Cellastra

Strategic Report 8/24/2023

TOP GENE THERAPY COMPANIES

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The gene therapy boom

EXECUTIVE SUMMARY

Gene Editing CRISP

A) CRISPR : “Clustered Regulatory Interspaced Short Palindromic Repeats “

[Palindromic =symmetric sequence which reads identical from one end or the other e.g. MADAM]

- Small DNA fragments found within prokaryotes (primitive cells e.g. bacterial – remnants from a previous virus infection of e.g. a bacterium
- Used as a marker to detect and destroy DNA from similar viruses during subsequent infections
- Thus, plays a key role in the anti-viral defense of prokaryotes such as bacteria.
- CRISPR/Cas9 I (=CRISPR Associated Nuclease 9) is a revolutionary technology that allows for precise, directed changes to genomic DNA.
- CRISPR/Cas9, when paired with a guide RNA, cuts double-stranded DNA allowing for specific changes to DNA.
- These site-specific DNA modifications can be utilized to carry out sophisticated gene knock-outs or knock-ins.

CRISP Patent Dispute

A)

- Patents filed in parallel by two group and no interference claim upheld and confirmed by US Appeals Court 10/2018:
- 2020/09/10: Patent Trial Appeals Board (PTAB) rules in favor of Broad but requests further arguments at a future hearing
- Patent filed by UC Berkeley/U of Vienna licensed to Caribou, CRISPR, Casebia, Intellia = companies involved in CAR-T, hemoglobinopathies, and rare diseases etc.
- Patent filed by Broad Institute (MIT) licensed to Editas (and used in JUNO Car T cell program)

CRISPR Patent controversy

UC Berkeley U Vienna (Doudna/Charpentier)

- First to publish 06/2012 and to file patents
- Did not specify if CRISPR works in eukaryotic cells which the considered obvious and included broad claims
- 2016: Claims “patent interference” Federal court later denied Appeal
- Later filed new claims. Led to Second “Interference”
- **2020/09/10: Patent Trial Appeals Board (PTAB) rules in favor of Broad but requests further arguments at a future hearing**
- **2022 FINAL RULING UPHOLDS BROAD INSTITUTE PATENTS**

Broad Institute (Zang)

- “First to reduce to practice” Report 7 mos later that CRISPR works in eukaryotic cells
- 2014: USPTO issued patents

https://www.broadinstitute.org/CRISPR/journalist

2020 Nobel Prize in Chemistry

Jennifer Doudna
UC Berkeley

- Cofounder Caribou Biosciences
- Spin out Intellia

- Partners: Regeneron, Novartis

- Cofounder Editas Medicines Inc
  Patent License from Broad Inst . /Harvard U

- Cofounder Mammoth Biosciences

Emmanuelle Charpentier
Max Planck Institute Berlin

- Cofounder CRISPR Therapeutics
  Casebia - JV CRISPR Ther. / Bayer

- Partner: Vertex

- Patent Licence from UC Berkeley, U Vienna, CRISPR Therapeutics

Gene Editing - mRNA

A

- TECHNOLOGY (predates the CRISPR revolution):
- “can direct the body’s cellular machinery to produce nearly any protein of interest, from native proteins to antibodies and other entirely novel protein constructs .”
- Successfully used by MODERNA and Biomtech/Pfizer for COVID Vaccines which won the race to the market and first full approval
- MODERNA with market cap of $38B (8/8/2023) B has raised 3 B in 13 rounds of venture funding
- and licensing deals with AZ, Merck, (immuno oncology/ vaccines),
- BARDA grant of 472M in 7/2020 COVID vaccine), DARPA grants (infectious diseases)

Gene Editing - Other Technologies

- Zink Finger (ZFIN) Nuclease Technology

Cconsidered to be more time consuming, expensive and difficult and less selective for targeted edits.

- Sangamo – founded 1995

- Stem Cell editing

Also older technology - placing a healthy gene into the patient's extracted bone marrow stem cells, and transplanting these corrected stem cells back into the patient

- Bluebird – founded 1992 -
- Universal Cell 2013

Gene Modified T-Cells - CAR-T

A

Patient's own T cells are modified in the lab: chimeric antigen receptor (CAR) T Cells –

Gene that encodes for a specific tumor antigen is incorporated in the T-cells-

These are reinfused into the patients where they multiply thousand fold–

Bind specifically to the tumor surface and become activated

Revolutionary cancer treatment: Complete response rate > 80% in acute lymphoblastic leukemia (ALL) and overall response rate of 50% in myeloma – 08/2017 FDA approved Kymriah (Novartis), and Yescarta (Kite acquired for 30 B by Gilead)

, JUNO acquired for 9 B by Celgene which on 11/119 closed acquisition by BMS for 75B

2022 approvals of Carvykti in US and EU (Legend/Janssen) and Breyanzi in EU and US (BMS) in Large B-cell lymphoma

Gene Transfer using AAV

AAV = Adeno Associated Viral Vector
Non - pathogenic & non-replicating

A

- 12/2017 FDA approved Luxturna (SPARK), AAV2 vector –2019 SPARK acquired by Roche for $4.3B
- 05/24 2019 FDA approved AveXis AAV9 based product ZOLGENSMA (onasemnogen abeparvovec; AVXS-101) for pediatric patients with Spinal Muscle Atrophy (SMA) –2018 Company acquired by oNivartis for $8.7B
- Hemophilia A:: Roctavia (Biomarin approved EU in 2022 and US 06/2023. Future coopetitor: Generation Bio
- Hemophilia B Hemgenix UniQure/CSL/Behring approved FDA 11/2022. : Future Competitors: m SPARK, Freeline, UniQure:
- Most companies focus on rare or ultra rare genetic diseases (metabolic, CNS etc.). Programs seem overlapping and competitive

Endogenous Expression of Therapeutic Peptide using AAV

Cellastra leads the way in wound and tissue healing after surgery, burn injuries and respiratory infections

A

- **- SCARLEXA): Applied in skin wound area before wound closure after surgery and burn injuries to prevent hypertrophic scarring**

- VIRLEXA: Applied by inhalation /intramuscular injection after COVID to prevent or treat Long-COVID

HUGE INDICATIONS WITH GREAT UNMDET NEED

USEFUL RESOURCES

Useful Links

- FDA Cellular Tissue and Gene Therapy Advisory Committee (CTGTAC) 70th Meeting (9/2-3/2021
- New NIH Gene Therapy Institute
- New FDA Guidelines on Gene therapy
- ARMs State of the Industry Report 2023
- Gene therapy Market approvals
- Successful Exits
- Recent Licensing Deals

Useful Links

Resource	Ref
Alliance of Regenerative medicine (ARM) – 2023 Cell & gene state of industry briefing	https://alliancerm.org/arm-event/sotibriefing/
FDA Final Guidelines on gene therapy 2/2020	https://www.fda.gov/vaccines-blood-biologics/biologics-guidances/cellular-gene-therapy-guidances
New NIH Institute for Gene Therapy 2/19/20	https://www.gene-therapies.org/post/new-institute-launched-to-ensure-the-u-s-healthcare-system-is-ready-for-gene-therapies

CTGTAC 70th Meeting 9/2-3/21

Document	Content/Link
FDA Cellular Tissue and Gene Therapy Advisory Committee (CTGTAC) 70th Meeting (9/2	Toxicity Risks of Adeno Associated virus (AAV) Vectors for Gene Therapy (GT -
Briefing Book	https://www.fda.gov/media/151599/download
Meeting Summary	https://www.fda.gov/media/151969/download

Series A – AAV Companies

Company	Series A	Year	Technology
Avado Bio	**80 M USD**	Q4/2021	AAV CNS
CODA Bio-therapeutics	240M raised in total in four rounds. **Ser A** 11/2019: **34M** 28M 12/2/2021	11/209-11-2021	AAV CNS
Dyno Therapeutics	**Ser A 100 M**	05/2021	AAV
Jaguar Gene Therapies	Ser A and B (04/2021) 139M	04/2021	AAV
Tenaya Therapeutics	total of $248M in funding *IPO 07/2021 160 M*	**Ser A 50M 2016** Ser B 92M 2019 Ser C 106M 03/2021	AAV, pluripotent stem cells, HDAC inhibit

Gene Therapy Market Approvals (1)

Date	Agency	Agent	Company	Indication	Price USD Treatm.	Comment
2/2022	FDA EMA	Carvykti CAR-T) citicabtagene	Legend Bio & Janssen	Multiple ,myeloma (4 or more lines	500k	US and EU
06/29/2023	FDA	RoctavianAAV valoctocogene roxaparvovec-rvox)	BIOMARINE	Severe Hemophilia A	2.9M	EU approval in 2022
EU 07/2022	EMA	Ustaz aludoxageneex uparvovec	PTC Therapeutics	aromatic L-aminoacid decarboxylase (ADAC) deficiency	3M	Infused into putamen in the brain
11/2022	FDA	Hemgenix	UniQure CSL Behring	Adult hemophilia B	3.5M	
12/2022	UU	Adsiladrin AAV vector	Ferring	Refract Bladder cancer	260k	
04/2022 06/2022	EU FDA	Breyanzi (CAR T)	BMS	Large B Cell Lymphoma	410k	

Gene Therapy Market Approvals (2)

Date	Agency	Agent	Company	Indication	Price USD treatm.	Comment
11/2012	EMA/EC	Glyberra	UniQure	lipoprotein lipase deficiency (LPLD) Ultra rare disease	1M	Company discontinued launch
12/2017	FDA	Luxturna (AAV)	Spark	Leber's hereditary optic neuropathy;	425,000	11/2018 Novartis gets approval in EU
08/2017	FDA EMA	Kymriah (CAR-T)	Novartis	ALL (acute lymphoblastic leukemia)	475,000	80% response rate; only responders have to pay 2018/05 approved in Non Hodgkin Lymphoma (NHL)
10/2017	FDA	Yescarta (CAR-T)	Kite (Gilead)	B Cell Lymphoma	373,000	
5/2019	FDA	Zolgensma (AAV)	AveXis (Novartis)	Spinal Muscle Atrophy (SMA)	1. M USD(5 annual installments of 300,000)	5/2019

Antisense Market Approvals

Date	Agency	Agent	Company	Indication	Price/ treatm.	Comment
2015	FDA	Spinraza musinersen (Antisense)	Novartis	Spinal Muscle Atrophy (SMA)	Dosed q 4 months	Intrathecal administration
08/2018	FDA and EMA	Onsattro (anti sense) (*Alnylam in EU)*	Amylam	Poly-neuropathy ITTR amyloidosis	450.000 USD/ year	RNAi therapeutics Dosed once weekly sub cut.
10/2018	FDA	Tegsedi (anti sense)	Akcea and Ionis	ITTR amyloidosis Poly-neuropathy	450.000 USD/ year	RNAi therapeutics Approved by EMA in 07/2018 Dosed once weekly sub. cut.
6/2019	EMA	Zynteglo	Bluebird	Betha thalassemia (transfusion resistant)	TBD	Manufacturing delaying launch to 2020

Successful Exits (1)

Company	Founded	Funding	Asset	Exit	Price	Acquirer
Kite	2009	• 4 rounds raised 85.3 M • IPO 06/2014 raised 127 M • Post-IPO Equity raised 250M	CAR T Yescarta appr.09/2017	**10/2017**	30 B	Gilead
Juno	2013	• 3 rounds raised 310 M • Series B 8/2014 raised 123M • IPO 12/2014 raised 264.6 M	CAR-T NHL BLA	01/2018	9 B	Celgene
AveXis	2013	• 5 rounds raised 75.1 M • IPO 02/2016 raised 95 M	AVX-101 SMA - Spinal Muscle atrophy	04/2018	8.7 B	Novartis
Celenex	(Spin off from Children's Hospital/OH	• Gene therapies for lysosomal storage diseases / funding not disclosed	Up to 10 indications	09/2018	100M upfront Total 452M	Amicus
Spark	2013	• 2 rounds raised 122.8 M • IPO 01/2015 raised 161 M	Luxturna approved 09/2017	Acquisition completed 11/20/2019	4.3 B	Roche

Successful Exits (2)

Company	Founded	Funding	Asset	Exit	Price	Acquirer
NightStar	2013	• 5 rounds raised 174.6 M • IPO 09/2017 raised 75 M	Genetic blindness	03/2019	800 M	Biogen
Exonics	2017	• 2 rounds raised 45M (incl. Ser. A in 11/2017)	CRISPR /musc.dystr	06/2019	245M plus 759M upon mile stones	Vertex
Audentes	2013	• 5 rounds raised 519.7M • IPO 6/2016 75M	AAV9 muscle dis.	12/2019	3-B	Astellas
Qiagen	1986 in EU. HQ in Hilde Germany And Venlo, The Netherlands	• 1996 IPO NYSE • Several funding rounds • 26 acquisitions	Testing kit corona virus; mol. diagnostics	03/03/2020 announced but failed 08/2020	11.5 B	ThermoFisher
Prevail	2017	• 3 rounds raised 129 • IPO 6/2019 raised 125M	AAV9 based gene therapies	1/22/2021	880M	Lilly

Successful Exits (3)

Company	Founded	Funding	Asset	Exit	Price	Acquirer
Myokardia	2012	• 2012 Third Rock Ser A 38 M • 2015 IPO 54M • 4 rounds raised funding 98M	Hypertrophic cardiomyopathy	11/2020	13.1 B USD all cash	BMS
Arctos Medical in Brisbane CA	2012	• CHF 8M	AMD/eye diseases		Not disclosed	Novartis
Ascleipos Bio Pharma in RTP (AskBio)	2001	• 4 rounds raised 241.8M	AAV in rare neurol/muscul/ metabol diseases	10/2020	2B USD	Bayer
Gain Sight Paris	2011	• Total raised 804M in 45 rounds	Leberäs disease	2020	1.1	Vista
Life-Edit (NC based)	2017	• Not disclosed	One of the largest/mos t diverse collection of arrays of RNA guided nucleases etc..	10/27/20 21	Not disclosed	Elevate Bio
Fibrogen Science	1993	• 43 M	Gene therapy for Epidermal Bullosa etc.	2019	$63M	Castle Creek Pharma

Encoding immune response against the virus

COVID-19 VACCINE COMPANIES

FDA APPROVED* COVID-19 VACCINES

Technology	Company	Approval	Comments
mRNA / PEG	Pfizer/ Biontech	12/2020	Store -70 C Doses 1-2 28 d
mRNA / LNP (Lipid Nano Particles)	Moderna	US 12/020	Store -20 C Doses 1-2 21 d
Recombin. S protein in nano-particle adjuvant	NovaVax	US 07//2022	EUA in US
Adenovirus modif. from Chimpanzee (ChAdOx1	AstraZenecaca /Oxford U	UK 12/29/2020	Not approved in US yet
		US 2/27/2021	

*Emergency Use. Authorization (EUA) - Later Full approval for Pfizer/Moderna. Updated monovalent versions of these vaccines based km Omicron XBB 1.5 in development forp0tential use use fall of 2023 Note Janssen withdrew the EUA for their vaccine in US.

For list of global approvals see WHO:
https://www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines

BioNTech

		Key Events	Key People
	2008	• BioNTech was founded in 2008 based on research by Uğur Şahin, Özlem Türeci,[9] and Christoph Huber with a seed investment of €150 million. The company's activities focus on the development and production of technologies and drugs for individualized cancer immunotherapy.[1] Andreas and Thomas Strüngmann, Michael Motschmann, and Helmut Jeggle were cofounders. • In 2009, the acquisition of EUFETS and JPT Peptide Technologies • 2014 and 2018, many research results on mRNA mechanisms were published by BioNTech • 06/2020, received €250 million from Temasek Holdings (Singapore) through a private placemen.A bonds. I also EUR100 million from the European Investment Bank in debt financing • 09/2019, equity investment of US$55 million from the Bill & Melinda Gates Foundation, with the option of doubling later • In December 2019, BioNTech received €50 million in financing from the Euroopean Investment Bank as part of the European Commission Investment Plan for Europe • 01/2020 just days after the SARS-Cov-2 genetic sequence was first made public. Began to develop the tozinameran m RNA vaccine with Pfizer and Fosun • 12/10/2020 COVID-19 vaccine approved in US (Pfizer) • 01/10/23 acquired InstaDeep in London (instant SI solutions) for GB 562M	• Prof. Ugur Sahin, M.D., Co-Founder and CEO of BioNTech, • development of mRNA vaccines and other types of immunotherapies. Sahin initiated and oversees “Project Lightspeed,” • Co-inventor of more than 500 filed patents applications and patents. • professor (W3) in Translational Oncology & Immunology at Johannes Gutenberg University in Mainz, Germany, where he was the supervisor for more than 50 PhD students. • Sean Marett , Chief Business and Commercial Officer. joined BioNTech in 2012. • Prep. GlaxoSmithKline in the United States and Pfizer in Europe before taking business development executive roles at Evotec and Loran is, until 2016. H • BSc (Hons) in Biochemistry from Kings College London and an MBA from Manchester Business School.
Based	Mainz, Germany US office in Cambridge MA		
Ownership	**NASDAQ: BNTX** **IPO 2019**		
Business Model	For profit		
Valuation	41.7B Market cap 4/7/22 25.9 B 8/11/23		
Financials	Total raised: $1,7B in 9 Rounds Q223 netloss of 190Mln EUR vs Profit of 1,67 B Euro previous year.		
Lead Product	COVID-19 vaccine		
Product Type	mRNA Vaccine		
Stage	Commercial		
website	Biontech.com		

Pfizer (Vaccines) (1)

		Key Events	Key People
Founded	1849	• Charles Pfizer and his cousin Charles F. Erhart, both of German descent, founded Pfizer in New York City in 1849. They launched the chemicals business, Charles Pfizer and Company, an antiparasitic called santonin. World War I caused a shortage of calcium citrate, Pfizer chemists learned of a fungus that ferments sugar to citric acid, and they were able to commercialize production of citric acid from this source in 1919. Expertise in fermentation technology, helped make penicillin available to Allied soldiers by the end of the WWII • Penicillin became very inexpensive in the 1940s, and Pfizer searched for new antibiotics with greater profit potential. They discovered Terramycin (oxytetracycline) in 1950, became research-based pharmaceutical company. Pfizer developed a drug discovery program focused on in vitro synthesis, also established an animal health division in 1959 with a 700-acre (2.8 km2) farm and research facility in Terre Haute, Indiana. • By the 1950s, Pfizer had established offices in Belgium, Brazil, Canada, Cuba, Mexico, Panama, Puerto Rico, and the United Kingdom. In 1960, moved its medical research laboratory to a new facility in Groton, Connecticut. • In 1980, they launched Feldene (piroxicam), a prescription anti-inflammatory medication that became Pfizer's first product to reach one billion dollars in total sales. During the 1980s and 1990s, Pfizer Corporation growth was sustained by the discovery and marketing of Zoloft, Lipitor, Norvasc, Zithromax, Aricept, Diflucan, and Viagra	Albert Bourla DVM. CEO, Born 1962 to Thessalonian Jewish parents who survived the Holocaust, he earned his doctorate in the biotechnology of reproduction at Aristotle University of Thessaloniki's Veterinary School. • Pfizer in 1993, first serving as a doctor of veterinary medicine and technical director for the company's animal health division in Greece. \Area President ident for Animal Health's • president of Pfizer's Vaccines, Oncology and Consumer Healthcare business,[• in 2016. Bourla became Pfizer's chief operating officer (COO) on January 1, 2018 the chief executive officer role in October 2018, effective January 1, 2019 Mikael Dolsten, President global R&D • MD, PhD, tom Lund University, Sweden, Prep .worked, Pharmacia, Boehringer Ingelheim, Wyeth and joined Pfizer in 2009
Based	NYC, NY and Gritin CT		
Ownership	**Public**		
Business Model	$		
Valuation	Market cap 311.5B 4/7/22 203.46 B on 8/11/23		
Financials	Sales in 2022 were 1 Trillion		
Lead Product			
Product Type	Multiple		
Stage	Commercial		
website	Pfizer.com		

Pfizer (Vaccines) (2)

		Key Events	Key People
Founded		• IPfizer grew by mergers, including those with Warner–Lambert for 111B (2000),[16] Pharmacia for 60B (2003),[17] and Wyeth for 68B (2009), Hospira , largest producer of generic injectable pharmaceuticals in the world, for 15B (2015). In May 2016, Anacor Pharmaceuticals for $5.2 billion, expanding the company's portfolio in both inflammation and immunology drugs areas.[offerings. August 2016 cancer drug-maker – Medivation – for $14 billion In n 2018, Pfizer signed an agreement with the German biotechnology company BioNTech, to conduct joint research and development activities, to further the advance of mRNA-based flu vaccines. Under theagreement, following BioNTech's completion of a first in-human clinical study, Pfizer would assume sole responsibility for further clinical development and commercialization of mRNA-based flu vaccines.	
Based			
Ownership			
Business Model			
Valuation			
Financials		• In 2020, Pfizer partnered again with BioNTech, to study and develop COVID-19 mRNA vaccine candidates. On July 27, 2020, the companies announced the start of a global (except China) Phase 2/3 safety and efficacy clinical study to evaluate the mRNA vaccine candidate BNT162b2.[112] The companies plan to use Pfizer facilities to manufacture the vaccine if they receive FDA approval. In November 2020, Pfizer announced that BioNTech's COVID-19 vaccine, tested on 43,500 people, was found 95% effective, which was described as a "milestone.	
Lead Product			
Product Type		• 12/11/2020 Covide-19 vaccine approved by FDA for emergency use Later full approval	
Stage			

Pfizer / Flagship Collaboration

		Key Events	Key People
Founded		• 07/18/23After reporting record sales of 100 B USD for 2022, Pfizer turned to Flagship Pioneering Ventues. They announced a joint investment of 100 M into ten of the early stage portfolio companies of the VC with the orisoect of investing up to 750 M per program from Pfizer to accelesrate development of new technologies.	• Alfred Bourla, Mikael Dolsten from Pfizer • Paul Bondi fro Flaship Pioneering.
Based			
Ownership			
Business Model			
Valuation			
Financials			
Lead Product			
Product Type			
Stage	Commercial		

Moderna Therapeutics (1)

		Key Events	Key People
	2010	***Mission: Deliver on the promise of mRNA science to create a new generation of transformative medicines for patients.*** Moderna was founded in 2010 and the name was originally written "ModeRNA". • At Moderna, they are pioneering the development of a new class of drugs made of messenger RNA (mRNA). This novel drug platform builds on the discovery that modified mRNA can direct the body's cellular machinery to produce nearly any protein of interest, from native proteins to antibodies and other entirely novel protein constructs that can have therapeutic activity, • In 2012, they had raised $40 million from Flagship Ventures' VentureLabs unit and other private investors • 2013, DARPA award up to $24.6 M to fight infectious diseases and biological weapons. 2014, deal w Alexion Pharmaceuticals entered a $125 million deal for orphan diseases. Alexion paid Moderna $100 million exchange for 10 product options to develop rare-disease drugs. [A year later Moderna launched its own venture, Epidera, for RARE DISEASES - SEE NEXT PAGE • 01/23/2020: Announces award from Coalition for Epidemic Preparedness Initiative (CEPI) do develop mRNA vaccine against novel corona virus • 08/11/2020: Announces contract with US federal government (483M grant from BARDA) to produce 100 million doses of anti COVID19 vaccine • 12/17/2020 COVID-19 Vaccine approved US for Emergency Uses and later full approval.	• Patrick Rossi, Tim Springer from Harvard, Bob Langer from MIT, Noubar Afevan from Flagship Ventures • Stepanie Barcel CEO of BIOMerieux (DIAGNOSTICS) recruited to become CEO in 2011. Pfrev. a sales director at Eli Lilly and Company, eventually become ihead of operations for Belgium. In 2007, he became CEO of French diagnostics company BioMérieux. His 9% stake in Meoderna was worth more than 1 B at peak.
Based	Cambridge, MA 735 employees		
Ownership	**NASAQ MRNA**		
Business Model	For Profit		
Valuation	At IPO 12/2018 $7.6 B Market cap $64.09 B 4/7/22; 08/11/23: 38.6 B		
Financials	Total cash raised in 13 rounds: $3B Netloss of 1.4 B in Q2 2034 vs profit of 19.3 B for 2022		
Lead Product	21 products, 11 in clinical Phase		
Product Type	infectious Diseases Immuno-Oncology Rare Diseases		
Stage			
website	www.modernatx.com/		

