Aging Biotech Sector Overview, AgingBiotech.info tool, & investing

Jul 2024

Karl Pfleger, PhD

Founder, AgingBiotech.info
Investor

Note: Talk slides at: `https://tinyurl.com/ABI24Jul`

(Investments disclosed on LinkedIn profile.)

https://www.linkedin.com/in/karl-r-pfleger/
https://twitter.com/KarlPfleger

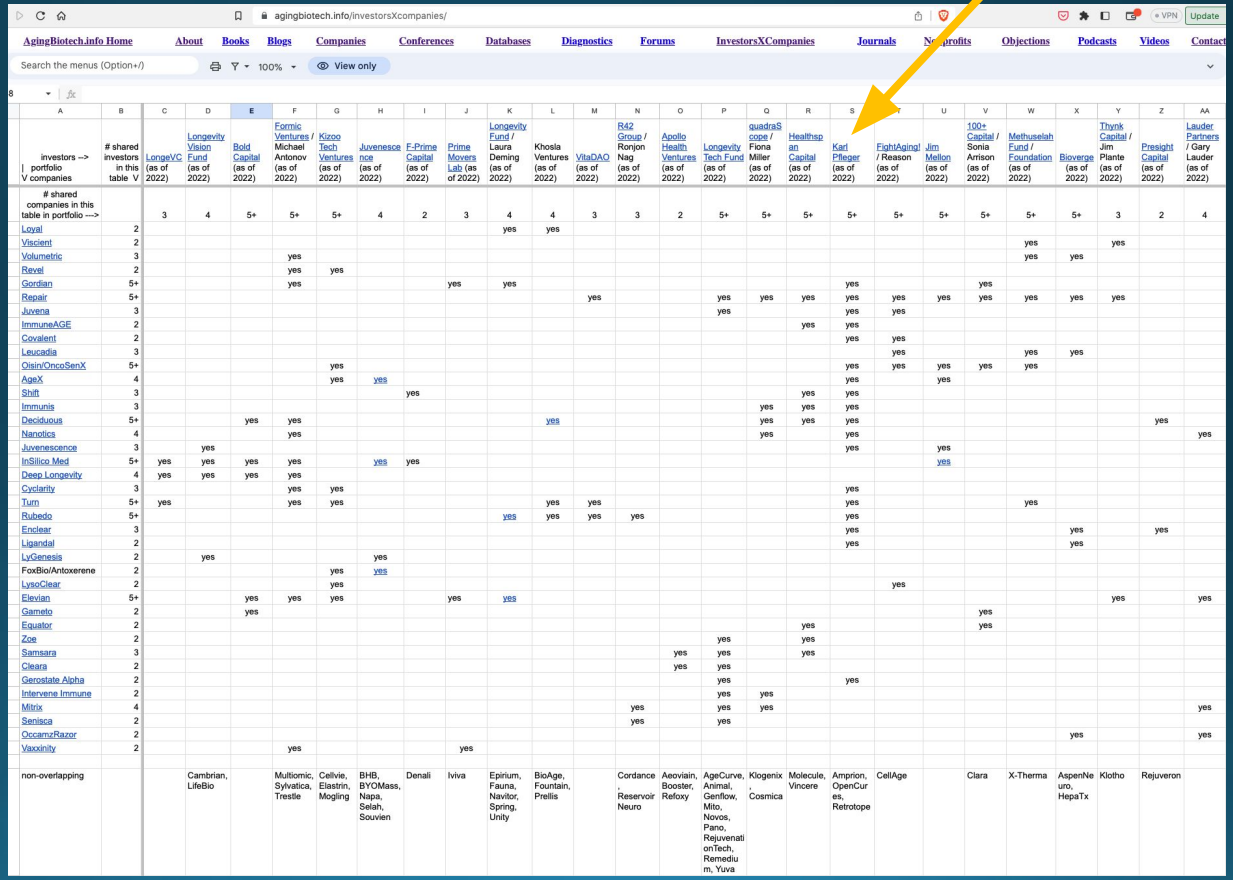
Why listen to me?

I run the website giving the broadest overview of the field.

I'm one of the most prolific investors in the field.

PhD Stanford in a data science field (CS/AI/ML).

I've been in the field for a decade



agingbiotech.info/investorsXcompanies/

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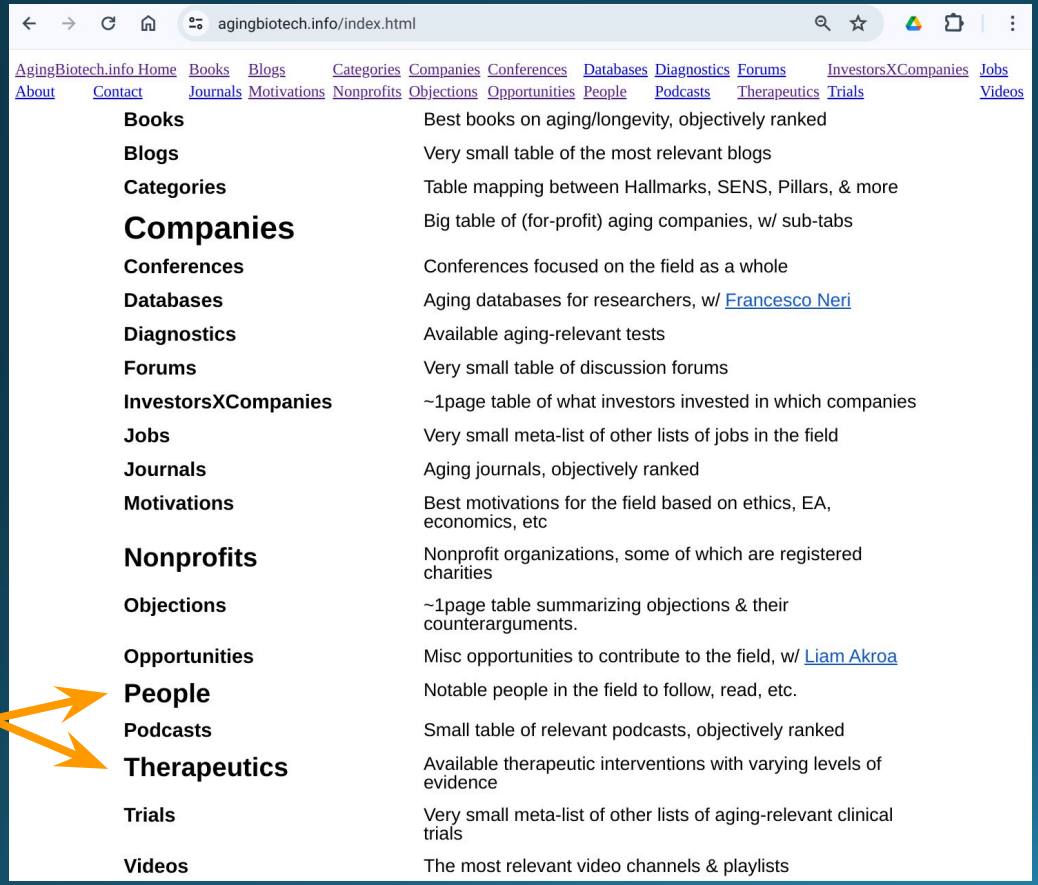
investors --> / portfolio V companies	# shared investors in this table V	LongeVC (as of 2022)	Longevity Vision Fund (as of 2022)	Bold Capital (as of 2022)	Formic Ventures / Michael Antonov (as of 2022)	Kizoo Tech Ventures (as of 2022)	Juvenescence (as of 2022)	F-Prime Capital (as of 2022)	Prime Movers Lab (as of 2022)	Longevity Fund / Laura Deming (as of 2022)	Khosla Ventures (as of 2022)	VitaDAO (as of 2022)	R42 Group / Ronjon Nag (as of 2022)	Apollo Health Ventures (as of 2022)	Longevity Tech Fund (as of 2022)	quadraScope / Fiona Miller (as of 2022)	Healthspan Capital (as of 2022)	Karl Pfleger (as of 2022)	FightAging! / Reason (as of 2022)	Jim Mellon (as of 2022)	100+ Capital / Sonia Arrison (as of 2022)	Methuselah Fund / Foundation (as of 2022)	Bioverge (as of 2022)	Thynk Capital / Jim Plante (as of 2022)	Presight Capital (as of 2022)	Lauder Partners / Gary Lauder (as of 2022)
# shared companies in this table in portfolio --->		3	4	5+	5+	5+	4	2	3	4	4	3	3	2	5+	5+	5+	5+	5+	5+	5+	5+	5+	3	2	4
Loyal	2									yes	yes															
Viscient	2																					yes		yes		
Volumetric	3				yes																	yes	yes			
Revel	2				yes	yes																				
Gordian	5+				yes				yes	yes								yes			yes					
Repair	5+											yes			yes	yes	yes	yes	yes	yes	yes	yes	yes	yes		
Juvena	3														yes			yes	yes							
ImmuneAGE	2																yes	yes								
Covalent	2																	yes	yes							
Leucadia	3																		yes			yes	yes			
Oisin/OncoSenX	5+					yes												yes	yes	yes	yes	yes				
AgeX	4					yes	yes											yes		yes						
Shift	3							yes									yes	yes								
Immunis	3															yes	yes	yes								
Deciduous	5+			yes	yes						yes					yes	yes	yes							yes	
Nanotics	4				yes											yes		yes								yes
Juvenescence	3		yes															yes		yes						
InSilico Med	5+	yes	yes	yes	yes		yes	yes												yes						
Deep Longevity	4	yes	yes	yes	yes																					
Cyclarity	3				yes	yes												yes								
Turn	5+	yes			yes	yes					yes	yes						yes					yes			
Rubedo	5+									yes	yes	yes	yes					yes								
Enclear	3																	yes								
Ligandal	2																	yes								
LyGenesis	2		yes				yes																			
FoxBio/Antoxerene	2					yes	yes																			
LysoClear	2					yes													yes							
Elevian	5+			yes	yes	yes			yes	yes														yes		yes
Gameto	2			yes																	yes					
Equator	2																				yes					
Zoe	2														yes		yes									
Samsara	3													yes	yes		yes									
Cleara	2													yes	yes											
Gerostate Alpha	2														yes				yes							
Intervene Immune	2														yes	yes										
Mitrix	4												yes		yes	yes										yes
Senisca	2												yes		yes											
OccamzRazor	2																						yes			yes
Vaxxinity	2				yes				yes																	
non-overlapping			Cambrian, LifeBio		Multiomic, Sylvatica, Trestle	Cellvie, Elastrin, Mogling	BHB, BYOMass, Napa, Selah, Souvien	Denali	Iviva	Epirium, Fauna, Navitor, Spring, Unity	BioAge, Fountain, Prellis		Cordance, Reservoir Neuro	Aeoviain, Booster, Refoxy	AgeCurve, Animal, Genflow, Mito, Novos, Pano, RejuvenationTech, Remedium, Yuva	Klogenix, Cosmica	Molecule, Vincere	Amprion, OpenCures, Retrotope	CellAge		Clara	X-Therma	AspenNeuro, HepaTx	Klotho	Rejuveron	

