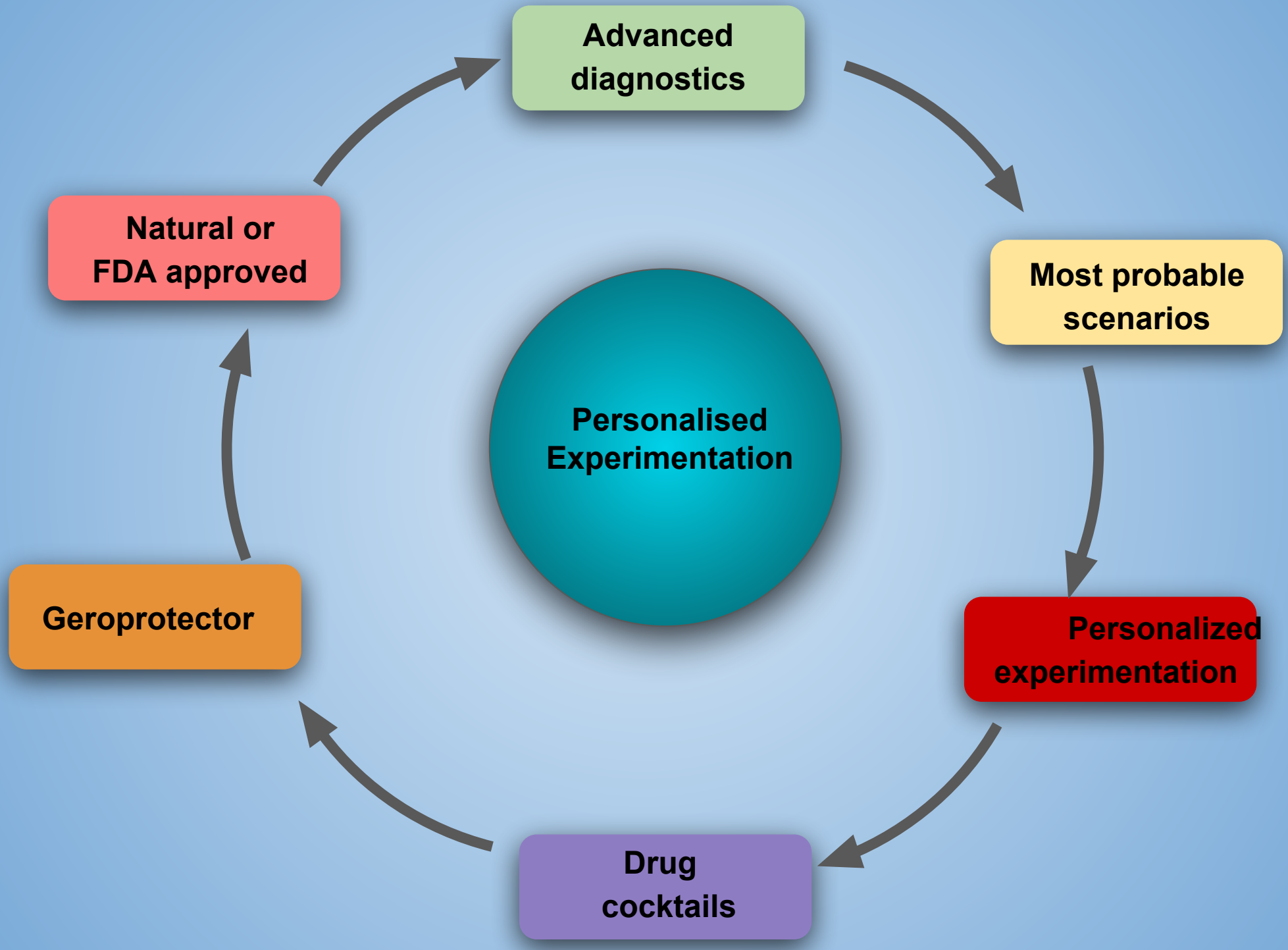


- Intelligent *in silico* experimentation
- Personalised *in vivo* experimentation on human cells
- Organ-on-a-chip systems
- Real time tracking of changes in health and aging biomarkers in response ongoing treatments
- Personalised ex *vivo* experimentation on 3D bioprinted tissues and organs using patient-specific cells
- AI based personalized biomarker development and drug response profiling via Deep Learning and Generative Adversarial Networks

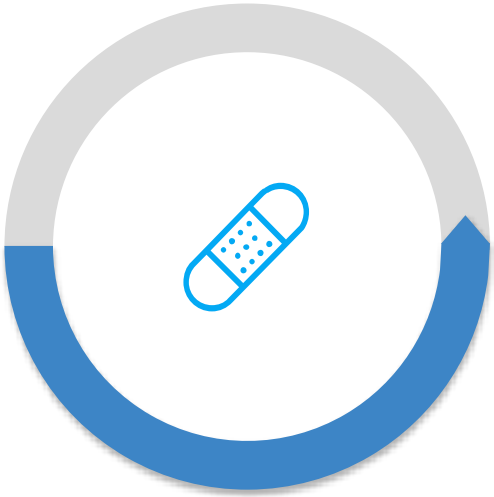




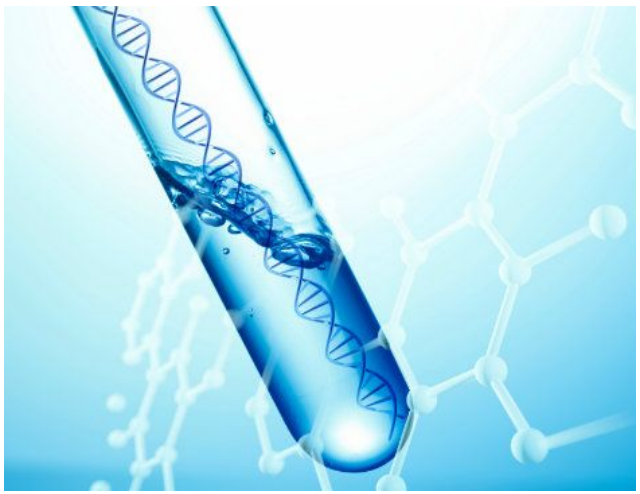



Advanced diagnostics
Most probable scenarios
Personalized experimentation
Drug cocktails
Geroprotector
Natural or FDA approved
Personalised Experimentation

Preventive Treatment



- Gene therapies
- Cell therapies
- Tissue engineering
- Small molecules & biologics
- Natural mimetics of validated geroprotectors (e.g. metformin, rapamycin)
- Genetically engineered cell therapies
- 3D bioprinting
- Microbiome engineering



Preventive Treatment

Small doses of medications

New intervention

Personalized dose optimization

Measurement of biomarkers

Digital avatar visualization

"Longevity is a blessing. And as an investor, it provides you opportunities to benefit from compounding and to have a longer investment horizon. But if you don't prepare for it, you are left with two options: Work longer in life, perhaps much longer than you'd like, or hope you've been good to your children and that they'll be willing to care for you in your old age. And, second, I hope you'll speak out. Longevity is an issue of social justice that will have a more profound impact on your generation than on any generation before. If we don't start to address it – not just in this country but globally – we're going to see fewer job prospects for young people, higher unemployment, lower growth and many older people – maybe your parents – left without the means to support themselves."