Moderna Therapeutics (2)

		Key Events	Key People
		• 2014, research and clinical partnership with Karolinska Institutet and Karolinska University Hospital, and established Moderna Therapeutics Sweden • Deals with AstraZeneca (immuno oncology), Merck (vaccines), Vertex (Cystic Fibrosis) - September 2016, Moderna announced that it was going to start building a 200,000 sq ft GMP mRNA manufacturing facility in Norwood, MA. • In 2017 Science published an article describing Moderna's platform, which was the result of several months of discussions with Moderna employees. Moderna had made the strategic decision to disclose some of its approach in an effort to break the hype cycle into which it was getting locked. • 01/17/23: MODERNA ANNOUNCES MRNA-1345, AN INVESTIGATIONAL RESPIRATORY SYNCYTIAL VIRUS (RSV) VACCINE, HAS MET PRIMARY EFFICACY ENDPOINTS IN PHASE 3 TRIAL IN OLDER ADULTS • 07/26/23; MERCK AND MODERNA INITIATE PHASE 3 STUDY EVALUATING V940 (MRNA-4157) IN COMBINATION WITH KEYTRUDA® (PEMBROLIZUMAB) FOR ADJUVANT TREATMENT OF PATIENTS WITH RESECTED HIGH-RISK (STAGE IIB-IV) MELANOMA • 08/09/23: NNOUNCED INVESTMENT OF 1 B USD to set up a new Subsidiary in China's Minhang District and operating out of Shanghai until the new headquarters are ready.	
Based			
Ownership			
Business Model			
Valuation			
Financials			
Lead Product			
Product Type			

GENE EDITING COMPANIES

Vertex Therapeutics

		Key Events	Key People
	1919	• Vertex was founded in 1989 by Joshua Boger[3] and Kevin J. Kinsella.[4] • By 2004, its product pipeline focused on viral infections, inflammatory and autoimmune disorders, and cancer. • In 2009, the company had about 1,800 employees, including 1,200 in the Boston area.[3] By 2019 there were about 2,500 employees.[7] • In January 2014, Vertex completed its move from Cambridge, Massachusetts to Boston, Massachusetts, and took residence in a new, $800 million complex. Located on the South Boston waterfront, it marked the first time in the company's history that all of the roughly 1,200 Vertex employees in the Greater Boston area worked together. • 9 projects, incl. 1 entering Phase 1 in hemoglobinopathies (Beta Thalassemia and Sickle Cell), partnered with CRISPR Therapeutics since 2015. Collaboration expanded in 6/2019 agreement when Vertex agreed to pay 175M upfront for exclusive worldwide tights to all IP of CRSIP Ther. And 1B for meeting R&D, regulatory and commeercial milestines for Duchenne and GM1 tjherapies • 6/2019 Acquired Exonics for 245 M I equity upfront and up to 750 M in potential ram • In September 2019 the company announced it would acquire Semma Therapeutics for $950 million in cash.[13] Semma Therapeutics created a "small, implantable device that holds millions of replacement beta cells, letting glucose and insulin through but keeping immune cells out.	• On 1 April 2020, former Chief Medical Officer, Reshma Kewalramani, became President and Chief Executive Officer of Vertex Pharmaceuticals. • She graduated in 1998 from Boston University.[finished her internship and residency at the Massachusetts General Hospital and her fellowship in nephrology at the Massachusetts General Hospital and Brigham and Women's Hospital • She graduated from the General Management Program at Harvard Business School in 2015. • king for Amgen for over 12 years, where she held leadership positions in research and development.[1] • In 2017 she joined Vertex d the role of president and CMO • CEO on April 1, 2020 and is a member of the Vertex Board of Directors
Based	Cambridge, MA		
Ownership	**NASDAQ VRTX**		
Business Model	For Profit		
Valuation	At IPO 8/1991 Market cap 4/7/22 70.2B$ 08/11/23 90,3 B		
Financials	3/2009 Venture Round $2.4 M 9/2009 Post-IPO $120 M 9/2009 Post-IPO $35 M Janssen Pharmaceuticals 12/2009 Post-IPO $443 14 rounds raised total 1.9B		
Lead Product	**Trikafta approved for cystic fibrosis Oct 21, 2019**		
Product Type			
Website	Vrtx.com		

Exonics Therapeut. (Vertex)

		Key Events	Key People
	Founded Nov 2016	• Founded in collaboration between non profit group Cure Duchenne and Eric Olsson, PhD, of U Texas Soutwestern. CRISPR technology licensed from U Texas SW. • Exonics' laboratory has demonstrated the ability to use adeno-associated virus (AAV) to deliver a payload based on CRISPR/Cas9 technology that can identify and correct exon mutations that prevent the production of dystrophin, a protein that helps stabilize and protect muscle fibers. • Exonics, which comes with $5 million seed funding from CureDuchenne Ventures, will focus on using CRISPR in Duchenne muscular dystrophy (aka DMD), the most common severe form of childhood muscular dystrophy that hits young boys, with both their skeletal and heart muscles affected. • If untreated, they can lose their ability to walk at around 10 to 12 years old, and will typically die of their disease in their mid-20s due to heart failure. It affects around 15,000 boys in the U.S. and around 300,000 globally. • September, the FDA approved a new type of treatment for DMD called Exondys 51 (eteplirsen) from Sarepta., pacifically indicated for patients who have a mutation of the dystrophin gene (dystrophin is the key protein missing in boys with Duchenne) amenable to exon 51 skipping, which affects around 13% of the population with DMD.	• Eric Olsson, PhD, U Texas Southwestern. • Annie and Willie Nelson Professorship in Stem Cell Research; Pogue Distinguished Chair in Research on Cardiac Birth Defects; The Robert A. Welch Distinguished Chair in Science • Department Molecular Biology • Eric Olson unveiled the molecular underpinnings of congenital and acquired diseases of the heart. Olson also discovered epigenetic mechanisms and microRNAs as regulators of muscle development and disease. • Olson is among the most highly cited researchers, with his publications cited over 90,000 times translate basic discoveries into new therapeutics for muscle disease. He was co-founder of Myogen, Inc., miRagen Therapeutics, which is developing new therapeutics for cardiovascular disease, based on microRNAs.[
Based	Watertown, Boston area MA		
Ownership	6/2019 Acquired by Vertex for 245 M I equity upfront and up to 750 M in potential future payments related to development milestones for DMD and DM1 program		
Business Model			
Valuation			
Financials	Ser A 45M funded by Column Group SF (40M) and Cure Duchenne Ventures (5M)		
Lead Product			
Product Type			
Stage			
website			
	Exonics.com		

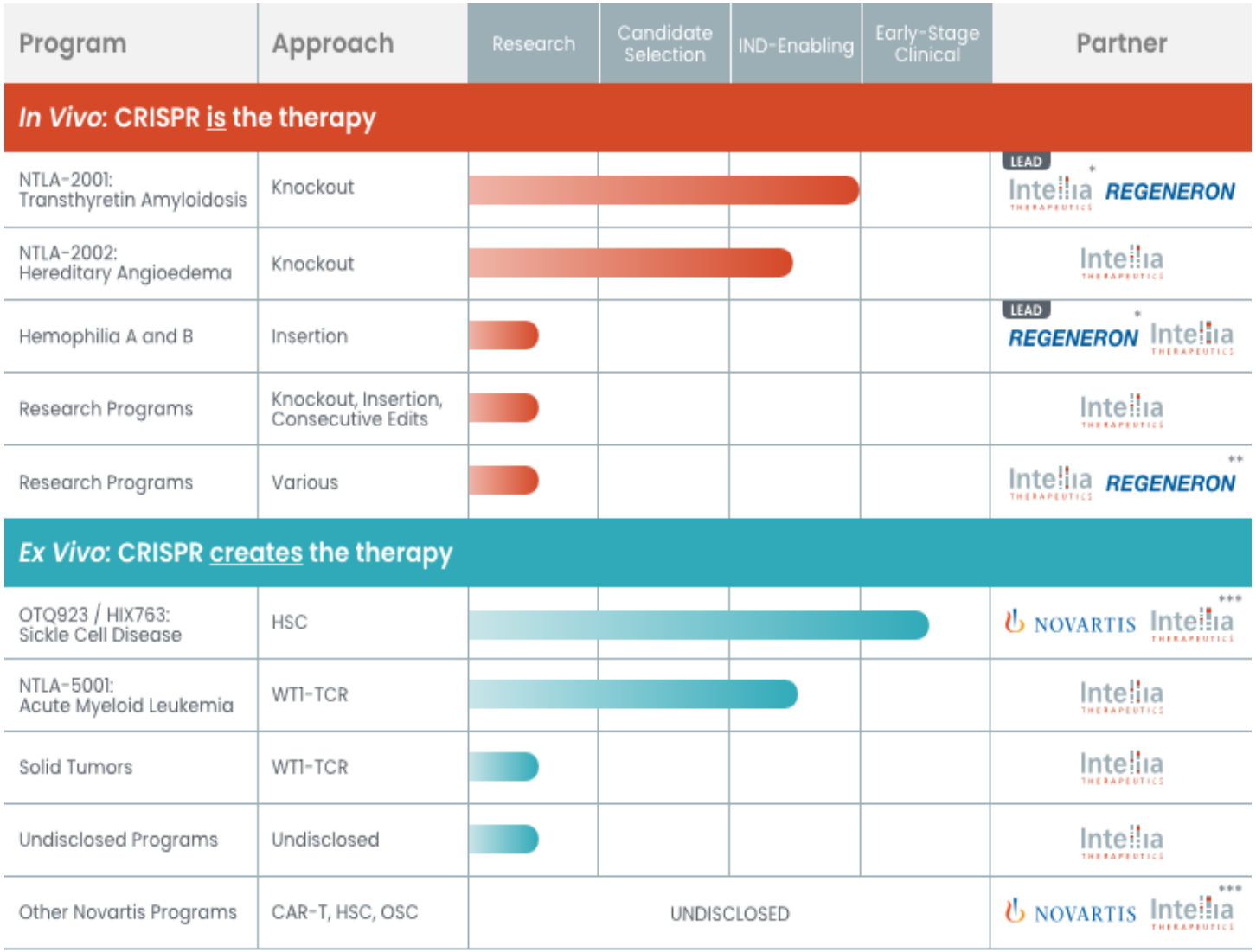
Intellia Therapeutics (1)

		Key Events	Key People
	2014	• There are two main components to the CRISPR/Cas9 genome editing system: The Cas9 protein, which initially recognizes the DNA and also acts like a pair of “molecular scissors” that precisely cleave the targeted DNA sequence and The guide RNA, which recognizes the specific target DNA sequence, allowing the Cas9 scissors to cut.5/2018: Intellia announced that its first cell therapy target is WT1 for the treatment of acute myeloid leukemia and other potential hematological malignancies, as well as for solid tumors. • 12/2018 collaboration agreement w Novartis, 10M upfront: Under the terms of the original agreement, Novartis received exclusive rights to develop all collaboration programs focused on engineered chimeric antigen receptor T cells (CARTs), while both companies committed to advancing their respective hematopoietic stem cell (HSC) programs. The work of these preclinical programs, including for sickle cell disease, is ongoing. • There are two main components to the CRISPR/Cas9 genome editing system: The Cas9 protein, which initially recognizes the DNA and also acts like a pair of “molecular scissors” that precisely cleave the targeted DNA sequence and The guide RNA, which recognizes the specific target DNA sequence, allowing the Cas9 scissors to cut. 5/2018: Intellia announced that its first cell therapy target is WT1 for the treatment of acute myeloid leukemia and other potential hematological malignancies, as well as for solid tumors	• 2017: John Leonard, M.D. • President and Chief Executive Officer • After a 30-year career in Pharmaceutical R&D, John Leonard retired from his position as Chief Scientific Officer and Senior Vice President of Research and Development at AbbVie in 2013. Inspired by the opportunity to work with a new therapeutic modality and form a new company, he returned to his life’s passion and joined the Intellia team to direct the research and development effort to make CRISPR/Cas9 technology into a therapeutic reality.
Based	Cambridge, MA		
Ownership	**NASDAQ NTLA**		
Business Model	For Profit		
Valuation	At IPO 5/2016 $772.1 M Follow on 06/02/2020 to raise 100M+ ; 12/4 2020 closing of 201M follow-on public offering Market Cap 4/7/22 4.9B 08/11/23 3.5 B		
Financials	11/2014 Ser. A $15 M Atlas Venture, Novartis 9/2015 Ser. B $70 M OrbiMed IPO 5/2016 raised $108 M 5 rounds raised total 1.2 B		
Lead Product			
Product Type			
Website	Intelliatx.com		

Intellia Therapeutics (2)

		Key Events	Key People
		• 12/2018 collaboration agreement w Novartis, 10M upfront: Under the terms of the original agreement, Novartis received exclusive rights to develop all collaboration programs focused on engineered chimeric antigen receptor T cells (CARTs), while both companies committed to advancing their respective hematopoietic stem cell (HSC) programs. • 2/20 acquired Rewrite Therapeutics , Berkeley/San Francisco, Shakked Helperin Co-founder CEO., PhD Bioengineering UC Berkeley 2018. undisclosed amount • Gene Knock out: • NTLA 2001 Phase 2 Thransthehyretin Amyloidosis Partner: Regeneron) • NTLA 2002: Phase 2 in Her. angiooedema	
Based			
Ownership			
Business Model			
Valuation			
Financials			
Lead Product			
Product Type			
Stage			
website			

Intellia Pipeline



* Lead development and commercial party ** Rights to certain *in vivo* targets *** Milestones & royalties

CAR-T: Chimeric Antigen Receptor T cells HSC: Hematopoietic Stem Cells OSC: Ocular Stem Cells

CRISPR Therapeutics

		Key Events	Key People
	2013	• Founded by Prof Roger Novak , Vienna, prof Emmanuelle Charpentier and Shaun Foy CRISPR Therapeutics is focused on the development of transformative medicines using its proprietary CRISPR/Cas9 gene-editing platform. CRISPR/Cas9 is a revolutionary technology that allows for precise, directed changes to genomic DNA. They have licensed the foundational CRISPR/Cas9 patent estate for human therapeutic use from their scientific founder, Dr. Emmanuelle Charpentier, Max Planck Institute in Germany [and previously Umea University, Sweden -filing patent with Jennifer Doudna, UC Berkeley, upheld in appeals court 2018], who co-invented the application of CRISPR/Cas9 for gene editing. Their multi-disciplinary team of world-class researchers and drug developers is working to translate CRISPR/Cas9 technology into breakthrough human therapeutics. **For latest update on patent litigation: https://www.broadinstitute.org/CRISPR/journalists-statement-and-background-CRISPR-patent-process** • β-thalassemia and sickle cell disease will soon enter clinical testing. • Allogeneic CAR-T cell therapies to treat cancers, offers potential therapeutic advantages over the current generation of therapies. • J-V with Bayer Casebia Therapeutics to bring breakthrough therapies to patients suffering from serious conditions such as blood disorders, blindness and congenital heart disease. • 3/31/20 Additional funding from NIH for CRISPR based COVID-19 test • 05/06/21 collaboration with Mkart in cancer	• Dr. Samarth Kulkarni has served as Chief Executive Officer since December 2017. • Prev. CBO • Prev. Partner at McKinsey & Company, where he had a leading role in the Pharmaceutical div. • Ph.D. in Bioengineering and Nanotechnology from the University of Washington and a B. Tech. from the Indian Institute of Technology • Cofounder Emmanuelle Charpentier shared Nobel Prize Chemistry 2020 wiith Jennifer Doudna, PhD, UC Berkeley
Based	Cambridge, MA /Base; Switzerl		
Ownership	**NASDAQ CRSP**		
Business Model	For Profit		
Valuation	At IPO 10/2016 $590.4 M Market Cap 4/7/22 4.9B 08/11/23 3.9 B Total funds raised 127M in **5 rounds**		
Financials	4/2014 Ser.. A $25 M Versant Ventures 4/2015 Ser.. A $35 M Celgene, SR One 4/2015 Ser.. B $29 M Celgene, SR One 6/2016 Ser.. B $38 M Franklin Templeton Investments, New Leaf Venture Partners IPO 10/2016 raised $56 M **Public Offering announced 11/20/2019:**		
Website	http://www.CRISPRtx.com		

Casebia Pipeline

	Platform	Programs	Status
		HEMATOLOGY	
in vivo	Liver	Hemophilia A	Research
		Undisclosed	Research
ex vivo	CD34+	Severe Combined Immunodeficiency (SCID)	Research
		Undisclosed	Discovery
		AUTOIMMUNE	
ex vivo	T cell	*Immunodysregulation polyendocrinopathy X-linked syndrome (IPEX)	Research
		Undisclosed	Discovery
		OPHTHALMOLOGY	
in vivo	Retina	Undisclosed	Research
		Undisclosed	Research
		Undisclosed	Research

CRISPR –Vertex-Casebia/Bayer Deals

		Key Events	Key People
		• 20 15 Vertex agreement: incl. 1 entering Phase 1 in hemoglobinopathies (Beta Thalassemia and Sickle Cell), partnered • 2016 J-V agreement with Casebia / Bayer: . specific disease areas including hematology and ophthalmology, as well as having access to protein engineering expertise and relevant disease know-how through the Bayer side. – • 2019 JV Renegotiated :would operate under the direct management of CRISPR Therapeutics," and not alongside Bayer, and "would focus on the development of its lead programs in hemophilia, ophthalmology and autoimmune diseases. • 2019 vertex agreement: Vertex agreed to pay 175M upfront for exclusive worldwide tights to all IP of CRSIP Ther. And 1B for meeting R&D, regulatory and commeercial milestines for Duchenne and GM1 tjherapies • Other programs in immuno-oncology, genetic diseases, muscular dystrophy, etc.. • J-V with Bayer Casebia Therapeutics to bring breakthrough therapies to patients suffering from serious conditions such as blood disorders, blindness and congenital heart disease.	
Based			
Ownership			
Business Model			
Valuation			
Financials			
Website			

Caribou Biosciences, Inc (1)

		Key Events	Key People
	2011	• Caribou was founded by James Berger, Jennifer Doudna, Martin Jinek, and Rac el Haurwitz, scientists from the U. California, Berkeley based on the remarkable nucleic acid modification capabilities found in prokaryotic CRISPR systems. • Caribou Biosciences is a biotechnology company in genome engineering. they develop technology-based solutions for cellular engineering and analysis based on7/22 the CRISPR-Cas9 technology platform. Cas9, when paired with a guide RNA, cuts double-stranded DNA allowing for specific changes to DNA. These site-specific DNA modifications can be utilized to carry out sophisticated gene knock-outs or knock-ins. • In 2007, Rodolphe Barrangou, a former Chairman of the Board of Directors of Caribou Biosciences and current scientific advisor, led the group that characterized CRISPR systems as a form of prokaryotic adaptive immunity that provides a critical line of defense against invading phages, plasmids, and environmental nucleic acids. CRISPR systems have evolved to enable prokaryotes to acquire DNA from their environment and incorporate it into their genomes within specialized arrays of repetitive DNA. These CRISPR sequences act as a form of prokaryotic adaptive immunity that provides a critical line of defense against invading phages, plasmids, and environmental nucleic acids. CRISPR systems have evolved to enable prokaryotes to acquire DNA from their environment and incorporate it into their genomes within specialized arrays of repetitive DNA. **CONTIUES NEXT PAGE**	• Rachel Haurwitz, Ph.D. • President and Chief Executive Officer • Rachel is a co-founder of Caribou Biosciences and has been President and CEO since its inception in 2011. • She has a research background in CRISPR-Cas biology • Co-founder of Intellia Therapeutics. • • Cofounder Jennifer Doudna, PhD, shared 2020 Nobel prize Chemistry with Emmanuelle, harpentier (Max Planck Institute, Berlin, Germany and cofounder CRISPR Therapeutics, Geneva).
Based	Berkeley, CA		
Ownership	NASDAQ CRBU		
Business Model	For Profit		
Valuation	Pre IPO eval 907,3M IPO raised 304M Market cap 4/20/22 504.7 M 08/11/23 588.7M		

Caribou Biosciences, Inc (2)

		Key Events	Key People
	2011	• These CRISPR sequences act as a form of genomic memory that can be accessed to defend the cell when it is invaded by plasmids or phages that contain the recorded sequences. • At the core of Caribou's extensive CRISPR technology IP portfolio The USPTO recently issued U.S. Patent No. 10,000,772 for the use of CRISPR/Cas9 genome editing covering widely used guide formats in various environments, including eukaryotic cells. The companies expect this is the first of many patents that will issue based on the foundational work done by Drs. Charpentier and Doudna and their teams.	•
Based			
Ownership			
Business Model			
Valuation			
Financials			
Lead Product			
Product Type			
Stage			
website			
	Cariboubio.com		

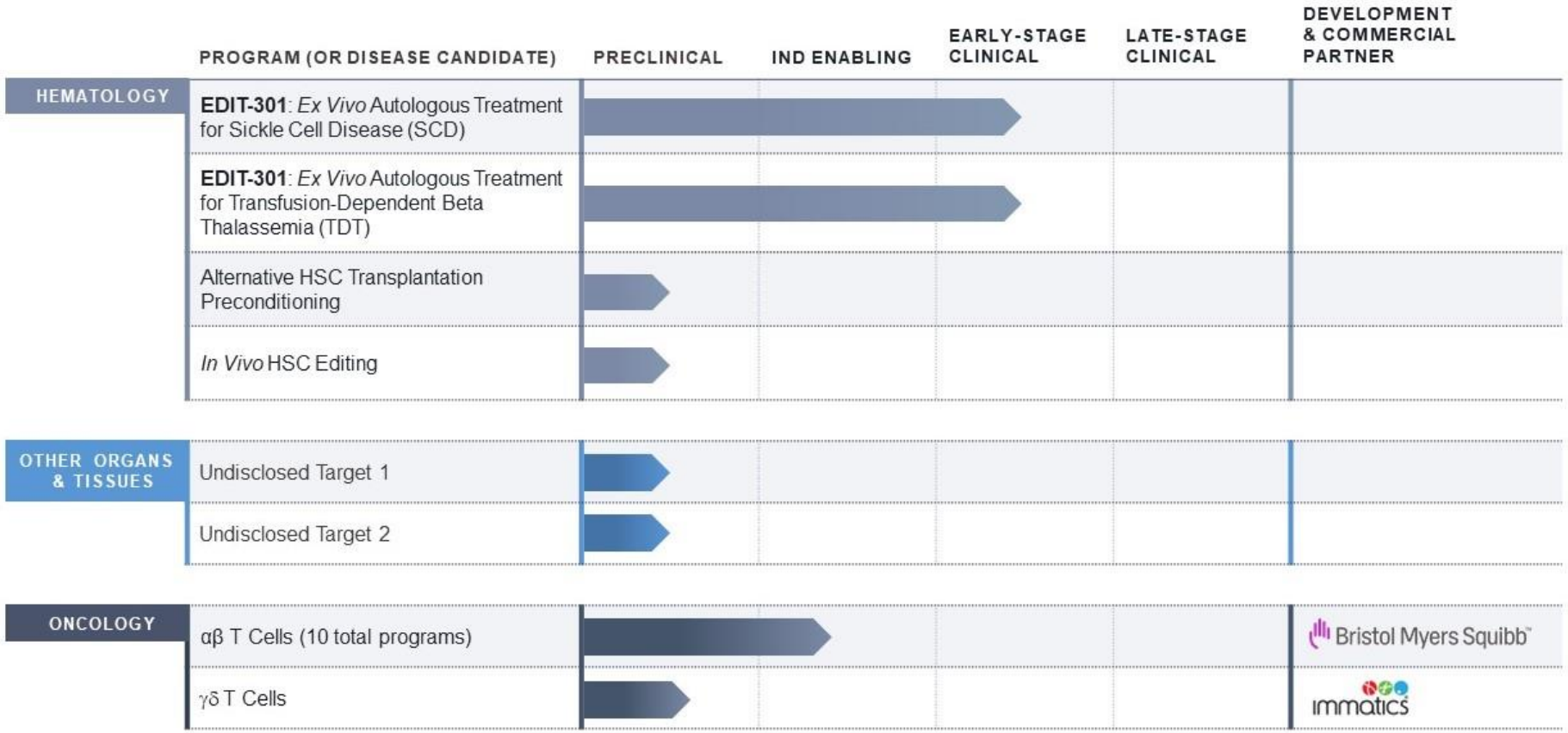
Caribou Biosciences, Inc. - Applications