AgingBiotech.info covers (almost) everything in the field



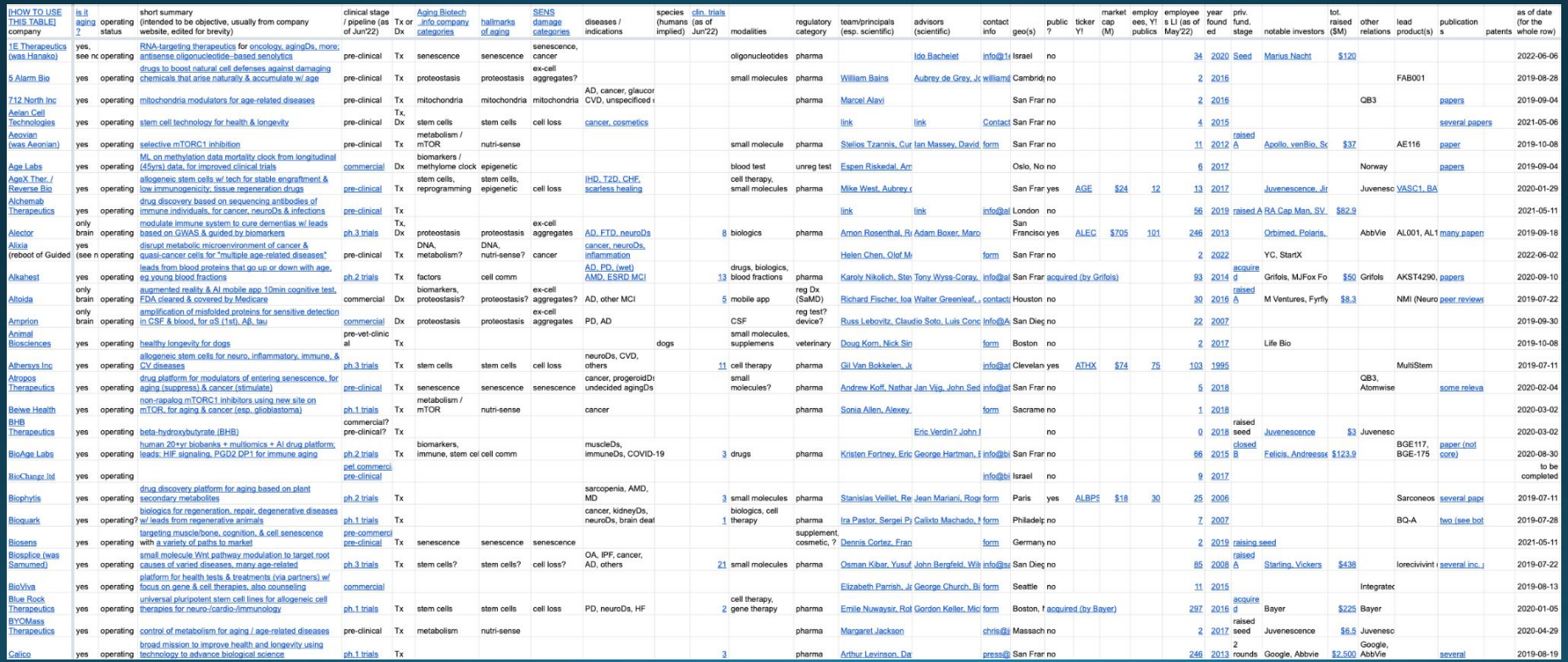
new!

Can’t go deep in a short talk. The site gives more info & links to go deeper.

AgingBiotech.info properties

- Non-profit, non-commercial public tool
- Asynchronously updated
- Focus on content, not flashiness
- Only public info: nothing unannounced
- Links direct to sources: easy to get latest info & explore more (this is also why you should trust the data more)