- ***Larry Fink, Chairman of Blackrock Capital***

"There will come an age when our average life expectancy will reach 200 years."

-Masayoshi Son, CEO of SoftBank and Vision Fund.

"To finance longer life spans, we must convince individuals to start investing now for the long term. But longevity should be an asset that can be leveraged, not a curse."

- *Laurence D. Fink, BlackRock Capital, Chairman of the World's Biggest Investment Fund, with $6.28 Trillion under management.*

The current financial system was designed 50-100 years ago, at a time when no one could imagine that life expectancy could increase at all, nevermind to the extend with which it has actually increased in the past 50 years. To adjust to the current reality nations will have to endure multiple financial paradigm shifts, gand experience of several significant financial crisis cycles. And they will have to enable these shifts fast if they hope to avoid systemic stagnation, within the next 10-15 years.

The backbone of today's global financial system do not possess the resources or infrastructures needed to enable such rapid adaptation and adjustment. This is why this report concludes that the necessary changes required to weather this storm will be deep and fundamental shifts, almost equal to the creation of wholly novel financial system from scratch.

This chapter considers how a preliminary blueprint of the novel financial Longevity economy should be designed, and outlines major topics which will be covered in greater detail in a forthcoming special report later this year titled "**Novel Financial System".**

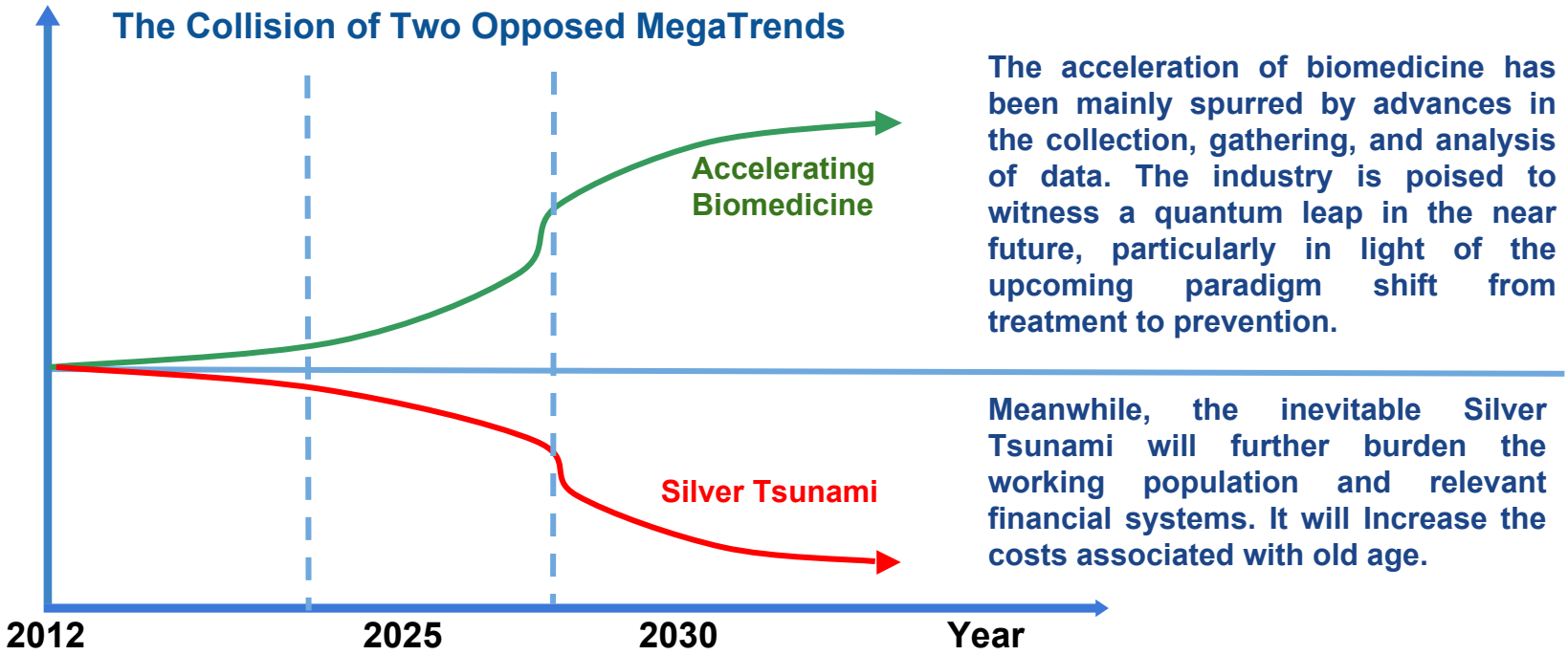
"The future of the longevity industry not only has the logical potential to become the wealthiest industry in all of history, but also represents the most ethical way of doing business."

- *Dmitry Kaminskiy, Managing Partner, Deep Knowledge Life Sciences.*

Novel FInancial Systems in the Age of Longevity

Chapter VII of the Global Longevity Industry Landscape Overview Volume II: The Business of Longevity outlines the collision of two global megatrends, about to collide like matter and antimatter, resulting in a global shockwave that will inevitably result in the creation of **Novel Financial System**.

- **The silver tsunami** (global aging population) described previously, and the concomitant global stagnation of the biopharma, national economies and healthcare systems.
- **The acceleration of biomedicine** as a result of its convergence with data science.



We consider the implications, opportunities and threats involved in this shift, and examine the range of tools at our disposal for making step-by-step predictions and forecasting for various possible futures. We analyze who will be left standing, who will thrive, and who will be swept away by the Silver Tsunami. The following chapter offers an overview of the factors involved with this analysis.