- Therapeutics – cofounded Intellia -see below
- Agricultural Biotech
- Biological Research
- Industrial Biotech

Editas Medicine, Inc

		Key Events	Key People
Founded	2013	• Founders: Feng Zhang, J. Keith Joung, Jennifer Doudna • Editas Medicine is engaged in discovering and developing a novel class of genome editing therapeutics. The company has generated substantial patent filings and has access to intellectual property covering foundational genome editing technologies, as well as essential advancements and enablements that will uniquely allow the company to translate early findings into viable human therapeutic products. • Editas Medicine's mission is to translate its genome editing technology into a novel class of human therapeutics that enable precise and corrective molecular modification to treat the underlying cause of a broad range of diseases at the genetic level. • CRSIPR technology likened from Broad Institute, MIT	• Gilmore O'Neill is President and Chief Executive Officer of Editas Medicine and a member of the Editas Board of Directors. • He joined Editas Medicine in June 2022. • Gilmore brings to Editas more than 20 years of experience • in genetic medicine, neurobiology, and clinical development. Gilmore also has a track record of driving and • leading several of biotech's most successful clinical programs and achieving marketing approvals for several medicines, including Amondys®, Vyondys®, Spinraza®, • Prev. Exec VP of R&D at Sarepta
Based	Camebridge, MA (Boulder CO)		
Ownership	**Nadaq EDIT**		
Business Model	For Profit		
Valuation	Market 4/7/22 1.3 B 8/11/23 708 6		
Financials	Total raised 781 M in 6 round		
website	Editas.com		

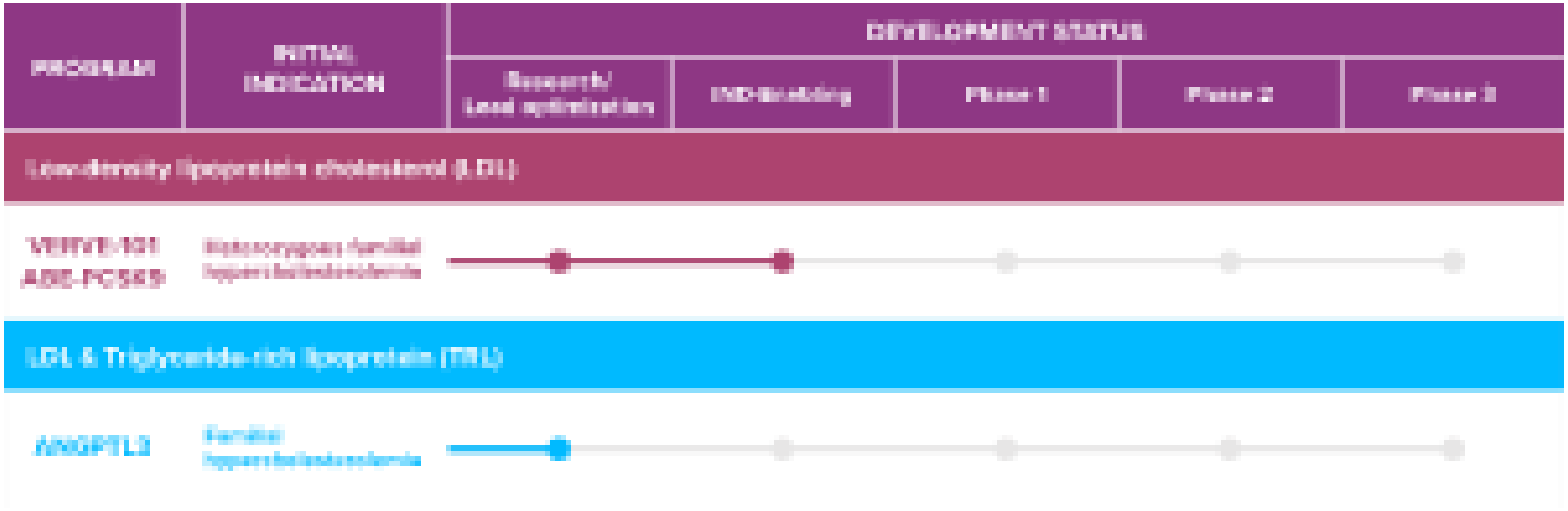
Editas Medicine Pipeline



Verve Therapeutics

		Key Events	Key People
Founded	2018	Verve Therapeutics is a biotechnology company created with a singular focus: to protect the world from heart disease. Founded by world-leading experts in cardiovascular medicine, human genetics and gene editing, the company aims to develop transformative, once-and-done therapies for coronary heart disease. Verve's gene editing medicines are designed to safely edit the genome of adults and mimic naturally occurring gene variants to permanently lower LDL cholesterol and triglyceride levels. The company is advancing a pipeline of precision genetic medicines, led by VERVE-101, which is being developed initially for heterozygous familial hypercholesterolemia, a potentially fatal genetic heart disease. In 2020, Verve was recognized as a "Best Places to Work" by the Boston Business Journal and one of the "Endpoints 11." • Focused initially on addressing disease populations that have genetically driven, life-long and severely elevated LDL-C, such as familial hypercholesteremia (FH) • FH, a genetic disease caused by life-long severely elevated LDL-C that leads to increased risk of early-onset Atherosclerotic cardiovascular disease IASCVD) ,and affecting approximately 1.3 million in the U.S. and 31 million globally.	Sekar Kathiresan, M.D. • Co-Founder, Chief Executive Officer and Board Member • a cardiologist and scientist who has focused his career on understanding the inherited basis for heart attack. Based on his groundbreaking discoveries in human genetic mutations that confer resistance to cardiovascular disease • Today, Verve is advancing two initial programs that target PCSK9 and ANGPTL3, respectively – genes that have been extensively validated by Dr. Kathiresan and others as targets for lowering blood lipids, such as low-density lipoprotein cholesterol, which is a major driver of cardiovascular disease. • Prior to joining Verve, Dr. Kathiresan's roles included director of the Massachusetts General Hospital (MGH) Center for Genomic Medicine, director of the Cardiovascular Disease Initiative.
Based	Camebridge MS		
Ownership	**Nasdaq VERV market cap 963.3 M 4/7/22** **8/11/23 1.1.B**		
Business Model			
Valuation	IPO 06/2021 raised 266.7M+		
Financials	Ser A 06/2020 raise 63M$		
Lead Product	VERVE-101		
Product Type			
Stage	Preclinical		
website	www.verve.com		

VERVE Pipeline



ElevateBio

		Key Events	Key People
	2019	• *Creating and operating a portfolio of cell and gene therapy companies to develop, manufacture and commercialize life-transforming medicines* • *A biotechnology holding company, established to create and operate a broad portfolio of cell and gene therapy companies through partnerships with leading academic researchers, medical centers and entrepreneurs. ElevateBio builds single- and multi-product companies by providing scientific founders with fully-integrated bench-to- bedside capabilities including world-class scientists, manufacturing facilities, drug developers and commercial expertise. ElevateBio is building a team of industry leaders who work at the holding company and are assigned exclusively or in-part to ElevateBio portfolio companies over time. ElevateBio BaseCamp, a company-owned Center of Cell and Gene Therapy Innovation, will serve as the R&D, process development and manufacturing hub across the entire ElevateBio portfolio while also supporting selected strategic partners.* • "Many Companies – One Robust Organization" • ElevateBio's novel business model, including BaseCamp, our centralized R&D and manufacturing organization, is structured to rapidly and efficiently build single- and multi-product cell and gene therapy companies. • 06/23/2021 invested 95M n Abata Bioscience Ser A • 10/27/2021 acquired AgBiomes stake in its spin off Life-Edit (formed 10/2020)	• Co-founders David Hallal, CEO and Chairman, Executive Paartner MPM Capital ➢ Prev. CEO of Alexion and 30 years in biotech incl. Eytech, Biogen and Amgen. • Co-founder Mitchell H. Finer, PhD, President & CSO, globally recognized pioneer in cell and gene therapies, former CSO BlueBird and CEO in many companies. and MPM portfolio companies. ➢ He founded and is the former CEO of Oncorus, focused on the development of oncolytic herpes viruses for the treatment of solid tumors. ➢ He is also a founder and the former CEO of CODA Biotherapeutics, focused on developing a chemogenetic neuromodulation platform for the treatment of severe neurological disorders..
Based	Cambridge, MA		
Ownership	Private		
Business Model	For Profit		
Valuation	Market cap 96.8 M 4/7/22 8/11/23		
Financials	5/2019 Ser.. A $150 M UBS Oncology 3/2020 Ser. B $170 M Investors include UBS Oncology Impact Fund; MPM Capital; F2Ventures; Samsara BioCapital; Redmile Group; $ 525M Series C 03/2021 EcoR1Capital Total raised 1.2 B in 5 rounds		
website	elevateBio.com		

Sangamo Therapeutics

		Key Events	Key People
	1995	• ***PIONEERING GENETIC CURES*** t- leader in the development of a proprietary technology platform that enables specific regulation of gene expression and gene modification. • The basis of this platform is a naturally occurring class of transcription factors, zinc finger DNA-binding proteins (ZFPs) which they can engineer to drive desired therapeutic outcomes. • Engineered ZFPs can be linked to functional domains that normally activate or repress gene expression to create ZFP trans/7/22 859.46M4cription factors (ZFP TFs) capable of turning genes on or off. <u>they can also link ZFPs to nuclease domains to create zinc finger nucleases (ZFNs) which enable precise gene-editing in cells.</u> • Engineered ZFNs can modify a cell's DNA at a precise location, thereby facilitating correction or disruption of a specific gene or the targeted addition of a new DNA sequence. "their primary mission is to develop ZFP Therapeutics®. they have ongoing clinical programs to evaluate ZFP TFs and ZFNs as novel approaches to unmet medical needs where they believe they have a differential technical advantage to impact the outcome of disease by functioning at the DNA level." • MPS I and MPS II : Phase 1- • **<u>02/08/2019 MPS II study failed to show benefit in first 6 patients –trying higher</u> dose but stock dropped 30%** • Hemophilia B: In Phase 1-2 SEE NEXT PAGE	• Founding CEO was Edward Lampier, the inventor of gene expression regulation based on "zinc-finger nuclease" gene editing technology • SANDY MACRAE, M.B., CH.B., Ph.D. Chief Executive Officer since June 2016. • Global Medical Officer of Takeda Pharmaceuticals. • From 2001 to 2012, Dr. Macrae held roles of increasing responsibility at GlaxoSmithKline, including Senior Vice President, Emerging Markets Research and Development (R&D), from 2009 to 2012. • Dr. Macrae received his B.S. in Pharmacology and his M.B., Ch.B. with honors from Glasgow University. He is a member of the Royal College of Physicians. Dr. Macrae also earned his Ph.D. in molecular genomics at King's College, Cambridge.
Based	Richmond, CA		
Ownership	NASDAQ SGMO		
Business Model	For Profit		
Valuation	At IPO 4/2000 Market Cap 08/11/23 185.6 M		
Financials	Total cash raised: $93.2 M		
Lead Product	See pipeline next page		
Product Type			
Stage			
Indications			
website	www.sangamo.com		

Sangamo Partnered Pipeline

- Hemophilia A Ph. 1-2 (Novartis)
- Betha Thalassemia Ph. 1-2 (Bioverativ)
- Sickle Cell –Preclin. (Bioverativ)
- ALS/FTLD –Prelin. (Pfizer)
- Huntingtons –Research (Shire)
- Oncology (Kite/Gilead)
- \
- HIV T-Cells –Ph. 1-2
- HIV -Stem cells –Ph. 1-2

Orchard Therapeutics plc

		Key Events	Key People
Founded	2015	• Orchard Therapeutics is a leading global fully integrated commercial-stage company dedicated to transforming the lives of patients with rare diseases through innovative gene therapies. • Orchard's portfolio of autologous ex vivo gene therapy programs has demonstrated sustained clinical benefit in over 150 patients across five disease areas. These programs include Strimvelis®, the first autologous ex vivo gene therapy approved by the EMA in 2016, 3 programs in advanced registrational studies in MLD (metachromatic leukodystrophy), WAS (Wiskott Aldrich syndrome) and ADA-SCID (adenosine deaminase severe combined immunodeficiency), 2 other clinical programs in X-CGD (X-linked chronic granulomatous disease) and beta-thalassemia, as well as an extensive preclinical pipeline. • The company is partnered with world-leading institutions in gene therapy, including University College London, Great Ormond Street Hospital, the University of Manchester and Central Manchester University Hospitals, the University of California Los Angeles and Boston Children's Hospital, and (by acquisition from GSK) Telethon Institute of Gene Therapy/Ospedale San Raffaele. • Orchard is a publicly traded company (NASDAQ: ORTX) with offices in the UK and the US, including London, San Francisco and Boston. • 10/27/2021 Announced acquisition of gen editing company Life Science, NC Undisclosed amount	• Mark Rothera, President, CEO • Andrea Spezzi, Co-founder. Chief Medical Officer
Based	London, UK, Boston, MA, SF CA		
Ownership	**NASDAQ ORTX**		
Business Model	For Profit		
Valuation	At IPO 10/2018 $1.2 B **Market Cap 10/9/2020 $700..9 M; 5/28/21 647.3M 11/30/2021 169.4 B 08-21-23 90.65M**		
Financials	IPO 2018 raised472M M (eval at IPO 1.2B) / Ser A,B,C raised 310.5M		
Lead Product	Strimvelis®		
Product Type	autologous ex vivo gene therapy		
Stage	Commercial		
website	www.orchard-tx.com		

Tessera Therapeutics

		Key Events	Key People
fOUNDED	2018	We use RNA Gene Writers™ to write or rewrite the genome RNAENGINEERING RNA GENE WRITERS RNA Gene Writers enable the full spectrum of genome editing outcomes. Tessera engineers these RNA Gene Writers to be modular and designs them to make a wide range of genomic alterations, enabling writing of long messages in the human genome as well as rewriting of short DNA sequences such as single base pair changes to correct disease-causing mutations.GENE WRI	• Michael Severino, a former high-level AbbVie executive who left in April to join Flagship Pioneering, will become CEO of a genetic medicine startup backed by the venture capital firm. • Flagship announced Thursday that Severino, who served as AbbVie's chief scientific officer and then its president, will lead Tessera Therapeutics, taking over for founding CEO Geoffrey von Maltzahn. • Michael Holmes • Chief Scientific Officer • Michael joined Tessera in December 2021 as Chief Scientific Officer. Dr. Holmes has over 20 years of experience working on the development and clinical translation of different genome editing- and gene therapy-based strategies for the treatment of inherited and acquired diseases
Based	Cambridge MA		
Ownership	**Seeded by Flagshiip Ventures**		
Business Model	For Profit		
Valuation	**Tessea CEOAotal raised 531.8 M in 4 rounds**		
Financials	Pre-IPO		
Lead Product			
Product Type			
Stage			
Indications			
website			

Gene Modified Cell Therapy

CAR –T COMPANIES

Novartis Gene Therapies

		Key Events	Key People
Founded	Unit founded 2012	• 2012 deal with U of Pennsylvania to acquire global rights to CAR-T technology developed by Carl June. – financials not disclosed • CAR = chimeric Antigen Receptor • From patients white blood cells Genetically modify T-cells to recognize tumor antigen CD-19 • "Turns the T-cells into hunter / attack cells that attacks the cancer cells"Each CAR-T cell can multiply to an army of 10,000 attack cells. • 83 % complete response rate in children with ALL (acute lymphoblastic leukemia) • **2016: Gene therapy unit integrated with the Oncology section of Novartis** • **2017/08 Kymriah Approved by FDA in ALLbased on a study in 82 pts, supported by historical data in about 90 patients with more than 90 % Complete response rate.** • **2018/05 second indication : NHL (DLBCL) approved by FDA based on overall response rate of 50 percent (incl.. 32% complete responses) in 68 refractory/relapsed pts in international MC trial\Price tag of 475,000 USD /patients / no charge if the patient does not respond. [value based pricing strategy]** • Sales 2019 projected to reach 200 M USD New indications to follow; Multiple Myeloma other hematol malignancies and solid tumors.	• **Vasant (Vas) Narasimhan, M.D. CEO since 2018** • Since joining Novartis in 2005, Vas has held a range of leadership roles, including Global Head of Development for Novartis Vaccines, and Global Head of Drug Development and Chief Medical Officer. In recognition of his sustained efforts to improve human health, he is an elected member of the National Academy of Medicine in the US. Since February 2023, Vas is chair of the Pharmaceutical Research and Manufacturers of America (PhRMA). • **Originally from Pittsburgh, Pennsylvania,** • **Carl June, Inventor, U of Pennsylvania** • **Mike Perry, DVM, Sr VP, CSO until 2017** • **Pascal Touchon, SVP,Global Head Cell& Gene Therapy until 2019**
Based			
Ownership			
Business Model	For Profit		
Valuation	Market cap 08/11/23 236.4 B		
Financials			
Lead Product	Kymriah		
Product Type	CAR-T		
Stage	approved		
Indications	B-cell ALL ; NHL (DLBCL), follicular lymphoma		
website	Novartis.com		

Kite Pharma (Gilead)

		Key Events	Key People
	2009	• founded in 2009 by Arie Belldegrun, M.D., FACS, an Israeli-American oncologist, who served as the company's chairman, president and chief executive office • CAR-T Technology • Kite Pharma, founded in 2009, is a clinical stage biopharmaceutical company focused on the development and commercialization of novel cancer immunotherapy products designed to harness the power of a patients own immune system to eradicate cancer cells • they are developing a pipeline of product candidates for the treatment of advanced solid and hematological malignancies using their therapeutic platform – engineered Autologous Cell Therapy (eACT™) – in which a patient's own T cells, or white blood cells, are engineered to recognize and destroy their cancer. • 7 programs in helmatol. malignancies Ph. 1, 2 and one in Ph. 3 • 10/2017, Kite Pharma's therapy, Yescarta (axicabatagene ciloleucel) became the first CAR-T therapy approved by the FDA for the treatment of adult patients with relapsed or refractory large B-cell lymphoma after two or more lines of systemic therapy. 04/01/2022: Approved for initial treatment in refractory large B-cell lymphoma, • 10/201703/21/2021 FDA approval of Yescarta in follicular lymphoma	• Arie Belldegrun, M.D., FACS, an Israeli-American oncologist, who served as the company's chairman, president and chief executive officer, Founder:
Based	Santa Monica, CA		
Ownership	**Acquired by Gilead in October 2017 for $30 B**		
Business Model	For Profit		
Valuation	At IPO 6/2014 $625 M		
Financials	3/2011 Ser.. A $15 M 12/2012 Debt Fin. $250 K 5/2013 Ser.. A $20 M Alta Partners 4/2014 Venture Round $50 M IPO 6/2014 raised $127 M Delisted 8/2017		
Lead Product	Yescarta approved 10/2017 LBCL		
Product Type			
Stage			
website	https://www.kitepharma.com/		

JUNO Therapeutics (Celgene/BMS)

		Key Events	Key People
	2013	• founded in 2013 through a collaboration of the Fred Hutchinson Cancer Research Center, Memorial Sloan-Kettering Cancer Center and pediatrics partner Seattle Children's Research Institute. The company was launched with an initial investment of $120 million, with a remit to develop a pipeline of cancer immunotherapy drugs. The company raised $300 million through private funding and a further $265 million through their IPO.	• **Funders: Isabelle Rivière, Michael Jensen, Michel Sadelain, Phil Greenberg, Renier Brentjens, Stan Riddell**
Based	Seattle, WA		
Ownership	**Acquired by Celgene in January 2018 for $9 B**		
Business Model	For Profit		
Valuation	At IPO 12/2014 $1.7 B		
Financials	12/2013 Ser.. A $120 M 4/2014 Ser.. A $56 M Bezos Expeditions, Venrock 8/2014 Ser.. B $134 M IPO 12/2014 raised $264.6 M Delisted 3/2018		
Lead Product			
Product Type	CAR-T		
Stage	Breyanzi approved EU o4/2022 US 06//2022		
Indications	Large B cell Lymphoma		
website	Celgene.com		

• In December 2014 the company signed an agreement with Opus Bio, Inc for a chimeric antigen receptor (CAR-T) cell product candidate targeting CD22.In April 2015 the company entered into a collaboration with MedImmune (a subsidiary of Astra Zeneca) investigating combination treatments for cancer. The trials will assess combinations of MEDI4736 and one of Juno's CD19 directed chimeric antigen receptor T cell candidates. In May 2015, the company announced its intention to acquire Stage Cell Therapeutics for up to $223 million.[5] Later in the same month the company launched a collaboration, with Editas Medicine, to create CAR-T and high-affinity T cell receptor therapies to treat cancer. In June, 2015 the company announced a 10-year partnership with Celgene valued at $1 billion. On January 22, 2018 Juno Therapeutics was acquired by Celgene for 9B USD. **January 2019 announced Celgene to be acquired by BMS in 74B USD stock deal.; completed in November 2019 --12/19/19 FDA submission of CAR-T in refractory large cell lymphoma. May 2020 –turned down by FDA due to manufacturing concerns. Program in myeloma and lymphoma ongoing.**