AgingBiotech.info lists 300+ companies



[HOW TO USE THIS TABLE] company	is it aging ?	operating status	short summary (intended to be objective, usually from company website, edited for brevity)	clinical stage / pipeline (as of Jun'22)	Tx or Dx	Aging Biotech .info company categories	hallmarks of aging	SENS damage categories	diseases / indications	species (humans implied)	clin. trials (as of Jun'22)	modalities	regulatory category	team/principals (esp. scientific)	advisors (scientific)	contact info	geo(s)	public ?	ticker Y!	market cap (M)	employees, Y! publics	employees LI (as of May'22)	year founded	priv. fund. stage	notable investors	tot. raised ($M)	other relations	lead product(s)	publications	patents	as of date (for the whole row)
1E Therapeutics (was Hanako)	yes, see nc	operating	RNA-targeting therapeutics for oncology, agingDs, more; antisense oligonucleotide–based senolytics	pre-clinical	Tx	senescence	senescence	senescence, cancer				oligonucleotides	pharma		Ido Bachelet	info@1e	Israel	no				34	2020	Seed	Marius Nacht	$120					2022-06-06
5 Alarm Bio	yes	operating	drugs to boost natural cell defenses against damaging chemicals that arise naturally & accumulate w/ age	pre-clinical	Tx	proteostasis	proteostasis	ex-cell aggregates?				small molecules	pharma	William Bains	Aubrey de Grey, Jc	william@	Cambrid	no				2	2016				FAB001			2019-08-28
712 North Inc	yes	operating	mitochondria modulators for age-related diseases	pre-clinical	Tx	mitochondria	mitochondria	mitochondria	AD, cancer, glaucor CVD, unspecificed				pharma	Marcel Alavi			San Frar	no				2	2016				QB3		papers		2019-09-04
Aelan Cell Technologies	yes	operating	stem cell technology for health & longevity	pre-clinical	Tx, Dx	stem cells	stem cells	cell loss	cancer, cosmetics						link	link	Contact	San Frar	no				4	2015						several papers		2021-05-06
Aeovian (was Aeonian)	yes	operating	selective mTORC1 inhibition	pre-clinical	Tx	metabolism / mTOR	nutri-sense					small molecule	pharma	Stelios Tzannis, Cur	Ian Massey, David	form	San Frar	no				11	2012	raised A	Apollo, venBio, Sc	$37		AE116	paper		2019-10-08
Age Labs	yes	operating	ML on methylation data mortality clock from longitudinal (45yrs) data, for improved clinical trials	commercial	Dx	biomarkers / methylome clock	epigenetic					blood test	unreg test	Espen Riskedal, Arn			Oslo, No	no				6	2017				Norway		papers		2019-09-04
AgeX Ther. / Reverse Bio	yes	operating	allogeneic stem cells w/ tech for stable engraftment & low immunogenicity; tissue regeneration drugs	pre-clinical	Tx	stem cells, reprogramming	stem cells, epigenetic	cell loss	IHD, T2D, CHF, scarless healing			cell therapy, small molecules	pharma	Mike West, Aubrey (			San Frar	yes	AGE	$24	12	13	2017		Juvenescence, Jir		Juvenesc	VASC1, BA			2020-01-29
Alchemab Therapeutics	yes	operating	drug discovery based on sequencing antibodies of immune individuals, for cancer, neuroDs & infections	pre-clinical	Tx										link	link	info@al	London	no				56	2019	raised A	RA Cap Man, SV	$82.9					2021-05-11
Alector	only brain	operating	modulate immune system to cure dementias w/ leads based on GWAS & guided by biomarkers	ph.3 trials	Tx, Dx	proteostasis	proteostasis	ex-cell aggregates	AD, FTD, neuroDs		8	biologics	pharma	Arnon Rosenthal, Ri	Adam Boxer, Marc		San Francisc	yes	ALEC	$705	101	246	2013		Orbimed, Polaris,		AbbVie	AL001, AL1	many papers		2019-09-18
Alixia (reboot of Guided	yes (see n	operating	disrupt metabolic microenvironment of cancer & quasi-cancer cells for "multiple age-related diseases"	pre-clinical	Tx	DNA, metabolism?	DNA, nutri-sense?	cancer	cancer, neuroDs, inflammation					Helen Chen, Olof M		form	San Frar	no				2	2022		YC, StartX						2022-06-02
Alkahest	yes	operating	leads from blood proteins that go up or down with age, eg young blood fractions	ph.2 trials	Tx	factors	cell comm		AD, PD, (wet) AMD, ESRD MCI		13	drugs, biologics, blood fractions	pharma	Karoly Nikolich, Ster	Tony Wyss-Coray,	info@al	San Frar	acquired (by Grifols)				93	2014	acquire d	Grifols, MJFox Fo	$50	Grifols	AKST4290,	papers		2020-09-10
Altoida	only brain	operating	augmented reality & AI mobile app 10min cognitive test, FDA cleared & covered by Medicare	commercial	Dx	biomarkers, proteostasis?	proteostasis?	ex-cell aggregates?	AD, other MCI		5	mobile app	reg Dx (SaMD)	Richard Fischer, Ioa	Walter Greenleaf, ,	contact	Houston	no				30	2016	raised A	M Ventures, Fyrfly	$8.3		NMI (Neuro	peer reviews		2019-07-22
Amprion	only brain	operating	amplification of misfolded proteins for sensitive detection in CSF & blood, for aS (1st), Aβ, tau	commercial	Dx	proteostasis	proteostasis	ex-cell aggregates	PD, AD			CSF	reg test? device?	Russ Lebovitz, Claudio Soto, Luis Conc		Info@A	San Dieg	no				22	2007								2019-09-30
Animal Biosciences	yes	operating	healthy longevity for dogs	pre-vet-clinic al	Tx					dogs		small molecules, supplemens	veterinary	Doug Korn, Nick Sin		form	Boston	no				2	2017		Life Bio						2019-10-08
Athersys Inc	yes	operating	allogeneic stem cells for neuro, inflammatory, immune, & CV diseases	ph.3 trials	Tx	stem cells	stem cells	cell loss	neuroDs, CVD, others		11	cell therapy	pharma	Gil Van Bokkelen, Jc		info@at	Clevelan	yes	ATHX	$74	75	103	1995					MultiStem			2019-07-11
Atropos Therapeutics	yes	operating	drug platform for modulators of entering senescence, for aging (suppress) & cancer (stimulate)	pre-clinical	Tx	senescence	senescence	senescence	cancer, progeroidDs undecided agingDs			small molecules?	pharma	Andrew Koff, Nathar	Jan Vijg, John Sed	info@at	San Frar	no				5	2018				QB3, Atomwise		some releva		2020-02-04
Beiwe Health	yes	operating	non-rapalog mTORC1 inhibitors using new site on mTOR, for aging & cancer (esp. glioblastoma)	ph.1 trials	Tx	metabolism / mTOR	nutri-sense		cancer				pharma	Sonia Allen, Alexey		form	Sacrame	no				1	2018								2020-03-02
BHB Therapeutics	yes	operating	beta-hydroxybutyrate (BHB)	commercial? pre-clinical?	Tx										Eric Verdin? John I			no				0	2018	raised seed	Juvenescence	$3	Juvenesc				2020-03-02
BioAge Labs	yes	operating	human 20+yr biobanks + multiomics + AI drug platform; leads: HIF signaling, PGD2 DP1 for immune aging	ph.2 trials	Tx	biomarkers, immune, stem cel	cell comm		muscleDs, immuneDs, COVID-19		3	drugs	pharma	Kristen Fortney, Eric	George Hartman, F	info@bi	San Frar	no				66	2015	closed B	Felicis, Andreesse	$123.9		BGE117, BGE-175	paper (not core)		2020-08-30
BioChange ltd	yes	operating		pet commerci pre-clinical												info@bi	Israel	no				9	2017								to be completed
Biophytis	yes	operating	drug discovery platform for aging based on plant secondary metabolites	ph.2 trials	Tx				sarcopenia, AMD, MD		3	small molecules	pharma	Stanislas Veillet, Re	Jean Mariani, Rog	form	Paris	yes	ALBPS	$18	30	25	2006				Sarconeos	several pape			2019-07-11
Bioquark	yes	operating?	biologics for regeneration, repair, degenerative diseases w/ leads from regenerative animals	ph.1 trials	Tx				cancer, kidneyDs, neuroDs, brain deal		1	biologics, cell therapy	pharma	Ira Pastor, Sergei Pa	Calixto Machado, I	form	Philadelp	no				7	2007				BQ-A	two (see bot			2019-07-28
Biosens	yes	operating	targeting muscle/bone, cognition, & cell senescence with a variety of paths to market	pre-commerci pre-clinical	Tx	senescence	senescence	senescence					supplement, cosmetic, ?	Dennis Cortez, Fran		form	Germany	no				2	2019	raising seed							2021-05-11
Biosplice (was Samumed)	yes	operating	small molecule Wnt pathway modulation to target root causes of varied diseases, many age-related	ph.3 trials	Tx	stem cells?	stem cells?	cell loss?	OA, IPF, cancer, AD, others		21	small molecules	pharma	Osman Kibar, Yusuf	John Bergfeld, Wil	info@sa	San Dieg	no				85	2008	raised A	Starling, Vickers	$438		lorecivivint (	several inc. j		2019-07-22
BioViva	yes	operating	platform for health tests & treatments (via partners) w/ focus on gene & cell therapies, also counseling	commercial										Elizabeth Parrish, Jc	George Church, Bi	form	Seattle	no				11	2015				Integratec				2019-08-13
Blue Rock Therapeutics	yes	operating	universal pluripotent stem cell lines for allogeneic cell therapies for neuro-/cardio-/immunology	ph.1 trials	Tx	stem cells	stem cells	cell loss	PD, neuroDs, HF		2	cell therapy, gene therapy	pharma	Emile Nuwaysir, Rol	Gordon Keller, Mic	form	Boston, I	acquired (by Bayer)				297	2016	acquire d	Bayer	$225	Bayer				2020-01-05
BYOMass Therapeutics	yes	operating	control of metabolism for aging / age-related diseases	pre-clinical	Tx	metabolism	nutri-sense						pharma	Margaret Jackson		chris@j	Massach	no				2	2017	raised seed	Juvenescence	$6.5	Juvenesc				2020-04-29
Calico	yes	operating	broad mission to improve health and longevity using technology to advance biological science	ph.1 trials	Tx						3		pharma	Arthur Levinson, Da		press@	San Frar	no				246	2013	2 rounds	Google, Abbvie	$2,500	Google, AbbVie	several			2019-08-19

Scope: what counts as aging/longevity

Aging's a subset of biotech, but everyone draws diff fuzzy boundary

Practical operational criteria for AgingBiotech.info:

1. Geroscience hypotheses: core platform/tech treats/measures the biology underlying multiple age-related diseases
2. Or… explicitly stated aging focus/mission if specifics still vague

Explained in more detail at AgingBiotech.info/about

For companies with many programs, a large % should be aging

See examples in tables. Gray area cases explained in notes column

Out of scope

- Purely palliative (AgeTech) care for elderly
- Oncology, a huge field itself
- General health
- Advances for 1 age-related disease unlikely to generalize
- AI / deep learning for drug discovery generally
- advances in underlying tools that might improve all of bio
- (for now) 3D bioprinting
- (for now) cryopreservation

Important & interesting work!

Hard to emphasize enough: Most of these companies are doing important things based on interesting science. A lot is not secret.