Chronological versus Biological Age

Chronological Age

- Measures how many times you, in this body, have revolved around the sun
- Cannot be altered by mind/body approaches
- Has little relevance to how you feel and function

Biological Age

- Measures how well your physiological systems are functioning
- Can be reversed by attending to your health
- Is the most important component of the aging process

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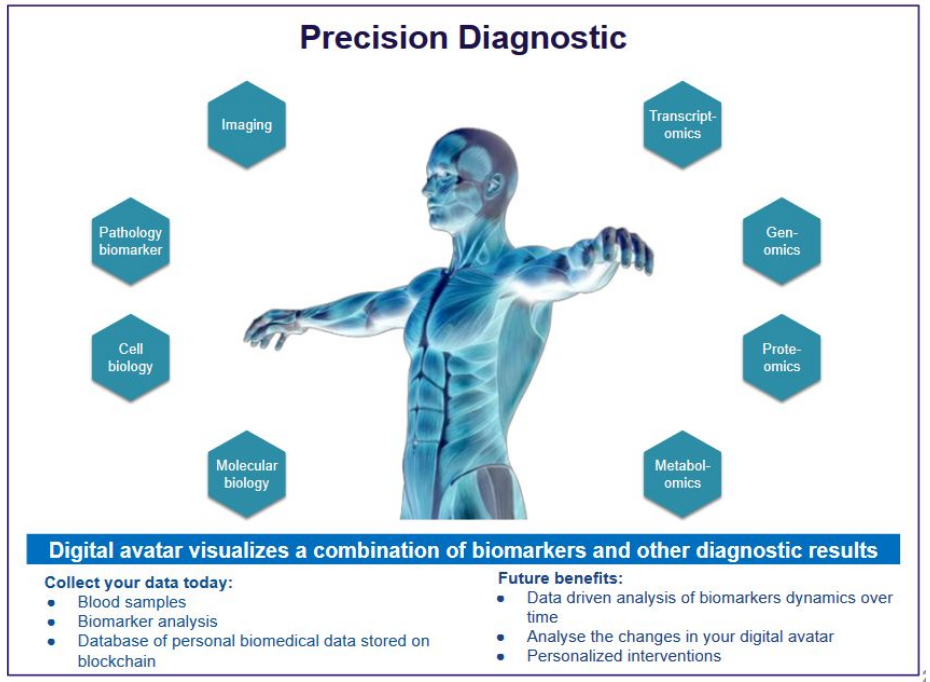
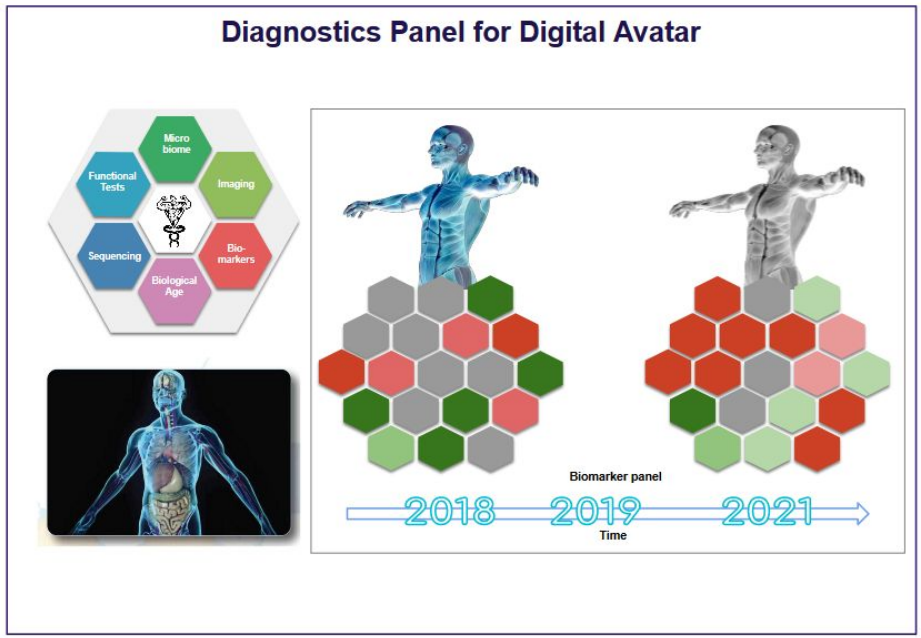
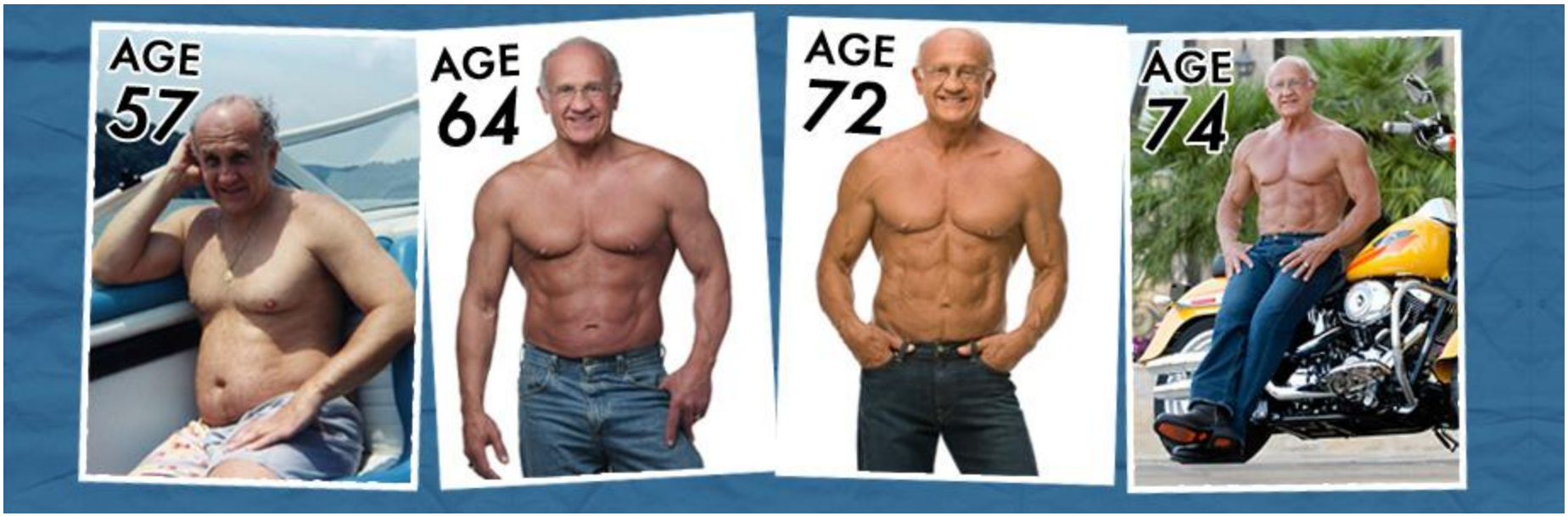