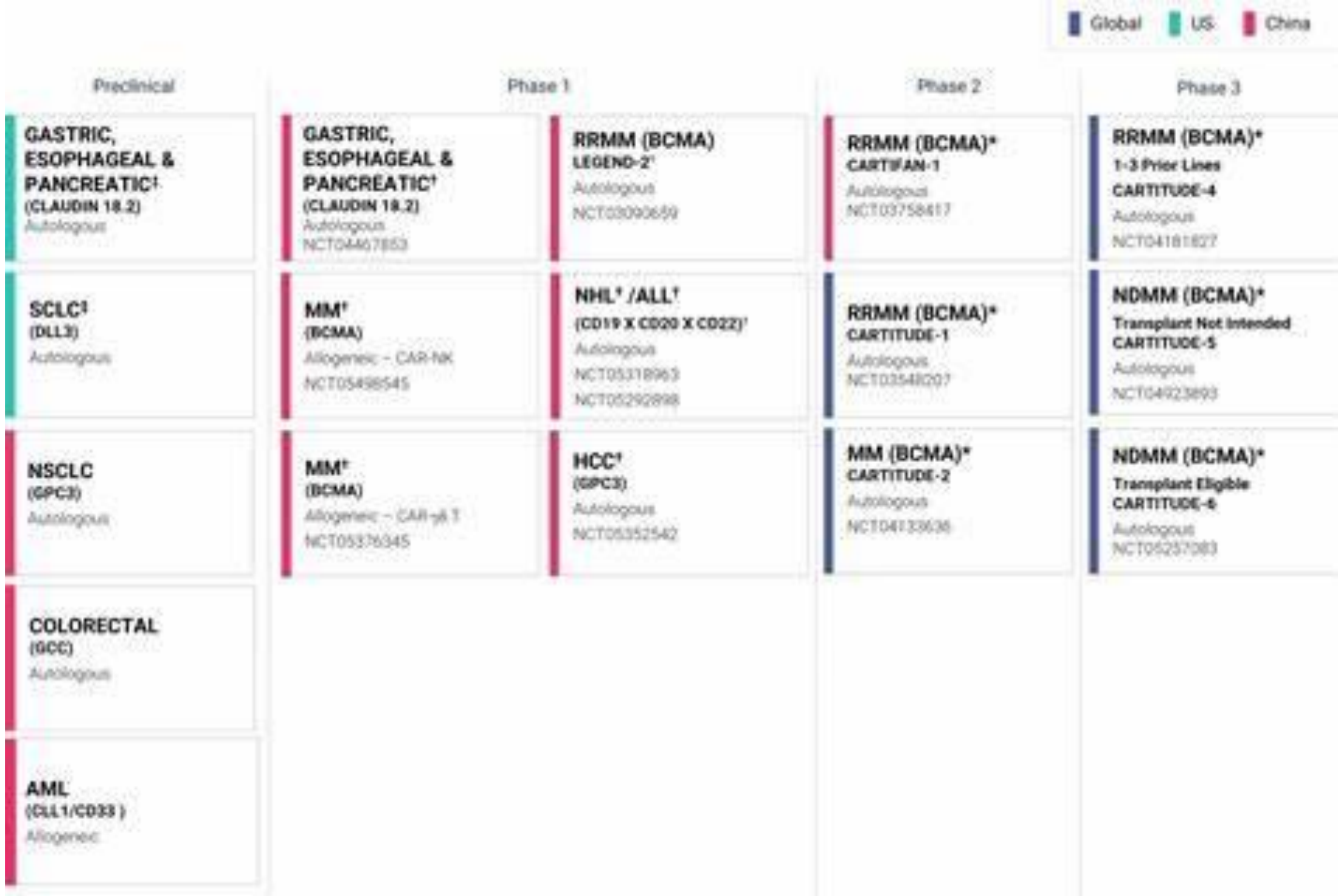
JUNO Therapeutics (Celgene/BMS)

		Key Events	Key People
	2013	• founded in 2013 through a collaboration of the Fred Hutchinson Cancer Research Center, Memorial Sloan-Kettering Cancer Center and pediatrics partner Seattle Children's Research Institute. The company was launched with an initial investment of $120 million, with a remit to develop a pipeline of cancer immunotherapy drugs. The company raised $300 million through private funding and a further $265 million through their IPO.	• **Funders: Isabelle Rivière, Michael Jensen, Michel Sadelain, Phil Greenberg, Renier Brentjens, Stan Riddell**
Based	Seattle, WA		
Ownership	**Acquired by Celgene in January 2018 for $9 B**		
Business Model	For Profit		
Valuation	At IPO 12/2014 $1.7 B		
Financials	12/2013 Ser.. A $120 M 4/2014 Ser.. A $56 M Bezos Expeditions, Venrock 8/2014 Ser.. B $134 M IPO 12/2014 raised $264.6 M Delisted 3/2018		
Lead Product			
Product Type	CAR-T		
Stage			
Indications	NHL		
website	Celgene.com		
		• In December 2014 the company signed an agreement with Opus Bio, Inc for a chimeric antigen receptor (CAR-T) cell product candidate targeting CD22.In April 2015 the company entered into a collaboration with MedImmune (a subsidiary of Astra Zeneca) investigating combination treatments for cancer. The trials will assess combinations of MEDI4736 and one of Juno's CD19 directed chimeric antigen receptor T cell candidates. In May 2015, the company announced its intention to acquire Stage Cell Therapeutics for up to $223 million.[5] Later in the same month the company launched a collaboration, with Editas Medicine, to create CAR-T and high-affinity T cell receptor therapies to treat cancer. In June, 2015 the company announced a 10-year partnership with Celgene valued at $1 billion. On January 22, 2018 Juno Therapeutics was acquired by Celgene for 9B USD. **January 2019 announced Celgene to be acquired by BMS in 74B USD stock deal.; completed in November 2019 --12/19/19 FDA submission of CAR-T in refractory large cell lymphoma. May 2020 –turned down by FDA due to manufacturing concerns. Program in myeloma and lymphoma ongoing.**	

Legend Biotech

		Key Events	Key people
Founded	2014	• Our Mission - The pursuit of a cure • Dedicated to quality and driven by excellence, we are committed to improving the lives of patients worldwide. We are steadfast in our goal to develop innovative cellular therapies that bring us closer to a cure.	Ying Huang, Ph.D. Chief Executive Officer, Legend Biotech. Prev. Chief Financial Officer, Legend Biotech. Dr. Ying Huang has served as Chief Financial Officer since July, 2019. He brings over 9 years of experience in research and development at major multi-national pharmaceutical companies and 12 years of experience as a biotechnology analyst on Wall Street. Most recently, Dr Huang was a Managing Director and Head of Biotech Equity Research at Bank of America Merrill Lynch Dr. Huang has been a biotech analyst since 2007 and previously worked at Wells Fargo (formerly Wachovia), Credit Suisse, Gand Barclays before j
Based	Somerset, NJ		
Ownership			
Business Model	For {rofit		
Valuation	**NASDAQ LEGN** **MARKET CAP 8/11/23** **12.16 B**	• Legend Biotech is actively developing cutting edge CAR-T therapies to address the unmet needs in oncology. • Legend Biotech has entered into a worldwide collaboration with Janssen Biotech, Inc. to develop and commercialize ciltacabtagene autoleucel, an investigational CAR-T for the treatment of multiple myeloma.	
Financials	Total raised 750M in 3 rounds 350M upfront payment from Janssen in license deal 2017	• *Ciltacabtagene autoleucel (cilta-cel) is an investigational B cell maturation antigen (BCMA) targeted chimeric antigen receptor T cell (CAR-T) therapy. It is being evaluated for the treatment of patients with multiple myeloma by regulatory authorities around the world • 2017 1221 annoubced collaboratij with Janssen with 350M upfront payment	
Lead Product	CARVYKTI ciltacabtagene	• 2/2022 Favorable CHMP opinion from EU Commission 2/2022 FDA approval OF Carvykti in Multiple Myeloma • 4th line	
Product Type			
Stage			
Indications			
Website	https://legendbiotech.com/		

Legend Pipeline



Protara Therapeutics (1)

		Key Events	Key People
Founded	2012	• Name change from Atara 05/2020 • A leading off-the-shelf, allogeneic T-cell immunotherapy company developing novel treatments for patients with cancer, autoimmune and viral diseases. • Our off-the-shelf, allogeneic T cells are bioengineered from donors with healthy immune function and allow for rapid delivery to patients. • Originating from over a decade of groundbreaking clinical experience at Memorial Sloan Kettering and QIMR Berghofer, Atara's T-cell immunotherapies are designed to precisely recognize and target cancerous or diseased • Atara's off-the-shelf, allogeneic T-cell immunotherapy in development, tabelecleucel, or tab-cel® (formerly known as ATA129), is being developed for the treatment of patients with Epstein-Barr virus (EBV) associated post-transplant lymphoproliferative disorder (EBV+ PTLD), **12/19/22 EBVALLO ap proved in EU off-the-shelf, allogeneic T cells** • s NOT GENE MODIFIED • and autologous ATA190 T-cell immunotherapies using a complementary targeted antigen recognition technology for specific EBV antigens believed to be important for the potential treatment of multiple sclerosis (MS)	• Jesse Shefferman is a co-founder of Protara and has led the Company since its inception through the addition of two late-stage assets, the establishment of multiple late-stage development programs and its listing on NASDAQ in early 2020. Jesse has spent over twenty years in the biopharma industry holding several strategic leadership and financial roles. • Prior to co-founding Protara, Jesse was Vice President and Head of Business Development at Retrophin Inc., a leading rare diseases company where Jesse was a member of the executive leadership team Prior to Retrophin, Jesse served as Director, Strategy and Business Development at Vertex Pharmaceuticals, Inc. focused on hepatology and rare diseases. • programs.
Based	New York, NY/ S. San Francisco		
Ownership	**NASDAQ PTRA**		
Business Model	For Profit		
Valuation	At IPO 10/2014 $52 M **Market 4/7/22 54. 9M** **8/11/23 26,96 M**		
Financials	Total cash raised: $700M		
Lead Product			
Product Type	T-cell; CAR-T		
Stage			
Indications	See table		
website	Protara.com		

Autolous Therapeutics plc

NASDAQ A		Key Events	Key People
fOUNDED	2014	utolus applies extensive programming capabilities to develop advanced autologous T cell therapies that have the potential to deliver life-changing benefits to cancer patients and is building a fully integrated, next-generation CAR T company ABOUT US Autolus is founded on advanced cell programming technology pioneered by Dr Martin Pule and was spun-out from University College London in 2014. Since its inception, the company has undergone rapid growth, systematically adding the capabilities and capital required to manufacture, develop and commercialise its programmed T cell product candidates. BLA submission planned for end of 2023	• Dr Christian Itin • CHIEF EXECUTIVE OFFICER • Christian Itin joined Autolus as Chairman of the Board of Directors at the inception of the company and subsequently also took on the role of Chief Executive Officer. In April 2021, a new Chairman was appointed with Christian remaining as Chief Executive Officer. • Previously he was Chief Executive Officer and Chairman of the Board of Directors of Cytos Biotechnology Ltd, a public biotechnology company that merged with Kuros Biosurgery Holding Ltd, and until May 2019 he served as Chairman of the Board of Directors of the merged entity, renamed Kuros Biosciences Ltd.
Based	London		
Ownership	**NASDAQ AUTL**		
Business Model	For Profit		
Valuation	**185,3 total raised in 3 rounds**		
Financials	Market cap 560,99 M 21/8/23		
Lead Product			
Product Type			
Stage			
Indications	ALL B-NHL		
website			

Protara Therapeutics (2)

		Key Events	Key People
Founded		• License agreement with Memorial Sloan Kettering Cancer Center; license, and research and development collaboration agreement with QIMR Berghofer Medical Research Institute; and strategic collaboration with H. Lee Moffitt Cancer Center. • 12/6/2020 Deal with Bayer to accelerate CAR-T development: 60M upfront +600M mile stone payments • Manufacturing plant in Thousand Oaks sold to Fuiji for 100 M and and includes continued manufacturing rights	• Jesse holds an MBA and Certificate in Health Sector Management from Duke University and a BA in Accounting from Gordon College.
Based			
Ownership			
Business Model			
Valuation			
Financials			
Lead Product			
Product Type			
Stage			
Indications			
website	Atara.com		

Cellectis S.A.(1)

		Key Events	Key people
Founded	1999	TALEN® • This ultra-precise gene-editing technology makes it possible to precisely edit the genome of any organism. • UCART (Universal Chimeric Antigen Receptor T-cells) are “off-the-shelf” allogeneic products, whose production can be industrialized and thereby standardized with consistent pharmaceutical release criteria, over time and from batch to batch. Paradigm shift in terms of ease of use, availability and the drug pricing challenge. - all allogeneic CAR T-cells engineered to be used for treating the largest number of patients with a particular cancer type. Each UCART product candidate targets a selected tumor antigen and bears specific engineered attributes, such as compatibility with specific medical regimens that cancer patients may undergo. UCART is our first therapeutic product line that we are developing with our gene editing platform to address unmet medical needs in oncology. • he UCART123 clinical trial in AML, AMELI-01, is a Phase 1, dose escalation study n January 2020 at MD Anderson Cancer Center. • 2020/02 deal with Servier Euro 25M uipfront plus 370M in milestone payments for CAR-T targeting CD-19 2020/12 GrAFT VS Host Phase 1 data favorable	• Chairman of the Board of Directors and CEO is **André Houlka** • **Philippe Duchateau, CSO** • **Bill Monteith** • **Executive Vice President, Technical Operations**
Based	Paris, France		
Ownership	**NASDAQ Global :CLSS**		
Business Model	For profit		
Valuation	Market Cap 4/7/22 209.9 M 8/11/23 93,88 M		
Financials			
Lead Product			
Product Type	CAR-T		
Stage			
Indications	AML		
website			

Cellectis S.A. (2)

		Key Events	Key people
Founded		• Cellectis has 20 years of expertise in gene editing based on its flagship TALEN® technology and pioneering electroporation system PulseAgile. This enables us to develop a new generation of immunotherapy product candidates with additional safety and efficacy attributes and equip them to resist mechanisms that inhibit immune system activity. • Cellectis is the pioneering gene editing company, deploying core proprietary technologies to develop off-the-shelf immunotherapies to target and eradicate cancer cells TALEN®	
Based			
Ownership			
Business Model			
Valuation			
Financials			
Lead Product			
Product Type			
Stage			
Indications			
website			

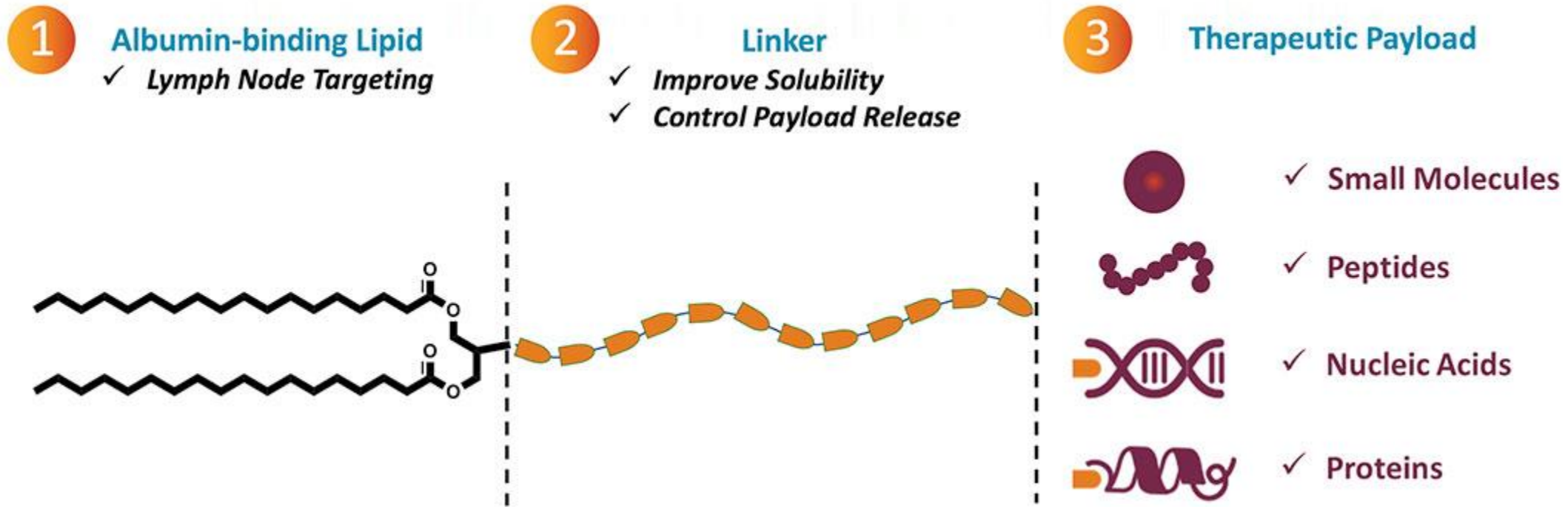
AdVerum Biotech

		Key Events	Key people
Founded	2006	• Founders: Mark S. Blumenkranz, Mitchell Finer, Steven D. Schwartz, Thomas W. Chalberg • Formerly Avalanch Biotechnologies. A clinical-stage gene therapy company targeting unmet medical need in ophthalmology and rare diseases. It develops gene therapy product candidates designed to provide durable efficacy by inducing sustained expression of a therapeutic protein. T • Leveraging its next-generation adeno-associated virus (AAV)-based directed evolution platform to engineer AAV capsids with enhanced tropism for certain tissues and improved antibody neutralization profiles over existing AAV variants. • ADVM-022 in wet AMD Phase 1 • 1/07/2021: New GMP manufacturing facility to be biilt in Research Triangle park, NC	**Leone Patterson. CEO** • **joined2016 as CFO and CEO since May 2018,** • **. Previously, CFO Diadexus, Inc. Transcept Pharmaceuticals, Inc. ,Exelixis, Inc. and Novartis AG as vice president of global business planning and analysis after working at Chiron, which was acquired by Novartis. Executive M.B.A. from St. Mary's College. Ms. Patterson is also a Certified Public Accountant (inactive status).** **Aaron Osborne, MBBS CMO 2019.** • **Prep (NHS as an ophthalmologist. Dr. Osborne brings previous experience from Genentech, Phase II and Phase III studies in wet age-related macular degeneration (AMD) and diabetic macular edema (DME),** • **Previously, Alcon. And Novartis ophthalmic programs at Novartis, where he led the medical oversight of Lucentis' late-stage development an**
Based	Redwood City , CA		
Ownership	**NASDAQ ADVM**		
Business Model	For Profit		
Valuation	At IPO 8/2014 $292 M **Market Cap 1/9/20 $1.16 B** **5/28/21 238.9M** **11/30/2021 130.8 M** **8/23/23 155.53**		
Financials	Raised 70M over three prev rounds. Raised 150M public offering closed 2/2014		
Lead Product	ADVM-022		
Product Type	AAV based engineering		
Stage			
Indications	Wet AMD		
Website	Adverum.com		

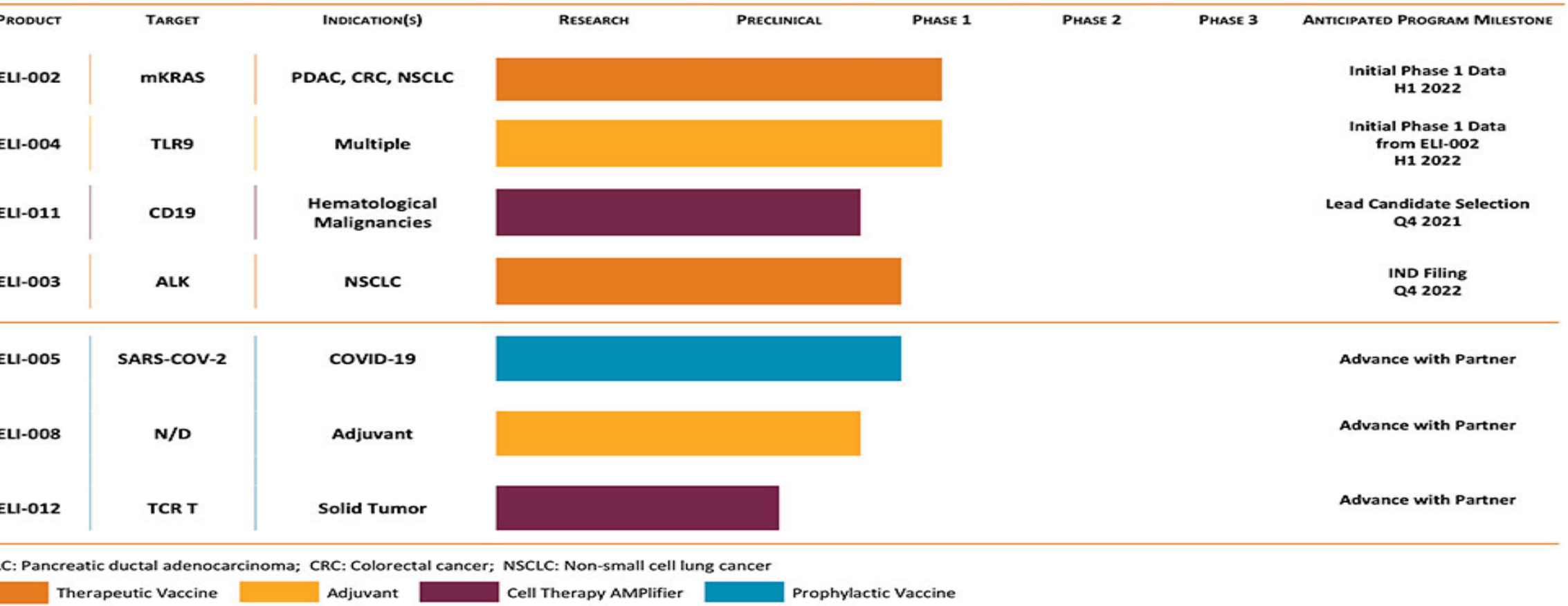
Elicio Therapeutics

2014		Key Events	Key People
Founded	2011	• Elicio Therapeutics • Founders Darrell Irvine, Satish Jindal • Elicio Therapeutics is re-engineering the body's immune response to defeat cancer with potent lymph node targeted immunotherapies. Elicio's Amphiphile platform combines expertise in materials science, immunology and immuno-oncology to develop novel immunotherapies, including cell therapy activators, immunomodulators, adjuvants and vaccines for an array of aggressive cancers.	ob joined Elicio as CEO in October 2018. He is a prolific entrepreneur and company builder/leader with 30+ years of experience in the Life Sciences sector. Since 2000, Bob has been the CEO and/or Chairman of startup or early-stage novel therapeutic companies, including as the founding CEO and first employee of Domantis (sold to GSK in 2007 for $454 million, the largest all-cash purchase of a preclinical company at that date), CEO of Pulmatrix (NASDAQ:PULM) and CEO f Axcella Health (NASDAQ:ALXA). Bob also served as a Venture Partner with Flagship Pioneering from 2013 to October 2018, working on the creation and management of 5 portfolio companies, He raised over $300 million in financing and led many partnering transactions for his companies, including product and platform license, government and foundation funding and M&A transactions while launching many innovative platforms and products across disease areas.
Based	Cambridge, MA		
Ownership	**Private**		
Business Model	For Prfofit		
Valuation			
Financials	Total Raised 172 M Incl 73M in Sries B 2/2021		

Elicio Technology Platform



Elicio Pipeline



The Gene Therapy Boom

GENE VECTOR COMPANIES

Novartis Gene Therapy (AveXis)