You should check some of it out

The table has a brief (~12 word) description for each company

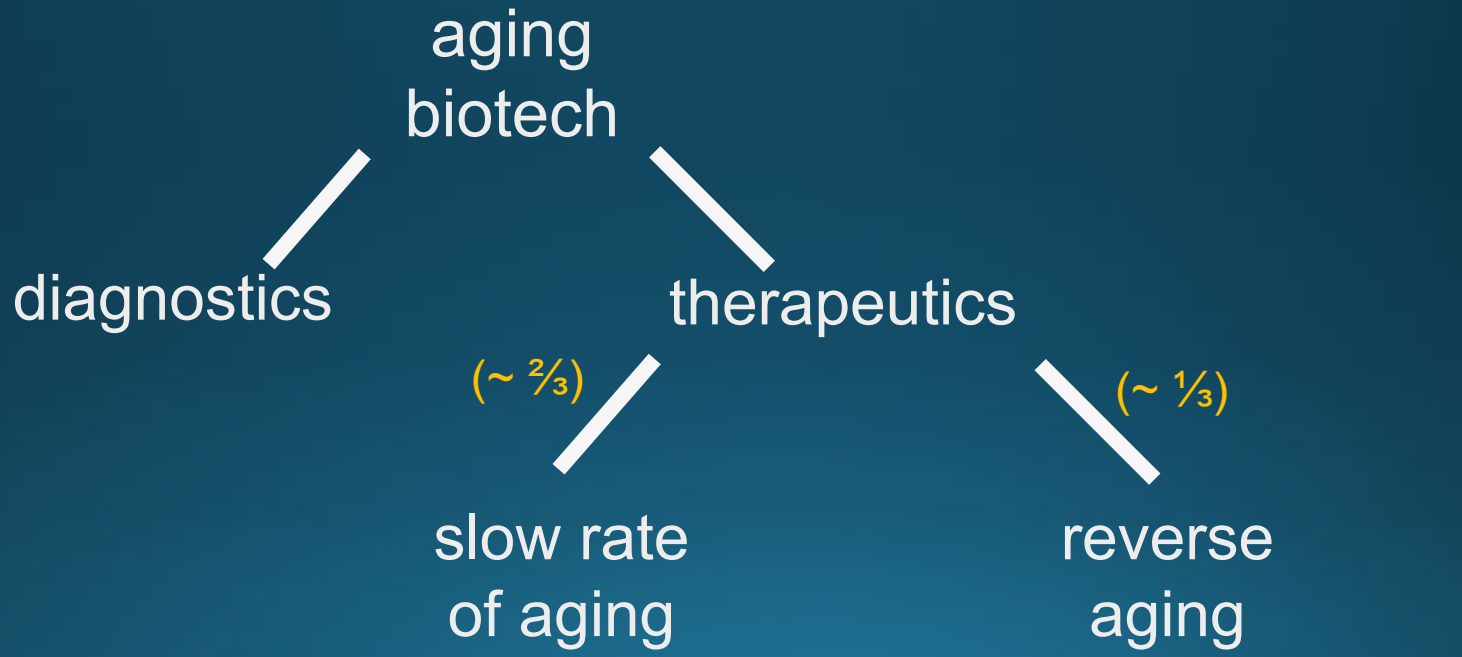
Most company websites describe the underlying science in detail

40% of companies have publications available (& directly linked)

Find-in-page for interests or sort & restrict by any column

Ways to partition the field

High level breakdowns



(old) Basic stats to summarize the field

Simple computations fall out of spreadsheet implementation

			stats to the right		
	status sub-list		only for those on the main list	is it aging?	therapy (Tx) or diagnostic (Dx)
grand totals:	299	total companies			
these rows	151	aging companies	------->>>	133 yes	120 therapy
count	117	to be considered		15 brain	23 diagnostic
number of	28	defunct		3 maybe	2 preventative
companies:		(or pivoted			
		to not aging)			
	3	acquired			
		(& not operating			
		independently)			

Clinical / commercial stage

Note: Not all the clinical trials are aging related. The total count is just the # of trials associated with these companies.

clinical stage (and pipeline)	clinical trials
	314
71 pre-clinical	# cos
11 ph.1 trials	w/ trials
16 ph.2 trials	43
12 ph.3 trials	
1 clinical unspec.	
1 approved	
32 commercial	
5 pre-commercial	

Vehicle and regulatory categories

Note: Modalities have not been systematically reconciled into uniform terminology so categories overlap & counts are approx, but still useful.

delivery modalities	regulatory category
7 drugs	82 pharmaceutical
36 small molecule	2 device
3 peptides	10 supplement
9 biologics	3 reg. diagnostic
9 cell therapy	11 unreg. test
9 gene therapy	3 veterinary
8 nutraceuticals	
5 blood test	

Geography

	geo(s)
these rows	44 San Francisco
count	12 Boston
number of	5 New York
companies:	6 San Diego
	3 Los Angeles
	5 Israel
	4 Cambridge, UK

	geo(s)
these rows	1709 San Francisco
count	512 Boston
number of	432 New York
employees:	329 San Diego
	123 Los Angeles
	137 Israel
	146 Cambridge, UK

Public vs private companies

	public?
these rows	15 yes
count	136 no
number of companies:	

	public?
these rows	1236 yes
count	2980 no
number of employees:	(^ both based on LI count)

	only public
	market cap (M)
grand totals:	$5,043

Ways to gauge size / significance

employees (LinkedIn)
4,216
120 w/ >=3
82 w/ >=10

total raised ($M)
$9,202
56 w/ >=1
48 w/ >=3
39 w/ >=10

market cap (M)
$5,181
15 w/ >=15
8 w/ >=50

clinical stage (and pipeline)	
72	pre-clinical
11	ph.1 trials
16	ph.2 trials
12	ph.3 trials
1	clinical unspec.
1	approved

Note: Amount raised is a big underestimate. Many raises are not public or are reported only after significant delay.

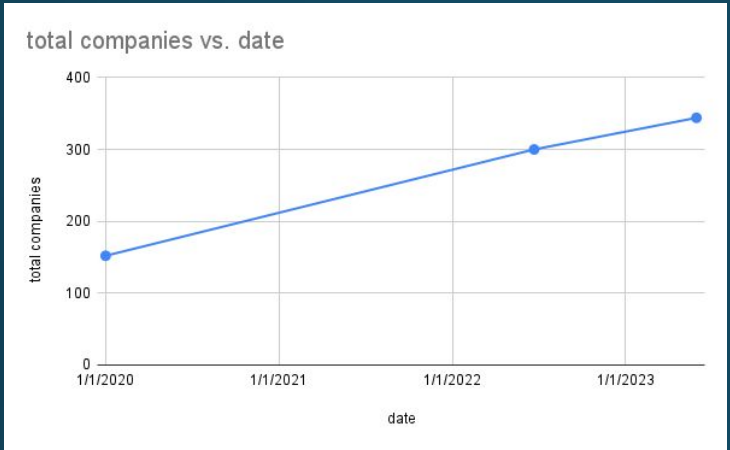
Senescence: much science underlying these

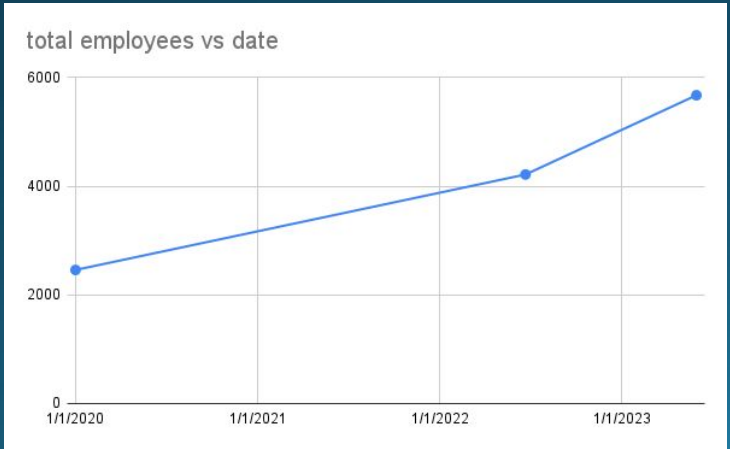
[HOW TO USE THIS TABLE] company	short summary (intended to be objective, usually from company website, edited for brevity)	clinical stage / pipeline (as of Jun'22)	Tx or Dx
Unity Biotechnology	treat aging, 1st w/ senolytics, 1st for knee OA (dropped? see notes), later youth factors & mito therapies	ph.2 trials	Tx
OneSkin Technologies	screening platform using 3D human skin culture & skin age clock, 1st therapy a topical senolytic peptide	commercial	Tx
1E Therapeutics (was Hanako)	RNA-targeting therapeutics for oncology, agingDs, more; antisense oligonucleotide–based senolytics	pre-clinical	Tx
Animal Biosciences	healthy longevity for dogs focused on cell senescence & NAD	pre-vet-clinical	Tx
Atropos Therapeutics	drug platform for modulators of entering senescence, for aging (suppress) & cancer (stimulate)	pre-clinical	Tx
Biosens	targeting muscle/bone, cognition, & cell senescence with a variety of paths to market	pre-clinical	Tx
Cleara Biotech	senolytics, initially based on FOXO4-p53 interfering peptide	pre-clinical	Tx
Deciduous Therapeutics	activate endogenous immune cells to clear senescent cells	pre-clinical	Tx
Dorian Therapeutics	block cellular senescence	pre-clinical	Tx
Eternans	senolytics, peptide (see patent)	pre-clinical	Tx
FoxBio (was Antoxerene)	drug platform using protein manufacturing tech, senolytics targeting p53 pathways (eg p53/FOXO4)	pre-clinical	Tx
Numeric Biotech	selective targeting of foxo4-p53, for inflammatory neuro diseases & auto-immune diseases	pre-clinical	Tx
Rejuveron Senescence Therapeutics	immune-mediated clearance of senescence cells by disabling a newly discovered immune evasion technique	pre-clinical	Tx
Rubedo Life Sciences	drug design platform that targets cells by type, first to kill senescent cells by apoptosis; later to improve stem cells	pre-clinical	Tx
SENISCA	reverse cell senescence by modulation of RNA alternative splicing, for diseases & aesthetics of aging	pre-clinical	Tx
Oisin Bio (& OncoSenX)	targeted non-viral gene therapy based on DNA expression, for senescent cells & cancer (via spinout)	pre-clinical	Tx
SIWA Therapeutics	humanized mAb targeting both senescent & cancer cells based on proprietary cell surface marker	pre-clinical	Tx
Newomics	microfluidics platform based on new emitter for improved LC-MS for multi-omics	commercial	Dx
TAmiRNA	blood circulated microRNA signatures as biomarkers for aging diseases, as a service, first for osteoporosis	commercial	Dx

A longer talk could cover more examples & area overviews. But we must move on.