The Example of Jeffry Life



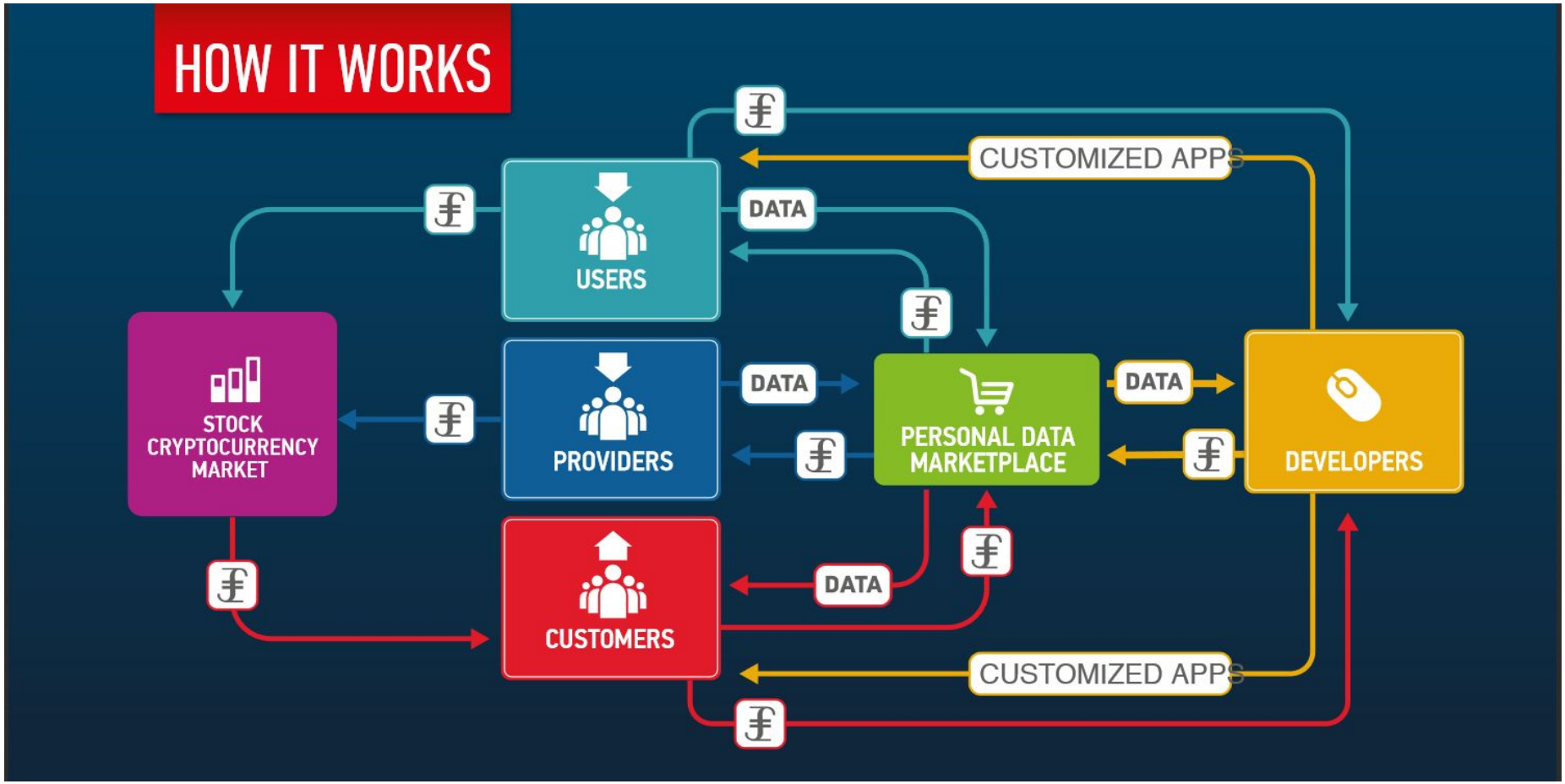
"Today at 78 years of age I am in the best shape of my life. I am in the gym 5 days a week. I have a thriving practice in Charleston, West Virginia (The Life Center for Healthy Aging), and I have authored three books: The Life Plan, Mastering the Life Plan and The Life Plan Diet. *At the end of 2012 Men's Fitness Magazine selected me and 24 others as the top 25 fittest men of the year.* The other 24 honorees were men in their 20's and 30's and most were professional athletes or actors. The program works, I am living my dream, and there is no end in sight. It just keeps getting better.

It would have never happened if I had not made the decision to live a healthier life. While your life may not take the same path as mine, it most certainly can be more productive, happier, and healthier for longer if you start taking care of it now. *It is never too late, nor too early, to start living a healthy and fit lifestyle*."

Dr. Life

Tying Healthcare Data to the Financial Industry: Longenesis as a Case Study

Longenesis was born out of a partnership between Insilico Medicine, a biotechnology company focused on deep learning for drug discovery and biomarker development, and the Bitfury Group, one of the largest private infrastructure providers in the Blockchain ecosystem. The pair aim to foster a decentralized ecosystem for exchange and utilization of human life data. They plan on achieving this by building a revolutionary platform that marries nextgen artificial intelligence and blockchain technologies. Their ultimate mission is to improve human performance, extend life, and prevent disease.



Financial Futurism

Dictionary.Com defines 'futurism' as: ***"The study or forecasting of trends or developments in science, technology, political or social structure, etc."***

So intertwined are the fates of technology and finance at this juncture in history that predicting them calls for a form of **'financial futurism'**.

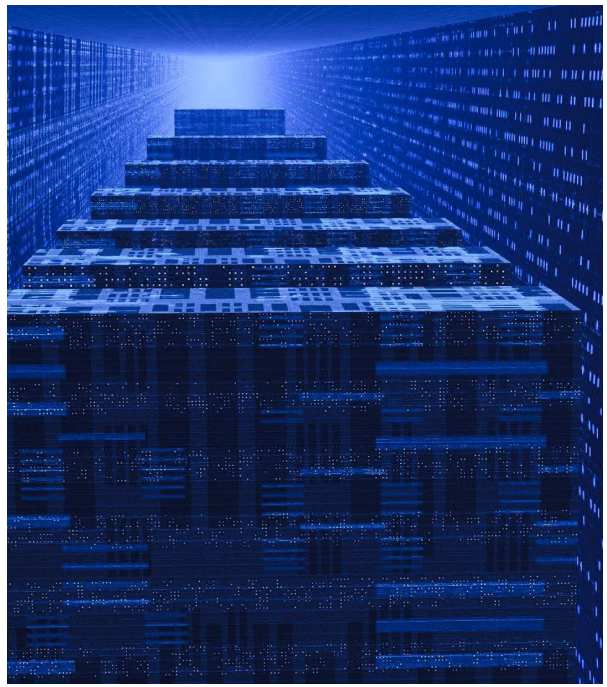
In this chapter we apply forecasting methods to identify possible scenarios and create a roadmap for how financial entities could evolve from scratch in the novel financial realm.

The Pathway toward Financial Futurism

Looming changes to the global financial system resulting from the convergence of two collapsing megatrends, the Silver Tsunami and advancing Longevity industry, will shake the global financial system.