Ian		Key Events	Key People
Founded	2013	AveXis was founded by John D. Harkey, Jr., their former Chairman, in 2013. Under Mr. Harkey's leadership, they formed a collaboration with National Children's Hospital (NCH), Philadelphia, to explore the use of gene therapy for the treatment of Spinal Muscle Atrophy (SMA) and secured their first institutional investors and expanded their leadership team. their current operations are a result of this collaboration with NCH and research conducted by their Chief Scientific Officer, Dr. Brian Kaspar. Dr. Kaspar has over 20 years of gene therapy experience,	• John Lennon, PhD, President since 6/2018; Novartis 11 years incl. Head Oncology Japan/US, VP New Products and Portfolio Strategy; McKinsey 4 years • Brian Kaspar, CSO, and Alan Kaspar, Head of Research, left the company in May 2019, after investigation of preclinical data breach. • investors including funds and accounts managed by Adage Capital Management, L.P., Boxer Capital of Tavistock Life Sciences, Deerfield Management, Foresite Capital Management, LLC, Janus Capital Management LLC, QVT Financial LP, RA Capital Management, Roche Finance Ltd, Rock Springs Capital Management • April 09, 2018 (GLOBE NEWSWIRE) -- Novartis will acquire AveXis for $218 per share or a total of $8.7 billion in cash. Completed in May 2018 • 02/2019 Novartis invests 200M USD in building a manufacturing plant employing more than 200 people.
Based	Bannockburn, IL		
Ownership	**Acquired by Novartis in April 2018 for $8.7 B**		
Business Model	For Profit		
Valuation	At IPO 2/2016 $430 M		
website	GLOBAL ZOLGENSMASALES 2022: 1.4 B = 91% OF GLOBAL GENE THERAPY SALES Zolensma price$ 2.1 M for single dose www.avexis.com/	• In 2014 license of NAV AAV9 gene vector from REGENXBIO for treatment of spinal muscular atrophy (SMA) Type 1. The company also intends to expand the study of gene therapy into other types of SMA and two additional rare neurological monogenic disorders: Rett syndrome (RTT) and a genetic form of amyotrophic lateral sclerosis (ALS) caused by mutations in the superoxide dismutase 1 (SOD1) gene. The U.S. Food and Drug Administration (FDA) has granted AVXS-101 Orphan Drug Designation for the treatment of all types of SMA and Breakthrough Therapy Designation, as well as Fast Track Designation, for the treatment of SMA Type 1. The European Medicines Agency (EMA) also granted AveXis access into its PRIority MEdicines (PRIME) program for AVXS-101 for the treatment of SMA Type 1. **5/24/19 FDA approved the product ZOLGENSMA for pediatric patients with SMA , 186M; 03/2020 approved Japan. 052020 approved in EU by EC.**	

BioMarin

		Key Events	Key people
	1998	US and EU	• Jean-Jacques Bienaime – CEO since 2006 • 2002 to April 2005, Genencor, acquired by Danisco enterprise value of over $1.2 billion. • 1998 to late 2002, Sangstat acquisition by Genzyme Corporation. • 1992 to 1998, several senior management positions at Rhone-Poulenc Rorer Pharmaceuticals (now SanofiAventis), position of Senior Vice President of Worldwide Marketing and Business Development responsible for launch of Lovenox® (and Taxotere® (for breast and lung cancer) worldwide. • Genentech, Inc. in the launch of tissue plasminogen activator (t-PA) for the treatment of heart attacks. • M.B.A. from the Wharton and a degree in economics from the École Supérieure de Commerce de Paris.
Based	Novato, CA	EU Conditional approval 08/252022	
Ownership	**NASDAQ BMRN**	US and EU	
Business Model	Fully Integrated, 2,500 employees globally	EU Conditional approval 08/252022	
Valuation	At IPO 7/1999 $58.5 M **Market Cap 4/7/22 15.3 B 08/13/23 17.6 b**	US and EU	
Financials	IPO 7/1999 raised $58.5 M	EU Condtional approval 08/252022	
Lead Product	7 on the market	US and EU	
Product Type	Gene therapy for hemophilia A	EU Condtional approval 08/252022	

Spark Therapeutics (ROCHE)

		Key Events	Key People
Founded	2013	• Founded in March 2013 by **Katherine High, MD (Director Ctr for Cell.&Mol. Therapeutics, Children's Hospital Philadelphia CHOP)Jeffrey Marrazzo, and Steven Altschuler, MD, (President & CEO CHOP**) as a result of the technology and know-how accumulated over two decades at Children's Hospital of Philadelphia (CHOP), • At Spark Therapeutics, a fully integrated company committed to discovering, developing and delivering gene therapies, they challenge the inevitability of genetic diseases, including blindness, hemophilia and neurodegenerative diseases. • they have successfully applied their technology in the first FDA-approved gene therapy in the U.S. for a genetic disease, and currently have three programs in clinical trials, including product candidates that have shown promising early results in patients • 2017/12 FDA approved LUXTURNA (voretigene neparvovec-rzyl) intraocular suspension for subretinal injection • 2018/01 Novartis licensed Lucturna for territories outside US 2018/11 Novartis gets approval by European Commission (EC) • One treatment – cost $425,000 USD • Fidanacogene elaparvovec, previously known by its study ID number SPK-9001,[6] is an experimental drug under investigation for treatment of hemophilia B	Jeff Marrazzo , Co-founder, CEO • MBA Wharton, MP Harvard, • Led the creation and growth of Spark Therapeutics from a research center within the Children's Hospital of Philadelphia to a fully integrated, commercial gene therapy company , secured more than $1 billion in capital and built an organization of more than 325 colleagues. Katherine High, MD, Cofounder, President &CSO 2013-02/2020 **Kathy Reap, MD CMO** until 3/2020, Prep Sr VP Aergan and Actavis **John Takefman, Head of Regulatory** 214-03/2020, prev 15 years with FDA
Based	Philadelphia, PA		
Ownership	**Acquisition by Roche announced in February 2019 and completed November 2019 – 4.3B USD**		
Business Model	For Profit		
Valuation	At IPO 1/2015 $352 M		
Financials	10/2013 Ser. A $50 M Children's Hospital of Philadelphia 5/2014 Ser. B $72.8 M Sofinnova Investments IPO 1/2015 raised $160 M Delisted 2/2019		
Lead Product	Luxturna		
Product Type	AAV2		
	Leber's hereditary optic neuropathy; hemophilia B		
website	www.sparktx.com		

Sarepta Therapeutics

		Key Events	Key people
Founded	**1980**	Changed name from Antivirals to AVI BioPharma just before going public . Its primary products are based on Morpholino oligomers (PMOs), synthetic nucleic acid analogs that were conceived of by James Summerton and invented by Summerton with Dwight Weller, originally developed under the name NeuGene Antisense. Since morpholino oligomers can form sequence-specific double-stranded complexes with RNA they are suitable use in antisense therapy. Morpholinos can also work as splice-switching oligos, targeting pre-mRNA to alter splicing and so causing changes in the structure of the mature mRNA (the mechanism of the approved drug eteplirsen). Morpholinos have been tested for a wide range of applications including prevention of cardiac restenosis after angioplasty, treatment of coronary artery bypass grafts, treatment of polycystic kidney disease, redirection of drug metabolism, treatment of some mutations causing Duchenne muscular dystrophy (DMD), and inhibition of infectious diseases. 2012: Moved from Portland, OR to Cambridge MA and changed name to Sarepta Therapeutics 2//1/22 Sarepta Biotech a rushes for GenEdit's polymer nanoparticles in $57M gene editing delivery partnership	• Doug Ingram has served as President, CEO, and board member since 2017. He has no ambiguity about Sarepta's mission: • Prev. General Counsel Allergan from 2001, holding positions of increasing responsibility until being named President in 2013. When Allergan was acquired by Actavis in 2016, he moved on to Chase Pharmaceuticals, before coming to Sarepta. JD from the University of Arizona and his BS from Arizona State University. • Ian Estepan came to Sarepta in January 2015 as Head of Investor Relations. • In December 2020, Ian was appointed executive vice president and chief financial officer (CFO) of Sarepta from 2017 to 2020, he led the development of Sarepta's strategy and was a key architect in securing $2.5 billion / • BA in psychology with a concentration in pre-medicine from Columbia University
Location	**Cambridge, MA + 5 other offices around the world**		
Ownership	**NASDAQ (SRPT)** **Market cap 1/21/22: 5.53B**		
Business Model	Market cap 10.6 B 08-23-23		
Valuation	IPO 1997 raised 18 M (eval 96M), Raised 1,4B in 6 rounds, latest round 10/2021		
Financials			
Lead Product			
Product Type			
Stage	C;inical/ commercial		
Indications			
website	Sarepta.com		

Exondys 51

30 milligrams per kilogram of body weight once weekly –IV in fusion ver 35 to 60 minutes

- **Indications and Use**
- EXONDYS 51 is an antisense oligonucleotide indicated for the treatment of
- Duchenne muscular dystrophy (DMD) in patients who have a confirmed
- mutation of the DMD gene that is amenable to exon 51 skipping. This
- indication is approved under accelerated approval based on an increase in
- dystrophin in skeletal muscle observed in some patients treated with
- EXONDYS 51

Yvondys 53

30 milligrams per kilogram administered once weekly as a 35 to 60-minute intravenous infusion

Indications and Use

- VYONDYS 53 is an antisense oligonucleotide indicated for the treatment of
- Duchenne muscular dystrophy (DMD) in patients who have a confirmed mutation of the DMD gene that is amenable to exon 53 skipping.
- This indication is approved under accelerated approval based on an increase in dystrophin production in skeletal muscle observed in patients treated with VYONDYS 53.

C_____

Almondys 45

30 milligrams per kilogram administered once weekly as a 35 to 60-minute intravenous infusion

Indications and Use

_ indicated for the treatment of

- Duchenne muscular dystrophy (DMD) in patients who have a confirmed mutation of the DMD gene that is amenable to exon 45 skipping.
- This indication is approved under accelerated approval based on an increase in
- dystrophin production in skeletal muscle observed in patients treated with AMONDYS 45 [

Sarepta Pipeline Gene Therapy (1)

Clinical Phase

- SRP-9001 Micro-dystrophin***
- GALGT2 Nationwide Children’s
- GNT 0004 Genethon
- SRP-9003 (LGMD2E β-sarcoglycan)
- SRP-9004 (LGMD2D α-sarcoglycan

Preclinical

- SRP-9005 (LGMD2C γ-sarcoglycan)
- SRP-6004 (LGMD2B Dysferlin)
- SRP-9006 (LGMD2L Anoctamin 5)
- Calpain 3 (LGMD2A) Nationwide Children’s
- Neurotrophin 3 (CMT 1A) Nationwide Children's

Sarepta Gene Therapy (2)

Preclinical Phase

- Cardiomyopathy University of Florida
- CNS-1 Lacerta
- Pompe Disease Lacerta
- Niemann-Pick Type C StrideBio
- Rett Syndrome 2 StrideBio
- Dravet Syndrome StrideBio

Gene Editing

CRISPR/CAS9 (Duke University)
Duchenne
Duchenne (Harvard University)

Preclinical Phase

- Angelman Syndrome (Stride Bio)
- Angelman Syndrome
- Emery-Dreifuss muscular dystrophy Type 1 (Columbia University)
- EDMD
- Multiple Sclerosis (University of Florida)
- Multiple Sclerosis
- Rett Syndrome (University of Massachusetts)
- Rett
- Duchenne (Institute of Myology)***

UltraGenyx Pharmaceutical

		Key Events	Key People
Founded	2010	• After stepping down as CSO of BioMarin for 12 years Dr. Kakkis went on to found UltraGenyx in 2010 to focus on developing many rare and ultra-rare disease therapeutics. The company went public in January 2014 (RARE; NASDAQ). S • Grown to more than 500 employees developing treatments for seven clinical stage rare and ultra-rare diseases and has now received approvals for two new products for rare diseases, Crysvita® for XLH and Mepsevii® for MPS VII. The company works on rare metabolic, bone, muscle and neurologic diseases with no approved treatments. • 2017 acquisition of gene therapy Dimension Therapeutics for 150 M USD **APPROVED:** • Crysvita®(burosumab) X-Linked Hypophosphatemia (XLH); Mepsevii™(vestronidase alfa) Mucopolysaccharidosis 7 (MPS 7) PPELINE UX007 Long-Chain Fatty Acid Oxidation Disorders (FAOD) GENE THERAPIES: • DTX301 Ornithine Transcarbamylase (OTC) Deficiency Ph. 1-2 • DTX401 Glycogen Storage Disease Type Ia (GSDIa) Ph. 1 • Crysvita for Tumor-Induced Osteomalacia (TIO) – approved by FDA 6/19/2020 • 1/7/22 Announced collaboration with Regeneron for sales and manufacturing of evkeeza, approved by FDA and EMA in 2021 for	• **Emil D. Kakkis, M.D., Ph.D.** • **Chief Executive Officer and President,** Dr. Kakkis is currently Chief Executive Officer, President and Founder of Ultragenyx Pharmaceutical where he leads a team developing and commercializing multiple rare and ultra-rare disease treatments. • Over the last 25 years, Dr. Kakkis is best known for his work developing novel treatments for rare diseases and working on policy issues affecting rare disease treatment development. • He began his work as an assistant professor developing an enzyme replacement therapy (Aldurazyme®) for the rare disorder MPS I. • After joining BioMarin in 1998, Dr. Kakkis guided the development and approval of two more treatments for rare diseases, MPS VI and PKU
Based	Novato, CA		
Ownership	**NASDAQ RARE**		
Business Model	For Profit		
Valuation	At IPO 1/2014 $436 M Market Cap 4/7/22 5.7B 8-23-23 2.58B		
Financials	6/2011 Ser.. A $45 M 7/2012 Ser.. A $15.1 M 12/2012 Private Equity Round $75 M IPO 1/2014 raised $121 M		
Lead Product			
Product Type			
Stage	Clinical / commercial		
Indications			
website	www.ultragenyx.com		

Audentes Therapeutics (Astellas)

		Key Events	Key People
	2012 (seeded by Orbited)	• their mission is to bring innovative gene therapy products to patients living with serious, life-threatening rare diseases. 1) WAT342 for the treatment of Crigler-Najjar Syndrome -ultra-rare, severe, debilitating condition that affects skeletal muscles, leading to severe muscle weakness (hypotonia) and profound respiratory distress, often requiring invasive ventilatory support. It affects an estimated one in 50,000 newborn males worldwide, and is caused by mutations in the MTM1 gene. T132 for the treatment of X-Linked Myotubular Myopathy - High levels of bilirubin in the blood and risk of irreversible neurological damage and death. CN is estimated to affect approximately one in 1,000,000 newborns. CN is caused by mutations in the gene encoding the UGT1A1 (resulting in an inability to convert unconjugated bilirubin).AT845 for the treatment of Pompe's disease. a rare, inherited disorder characterized by severe, progressive muscle weakness and respiratory impairment. It is caused by mutations in the gene that encodes an enzyme called acid alpha-glucosidase, also known as GAA - one in every 40,000 births.AT307 for the treatment of CASQ2-related Catecholaminergic Polymorphic Ventricular Tachycardia, an inherited disease caused by mutations in the CASQ2 gene. CASQ2 encodes a protein called calsequestrin 2, which plays a key role in the physiology of calcium release in cardiac muscle cells, and which is required to maintain normal heart rhythm. 2) 2020/02/18: Announces plan to invest 109M to build new manufacturing plant in Sanford, NC	• Matt Patterson is the co-founder of Audentes Therapeutics and has served as Chief Executive Officer since the Company's inception in November 2012. Mr. Patterson is also Chairman of the Board of Directors and formerly served as President until May 2018. He has more than 25 years of experience in the research, development, and commercialization of innovative treatments for rare diseases and has held positions of senior management in both private and public biotechnology companies. Previously Mr. Patterson worked for Genzyme Corporation, BioMarin Pharmaceutical, and Amicus Therapeutics. Prior to Audentes he was an Entrepreneur-In-Residence with Orbited, the world's largest health-care dedicated investment. • The other cofounder was Thomas Schuetz, MD, PhD, also a prev.. Venture Partner with Oorbimed, current CEO of **Compass Therapeeutics.**
Based	101 Montgomery St, San Francisco, CA		
Ownership	**NASDAQ BOLD** **Acquired 12/03/2019 by Astellas for $3 B**		
Business Model	For Profit		
Valuation	Market Cap 10/2019 $1.2 B		
Financials	7/2013 Ser.. A $30 M OrbiMed 12/2014 Ser.. B $42.5 M Deerfield 10/2015 Ser.. C $65 M Redmile Group, Sofinnova Investments IPO 7/2016 raised $75 M		
Lead Product	See Next column		
Product Type			
Stage	Ph. 1-2 for first two		
Indications			

Askleipos BioTherapeutics

		Key Events	Key People
fOUNDED	2001	unded in 2001, Asklepios BioPharmaceutical, Inc. (AskBio) is a privately held, clinical-stage gene therapy company dedicated to improving the lives of children and adults with genetic disorders. AskBio's gene therapy platform includes an industry-leading proprietary cell line manufacturing process called Pro10™ and an extensive adeno-associated virus (AAV) capsid and promoter library. Based in Research Triangle Park, North Carolina, the company has generated hundreds of proprietary third generation AAV capsids and promoters, several of which have entered clinical testing. An early innovator in the space, the company holds more than 500 patents in areas such as AAV production and chimeric and self-complementary capsids. AskBio maintains a portfolio of clinical programs across a range of neurodegenerative, neuromuscular and cardiovascular indications with a current clinical pipeline that includes therapeutics for Pompe disease, Parkinson's disease and congestive heart failure, as well as out-licensed clinical indications for hemophilia and Duchenne muscular dystrophy. Learn more at https://www.askbio.com. RT	• CEO and co-founder Sheila Mikhail says the pioneering gene therapy company is hitting all its targets.
Based	Research Triangle NC		
Ownership	**Provate**		
Business Model			
Valuation	**Acquired in 10/ 2020 by Beyer for 4 B**		
Financials			
Lead Product			
Product Type			
Stage			
Indications			
website			

FerGene (Ferring Spin Out)

		Key Events	Key People
Founded	2019	• **FerGene is a new Gene therapy, spin off from Ferring Pharmaceuticals. has been created to potentially commercialize nadofaragne firadenovec in the US and to advance the global clinical development.** • **A replication-deficient recombinant adenovirus encoding human interferon alpha-2b with potential antineoplastic activity. Upon intravesical administration, nadofaragene firadenovec infects nearby tumor cells and expresses INF alpha-2b intracellularly which activates the transcription and translation of genes whose products mediate antiviral, antiproliferative, antitumor, and immune-modulating effects** • **Nadofaragene firadenovec – a 150 patient Phase 3 study completed in patients with BCG unrespnsive bladder cancer**	• **On Dec 19, 20019 announced the appointment of David Meek as President and Chief Executive Officer, effective January 14, 2020.** • **Mr. Meek has 30 years of industry y, he has served as CEO of Ipsen, a leading global biopharmaceutical company focused on innovation and specialty care and dedicated to improving lives through the discovery of new medicines in oncology, neuroscience and rare diseases.**
Based	Saint-prex, Vaud, Switzerland		
Ownership	**Private**		
Business Model	For Profit		
Valuation			
Financials	11/2019 Ferring $400 M 11/2019 Blackstone Group $170 M		
Lead Product	Nadofaragene firadenovec		
Product Type	Recombinant AAV virus		
website	FerGene.com		

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Based	Saint-prex, Vaud, Switzerland		
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Amicus Therapeutics

		Key Events	Key People
Founded	2002	• Amicus Therapeutics is a biopharmaceutical company at the forefront of developing therapies for rare and orphan diseases. The Company has a robust pipeline of novel, first-in-class, small molecules called pharmacological chaperones for the treatment of lysosomal storage diseases (LSDs). These chaperones may offer a dual-treatment approach for Fabry, Pompe, Gaucher and other LSDs. • As orally administered monotherapy agents, pharmacological chaperones are designed to bind to, stabilize and increase the activity of a patient's own misfolded enzyme. In combination with enzyme replacement therapy (ERT), pharmacological chaperones may improve the uptake of the infused enzyme and potentially improve ERT outcomes. • 9/2018 acquisition of Celenex for $452M and gene therapy programs for lysosomal storage disorders, based in Columbus, Ohio, which operates as a subsidiary of Amicus . • 10/2018 Enters collaboration the Wilson Lab at with U of Pennsylvania to develop AAV gene therapies. All programs use intrathecal delivery of the AAV vector. • 12/01/2020 Announces rolling BLA submission of two component therapeutics for treatment of Late stage Pompe's Disease. • 09 29 /2021 Amicus announces spin off of its gene therapy Unit in 600 M SPAC deal (Special Purpose acquisition Company) with Crawley as CEO	• John F. Crowley is our Chairman and CEO. J • His involvement with biotechnology stems from the 1998 diagnosis of two of his children with Pompe disease—a severe and often fatal neuromuscular disorder. • In his drive to find a cure for them, he left his position at Bristol-Myers Squibb and became an entrepreneur as the Co-founder, President and CEO of Novazyme Pharmaceuticals, a biotech start-up conducting research on a new experimental treatment for Pompe disease (which he credits as ultimately saving his children's lives). • In 2001, Novazyme was acquired by Genzyme Corporation and John continued to play a lead role in the development of a drug for Pompe disease as Senior Vice President, Genzyme Therapeutics.
Based	Cranbury, NJ		
Ownership	**NASDAQ FOLD**		
Business Model	For Profit		
Valuation	At IPO 5/2007 $330 M **Market cap 4/7/22 3.5 08/15/23 3.73B**		
Financials	Total cash raised $ 843.1 M in 13 rounds. M 5/2017 Raised $330M at IPO		
Lead Product			
Product Type			
Stage			
Indications	Lysosomal storage disorders		
website	https://www.amicusrx.com/		

Bridge Bio Pharma

		Key Events	Key People
	9/2014	• Series A 9/2017 raised 135M from VC syndicate incl Viking Global Investors, KKR, AIG, Aisling Capital, Cormorant Capital and Janus Capital • Our mission; mTo find, develop, and deliver breakthrough medicines for genetic diseases to patients as quickly and safely as possible. • Every investigational drug in our pipeline represents hope for an important segment of patients in need of a treatment. By targeting the known drivers of genetic diseases, we are applying precision medicine techniques to develop drugs that show promise • BridgeBio has had 2 exits. BridgeBio's most notable exits include MyoKardia and Eidos Therapeutics. • BridgeBio has acquired Eidos Therapeutics on Oct 5, 2020. They acquired Eidos Therapeutics for $175M. • Pipeline includes gene therapy with AAV 5 congenital adrenal hyperplasia (CAH) and AAV9 for Canavan disease • Other programs include various rare or ultra rare genetic diseases with a variety of approaches. • 12/07/2020 : Announces joint venture with Maze Therapeutics on genetics form of heart failure	• **Neil Kumar, Ph.D. has served as Founder and CEO of BridgeBio since Sept 2014** and Eidos' Chief Executive Officer and a member of its board of directors since March 2016. • and CEO of Eidos\s since 3/016. • Principal at Third Rock Ventures from 2011 -14. • B.S. and M.S. degrees chemical engineering from Stanford U, Ph.D. in chemical engineering from MIT • **Justin To VP of Business Development and Operations, Gene Therapy** • **Eli M. Wallace CSO In Residence**
Based	Virtual company based in Palo Alto, CA		
Ownership	**NASDAQ BBIO**		
Business Model	For Profit		
Valuation	**Market Cap 1/9/202 8.04B 5/28/21 8.84B 11/30/2021 5.96 B 8-23-23 4.69B**		
Financials	**Total of $949.2M in funding over 5 rounds incl. IPO 6/2019**		
Lead Product			
Product Type	Gene targeting therapies		
Stage	Preclin and Phase 3		
website			
	BridgeBio.com		

BridgeBio Pipeline

AAV Gene therapies

- **BBP-631** is an investigational adeno-associated virus (AAV) gene therapy to treat CAH due to 21-hydroxylase deficiency at its source. BBP-631 is designed to deliver a functional copy of the 21-hydroxylase gene and has been shown through multiple animal studies to result in efficient and persistent delivery to the adrenal gland, where hormones are naturally made.
- **BBP-812** is an investigational adeno-associated virus (AAV) gene therapy for Canavan disease, which begins in infancy and progresses rapidly to severe neuromuscular symptoms and early mortality. Using AAV gene therapy, we seek to deliver functional copies of the ASPA gene throughout the body and into the brain, correcting the disease. Proof-of-concept work in Canavan disease mouse models has shown that our approach restores survival and normal motor function in these disease models.
- GMP Manufacturing collaboration with Catalent

Preclinical Program

- **BBP-631** AAV5 gene therapy for congenital adrenal hyperplasia (CAH)
- **BBP-812** AAV9 gene therapy for Canavan disease (1000 pts in US+US). Partnered with Aspa