Growth

(as of 2023)

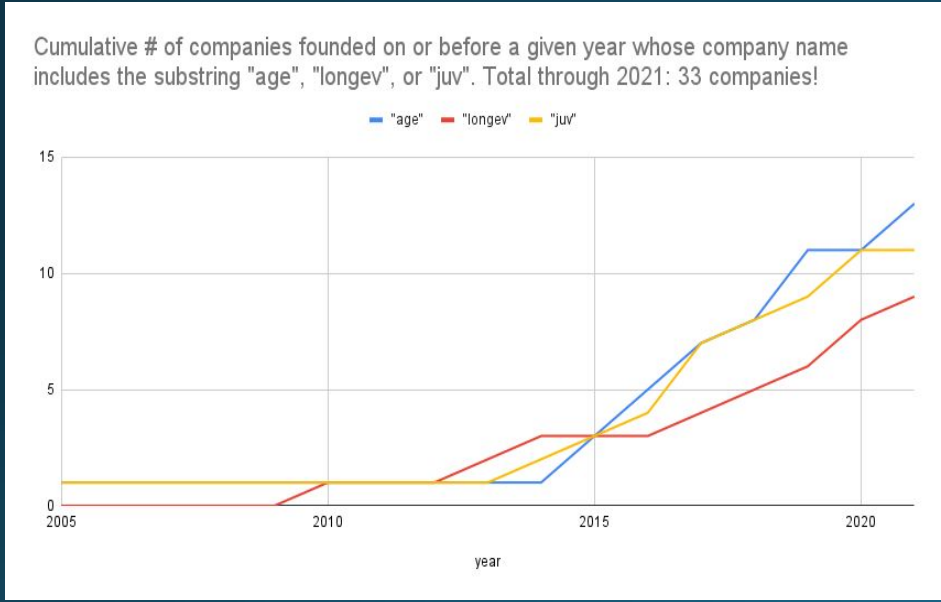




# clinical trials	173		314		
	most advanced trial phase				
company	1/1/2020		6/22/2022		5/31/2023
Alector	2	↗	3		3
Alkahest	2		2		2
Ambrosia	clinical	↘	defunct		defunct
Athersys	3		3		3
BioAge	pre-clinical	↗	2		2
Biophytis	2		2	↗	3
Bioquark	1		1	↘	defunct?
Biosplice (was Samumed)	3		3		3
Calico	pre-clinical?	↗	1		1
Cerevance	1		1	↗	3
ChormaDex	3	↗	4		4
CohBar	1		1		1
Denali	1	↗	2	↗	3
Eidos	3		3		3
Elysium	1		1	↗	4
GEn1E Lifesciences	pre-clinical	↗	1		1
Genome Protection	2		2		2
GenSight	3		3		failed by succeeding
InSilico Medicine	pre-clinical	↗	1	↗	2
Intervene Immune	pre-clinical	↗	2		2
Longeveron	2		2		2
Longevity Biotech	clinical		clinical		clinical
LyGenesis	pre-clinical	↗	2		2
Mesoblast	3		3		3
Minovia	2		2	↘	pre-clinical
Navitor	1	↗	2		2
Pentraxin	2		2		2
PharmatrophiX	2		2		2
Proclara	1		1		1
Proteostasis Tx / Yumanity	2	↘	1	↘	defunct
Prodrome Sciences	pre-clinical		1		1
resTORbio	3	↘	failed		defunct
Retrotope	2-3		3	↘	2
Stealth BioTherapeutics	3		3		3
Vaxxinity (was United Neuro)	2	↗	3		3
Unity Bio	1	↗	2		2
regressed or failed / appear defunct		3		4	
progressed		12		5	
progressed by 2+ steps		3		2	

Quirky growth metric: overused roots

Growing # of companies named with: “age”, “longev”, or “juv”



Age Labs
Age Curve
Ageless Partners
Ageless Rx
AgeX
BioAge
CellAge
Ctrs for Age Ctrl
DoNotAge
GlycanAge
ImmuneAGE
myDNAge
StarkAge

Human Rejuvenation Bio
Juvena
Juvenescence
Juvenon
Juvicell
Juvify
Rejuvant
Rejuvenate Bio
Rejuvenate Biomed
Rejuvenation Tech
Rejuveron

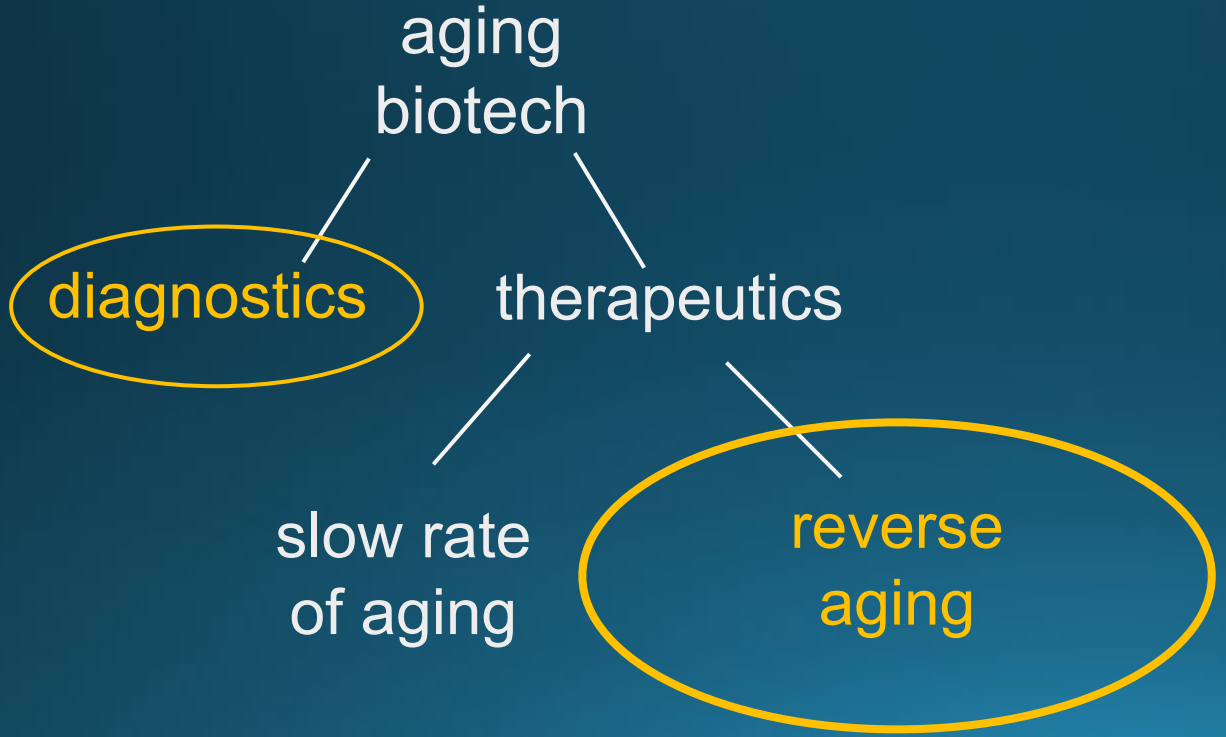
Deep Longevity, Extended Longevity, Human Longevity Inc, Longeveron, Longevica, Longevity Biotech, Longevity Bridge, Longevity InTime, Panacea Longevity (as of Jun’22)

Quirky field size metric: name collisions

Amprion (detects misfolded proteins for dementias) also the name of a German power company.
Beiwe (mTORC1 inhibition) also the name of a digital phenotyping research platform.
Integrated Health Sys (aging treatments med. tourism) also name of IT for senior living co.
Pano Therapeutics (mitochondria). Panos Therapeutics was UK pharma. Pano.com bio R&D inst.
Ridgeline Therapeutics (NAD+ related). Ridgeline of Switzerland creates new biotech cos.
Samsara Therapeutics (autophagy boosting) also the name of a large software company.
Ambrosia Plasma (young blood, defunct). Ambrosia Bio (enzyme to make sugars harmless).
Aurora Bio (nonCSF amyloid diagnostics). 3 more Aurora Bios! Bioscience, Biopharma, Biosciences.
Continuum Bio (was mito sub-co of Life Bio). Also Continuum Biosciences Consulting.
IMYu (reported name for apheresis/TPE co, now maybe Lyfspn). IMYoo (immune health).
Oxitope Inc (mAbs for oxidative damage, defunct). Oxitope Pharma (aging inflammation).
Skylark Biosciences (exercise in a pill). Skylark Therapeutics (programmable cell therapies).
Gordian Bio. Other Gordians: IT, banking, staffing, software, aviation, travel.
Cyclo Therapeutics. Cyclone Therapeutics (defunct). Cycle Pharma. (Plus now Cyclarity.)