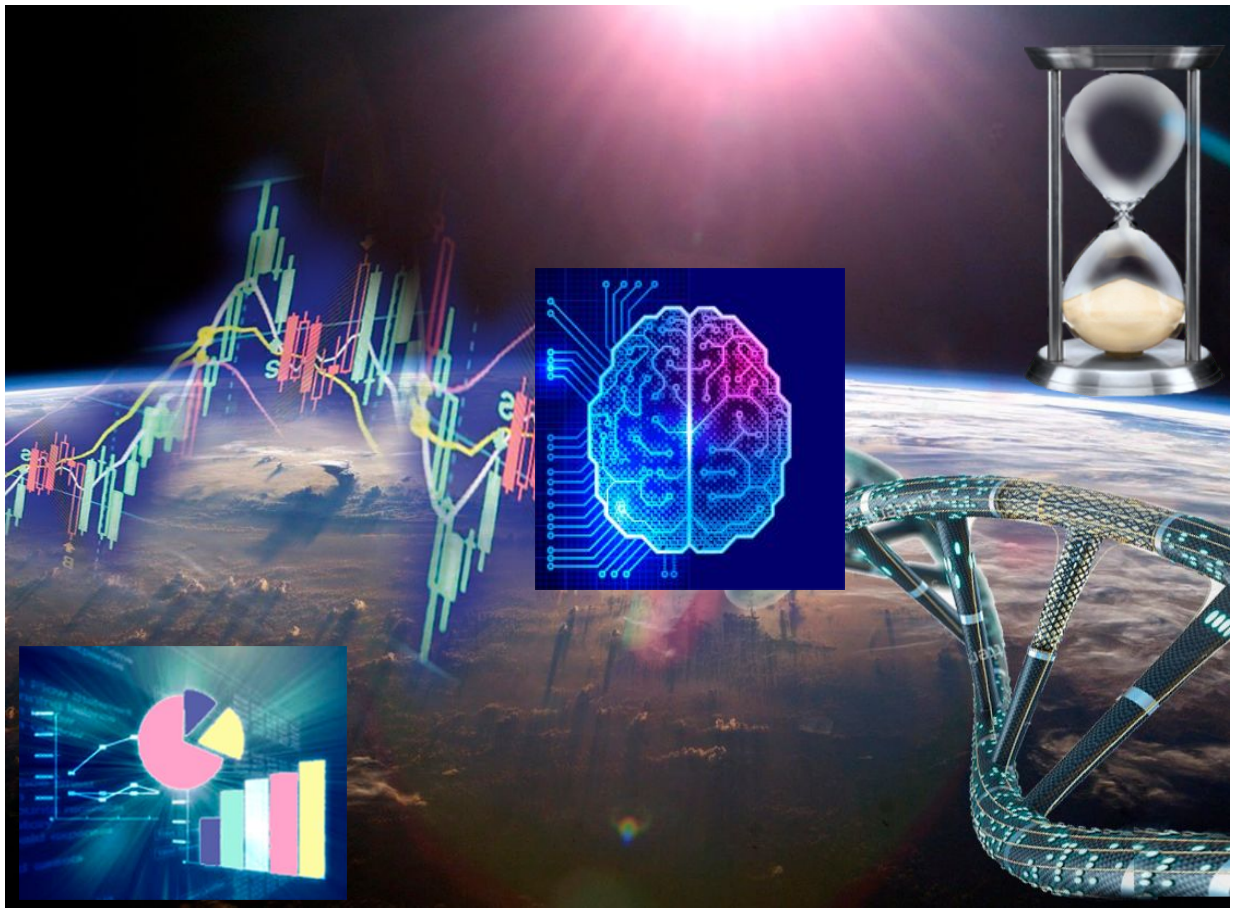
Financial institutions that don't adapt will not survive in their present form

After the tsunami has passed, such economies will have reformed themselves beyond recognition, absorbed by novel financial institutions and systems, or transformed by government initiatives of progressive technocratic countries.

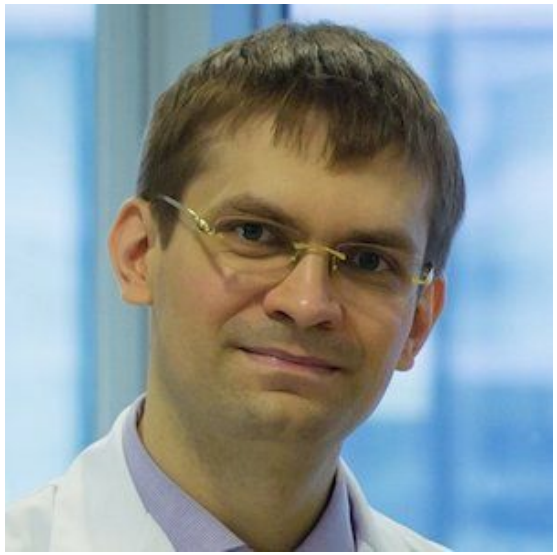


"There have been many well documented efforts to predict the future of biomedical progress, but is there any good reason why the same logic could not be applied for the financial sphere? Many thought leaders have made reasoned predictions on how some fragments of collapsing financial systems will evolve, adapt and adjust to increasing life expectancy. We should work to assemble the framework of scenarios regarding the evolution of financial system in the next 10 years, and create the pathways that will be able to neutralize collapses and accelerate the dynamic of progress of the longevity industry, with a focus on extension of healthy period of life for the betterment of all of humanity."

- Dmitry Kaminskiy, Managing Partner, Deep Knowledge Ventures



The following pages give an initial overview on how several potential types of financial institutions could and should operate in the next 5 - 10 years in the face of these changes.



"The way we prioritize projects at Insilico Medicine is by looking at the number of quality-adjusted life years (QALY) each project can generate. It is the most altruistic cause and the most effective investment. If you add just one year of life to everyone on the planet, you generate over 7 billion QALY."

"The majority of politicians and the general public are unaware of the tremendous potential benefits of regenerative medicine. They fail to grasp the profound implications that extended longevity could have on the global economy, on their respective nation's economic survival, and on their own lifespan and health." - Alex Zhavorokov, Chief Science Officer of the Biogerontology Research Foundation and a scientific advisor on the reports.

***"A mere three years ago the rise of the Longevity Industry was yet unthinkable. Now, a mere few years later, it has become unthinkable to consider biomedicine without healthy longevity. The time has come to establish a framework for the rising Longevity Industry."* -** Dmitry Kaminskiy, Managing Partner of Deep Knowledge Ventures

***"The future of the longevity industry not only has the logical potential to become the wealthiest industry in all of history, but also represents the most ethical way of doing business."* -** Dmitry Kaminskiy, Managing Partner of Deep Knowledge Ventures

***"Aging is the ultimate evil. To invest in Anti-Aging technologies is the most ethical business, and to donate to longevity research is the most effective form of altruism."* -** Dmitry Kaminskiy, Managing Partner of Deep Knowledge Ventures

"The entire system is now wired toward the short term. Banks and securities firms grow revenue from the velocity of money. So they have a short-term incentive. Media, especially in the online age of the 24/7 news cycle, draw traffic from hyper-focusing on the latest developments… But they should do just the opposite, taking advantage of their longer investment horizon to keep their money working for them. Because let's face it – if you have 25, 30 or 40 years to save for retirement and 20 or 30 years to fund in retirement, you should not be worrying about what's happening this second, today, this week – even this quarter."