BridgeBio Other Gene Target Drugs 1/3

Disease	Pts US+EU	Treatment	Phase	Affiliate
TTR myloidosis	**400,000**	**Acoramidis small molecule**	**Phase 3**	**Eidos**
MoCD Type A (MoCD-A),	100	Fosdenopterin /syhhthetic cPMP	NDA 12/201	Origin
Gorlin Syndrome and High Frequ. Basal Cell	120,000	Patidegib Topical Gel	Phase 3	Cellepharm
chondroplasia	55,000	Low-dose infigratnibFGFR1-3 inhibit	Phase 2	QED Therapeutics
Autosomal Domin. Hypocalcemia Type 1 Hypoparathyroidism	12,000-200,000	Encaleret smnal small molecule antagonist of the calcium sensing receptor	Phase 2	calcilytix
Dystrophic Epidermolysis Bullosa	1,500	BBP-589 Recombinant Collagen 7 for rDEB	Phase 1-2	Phoenix Tissue repair
Leber Congenital/ Retinitis Pigmentosa	2,000	Synthetic Retinoid	Phase 1-2	Retinagenix

BridgeBio Other Gene Target Drugs 2/3

Disease	Bumber US+EU	Treatment	Phase	Affiliate
Limb-Girdle Muscular Dystrophy 2i (LGMD2i)	**7,000**	**BBP-418 Glycosylati Substrate Pro-drug for LGMD2i**	**Phase 1**	**ML Bioaolutiona**
Venous and lymphatic malformations (VM and LM, mutatiate dTEK / PIK3CA	117,000	Topical PI3Ka Inhibitor for VM & LM	Phase 1	Venthera
Primary Hyperoxaluria Type 1	5,000-1.5M	BBP-711 GO Inhibitor of glycolate oxidase (GO)	Preclin	CoA
PKAN & Organic Acidemias Primary Hyperoxaluria Type 1 (PH1) and frequent kidney stone formation	7,000	BBP-671 PanK Activator	Preclin	orfan
Pantothenate kinase-associ neurodegeneration (PKAN),		small molecules can bind to all three PanK isoforms	Preclin	CoA

BridgeBio Other Gene Target Drugs 3/3

Disease	Bumber US+EU	Treatment	Phase	Affiliate
Netherton Syndrome severe skin inflammation, scaling	**11,000**	**BBP-561 KLK 5/7 Inhibitor for Netherton Syndrome**	**Preclin**	**MoST**
PTEN autism	120,000	BBP-472 PI3KB inhibitor for PTEN Autism	Preclin	
Leber's Hereditary Optic europathy, (LHON)	20,000	BBP-761Succinate Pro-drug for LHON	Preclin	fortify
FGFR3 + cancers holangiocancer	37,000	High-dose infigratinib FGFR1-3 inhibitor	Phae 1	QED
RTTK driven cancers PTPN11 gene, RAS/ERK /MAPK athway	500,000	BBP-398SHP2 Inhibitor for RTK cancers	Phase 1	navire
K-RAS driven cancers	500,000	BBP-454KRAS Inhibitor	Preclin	TheRas
Multiple tumors	500,000	BBP-954 OraGPX4 neutralizes toxic free radicals.	Preclin	ferro

Krystal Biotech

		Key Events	Key People
Founded	2015	• Our modified HSV-1 is a replication-defective, non-integrating viral vector that can efficiently penetrate a broad range of skin cells. Use of our proprietary, modified HSV-1 as a gene therapy platform has a number of distinct advantages over other viral gene therapy vectors, including: 1) it can be administered topically; 2) it transduces dividing and non-dividing cells, increasing 1.7Bg the efficiency of therapeutic gene transfer; 3) it is non-replicating and is diluted by cell divisions, leading to transient transgene expression; 4) its high payload capacity can accommodate large or multiple genes; 5) it allows for repeat administration; and 6) it does not insert itself into, or otherwise disrupt, the human genome. The myriad benefits of our engineered vector make the STAR-D platform a suitable choice for direct and repeat delivery of therapeutic genes to the skin. • KB103 for Dystrophic Epidermolysis Bullosa • KB103 is Krystal's patented lead product candidate that seeks to use gene therapy to treat all forms of dystrophic epidermolysis bullosa, or DEB. KB103 uses Krystal's STAR-D technology to deliver functional human COL7A1 genes directly to the skin of affected patients. The COL7A1 genes then express functional collagen VII to form anchoring fibrils, thus stabilizing the patient's otherwise • 1/24/2020: breaks ground on 2nd commercial manufacturing site • 10/08/2020 To present positive pre clinical data at ASDS Virtual Meeting; 11/29/2021 announced positive Phase 3 results on dystrophic Epidermolysis Bullosa	• Chairman & CEO K Krish Krishnan is an accomplished biotech executive. He was specifically involved in two successful IPOs (COO/CFO of New River Pharmaceuticals, Inc., NASDAQ: NRPH) and COO of Intrexon Corporation, Inc., NYSE:XON), approval of the blockbuster drug Vyvanse (for ADHD in 2007) and the sale of New River Pharmaceuticals, Inc. to Shire Pharmaceuticals, plc for $2.6 billion. • Undergraduate degree from the Indian Institute of Technology and a graduate degree in Finance from The Wharton School at U of Penn • Founder and COO : Suma Krishnan has 25 years of drug development experience as Head of Therapeutics at Intrexon Corporation (NYSE:XON). She began her career as a discovery scientist for Janssen Pharmaceuticals, Inc. • Master of Science in Organic Chemistry from Villanova University, an M.B.A. from Institute of Management and Research.
Based	Pittsburgh, PA		
Ownership	**NASDAQ KRYS**		
Business Model	For Profit		
Valuation	At IPO 9/2017 $96.4 M **Market Cap 4/7/22 1.7B** **8-23-23 3.5B**		
Financials	8/2017 Sun Pharma $7 M IPO raised $ 546 M in 6 rounds,		
Lead Product	RSV-1 viral vector		
Product Type			
Stage			
Indications	Dystrophic Epidermolysis bullosa		
website	Krystalbio.com		

REGENXBIO Inc

		Key Events	Key People
Founded	2009	▪ Novel AAV (NAV) Technology Platform (licensed from U of Penn, developed in James Wilson's Lab)n consists of exclusive rights to AAV7, AAV8, AAV9, AAVrh10 and over 100 other novel AAV vectors (NAV Vectors). We currently have exclusive rights to over 100 patents and patent applications worldwide covering our NAV Vectors, including composition of matter claims for AAV7, AAV8, AAV9 and AAVrh10, as well as methods for their manufacture and therapeutic uses. We believe this patent portfolio forms a strong foundation for our current programs and with our ongoing research and development, we expect to continue to expand this robust patent portfolio.	• Founders: Scientific founder James Wilson, U Penn. • Cofounders: James Brown, Kenneth Mills Ken Mills: President and CEO, prev. with diagnostic companies MesoScale Diagnostics and Igen International. S.B. in chemistry from the Massachusetts Institute of Technology.
Based	Rockville, DC		
Ownership	**NASDAQ RGNX**		
Business Model	For Profit		
Valuation	At IPO 9/2015 $492 M **Market Cap 4/7/22 1,4B 08/15/23 792.6M**		
Financials	9 rounds raise $638,2M IPO 2018/08 raised $201.8 M	▪ The foundation of our NAV Technology Platform was discovered in an effort to identify next generation AAV vectors that could overcome the limitations of earlier generation AAV vectors (AAV1 through AAV6).	
Lead Product			
Product Type	AAV Vectors 7, 8 ,9, 10	• **Sex programs in Phase1/2 and a number of preclinical programs**	
Stage		• **1/08/2021 Announces pricing of private offering aiming to raise about 200M**	
Indications	See next page		
website	Regenxbio.com		

REGENXBIO PIPELINE

- RGX 314 wet age-related macular degeneration (AMD). Ph. 1/2a
- RGX121 MPS II Phase 1-2
- RGX 111 MPS I Phase 1-2
- RGX 181 Late-infantile neuronal ceroid lipofuscinosis Type 2 (or CLN2 disease) Preclin.
- RGH 501 HoFH Ph. 1-2

2017/08/25 Acquired Dimension Therapeutics for 85M USD, with two AAV gene therapy products at IND stage (DTX 301 and DTX401 , both with Orphan rug status for metabolic diseases –ornithin transcarbamylas e(OTC) deficiency, and glycogen storage disease, respectively.

Amicus Therapeutics

		Key Events	Key People
Founded	2002	• Amicus Therapeutics is a biopharmaceutical company at the forefront of developing therapies for rare and orphan diseases. The Company has a robust pipeline of novel, first-in-class, small molecules called pharmacological chaperones for the treatment of lysosomal storage diseases (LSDs). These chaperones may offer a dual-treatment approach for Fabry, Pompe, Gaucher and other LSDs. • As orally administered monotherapy agents, pharmacological chaperones are designed to bind to, stabilize and increase the activity of a patient's own misfolded enzyme. In combination with enzyme replacement therapy (ERT), pharmacological chaperones may improve the uptake of the infused enzyme and potentially improve ERT outcomes. • 9/2018 acquisition of Celenex for $452M and gene therapy programs for lysosomal storage disorders, based in Columbus, Ohio, which operates as a subsidiary of Amicus . • 10/2018 Enters collaboration the Wilson Lab at with U of Pennsylvania to develop AAV gene therapies. All programs use intrathecal delivery of the AAV vector. • 12/01/2020 Announces rolling BLA submission of two component therapeutics for treatment of Late stage Pompe's Disease. • 09 29 /2021 Amicus announces spin off of its gene therapy Unit in 600 M SPAC deal (Special Purpose acquisition Company) with Crawley as CEO	• John F. Crowley is our Chairman and CEO. J • His involvement with biotechnology stems from the 1998 diagnosis of two of his children with Pompe disease—a severe and often fatal neuromuscular disorder. • In his drive to find a cure for them, he left his position at Bristol-Myers Squibb and became an entrepreneur as the Co-founder, President and CEO of Novazyme Pharmaceuticals, a biotech start-up conducting research on a new experimental treatment for Pompe disease (which he credits as ultimately saving his children's lives). • In 2001, Novazyme was acquired by Genzyme Corporation and John continued to play a lead role in the development of a drug for Pompe disease as Senior Vice President, Genzyme Therapeutics.
Based	Cranbury, NJ		
Ownership	**NASDAQ FOLD**		
Business Model	For Profit		
Valuation	At IPO 5/2007 $330 M **Market cap 4/7/22 3.5 08/15/23 3.73B**		
Financials	Total cash raised $ 619.7 M in five rounds. M Raised $315M at IPO		
Lead Product			
Product Type			
Stage			
Indications	Lysosomal storage disorders		
website	https://www.amicusrx.com/		

Prevail Therapeutics (Lilly)

		Key Events	Key People
	2017	• Founded in a collaborative effort by Asa Abeliovich, M.D., Ph.D., OrbiMed and The Silverstein Foundation for Parkinson's with GBA, • Vision: to eradicate Parkinson's disease and related disorders. • they aim to translate recent advances in their understanding of the root genetic causes of these diseases into therapeutics for patients. • Through a partnership with REGENXBIO, they are utilizing the NAV AAV9 vector technology to advance a pipeline of gene therapy programs into therapies for patients in need. **"We e are developing potentially disease-modifying AAV9-based gene therapies for the treatment of genetically defined neurodegenerative diseases."** • **12/15/2020 Eli Lilly to buy Prevail for est 1B.**	• Asa Abeliovich is their Founder and Chief Executive Officer, bringing more than 25 years of academic and industry experience in research and the understanding of genetic and molecular mechanisms that underlie neurological disorders of aging, such as Parkinson's disease. • Prior to Prevail Therapeutics, Asa was Chief Innovation Officer and Co-Founder of Alector, a biotechnology company which is developing immune therapies for the treatment of neurodegenerative diseases. • Previously a tenured Associate Professor of Pathology, Cell Biology, and Neurology at Columbia University, as well as a member of the Taube Institute for Alzheimer's Disease and the Aging Brain. He has also previously served as an Attending Physician in Neurology at the New York-Presbyterian Hospital and the New York Psychiatric Institute. • 3 board members from OrbiMed VC
Based	New York, NY		
Ownership	ACQUIRED JAN 22 2021 BY LILLY FOR EST. $ 1 B		
Business Model	For Profit		
Valuation	Evaluation at IPO 6/2019 $578 M **Market Cap 4/7/22 787.6M**		
Financials	3/2018 Ser.. A $75 M OrbiMed 3/2019 Ser.. B $50 M Total cash raised: $129 M Raised $125 M at IPO 6/2019		
Lead Product			
Product Type			
Stage	Clinical		
Indications	See next page		
website	www.prevailtherapeutics.com		

Prevail Program

- We are a gene therapy company leveraging breakthroughs in human genetics with the goal of developing and commercializing disease-modifying AAV-based gene therapies for patients with devastating neurodegenerative diseases.

- We are applying a precision medicine approach to neurodegeneration by studying our gene therapies in genetically defined patient populations.

- We believe this will increase the probability of creating disease-modifying therapies that improve patients' lives.

- R001 for the treatment of Parkinson's disease with GBA1 mutation
  PD-GBA, and Type 2 neuropathic Gaucher's disease.
- PR006 for the treatment of frontotemporal Fronto-Temporal Dementia (FTD with GRN mutation)
- PR004 for the treatment of synucleinopathies.

Prevail – Phase 1-2 Studies

- ***Propel Study:*** PPPR001 in Parkinson's Disease :Deliver a healthy copy of the GBA1 gene to the brain. one-time injection into an area above the spinal canal called the cisterna magna — a direct, non-surgical technique that has been used safely in humans for a century.

- ***Provide Study***: PR001 in Type 2 neuropathic Gauchet Disease

- ***Proclaim Study***: PR006 single-dose gene therapy for patients with frontotemporal dementia with GRN mutations (FTD-GRN). - a rapidly progressing neurodegenerative disease caused by a lack of progranulin, a protein that is found both outside of brain cells and inside the cells, in the lysosomes.
  - Healthy levels of progranulin are necessary for cellular processes such as lysosomal function, neuronal survival and normal activity of the microglia, a type of brain-based immune cell.
  - In FTD-GRN patients, mutations in the gene GRN cause the body to produce insufficient progranulin. Without enough of the enzyme, the lysosomes cannot effectively degrade or recycle proteins. This leads to inflammation and neurodegeneration.

UniQure N.V.

		Key Events	Key People
Founded	2012	•	• Matt Kapusta • Chief Executive Officer • Mr. Matthew Kapusta joined uniQure as their chief financial officer in January 2015 and was elected to their Management Board at the 2015 annual general meeting. In December 2016 he was appointed their chief executive officer. • Collaboration agreements with 4 D Molecular Therapeutics and SyPromics regarding gene vectors expression
Based	Amsterdam, Netherlands and Lexington, MA		
Ownership	**NASDAQ QURE**	• HemGenix is AAV based gene therapy for Hemophilia B (Factor IX deficiency} approved by FDA 11/ 2022 • partnered with CSL Behring	
Business Model	For Profit		
Valuation	At IPO 2/2014 $235 M **Market Cap 425.5 M 8-23-23**		
Financials	7/2013 Private Equity Round $58 M Collar Capital IPO 2/2014 raised $88.5 M		
Lead Product	Glybera –first approved gene therapy – withdrawn from market		
Product Type			
Stage	Clinical		
Indications	See next column		
website	http://uniqure.com/		

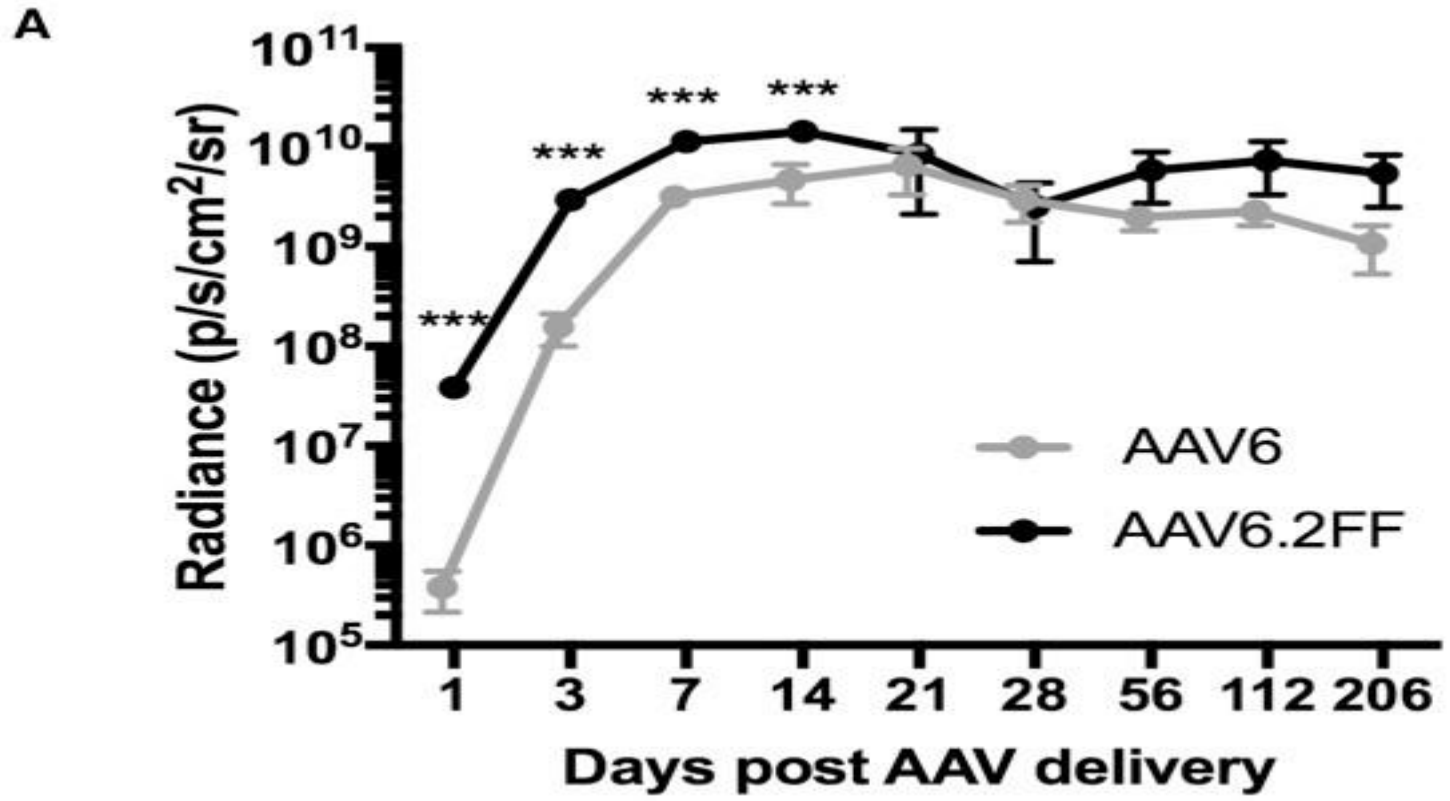
Glybera –1st EU Approved Gene Therapy

- Gene therapy to reverse lipoprotein lipase deficiency (LPLD), a rare inherited disorder which can cause severe pancreatitis.
- 1986, Michael R. Hayden and John Kastelein began research at UBC, confirming the hypothesis that LPLD was caused by a gene mutation. ULTRA RARE DISEASE PREVALNCE 1-2 PTS PER MILLION POPULATION
- 2002, Hayden and Colin Ross successfully performed gene therapy on test mice to treat LPLD; their findings were featured on the September 2004 cover of Human Gene Therapy.
- Kastelein—who had, by 1998, become an international expert in lipid disorders—co-founded Amsterdam Molecular Therapeutics (AMT), which acquired rights to Hayden's research with the aim of releasing the drug in Europe.
- In July 2012, the European Medicines Agency recommended it for approval (the first recommendation for a gene therapy Endorsed by the European Commission in November 2012. Initial price tag 1.6M per treatment (60 i.m. injections).
- AMT went bankrupt and in 2015 the assets acquired by UniQure and drug relaunched at 1M USD/treatment
- 2017 UNIQURE DECIDED NOT TO RENEW THE APPROVAL WITHDRAWN FROM MARKET –ONLY 31 PTS TREATED – ONLY ONE PATIENT HAD BEEN TREATED OUTSIDE A CLINICAL TRIAL

Cellastra Inc.