Investing (skip but can be part of Q&A).....

Early Stage Angel Investing in Rejuvenation



(pre-seed / F&F)

Seed

(bridge)

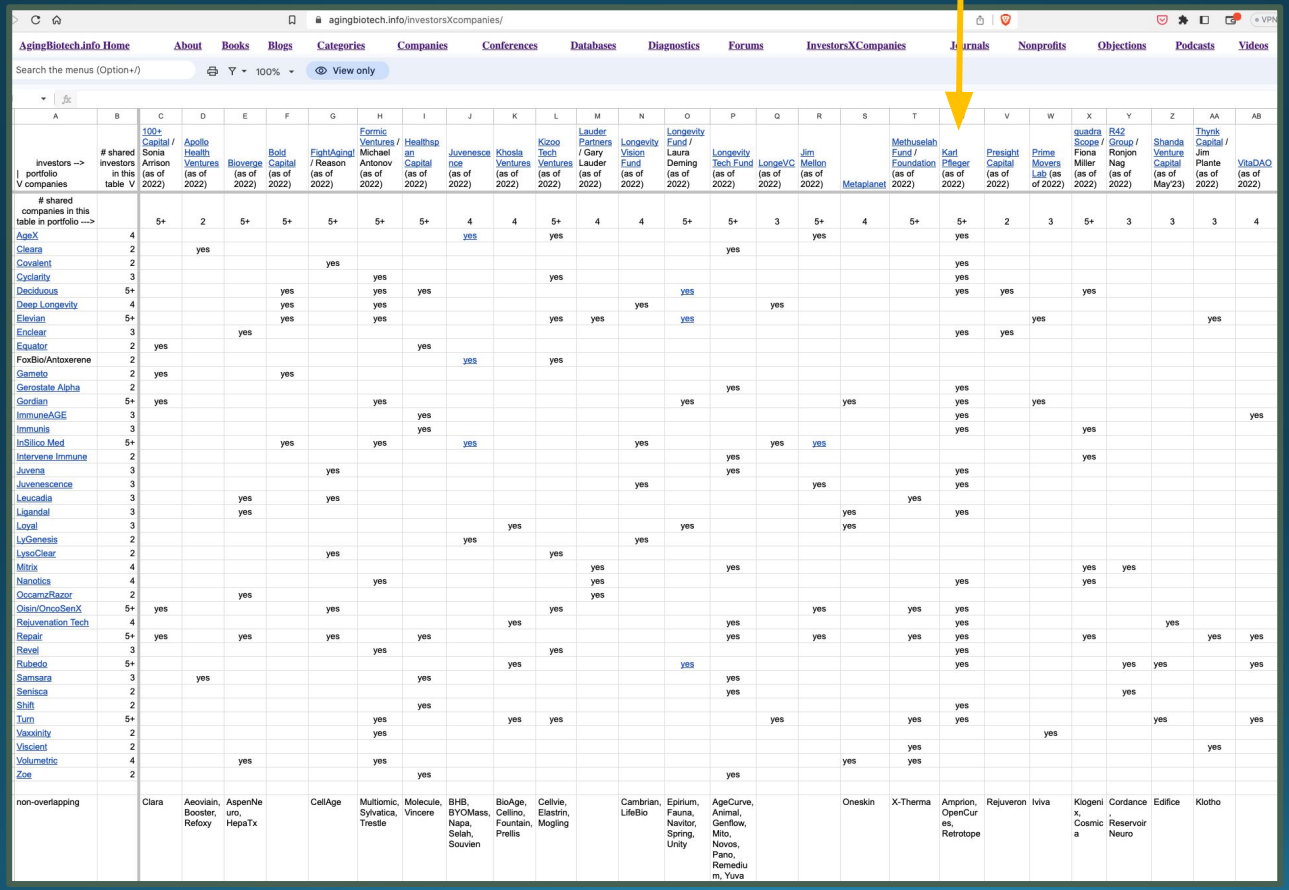
Series A

(bridge)

Series B

...

(Repeat) Investors X Companies



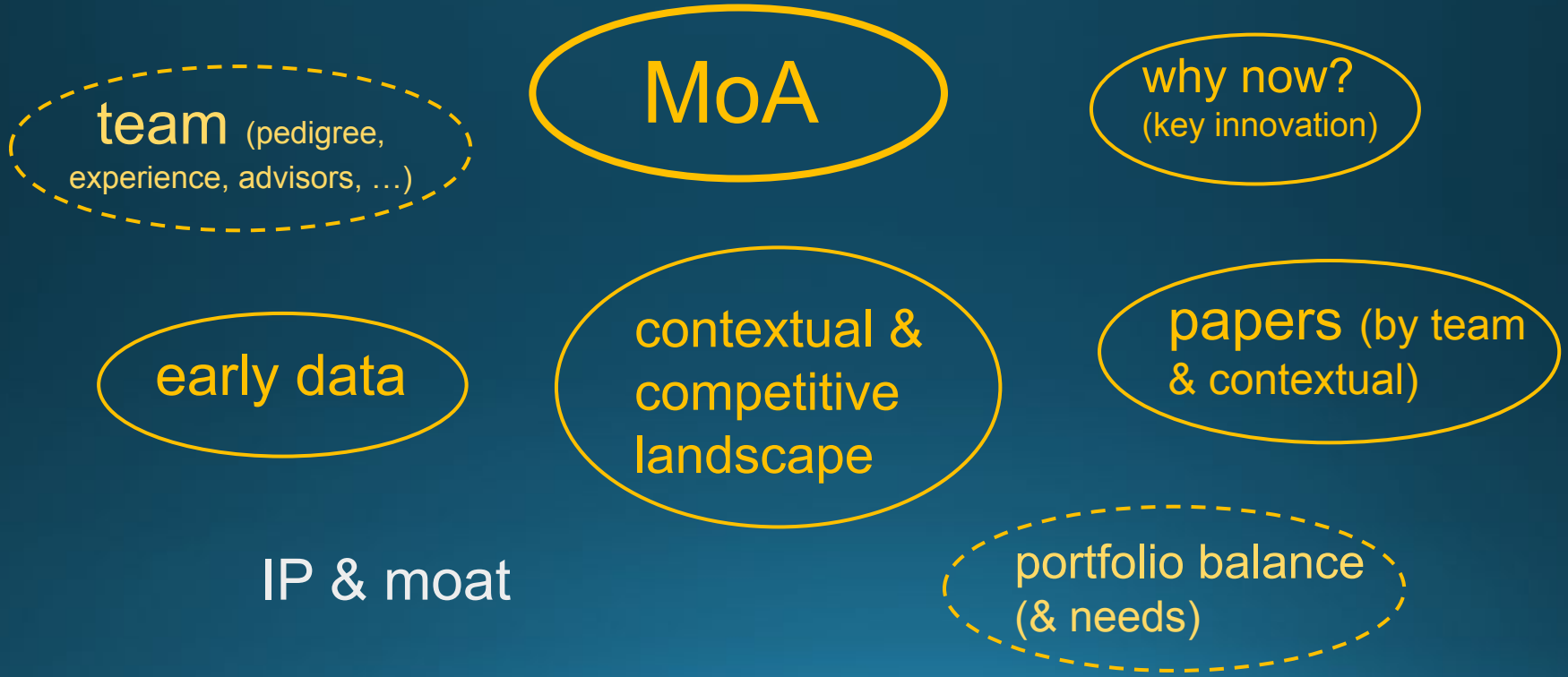
aging biotech.info/investorsXcompanies/

AgingBiotech.info Home | About | Books | Blogs | Categories | Companies | Conferences | Databases | Diagnostics | Forums | InvestorsXCompanies | Journals | Nonprofits | Objections | Podcasts | Videos