- ***Larry Fink, Chairman of Blackrock Capital***

"People are living longer than ever before, dramatically altering the financial challenges of retirement. Increased longevity is a blessing, but it's an expensive one because that translates into the need for a bigger retirement nest egg and access to secure, retirement-long income. As our survey suggests, many Americans simply won't have the money they need to enjoy their longer lives if they don't start investing differently."

- ***Rob Kapito, President of Blackrock Capital***

"I'm actually pretty optimistic about the U.S. economy. But Europe's got real challenges. A lot of that is due to the demographics in Europe. China has been the engine of growth for the world for the last 20 years, or the last 10 years in particular, but that's not sustainable. So you're looking at a world where growth is going to be more challenged than it's been, unless you see some really big jumps in productivity."

- ***Bill McNabb, Chair of Vanguard***

Key Players in the Tech Industry on the Subject of Longevity and Long Term Planning

"Every country needs a Minister for the Future"

- ***Mark. R. Benioff, Chairman and CEO of Salesforce***

"With some longer term, moonshot thinking around healthcare and biotechnology, I believe we can improve millions of lives"

- ***Larry Page, CEO of Google***

"The opportunity to raise the quality of life is the biggest business opportunity going"

- ***Anand Mahindra, Chairman and Managing Director of Mahindra & Mahindra***

Death never made any sense to me.

- ***Larry Ellison, Founder of Oracle***

AGING ANALYTICS AGENCY
Invest for life

Biogerontology Research Foundation
Prevent. Restore. Preserve.

Our Publications Timeline

DEEP KNOWLEDGE LIFE SCIENCES

LONGEVITY.INTERNATIONAL

2013

2013 Regenerative Medicine Industry Framework

(150 pages)

2014

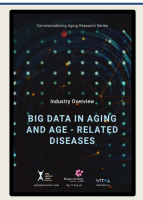
2014 Regenerative Medicine Analysis & Market Outlook

(200 pages)

2015

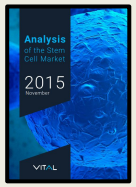
Big Data in Aging & Age-Related Diseases

(200 pages)



Stem Cell Market Analytical Report 2015

(200 pages)



2016

Longevity Industry Landscape Overview 2016

(200 pages)

2017

Volume I: The Science of Longevity

(750 pages)

2018

Volume II: The Business of Longevity

(635 pages)

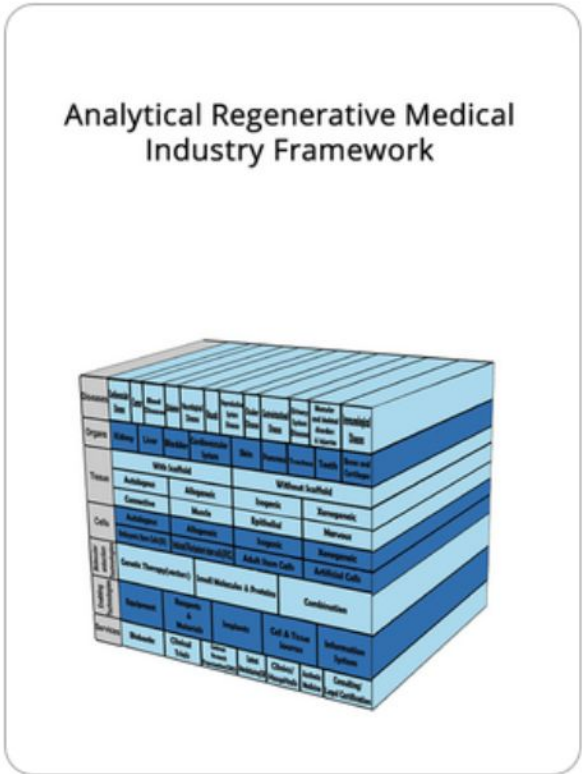
Volume III: 10 Special Case Studies

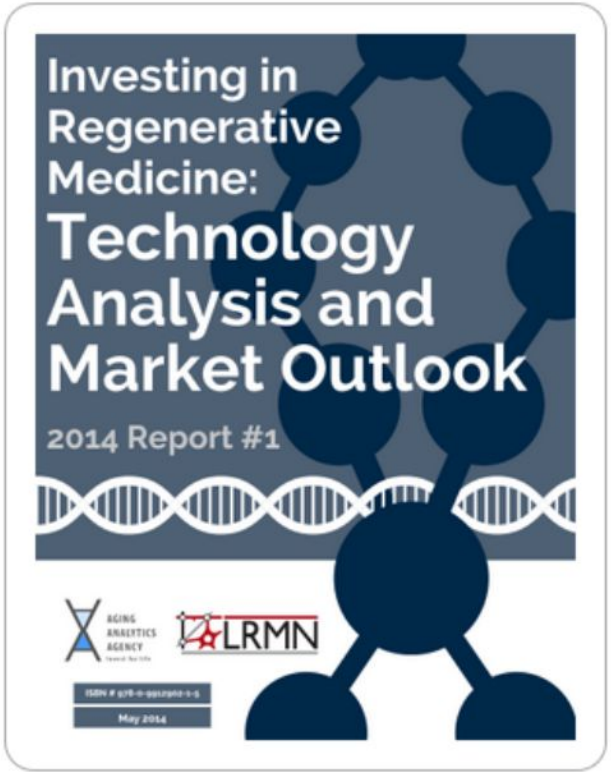
Volume IV: Novel Financial Longevity Industry

Volume V: Regional Case Studies

Our Previous Reports

The Global Longevity Consortium, consisting of the Biogerontology Research Foundation, Deep Knowledge Life Sciences, Aging Analytics Agency and Longevity.International platform, have authored two major analytical reports on the Longevity Industry previously: Longevity Industry Landscape Overview *Volume I: The Science of Longevity, and Volume II: The Business of Longevity,* in addition to the previous reports produced by Aging Analytics Agency, which focused on broader biomedical sectors, such as their 2015 report *Big Data in Aging and Age-Related Diseases Industry Overview*, their 2014 report *Investing in Regenerative Medicine: Technology Analysis and Market Outlook*, and their 2013 report *Analytical Regenerative Medicine Industry Framework*.





Our Previous Reports

Volume I: The Science of Longevity, set the landscape of geroscience against the backdrop of the 'silver tsunami' of global demographic aging, detailing the present state of precision, predictive and preventive medicine (referred to hereafter as 'P3'), how it works in conjunction with emerging preventative medical technologies, and the prospects for the next five years. It summarised the history and current state of development in geroscience, examined whether existing proposed solutions measure up to the impending problems. The consortium's first report tied together the progress threads of the constituent industries into a coherent narrative, mapping the intersection of biomedical gerontology, regenerative medicine, precision medicine, artificial intelligence, offering a brief history and snapshot of each. It also categorized, systematized and individually profiled 650 longevity-focused entities, including research hubs, non-profit organizations, leading scientists, conferences, databases, books and journals.