		Key Events	Key people
Founded	**2005**	04/02/2022 CELLASTRA ANNOUNCES UPDATES ON PIPELINE, PROMOTIONS AND DEVELOPMENT PLANS. “Our Series A, now ongoing will help accelerate our program from bench to bedside.” 12/10/2021 CELLASTRA ANNOUNCES SPECIAL SHAREHOLDERS MEETING TO VOTE ON INCREASING MASIMUM NJMBVER OFD SHARES FROM 10 MILLION TO 1OO MKILLION IN PREPARATION FOR PRIVATE OFFERING. 07/31/2021 Cellastra announces the License of a Recombinant AAV6 Gene Vector from University of Guelph 06/22/2021 Cellastra announces joining Centre for Advanced Medical Product,(CAMP) to explore Cellexa gene therapy in burn injuries, the company has joined CAMP, a Swedish consortium funded with grant of 48 M SEK from the Swedish government to explore new treatment modalities in burn injuries.	• **Karl Mettinger** MD, PhD, Cofounder President & CEO since 2011, 35-ear biotech veteran: (Kabi/Pharmacia (acquired by Pfizer for 60B), IVAX (acquired by TEVA) for 7 B, Supergen/Astex (acquired by Otsuka 1B), Consultant Pharmacyclics (acquired by AbbVie for 21B), Associate Prof\Karolinska Institute • **Brad Thompson**, Chairman, PhD, CTO , inventor of CLX Gene Therapy platform. Cofounder President& CEO Kickshaw Ventures, 35 year biotech veteran incl. Chair of BIOTECanada • **Vinod Kumar**, CMO, Sr VP, Prev, Section Head Global Medical Director, Novartis. >30 years experience of drug development in industry and academia • **Henrik (Hank) Kulmala**, PhD, Sr VP Product Development & RA 35-year biotech **veteran incl. Fujisawa/Astella** • **Sven Andreasson**, 40-year biotech veteran, prev. Kabi/Pharmacia (acquired by Pfizer, CEO Iscanova (acquired by NovaVax where he is currently Sr VP Corp Development • **Daniel Quintero**, General Counsel, Secretary, Founding Partner and MD Prometheus Partners LLP,
Location	**San Francisco**		
Ownership	**Private**		
Business Model	For Profit		
Valuation			
Financials			
Lead Product	CELLEXA-Scar prevention COVVEXA –Anti COVID-19		
Product Type	Recombinant AAV6.sFF gene vector programmed for local anti scarring peptide production in a wound area		
Stage			
Indications	Scar / adhesion prevention after burn injuries/ surgery res		
website	www.cellastra.com		

AAV6.2FF – Rapid and Robust Expression > 6 Months



Universal Cells, Inc (Astella)

		Key Events	Key People
	2013	• development stage company based in Seattle, Washington. Their technology is based on intellectual property developed at the University of Washington, and includes methods for genome editing in human stem cells via homologous recombination with recombinant adeno-associated virus (rAAV) vectors. • recombinant adeno-associated virus (rAAV)-mediated gene editing to efficiently edit chromosomal genes without the use of genotoxic nucleases. rAAV vectors are effective and safe, and have been used in numerous clinical trials. • Recombinant Adeno-Associated Virus • Licensed a stem cell-tropic rAAV vector serotype for engineering human pluripotent stem cells. Their technology allows us to produce customized stem cells that contain deletions, insertions, or point mutations at any genomic position. • Unlike nuclease-based genome editing, their approach is not genotoxic. It does not require a double strand break, generate off-target alterations to the genome, or produce unwanted mutations at the target site. It also does not introduce nuclease genes into the cell that may have unintended effects. • their genome editing platform has been used to generate cell lines that do not express human leukocyte antigen (HLA) molecules on their cell surface, which are critical for determining whether donor tissue will be rejected. Human pluripotent stem cells and cells differentiated from those cells fail to elicit an immune response when HLA antigens are missing from their surface.	• Claudia Mitchell is the former CEO and co-founder of Universal Cells Inc. She previously co-founded Halo-Bio RNAi Therapeutics • Ph.D. in Molecular Biology from the University of Paris and an Executive MBA from the Ecole des Ponts Business School, Paris, France. • David Russell is the CSO and co-founder, discovered the rAAV-mediated gene editing technology licensed by Universal Cells, and has used this approach to engineer HLA genes in human stem cells. • 2015 Collaboration agreement w AdaptImmune on allogeneic T Cell development. • 10/2017 agreement with Catapult. Universal Cells to utilize CGT Catapult's induced Pluripotent Stem Cells to create universally accepted cells • 02/2018 acquired by Astellas to produce pluripotent stem cells with reduced potential for immunological rejection
Based	Seattle, WA		
Ownership	**Acquired by Astellas in February 2018 for $102 M upfront + mile stone payments** **Private**		
Business Model			
Valuation			
Financials	1 round raised 60k		
Lead Product			
Product Type			
Stage			
website	http://www.universalcells.com/		

Nightstar Therap. (Biogen)

		Key Events	Key People
Founded	2013	• **Co-founder Matthew J. During, BA fro U Auckland, , fellow MIT in Neuroscience, and Harvard med School in Neology/Neurosurgery. Prof molecular Med U Auckland 1996-2013, visiting professor Oxford University since 2011,also founder of Vector Neurosciences Inc.** • their mission is to maintain and restore sight in patients with inherited retinal diseases. • they are a clinical-stage company focused on developing and commercializing a pipeline of novel and potentially curative, one-time retinal gene therapies for patients suffering from rare inherited retinal diseases that would otherwise progress to blindness, and, for which, there are no currently approved treatments. • their lead retinal gene therapy product candidate, NSR-REP1, is being developed for the treatment of choroideremia (CHM), a rare, degenerative, X-linked genetic retinal disorder primarily affecting males that is caused by a mutation in the CHM gene. • they have an ongoing Phase 3 registration clinical trial, known as the STAR trial, of NSR-REP1 for CHM. they anticipate that STAR study will be fully enrolled by the first half of 2019 and expect the one-year follow-up results of the STAR trial to be available in 2020. they are also currently conducting a prospective, natural history study, known as the NIGHT study, across multiple clinical sites in the United States, Europe and Canada.	• David Fellow, CEO, Board Member since January 2015 and previously served as a non-executive director of Nightstar from February 2014 to January 2015. • Prep. VP of Johnson & Johnson's Vision Care Franchise where he led the global marketing, new product and licensing active • Prior to that he spent over 20 years at Allergan, Inc., where he served primarily in the sales and marketing areas in a number of capacities, including regional president, corporate vice president and senior vice president in locations in North America, Europe and Asia. • B.A. from Butler University and is currently a board member of the Glaucoma Foundation.
Based	London, UK		
Ownership	**Acquired by Biogen in March 2019 for $800 M**		
Business Model	Investors Ser. C incl.. Redmile, NEA, Syncona, Wellington		
Valuation	At IPO 9/2017 $393 M		
Financials	2/2014 Venture Round £12 M 11/2015 Ser.. B $35 M New Enterprise Associates 6/2017 Ser.. C $45 M Redmile Group, Wellington Management IPO 9/2017 raised $75 M 5 rounds raised 174.6M		
Website			

Nightstar Pipeline

- Lead product candidate NSR-REP1, -designed to substantially modify or halt the progression of inherited retinal diseases AAV2 vector containing recombinant human complementary DNA, or cDNA, that is designed to produce REP1 inside the eye.

- Choroideremia (CHM) - a rare, degenerative, X-linked genetic retinal disorder primarily affecting males. Ph. 3 based on pos results in Ph. 2/2 published in NEJM, Lancet etc..,

- X-linked Retinitis Pigmentosa (XLRP) - a rare inherited X-linked recessive genetic retinal disorder primarily affecting males.

- Stargardt Disease - The form of Stargardt disease they are targeting is an autosomal recessive disease that is linked to mutations in the ABCA4 gene that are inherited from both parents

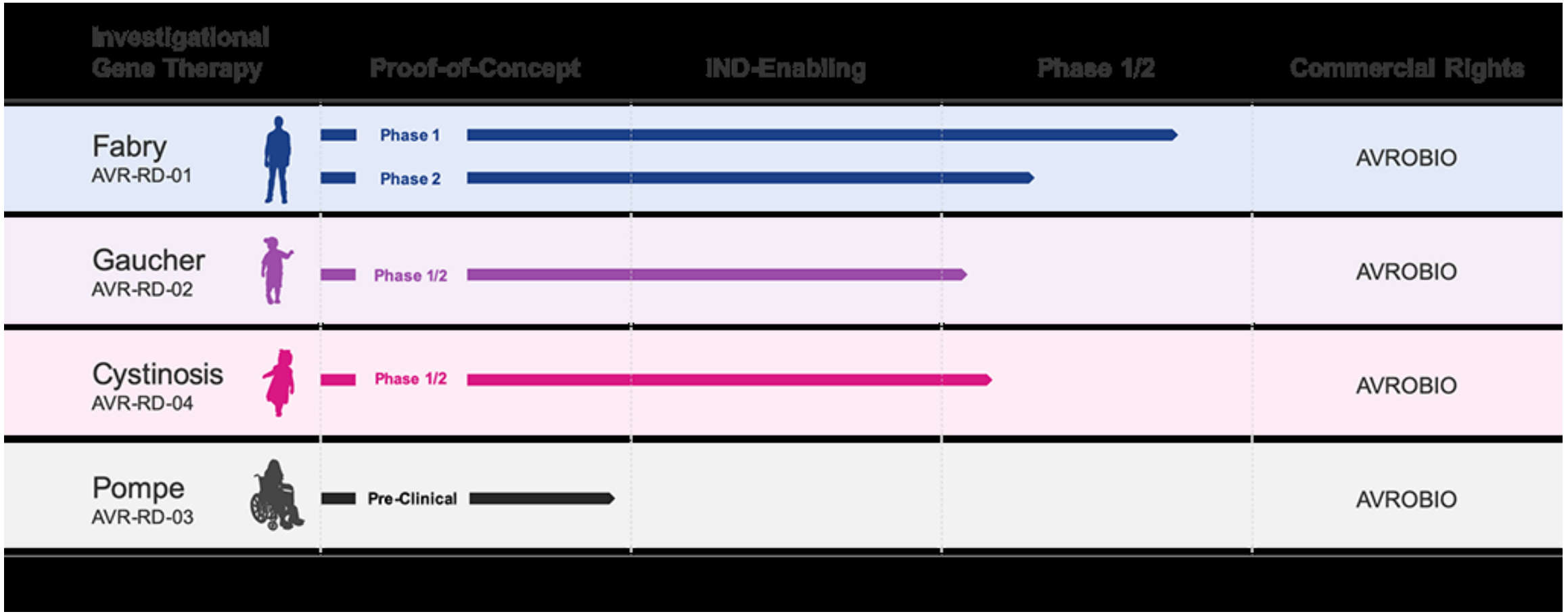
Voyager Therapeutics

		Key Events	Key People
Founded	2013	***ONE-TIME DELIVERY. BENEFITS FOR A LIFETIME.*** • Strategic collab U Mass Med School (UMMS) and UCSF • their pipeline includes VY-AADC01 for Parkinson's disease, which is in an ongoing Phase 1b study with their collaborators at the University of California, San Francisco, • preclinical programs VY-SOD01 for a monogenic form of amyotrophic lateral sclerosis (ALS) • VY-FXN01 for Friedreich's ataxia. • Voyager innovates and invests in novel adeno-associated virus (AAV) vector engineering and optimization, manufacturing that includes a baculovirus production system for producing AAV vectors at scale in insect-derived cells, and dosing that includes intraparenchymal, intrathecal and intravenous delivery techniques. 2019/01 Strategic deal with Neurocrine in Parkinson and Friedrich Ataxia under the terms of the agreement, Neurocrine Biosciences has agreed to pay Voyager $165 million in cash including a $115 million upfront payment and a $50 million equity investment.4 19/06/19: strategic partnership with Sanofi Genzyme restructured 03/08/2022: License option agreement with Novartis with on AAV TRACER capsid . $54 M upfront for first three CNS indications with additional milestone payments and lotion on two additional indications for a total value of up to `.7 B USD	**•2018 Andre Turenne, MBA, appointed President and Chief Executive Officer, prev.. Genzyme** •**<u>Founders:</u>** •**Krystof Bankiewicz, M.D., Ph.D.** Kinetics Foundation Chair in Translational Research and Professor in Residence of Neurological Surgery and Neurology, University of California at San Francisco •**Guangping Gao, Ph.D.** Director, University of Massachusetts Medical School (UMMS) Gene Therapy Center & Vector Core; Scientific Director, UMMS-China Program Office; Professor of Molecular Genetics and Microbiology, UMMS •**Mark Kay, M.D., Ph.D.** Dennis Farrey Family Professor, Head, Division of Human Gene Therapy, Departments of Pediatrics and Genetics, Stanford University School of Medicine •**Phillip Zamore, Ph.D.** Professor of Biochemistry and Molecular Pharmacology, and Chair of the RNA Therapeutics Institute, University of Massachusetts
Based	Cambridge, MA		
Ownership	**NASDAQ VYGR**		
Business Model	For Profit		
Valuation	At IPO 11/2015 $360 M **Market Cap** 4/7/22 344.18 M 8-23-23 414.86 M		
Financials	2/2014 Ser. A $45 M Third Rock Ventures 2/2015 Corporate Round $30 M Genzyme 4/2015 Ser. B $60 M IPO 11/2015 raised $70 M		
Lead Product			
Product Type			
Stage	Ph. 2 in Parkinson		
Indications	Prelim. in ataxia		
website	https://www.voyagertherapeutics.com/		

AVRO Bio Inc

		Key Events	Key People
Founded	2015	• AVROBIO, Inc., a leader in lentiviral-based gene therapies, • is a clinical stage company developing disruptive therapies that have the potential to transform patients' lives in a single dose	**Geoff MacKay,** President & CEO • Prep. CEO of Organogenesis Inc., the company treated 1 million patients with living cell therapies, received the first FDA CBER allogeneic cell-therapy approval and achieved an unparalleled position within regenerative medicine. • Founding CEO of eGenesis, applying CRISPR Cas-9 gene editing to xenotransplantation. • 11 years at Novartis in senior leadership positions Past Chairman of the Board of Alliance of Regenerative medicine (ARM). **Birgitte Volck, MD, PhD ,** President of Research & Development, • prev. Senior Vice President and Head of R&D, Rare Disease at GSK in the UK, CM) and SVP, Head of Development at Swedish Orphan Biovitrum (SOBI)
Based	Cambridge, ma		
Ownership	**NASDAQ AVRO**		
Business Model	For Profit		
Valuation	At IPO 6/2018 $440 M **Market Cap 8-23-23 85.46MTotal raised 935.4 M**		
Financials	8/2016 Ser. A $25 M Atlas Venture 2/2018 Ser. B $60 M Citadel IPO 6/2018 raised $99.7 M		
Lead Product	2020/02/19: Announces follow on public offering $100M		
Product Type	Lenti-viral based gene therapy		
Stage	Clinical		
Indications			
website	Avrobio.com		

AVRO BIO PIPELINE



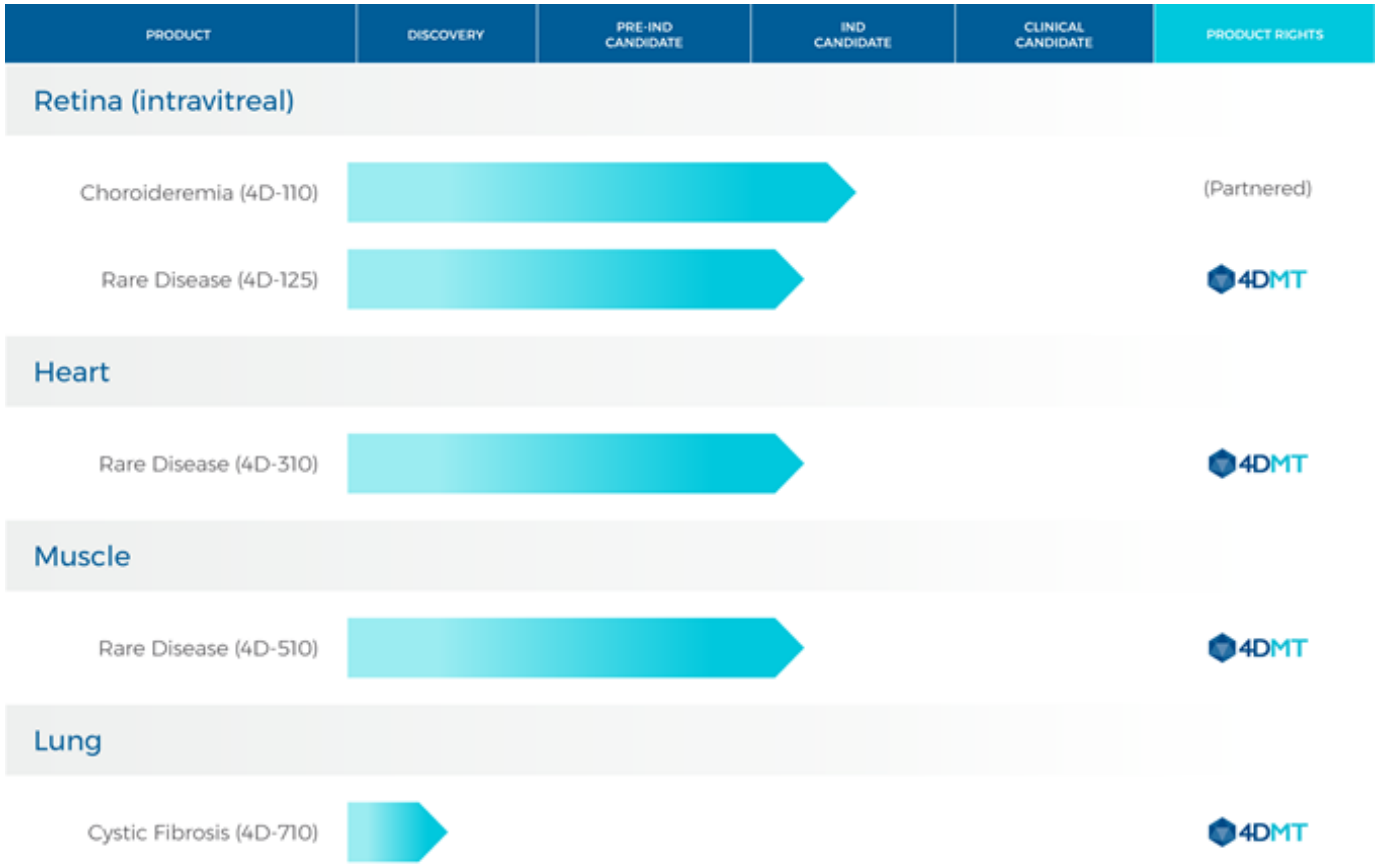
Meira GTX Holdings plc

		Key Events	Key People
Founded		• Clinical-stage gene therapy company focused on developing potentially curative treatments for patients living with serious diseases. • We currently have six programs in clinical development including four ocular indications, a salivary gland condition, and a Parkinson's disease program. • Our initial focus on diseases of the eye, salivary gland and central nervous system is based on the significant unmet medical need coupled with the high potential gene therapy has to provide meaningful clinical benefit in these areas. • AAV vector is manufactured in 20,000 sqf state-of-the-art manufacturing facility, completed in early 2018. • We currently have six programs in clinical development, including Phase 1/2 clinical stage programs in Achromatopsia (ACHM), X-Linked Retinitis Pigmentosa (XLRP) and RPE65-Deficiency, a Phase 1 program and a second Phase 1/2 trial clinical trial in radiation-induced xerostomia (RIX) and a Parkinson's program that has completed a Phase 2 trial with published data.	**Dr. Alexandria Forbes President, CEO Executive Officer** • Prep. served as Senior VP Commercial Operations at Kadmon Holdings, Inc., • Prep. healthcare investor at Sivik Global Healthcare, and Meadowvale Asset Management, • Prep. Human Frontiers/Howard Hughes postdoctoral fellow at the Skirball Institute of Biomolecular Medicine at NYU Langone Medical Center and research fellow at Duke University, and also at the Carnegie Institute at Johns Hopkins University. • Dr. Forbes received an M.A. in Natural Sciences from Cambridge University and a Ph.D. in molecular biology from Oxford University
Based	New York NY, London UK		
Ownership	**NASDAQ MGTX**		
Business Model	For Profit		
Valuation	At IPO 6/2018 $407 M **M Market cap 08-23-23 365.55** **4/7/22 315.66M**		
Financials	12/2017 Venture Round £2 M 3/2018 Ser. B $5 M Essex Bio-Technology IPO 6/2018 raised $75 M		
Lead Product			
Product Type	AAV based treatments of rare disorders		
Stage			
Indications			
website	Meiragtx.com		

4D Molecular Therapeutics

		Key Events	Key People
Founded	2013		Prior to forming 4DMT, **their CEO David Kirn MD** and development team members have developed over 10 different therapeutic viral vectors, including translation into the clinic and Phase 1-3 clinical development in over 30 clinical trials.
Based	Emeryville, CA		
Ownership	**Private**		
Business Model	For Profit		
Valuation	Market cap 4/7/22 460.M 08-23-23 711.5 M		
Financials	8/2015 Venture Round $7 M 9/2017 Venture Round $3 M Cystic Fibrosis Foundation 9/2018 Ser. B $90 M Viking Global Investors 6/2020 Ser. C $75 M Viking Global Investors Total raised 175M		
Lead Product			
Product Type			
Stage	clinical		
Indications			

4D Molecular Ther. Pipeline



Freeline Therapeutics

		Key Events	Key People
Founded	2015	• 2010 • Professor Amit Nathwani, in collaboration with St. Jude Children's Research Hospital (Memphis, Tennessee), dosed his first hemophilia B patient using a gene therapy approach. This gene therapy showed very promising results with sustained long-term activity levels. • 2015 company founded by Professor Amit Nathwani, and collaborates with St Jude's • Adenovirus-Associated Virus Vector–Mediated Gene Transfer in Hemophilia B • Long-Term Safety and Efficacy of Factor IX Gene Therapy in Hemophilia B Ph. 1-2 • Pipeline includes lysosomal storage disorders • Targeting the liver with their novel gene therapy platform enables us to treat a wide range of chronic diseases. their unique split packaging technology and their high performing capsid allows us to target monogenic diseases and in the future treat complex disease areas not currently targeted by gene therapy. they will commercialize their next-generation AAV gene therapy platform for hemophilia B, while they continue to deploy the capsid and manufacturing platform across their pipeline of novel indications.	• **Anne Prener** • **Chief Executive Officer** • Anne brings to Freeline over 25 years of experience in drug development and executive leadership across several therapeutic areas, with special focus on rare diseases and gene therapy. • Anne most recently served as the CEO of Gyroscope Therapeutics, a preclinical gene therapy company focusing on ophthalmology, where she continues to serve as a non-executive Member of the Board. From 2014-2016, Anne was VP of Clinical Research Hematology and Global Therapeutic Area Head of Hematology in Baxalta, Boston, USA. • **MD from Copenhagen University** and holds a **PhD in Epidemiology.**
Based	UK and Germany		
Ownership	**NASDAQ FRLN**		
Business Model	For Profit		
Valuation	At IPO Global Select market 8/2020 $466.6 M **Market Cap 1/9/20 $619.5M** **5/28/21 894.2M** **11/30/2021 83.09 M** **'08-23-23 18.3 M**		
Financials	al cash raised: $276 M Raised $158.8 M at IPO 8/2020		
Webdite	Freeline.com		

Tenaya Therapeutics

		Key Events	Key People
Founded	2016	Founders: • Eric Olsson e is professor and chair of the Department of Molecular Biology at the University of Texas Southwestern Medical Center in Dallas, where he also holds the Robert A. Welch Distinguished Chair in Science, the Annie and Willie Nelson Professorship in Stem Cell Research, and the Pogue Distinguished Chair in Research on Cardiac Birth Defects. • Bruce R. Conklin, MD, is a senior investigator at Gladstone Institutes. He is also a professor in the Departments of Medicine, Cellular and Molecular Pharmacology, and Ophthalmology at UC San Francisco, as well as the deputy director of the Innovative Genomics Institute. Tenaya Therapeutics is a developer of novel therapies designed to offer treatment for heart disease. The company's therapies address heart failure through multipronged efforts that target the fundamental cellular pathologies present in diseased cardiac muscle and that leverage cutting-edge research in cardiac development and regeneration, enabling physicians to regenerate heart tissue, and additional programs focused on cardiomyopathies.	Faraz Ali, MBA Chief Executive Officer Mr. Ali was most recently chief business officer at REGENXBIO, where he had accountability for corporate development, commercial planning, portfolio strategy, alliance management and corporate communications. Prior to that, he was a vice president at bluebird bio, where he had accountability for new product planning, program management, patient advocacy and external affairs. Mr. Ali also had roles of increasing global commercial leadership at Genzyme Corporation, where he helped launch multiple first-in-class enzyme replacement therapies for rare diseases. He started his career at General Electric, including technical roles at GE Healthcare and business assignments at GE Corporate. Mr. Ali received his MBA. from Harvard Business School and his B.S. from Stanford University.
Based	South San Francisco		
Ownership	**NASDAQ TNYA** **market cap 4/7/22 547.56M** **08-23-23 292.5 M**		
Business Model	For profit		
Valuation	IPO 7/2021 raised $160M		
Financials	Tenaya Therapeutics has raised a total of $248M in funding over 3 rounds. Their latest funding was raised on Mar 1, 2021 from a Series C round.		
Lead Product			
Product Type	AAV vectors Pluripotent stem cells HDAC6 Inhib		
Stage	Preclinical		
website	/tayshagtx.com		

TENAYA -DWORF GENE THERAPY

SCIENCE | JAN 15, 2016

- A peptide encoded by a transcript annotated
- as long noncoding RNA enhances SERCA

CIRCULATION RESEARCH | OCT 23, 2020

- Gene Therapy with the DWORF Micro peptide Attenuates Cardiomyopathy in Mice
- activity in muscle

ELIFE | OCT 9, 2018

- The DWORF micro peptide enhances contractility and prevents heart failure in a mouse model of dilated cardiomyopathy

TENAYA -HDAC6 INHIBITOR SMALL MOLECULE PROGRAM

2021 EUROPEAN SOCIETY OF CARDIOLOGY - HEART FAILURE CONGRESS | JUN 29, 2021
HDAC6 Inhibition Improves Diastolic Function in a Mouse Model of Heart Failure with Preserved Ejection Fraction

2021 EUROPEAN SOCIETY OF CARDIOLOGY - HEART FAILURE CONGRESS | JUN 29, 2021
Phenotypic Screening Identifies HDAC6 Inhibitors as Cardioprotective Agents