Search the menus (Option+/) | 100% | View only

investors --> / portfolio companies	# shared investors in this table	100+ Capital / Sonia Arrison (as of 2022)	Apollo Health Ventures (as of 2022)	Bioverge (as of 2022)	Bold Capital (as of 2022)	FightAging! / Reason (as of 2022)	Formic Ventures / Michael Antonov (as of 2022)	Healthspan Capital (as of 2022)	Juvenescence (as of 2022)	Khosla Ventures (as of 2022)	Kizoo Tech Ventures (as of 2022)	Lauder Partners / Gary Lauder (as of 2022)	Longevity Vision Fund (as of 2022)	Longevity Fund / Laura Deming (as of 2022)	Longevity Tech Fund (as of 2022)	LongeVC (as of 2022)	Jim Mellon (as of 2022)	Metaplanet	Methuselah Fund / Foundation (as of 2022)	Karl Pfleger (as of 2022)	Presight Capital (as of 2022)	Prime Movers Lab (as of 2022)	quadra Scope / Fiona Miller (as of 2022)	R42 Group / Ronjon Nag (as of 2022)	Shanda Venture Capital (as of May'23)	Thynk Capital / Jim Plante (as of 2022)	VitaDAO (as of 2022)
# shared companies in this table in portfolio --->		5+	2	5+	5+	5+	5+	5+	4	4	5+	4	4	5+	5+	3	5+	4	5+	5+	2	3	5+	3	3	3	4
AgeX	4								yes		yes						yes			yes							
Cleara	2		yes												yes												
Covalent	2					yes														yes							
Cyclarity	3						yes				yes									yes							
Deciduous	5+				yes		yes	yes						yes						yes	yes		yes				
Deep Longevity	4				yes		yes						yes			yes											
Elevian	5+				yes		yes				yes	yes		yes								yes				yes	
Enclear	3			yes																yes	yes						
Equator	2	yes						yes																			
FoxBio/Antoxerene	2								yes		yes																
Gameto	2	yes			yes																						
Gerostate Alpha	2														yes					yes							
Gordian	5+	yes					yes							yes				yes		yes		yes					
ImmuneAGE	3							yes												yes							yes
Immunis	3							yes												yes			yes				
InSilico Med	5+				yes		yes		yes				yes			yes	yes										
Intervene Immune	2														yes								yes				
Juvena	3					yes									yes					yes							
Juvenescence	3												yes				yes			yes							
Leucadia	3			yes		yes													yes								
Ligandal	3			yes														yes		yes							
Loyal	3									yes				yes				yes									
LyGenesis	2								yes				yes														
LysoClear	2					yes					yes																
Mitrix	4											yes			yes								yes	yes			
Nanotics	4						yes					yes								yes			yes				
OccamzRazor	2			yes								yes															
Oisin/OncoSenX	5+	yes				yes					yes						yes		yes	yes							
Rejuvenation Tech	4									yes					yes					yes					yes		
Repair	5+	yes		yes		yes		yes							yes		yes		yes	yes			yes			yes	yes
Revel	3						yes				yes									yes							
Rubedo	5+									yes				yes						yes				yes	yes		yes
Samsara	3		yes					yes							yes												
Senisca	2														yes									yes			
Shift	2							yes												yes							
Turn	5+						yes			yes	yes					yes			yes	yes					yes		yes
Vaxxinity	2						yes															yes					
Viscient	2																		yes							yes	
Volumetric	4			yes			yes											yes	yes								
Zoe	2							yes							yes												
non-overlapping		Clara	Aeoviain, Booster, Refoxy	AspenNeuro, HepaTx		CellAge	Multiomic, Sylvatica, Trestle	Molecule, Vincere	BHB, BYOMass, Napa, Selah, Souvien	BioAge, Cellino, Fountain, Prellis	Cellvie, Elastrin, Mogling		Cambrian, LifeBio	Epirium, Fauna, Navitor, Spring, Unity	AgeCurve, Animal, Genflow, Mito, Novos, Pano, Remediu m, Yuva			Oneskin	X-Therma	Amprion, OpenCures, Retrotope	Rejuveron	Iviva	Klogenix, Cosmica	Cordance, Reservoir Neuro	Edifice	Klotho	

Investing Decision Drivers



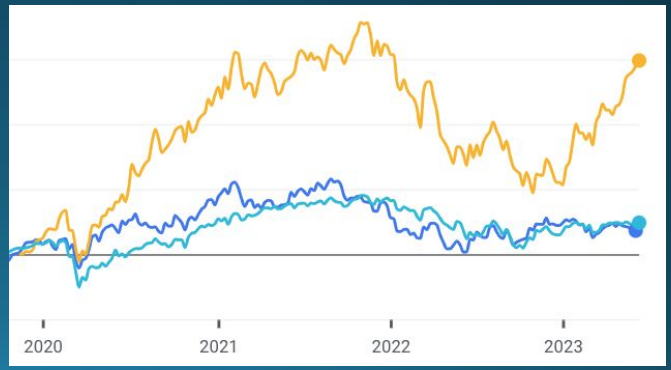
Reward/Risk in Aging Biotech & Current Valuations

My view on reward/risk for pharmaceutical clinical trials path:

Risk: similar to other assets

Reward: initial jackpot similar + label expansion multiplier

Current valuations: global macro downturn caused flat bridge rounds despite progress; looking up?



Aging/longevity optimization today with lifestyle & current clinical medicine (old slides after here);

skip but happy to chat about it later…..

Aging/longevity optimization today: lifestyle & current clinical options

Who’s asleep ?

Sleep is super important of course!

Sleep, diet, & exercise are foundations.

How to think critically
(especially about popular things)

Dose is key

Subject populations & controls matter

MoA (mechanism of action) needs to be understood

Human data isn't always better

RCTs (randomized controlled trials) aren't always better

8 examples (we'll go over 3-4)....

Metformin

(note: paper links are clickable from the slide deck)

Diabetics on Metformin lived longer than matched non-diabetic controls (by ~15%).


DIABETES, OBESITY AND METABOLISM
A JOURNAL OF PHARMACOLOGY AND THERAPEUTICS

ORIGINAL ARTICLE

Can people with type 2 diabetes live longer than those without? A comparison of mortality in people initiated with metformin or sulphonylurea monotherapy and matched, non-diabetic controls

C. A. Bannister, S. E. Holden, S. Jenkins-Jones, C. Ll. Morgan, J. P. Halcox, G. Schernthaner, J. Mukherjee, C. J. Currie

First published: 07 July 2014 | https://doi.org/10.1111/dom.12354 | Citations: 219

But who were these controls?

Healthy lifestyle gives 10-15yrs.


Impact of Healthy Lifestyle Factors on Life Expectancies in the US Population

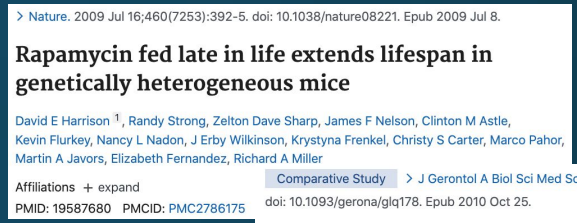
Yanping Li, An Pan, Dong D. Wang, Xiaoran Liu, Klodian Dhana, Oscar H. Franco, Stephen Kaptoge, Emanuele Di Angelantonio, Meir Stampfer, Walter C. Willett and Frank B. Hu

Originally published 30 Apr 2018 | https://doi.org/10.1161/CIRCULATIONAHA.117.032047 | Circulation. 2018;138:345–355

Did the metformin effect just reposition within this range?

Rapamycin / mTOR modulation

Extends lifespan, eg mice 9-18%.



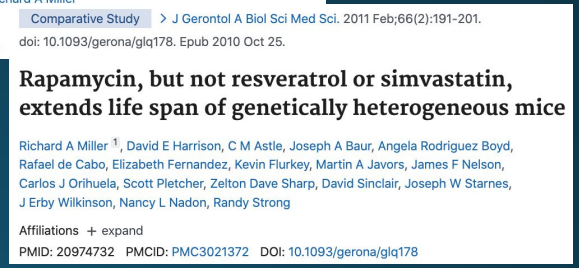
> Nature. 2009 Jul 16;460(7253):392-5. doi: 10.1038/nature08221. Epub 2009 Jul 8.

Rapamycin fed late in life extends lifespan in genetically heterogeneous mice

David E Harrison [1], Randy Strong, Zelton Dave Sharp, James F Nelson, Clinton M Astle, Kevin Flurkey, Nancy L Nadon, J Erby Wilkinson, Krystyna Frenkel, Christy S Carter, Marco Pahor, Martin A Javors, Elizabeth Fernandez, Richard A Miller

Affiliations + expand

PMID: 19587680 PMCID: PMC2786175



Comparative Study > J Gerontol A Biol Sci Med Sci. 2011 Feb;66(2):191-201. doi: 10.1093/gerona/glq178. Epub 2010 Oct 25.

Rapamycin, but not resveratrol or simvastatin, extends life span of genetically heterogeneous mice

Richard A Miller [1], David E Harrison, C M Astle, Joseph A Baur, Angela Rodriguez Boyd, Rafael de Cabo, Elizabeth Fernandez, Kevin Flurkey, Martin A Javors, James F Nelson, Carlos J Orihuela, Scott Pletcher, Zelton Dave Sharp, David Sinclair, Joseph W Starnes, J Erby Wilkinson, Nancy L Nadon, Randy Strong

Affiliations + expand

PMID: 20974732 PMCID: PMC3021372 DOI: 10.1093/gerona/glq178

But what are baseline mTOR levels?