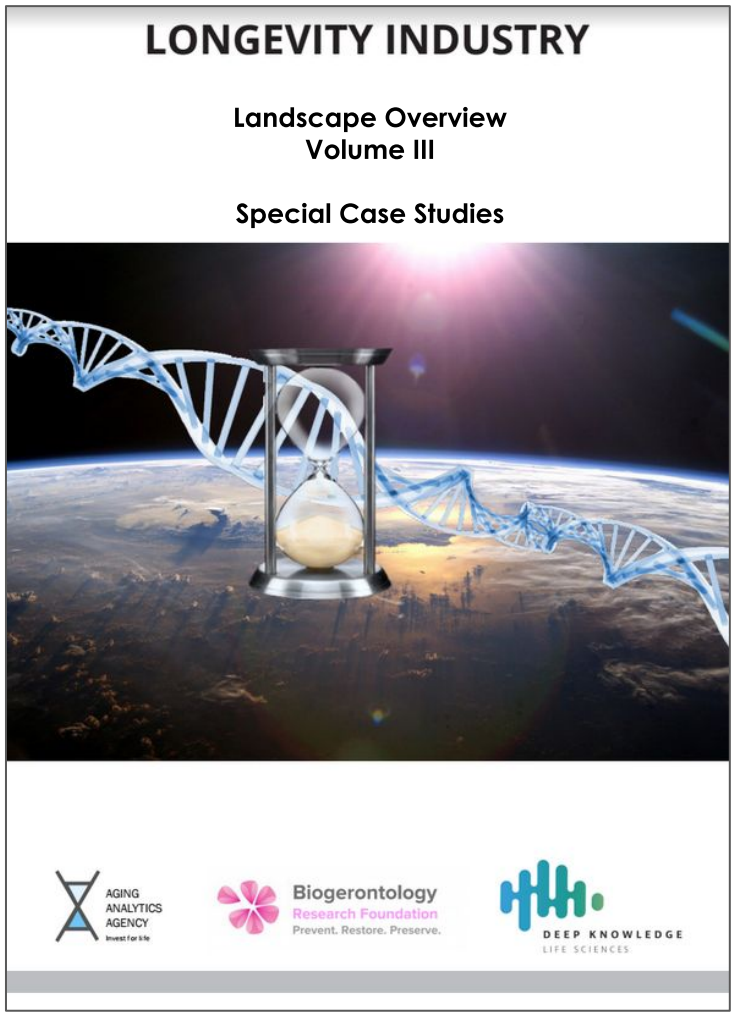
Volume III:
Special Case Studies

Biomarkers of Aging

Geroprotectors and Nutraceuticals

Gene Therapy

AI & Blockchain



P3 Medicine Clinics

Regenerative Medicine

Stem Cells

Novel Regulatory Approaches

Framework for Optimal Industry Forecasting: Applying Technology Readiness Levels to Geroscience

Framework for Industry Optimization: Differentiating Valid Science from Overvalued, Hyped and Fraudulent Technologies

Novel Financial System 2022-2025 perspective

Longevity Venture Funds

BioPharma corporations in 2022-2025

Longevity Hedge Funds

Pension Funds

Insurance Companies

Longevity Derivatives

AgeTech Bank

Longevity Trust

Longevity Index Fund

Longevity Stock Exchange

Progressive Regulatory systems

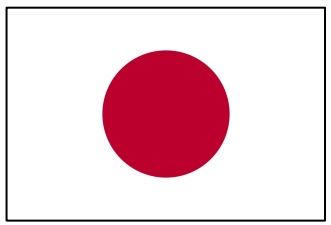
Progressive Government Healthcare Systems

Volume V:
Regional Case Studies

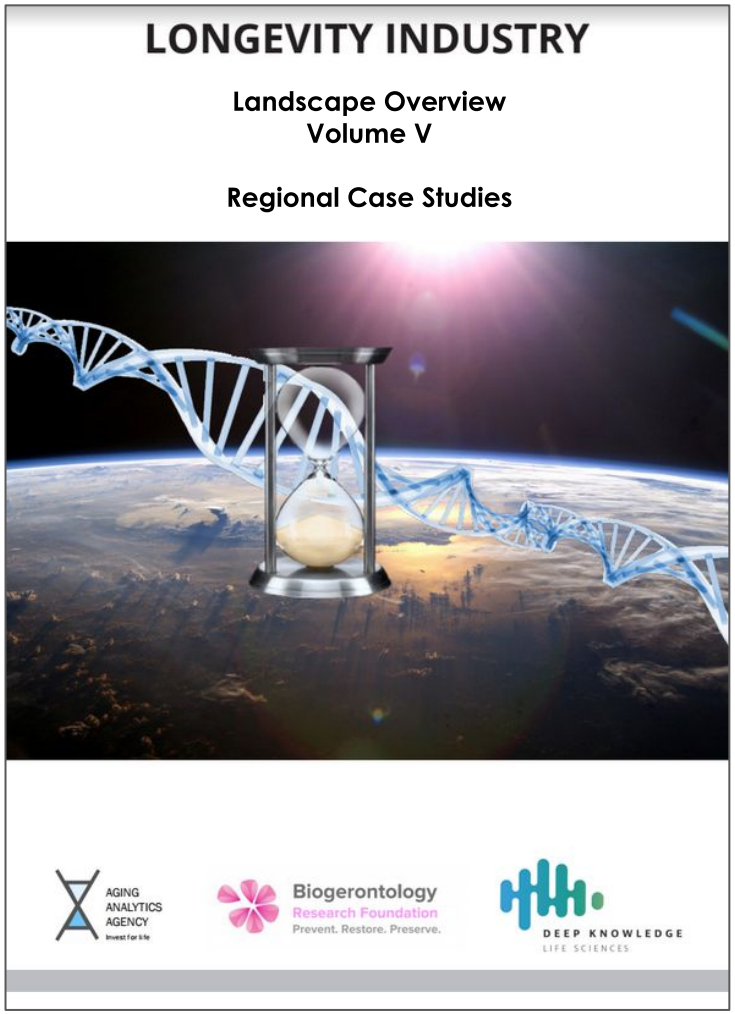
USA

UK

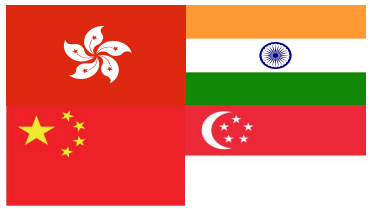
European Union



Japan



Asia



Eastern Europe

Israel

Biogerontology Research Foundation
Prevent. Restore. Preserve.

Longevity Industry in UK

LANDSCAPE OVERVIEW

DEEP KNOWLEDGE VENTURES

SCIENCE, TECHNOLOGIES, COMPANIES, INVESTORS, TRENDS

Our Previous Reports

In December 2017 Deep Knowledge Analytics released its inaugural report on the state of the AI for Drug Discovery industry, entitled AI for Drug Discovery Landscape Overview 2017, and in January 2018 released AI for Drug Discovery, Biomarker Development and Advanced R&D 2017. In April 2018, it also published an upgraded and much extended version of AI for Drug Discovery and Advanced R&D Q1.

These reports give in-depth coverage of the exponentially-growing global AI in Healthcare industry, with a specific focus on AI for drug discovery, biomarker development and advanced R&D, profiling the top companies, investors and influencers in the AI for drug discovery space.

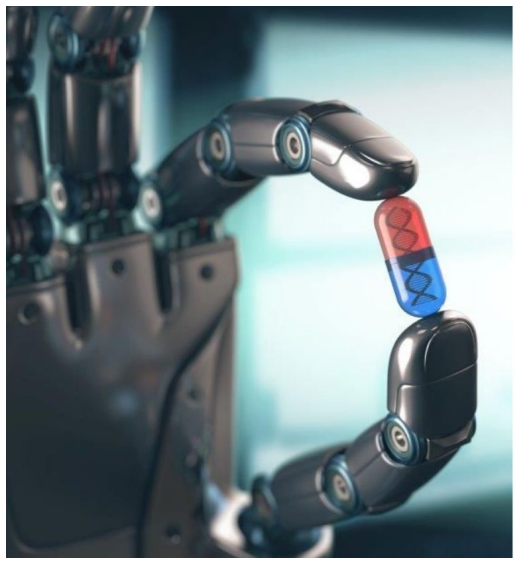
On average, it takes about a decade of research — and an expenditure of $2.6 billion — to shepherd an experimental drug from lab to market. And because of concerns over safety and effectiveness, only about 5 percent of experimental drugs make it to market at all.

But drug makers and tech companies are investing billions of dollars in artificial intelligence with the hope that AI will make the drug discovery process faster and cheaper.

AI FOR DRUG DISCOVERY, BIOMARKER DEVELOPMENT AND ADVANCED R&D LANDSCAPE OVERVIEW 2017

www.dkv.global

DEEP KNOWLEDGE VENTURES



AI for Drug Discovery Landscape Overview 2017

www.dkv.global

DEEP KNOWLEDGE VENTURES

AI in UK Healthcare

Landscape Overview 2017

TECHNOLOGY, COMPANIES, INVESTORS, TRENDS

- Digital Health Monitoring
- Drug Discovery
- Advanced R&D
- Medical Imaging and Diagnostics
- Hospital Management
- Patient Data
- Risk Analytics
- Surgery
- Lifestyle Management
- Virtual Assistants

AI FOR DRUG DISCOVERY, BIOMARKER DEVELOPMENT AND ADVANCED R&D LANDSCAPE OVERVIEW 2018 / Q1

Companies - 70
Investors - 180
Corporations - 20
R&D Centers - 20

www.analytics.dkv.global

DEEP KNOWLEDGE VENTURES

Longevity.International

Longevity.International provides longevity industry services crucial to its functioning on all levels

The platform contains a network section allowing different stakeholders in the longevity industry, from companies to investors to scientists to activists, to connect with one another and collaborate.

With an interactive database section that employs automated data filtering and visualization tools for its longevity company and investor databases, Longevity.International provides vital information to industry players and presents new opportunities for everyone in the field.

Longevity.International contains the latest Longevity Industry Reports, offering a complementary overview of the current longevity landscape: from the most successful investors and disruptive startups to the most recent advancements in science, technology and regulation fields.

Longevity.International will serve as a platform for distributed longevity company and project assessment, due diligence and valuation, crowdsourced from industry and scientist experts

Longevity.International virtual databases will be updated regularly in sync with the launch of new Longevity companies to chart the changing landscape of the Longevity industry

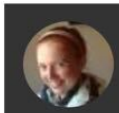
Longevity Record

With the aim of getting the ball rolling in the emerging longevity industry, Dmitry Kaminskiy announced a $1 million prize for the first person to reach the age of 123 - just 6 months longer than the current record holder, Jeanne Calment, who achieved 122 years and 6 months age.

Life record of 122.5 by Jeanne Calment who died in 1997

Forbes / Pharma & Healthca

Venture Capitalist Promises $1M To First Person To Reach 123rd Birthday



Sarah Hedgecock, FORBES STAFF
Apr 21, 2015 12:40 PM
8,556

Venture capitalist Dmitry Kaminskiy thinks he has what it takes to lengthen people's life spans: a million-dollar prize, which he will award to the first person to beat the current longevity record and reach his or her 123rd birthday.

Using P3 medicine technologies, and leveraging the work of Geroscientists, why should 122.5 years of age be considered the limit?

Biogerontology Research Foundation

Prevent. Restore. Preserve.

Website: http://bg-rf.org.uk

Contact: info@bg-rf.org.uk

The Biogerontology Research Foundation (BGRF) is the UK's oldest longevity non-profit organization founded by leading geroscientists. **The BGRF** funds and conducts research which aims to develop biotechnological interventions to remediate the molecular and cellular deficits which accumulate with age and which underlie the ill-health of old age. **The BGRF's** Board of Trustees include British billionaire Jim Mellon, prominent longevity investor Dmitry Kaminskiy, renowned geroscientists Dr. Alex Zhavoronkov, João Pedro De Magalhães and Dr. Richard Faragher, as well as Jim Plante and Franco Cortese.

DEEP KNOWLEDGE LIFE SCIENCES

Website: http://deepknowledge.life

Contact: info@deepknowledge.life

Deep Knowledge Life Sciences is a London based investment fund focused on ground- breaking research in life sciences and aging. **DKLS** strategically invests in mission-driven companies and supports founders who will bridge the gap between basic biological research and real-world healthcare products that extend healthy lifespan. **Insilico Medicine**, a company applying the latest advances in deep learning to biomarker development, drug discovery and aging research, is **the DKLS flagship investment.**

LONGEVITY.INTERNATIONAL

Website: http://longevity.international

Contact: info@longevity.international

Longevity.International is an online interactive database of longevity scientists, companies, and investors. This platform allows different stakeholders in the longevity industry to connect, network, research and analyze.

On the next stage this platform will also employ *cutting-edge data visualization software and a networking section* where various stakeholders within the longevity industry can connect and collaborate, where longevity companies are matched with the right investors, and where scientists can make contributions.

AGING ANALYTICS AGENCY

Invest for life

Website: http://aginganalytics.com

Contact: info@aginganalytics.com

Aging Analytics Agency aims to use its knowledge of anti-aging technologies and current research paradigms to create invaluable databases and provide a supporting **Aging Analytics Agency** aims to use its knowledge of anti-aging technologies and current research paradigms to create invaluable databases and provide a supporting framework for financial decision making. The goal of **the Agency** is to promote the growth of biogerontology, enhance international collaboration, and increase interaction and cooperation between companies to benefit the field as a whole.