Mice: Controls ad-lib. Effect size vs total calorie consumption?

Humans: Effect size vs (i.e. stratified by) BMI?
(...or even better by mTOR measures themselves)

Sauna

Evid Based Complement Alternat Med. 2018; 2018: 1857413.
Published online 2018 Apr 24. doi: 10.1155/2018/1857413
PMCID: PMC5941775
PMID: 29849692

Clinical Effects of Regular Dry Sauna Bathing: A Systematic Review

Joy Hussain and Marc Cohen

Multiple health benefits / many studies.
But relative to what?

How did controls spend the sauna time? (Lying down in the placebo-controlled RCTs. Not prescribed in most studies.)

How much MoA overlaps with exercise? (Eg, sweat?)
Did study populations even achieve min exercise recs?
Effect size stratified by baseline exercise levels?
Little effect if controls spend sauna minutes on extra exercise.

Health Sci Rep. 2021 Dec; 4(4): e393.
Published online 2021 Oct 1. doi: 10.1002/hsr2.393
PMCID: PMC8485612
PMID: 34622026

Standalone sauna vs exercise followed by sauna on cardiovascular function in non-naïve sauna users: A comparison of acute effects

Earric Lee,[1] Joel Kostensalo,[2] Peter Willeit,[3,4] Setor K. Kunutsor,[5,6] Tanjaniina Laukkanen,[7] Francesco Zaccardi,[8] Hassan Khan,[9] and Jari A. Laukkanen[1,10,11]

Hormesis: CR/DR, IF, cold, heat, phytochemicals, hypoxia, radiation, dehydration

Many stressors produce beneficial adaptation. Huge # studies. But dose important. Too much is bad. Clear U-shaped curves.

Dose U-curves not well mapped individually, but what's more: Interactions not well understood. Stressors may be additive.

Healthy lifestyle may be low dose of many (CR, IF, phytochemicals). Lifestyle alters U position for other hormetic interventions. Probably important eg for a lot of IF work (eg Longo).

Care needed interpreting negative studies too e.g. countless failed vitamin trials

Most physiological variables have a healthy range (U again). Many vitamin/mineral trial failures importance over-stated even when reasons for failing to show benefit are obvious, eg:

- high baseline levels
- too low dose
- controls also took it

Guidelines for optimizing design and analysis of clinical studies of nutrient effects FREE

Robert P Heaney ✉

Nutrition Reviews, Volume 72, Issue 1, 1 January 2014, Pages 48–54, https://doi.org/10.1111/nure.12090

Review > Endocr Connect. 2020 Oct;9(9):R195-R206. doi: 10.1530/EC-20-0274.

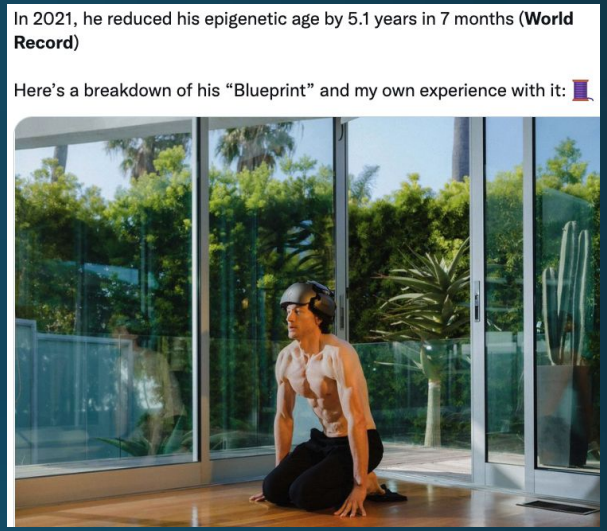
Why do so many trials of vitamin D supplementation fail?

Barbara J Boucher [1]

Affiliations + expand

PMID: 33052876 PMCID: PMC7487184 DOI: 10.1530/EC-20-0274

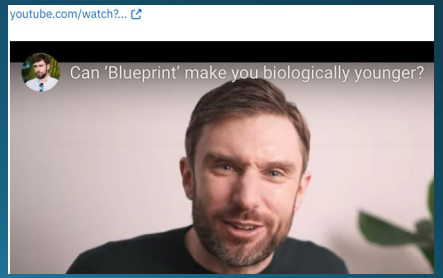
Aging clock reversal



Aging clocks will allow faster screening, & will eventually be clinically useful.

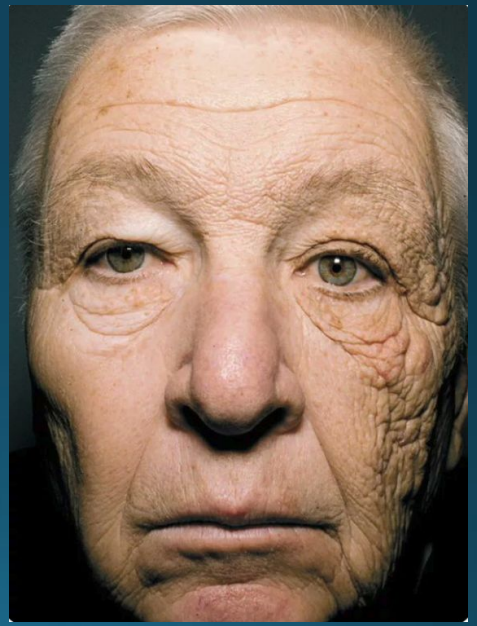
But early gen clocks are noisy & shouldn't be used n=1 or in small studies the way many published studies have.

Some results are data artifacts (per Levine).
Mix changes can obscure (per Verdin).
There's no "world record"



Care needed interpreting harmful stuff too

Viral spread photo of trucker widely used to suggest sun exposure harmful. Taken by many to argue for total sun avoidance.



So many caveats:
Dose makes the poison.
Other harmful exposures (eg exhaust fumes) asymmetric for the same reason.
Regular sun exposure assoc. w/ **decreased** melanoma risk (high irregular w/ increased).

Meditation

Best evidence is for specific conditions: e.g., depression, anxiety.

Other benefit claims. Fewer studies of hard aging/health markers.

Some studies on very busy, high-stress people (eg CEOs).
Like sauna, worth considering benefits vs other use of same time.

Details matter. Eg, in one BP study:
lower clinic BP but not ambulatory.

Randomized Controlled Trial of Mindfulness-Based Stress Reduction for Prehypertension

Hughes, Joel W. PhD; Fresco, David M. PhD; Myerscough, Rodney PhD; H. M. van Dulmen, Manfred PhD; Carlson, Linda E. PhD; Josephson, Richard MS, MD

Author Information

Psychosomatic Medicine: October 2013 - Volume 75 - Issue 8 - p 721-728
doi: 10.1097/PSY.0b013e3182a3e4e5

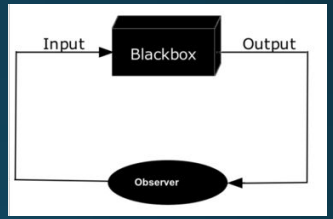
More comparative research needed vs other high-focus activities (eg coding “in the zone”, master level chess, etc.).

U-shaped curves and black boxes

Lifestyle won't buy many extra decades. Advances will eventually do better.

Meantime don't overgeneralizing effect sizes from bad controls.

Bio is full of U-shaped curves. More of good thing not always better.



Bodies are complex, non-linear, dynamic & mostly black boxes.
Poking black boxes to understand them is inefficient.
New/better tech needed for seeing inside the black boxes.

Aging interventions should have tests (a) indicating who needs them,
(b) indicating whether MoA working, & (c) allowing titration of dose.

Long-term progress in aging/longevity

Monotherapy effect sizes within the range achievable by lifestyle optimization aren't as interesting long-term.

The field needs heuristics for what interventions / MoAs could more likely be part of achieving effect sizes beyond lifestyle.

Which MoAs will combine well? Maybe those that do great at fixing separable aspects of aging, even if not great as monotherapy.

Q&A

Possible topics

- companies I know a lot about (especially senolytics, reprogramming, & stem cell secretions)
- Investing mechanics (see also Venture Deals book)
- Personal longevity practice details
- Regulation, FDA, & clinical trials (super important though didn’t have time to talk about it)

[bonus slides in case of Qs]

Human data not always better

Human data is better because other species differ importantly.

But often harder to look inside the human black box.

So it's crucial to use all data: model organisms, organoids, in vitro, epidemiological, & basic theory / biological reasoning.

Easier to answer many Qs posed earlier with non-human data.

RCTs don’t trump all other data types

RCTs are the gold standard due to easily showing causality.

But human RCTs expensive & slow, and limited in how widely their results can be generalized.

Recruitment, controls, & placebos can introduce tricky details.

So again crucial to use many types of data.

Correlation does tell us important things.

And there are other ways to infer causality.

Questions to consider in evaluating a study

Is the control group right for the conclusions being drawn?

Is the study population reasonable? Unusually worse?

What's the MoA?

What health variables are relevant & are they tested?

Is effect size likely to vary across subjects? Can it be stratified?

Etc.