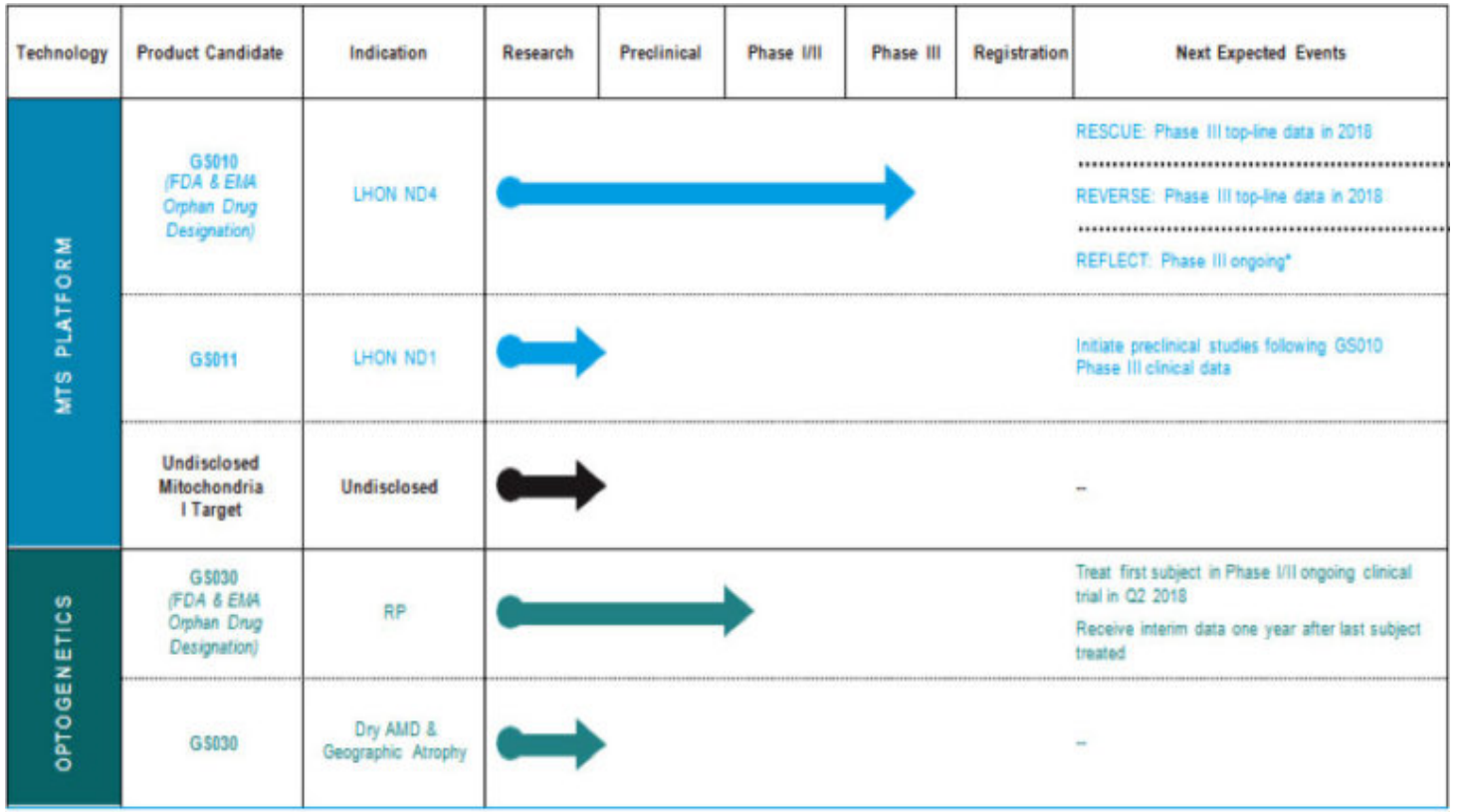
TENAYA - GENE THERAPY CAPSID ENGINEERING

2020 AMERICAN SOCIETY OF GENE & CELL THERAPY
23RD ANNUAL MEETING | MAY 12, 2020
Engineering Novel rAAV Vectors with Enhanced Cardiac Tropism

Gainsight Biologics S.A.

		Key Events	Key People
Founded	2011	• they are a clinical-stage biotechnology company discovering and developing novel therapies for mitochondrial and neurodegenerative diseases of the eye and central nervous system. To address these therapeutic areas, they leverage their integrated development platform by combining a gene therapy-based approach with their core technology platforms of mitochondrial targeting sequence, or MTS, and optogenetics. • GS010 is an AAV2 gene therapy vector that encodes the human wild-type ND4 protein, which they are developing as a treatment of LHON caused by mutation of the ND4 gene. **GS010 for Leber Hereditary Optic Neuropathy (LHON) Phase 3** • The ND4 gene is normally located in the mitochondria where ND4 proteins are synthesized. GS010 allows efficient allotopic expression of the mitochondrial gene ND4 in the nucleus thanks to a proprietary Mitochondrial Targeting Sequence that shuttles the messenger RNA from the nucleus directly to the outer membrane of the mitochondria. There, the ND4 proteins are synthesized and incorporated into the mitochondria. Wild-type ND4 proteins then integrate into Complex I of the respiratory chain and rescue the deficiency. • **GS030 for Retinitis Pigmentosa.** The leading cause of hereditary blindness in developed countries, Retinitis Pigmentosa is characterized by progressive vision loss, for which there is currently no cure. • 07/01/2020 Myriad launches GenSights Psychotopic Patient Collection Kit SEE PIPELINE NEXT PAGE	• Bernard Gilly, Ph.D., one of their founders, has served as their Chief Executive Officer since their creation. From their creation through to 2016, Bernard served as Chairman of their Board of Directors. • From 2011 through 2014, he served as Chief Executive Officer at Pixium Vision and from which date he has served as nonexecutive Chairman of the board of directors. In addition, he currently serves on the boards of Prophesee S.A. (formerly Chronocam) and Gecko Biomedical. From 2005 to 2009, he founded and was Chairman and Chief Executive Officer of Fovea Pharmaceuticals S.A., or Fovea, a privately funded company.
Based	Paris, France		
Ownership	**EPA SIGHT**		
Business Model	For Profit		
Valuation	**Market Cap4/7/22 104.57M USD** **08-23-23 ACQUIRED BY VISTA FOR 1,1 B**		
Financials	4/2013 Ser.. A €32 M Abingworth, Index Ventures, Novartis Venture Fund, Versant Ventures 7/2015 Ser.. B $36 M Total cash raised $804M in 45 rounds		
Lead Product	GS010 for Leber Optic neuropathy		
Stage	clinical		
Website	gensight-biologics.com		

Gainsight Pipeline



Technology	Product Candidate	Indication	Research	Preclinical	Phase I/II	Phase III	Registration	Next Expected Events
MTS PLATFORM	GS010 *(FDA & EMA Orphan Drug Designation)*	LHON ND4						RESCUE: Phase III top-line data in 2018 REVERSE: Phase III top-line data in 2018 REFLECT: Phase III ongoing*
	GS011	LHON ND1						Initiate preclinical studies following GS010 Phase III clinical data
	Undisclosed Mitochondrial Target	**Undisclosed**						–
OPTOGENETICS	GS030 *(FDA & EMA Orphan Drug Designation)*	RP						Treat first subject in Phase I/II ongoing clinical trial in Q2 2018 Receive interim data one year after last subject treated
	GS030	Dry AMD & Geographic Atrophy						–

* Conducting this trial under a special protocol assessment with the FDA

Taysha Gene Therapies Inc

		Key Events	Key People
Founded	1/01/2020	• Taysha Gene Therapies is a developer of treatments to eradicate severe & life-threatening monogenic diseases of the central nervous system. Taysha Gene Therapies is on a mission to eradicate monogenic CNS disease. • With a singular focus on developing curative medicines, we are able to rapidly translate our treatments from bench to bedside. We have combined our team's proven experience in gene therapy drug development and commercialization with the world-class UT Southwestern Gene Therapy Program to quickly and efficiently build an extensive, AAV9 gene therapy pipeline focused on both rare and large-market indications. This vector penetrate the Blood=-Brain • Through our partnership, we are able to leverage the collective expertise of UT Southwestern researchers, clinicians and investigators with decades of experience in conducting cutting-edge research and providing clinical care. This includes the esteemed scientists who lead the UT Southwestern Gene Therapy Program: Steven Gray, Ph.D., and Berge Minassian, M.D. • We have access to UT Southwestern's faculty, GMP viral vector manufacturing facility and integrated research and clinical care approach. Together, we believe this will enable us to advance our development programs with speed and scale. • Q4/2020 announcements: GMP manufac. Partnering Catalent, partnering with AllStripes to accelerate patient recruitment	RA Sessions, Founder CEO, $/2020 Entrepreneur in Residence UT SW 4/2019 –[recently Prep, CBO Bridge BIO, Sr VP DD AveXis, AstraZeneca, JnJ, MBA from Texas A&M University Frev. Porter CTO, Prep Sr Vp Techn Dev and Manufacturing Bridge Bio, Sr Dir Duke Humman Vaccine Inst, Head Dug Substance R&D GAK, Dept Head US Drug Substqnce (Viral Vectors); Novartis Vaccines Diagnostics, PhD Biochemistry from U Wisconsin Madison and Postdoc there
Based	Dallas. TX		
Ownership	**ymbol** **NASDAQ:TSHA** **IPO 24./9/2020 raised 181M**		
Business Model	For profit		
Valuation	Market cap 4/7/22 243.92M 08-23-23 128.29		
Financials	Series A 30 M USD 04/2020 Series B 95 M USD 8/05/2020		
Lead Product	AAV gene therapy		
Product Type			
Stage			
Indications	Various CNS indications		
website	www.tayshagtx.com		

Taysha Pipeline

Preclinical

- SHA-101 GRT GM2 GANGLIOSIDOSIS
- TSHA-118 GRT CLN1
- TSHA-104 GRT SURF1 DEFICIENCY
- TSHA-103 GRT SLC6A1 UNDISCLOSED

GRT= Gene Replacement Therapy
shRNA =short chain RNA
miRNA = microRNA

Scientific

- TSHA-112GRT/miRNA APBD
- TSHA-111 GRT/miRNA LAFORA
- TSHA-113 miRNA TAUOPATHIES
- TSHA-115 miRNA
- TSHA-106 shRNA ANGELMAN SYNDROME
- TSHA-114 GRT FRAGILE X SYNDROME
- TSHA-116 shRNA PRADER-WILLI SYNDROME
- TSHA-117 Regulated GRFOXG1 SYNDROME
- TSHA-107 GRTUNDISCLOSED TARGET
- TSHA-108 GRT UNDISCLOSED TARGET
- TSHA-109 GRT UNDISCLOSED TARGET
- TSHA-105 GRTSLC13A5UNDISCLOSED TARGET
- TSHA-110 GRKCNQ2 UNDISCLOSED TARGET

Generation Bio

		Key Events	Key People
Founded	2016	• their mission is to make the ravages of genetic diseases as imaginary to the next generation as polio and smallpox are for children. Co-founder and vice president, Robert Kotin, prev. with Voyager, scientist at NIH - developed **using close-ended DNA (ceDNA) instead of viruses.** ceDNA can move from the cytoplasm of the cell into the nucleus without a virus. It has been dubbed GeneWave technology, and the company believes it avoids the immune response that can be toxic in AAV-based gene therapy approaches. Provides durable, high levels of gene expression. This capsid-free technology enables repeated dosing and allows us to deliver transgenes of unprecedented size (>20 kb) . **Liver disorders** they are advancing a diverse portfolio of therapeutic candidates, formulated in lipid nanoparticles, for diseases of the liver. ▪ GSD1a, Glycogen storage disease type 1a (GSD1a); Hemophilia A; Progressive familial intrahepatic cholestasis (PFIC); PKU **Eye disorders**: Leber's congenital amaurosis; Stargard's disease **C05/21: OVID : anti SSARS-COV-2 spike protein expressed at relevant concentrations**	**GEOFF MCDONOUGH, MD** **President & Chief Executive Officer** Geoff formerly served as president and chief executive officer of Swedish Orphan Biovitrum AB (Sobi) from 2011 – 2017 Prior to Sobi, he held a variety of senior roles at Genzyme Corporation, including president of Genzyme Europe and senior vice president and general manager of the global lysosomal storage disease business. He obtained his **MD at Harvard Medical Schoo**l and completed his residency training in internal medicine and pediatrics at Massachusetts General Hospital and Boston Children's Hospital. Chairman BOD: Jason Rhodes is a partner at Atlas Venture.
Based	Cambridge, MA		
Ownership	**NASDAQ GBIO**		
Business Model	For Profit		
Valuation	At IPO 6/2020 $848 M **Market cap 4/7/22 499.9M** **08-23-23 325.69 M**		
Financials	1/2018 Ser. A $25 M Atlas Venture 2/2018 Ser. B $100 M Fidelity Management 1/2020 Ser. C $110 M T. Rowe Price Raised $200 M at IPO 6/2020		
Lead Product			
Product Type			
Stage	Preclinical		
Indications			
website	generationbio.com/		

Gainsight Biologics S.A.

		Key Events	Key People
Founded	2011	• they are a clinical-stage biotechnology company discovering and developing novel therapies for mitochondrial and neurodegenerative diseases of the eye and central nervous system. To address these therapeutic areas, they leverage their integrated development platform by combining a gene therapy-based approach with their core technology platforms of mitochondrial targeting sequence, or MTS, and optogenetics. • GS010 is an AAV2 gene therapy vector that encodes the human wild-type ND4 protein, which they are developing as a treatment of LHON caused by mutation of the ND4 gene. **GS010 for Leber Hereditary Optic Neuropathy (LHON) Phase 3** • The ND4 gene is normally located in the mitochondria where ND4 proteins are synthesized. GS010 allows efficient allotopic expression of the mitochondrial gene ND4 in the nucleus thanks to a proprietary Mitochondrial Targeting Sequence that shuttles the messenger RNA from the nucleus directly to the outer membrane of the mitochondria. There, the ND4 proteins are synthesized and incorporated into the mitochondria. Wild-type ND4 proteins then integrate into Complex I of the respiratory chain and rescue the deficiency. • **GS030 for Retinitis Pigmentosa.** The leading cause of hereditary blindness in developed countries, Retinitis Pigmentosa is characterized by progressive vision loss, for which there is currently no cure. • 07/01/2020 Myriad launches GenSights Psychotopic Patient Collection Kit • SEE PIPELINE NEXT PAGE	• Bernard Gilly, Ph.D., one of their founders, has served as their Chief Executive Officer since their creation. From their creation through to 2016, Bernard served as Chairman of their Board of Directors. • From 2011 through 2014, he served as Chief Executive Officer at Pixium Vision and from which date he has served as nonexecutive Chairman of the board of directors. In addition, he currently serves on the boards of Prophesee S.A. (formerly Chronocam) and Gecko Biomedical. From 2005 to 2009, he founded and was Chairman and Chief Executive Officer of Fovea Pharmaceuticals S.A., or Fovea, a privately funded company.
Based	Paris, France		
Ownership	**EPA SIGHT**		
Business Model	For Profit		
Valuation	**Market Cap4/7/22 104.57M USD**		
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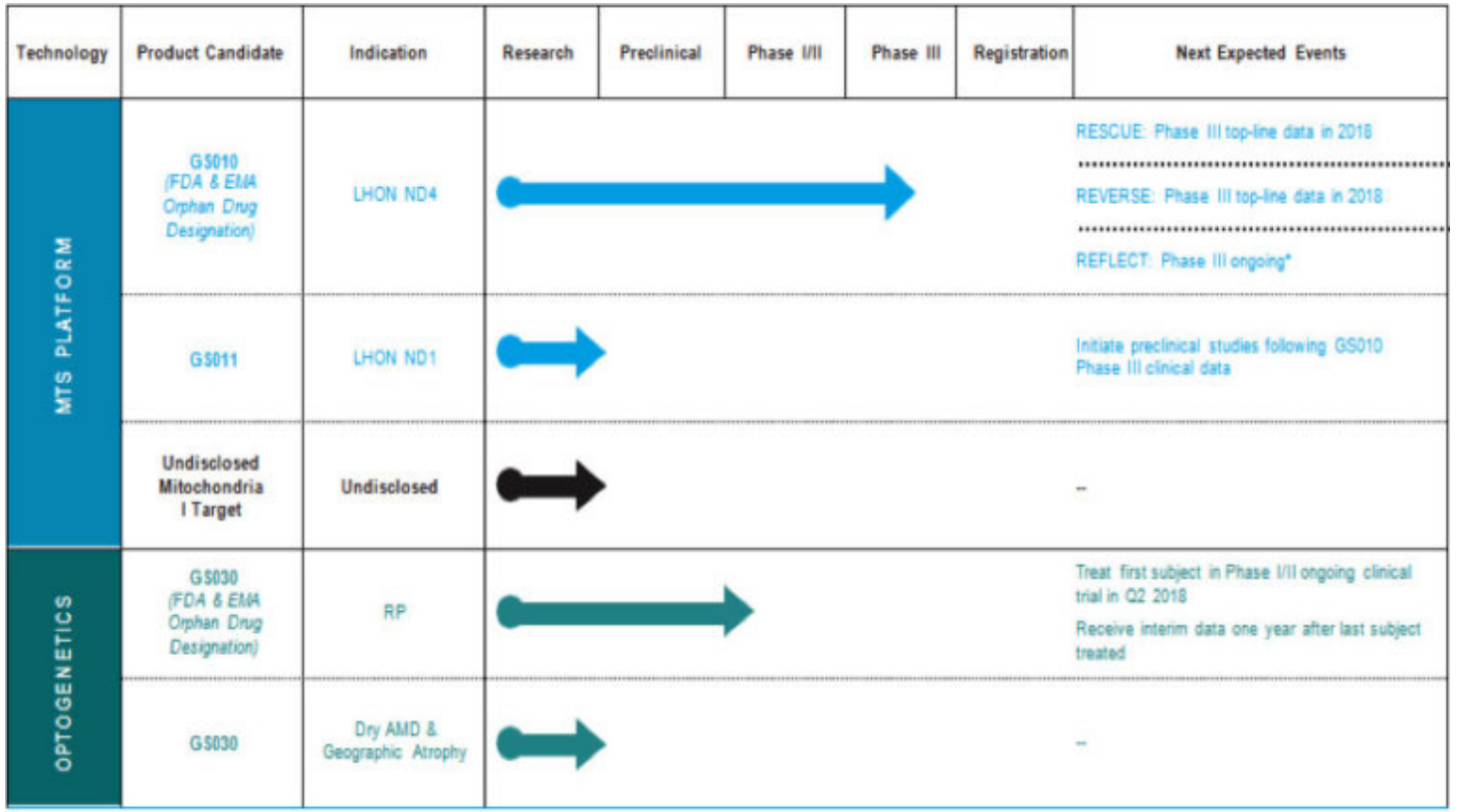
Lead Product	GS010 for Leber Optic neuropathy		
Product Type			
Stage	Clinical		
Indications	See next page		
website	gensight-biologics.com		

Gainsight Pipeline



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	Undisclosed Mitochondrial Target	**Undisclosed**						–
OPTOGENETICS	GS030 *(FDA & EMA Orphan Drug Designation)*	RP						Treat first subject in Phase I/II ongoing clinical trial in Q2 2018 Receive interim data one year after last subject treated
	GS030	Dry AMD & Geographic Atrophy						–

* Conducting this trial under a special protocol assessment with the FDA

Solid Biosciences Inc

		Key Events	Key People
Founded	2013	• Focus on muscle dystrophy: Mechanism In Duchenne, the absence or near-absence of the protein dystrophin leads to muscle membrane instability and disruption of the dystrophin glycoprotein complex (DGC). Microdystrophin is a synthetic version of the dystrophin gene that is believed to retain its key components and functionality. In preclinical models, therapeutic administration of microdystrophin by adeno-associated virus (AAV) has been shown to stabilize the DGC and restore muscle function. • Impact on Duchenne The large size of the dystrophin gene has historically prevented direct replacement as a therapeutic strategy. Preclinical studies have shown that microdystrophin AAV-mediated gene transfer enables systemic delivery of the truncated gene and has the potential to slow or halt disease progression, regardless of the type of dystrophin gene mutation.	**Ilan Ganot** started Solid in 2013 to find treatments, and potentially a cure, for Duchenne muscular dystrophy, a disease that afflicts his son Eytani. • Prior to starting Solid, Mr. Ganot was an investment banker at JPMorgan Chase in London, specializing in hedge fund driven equities business for the firm. • Also worked at Nomura Securities in London, Hong Kong and New York, where he managed relationships with investors and clients of the firm. • Prior to Nomura, Mr. Ganot was a senior salesperson for Lehman Brothers' European Equities business. • Prep. practiced law at the Israeli law-firm, Haim Zadok & Co, where his focus was private equity law and mergers and acquisitions. • MBA from London Business School and holds law and business degrees from the IDC in Herzliya, Israel.
Based	Cambridge, MA		
Ownership	**NASDAQ SLDB**		
Business Model	For Profit		
Valuation	IPO 1/2018 raised $125 M 4/7/22 13367M **Market Cap 4/7/22 133.67M**		
Financials	MARKET CAP 8-23-23 74.02 M		
Lead Product			
Product Type	AAV base gene therapy		
Stage	Phase 1		
Indications			
website	Solidbio.com		

JAGUAR Gene Therapy

		Key Events	Key People
Founded	2019	Founded by former Avexis leaders • Jaguar Gene Therapy is accelerating breakthroughs in gene therapy for patients suffering from severe genetic diseases. Led by a proven management team including former AveXis leadership, Jaguar Gene Therapy has the expertise to accelerate the development, manufacturing and commercialization of novel gene therapy treatments. The company is supported by a group of visionary	oe Nolan Chief Executive Officer Joe Nolan Joe is a results focused pharma growth leader with 30 plus years of experience building high performance teams, driving operational efficiency and growing products in competitive pharma spaces. Accountable for full P&L and revenue. Formerly AveXis, Lundbeck, and Abbott Laboratories.
Based	Lake Forest IL		
Ownership	**Private**		
Business Model			
Valuation		investors, including Deerfield Management, Eli Lilly and Company, ARCH Venture Partners, Goldman Sachs and Nolan Capital.	
Financials	Ser A and B (04/2021) 139M	• Jaguar's current pipeline utilizes the proven and well-characterized **AAV9 vector** to target diseases in patient populations with large unmet need, including galactosemia, genetic causes of autism spectrum disorder and Type 1 diabetes.	
Lead Product		• Additionally, Axovia Therapeutics, a majority-owned subsidiary of Jaguar Gene Therapy that is focused on creating transformative therapies for ciliopathies, is advancing a gene therapy treatment for BBS1, a subset of Bardet-Biedl syndrome.	Sukumar "Suku" Nagendran, MD President of R&D Sukumar "Suku" Nagendran Suku brings more than 25 years of experience in gene therapy development, clinical development strategy, medical affairs, diagnostics, payer strategy and commercialization of therapeutic products; also currently advising many other gene therapy and healthcare companies. Formerly of AveXis, Quest Diagnostics and Pfizer.
Product Type	AAV 9		
Stage	Preclinical	• 11/01/21 announced 125M investment in man.plant in NC	
website			
	https://jaguargenetherapy.com/		

Dyno Therapeutics

		Key Events	Key People
Founded	2018	Who We Are Dyno Therapeutics is pioneering an artificial intelligence (AI) powered approach to gene therapy. Using machine learning and quantitative high-throughput in vivo experimentation, we are inventing new ways to design gene vectors with a focus on cell-targeting capsid proteins from adeno-associated virus (AAV), the most widely-used vector for gene therapies. Our team includes world-class molecular and synthetic biologists, protein engineers and gene therapy scientists working alongside software engineers, data scientists, and AI and machine learning experts. As we create AI-powered gene therapies that enhance the life-changing potential of gene therapies for millions of patients, we believe the future is within reach. Dyno's CapsidMap platform represents a transformative approach applying in vivo experimental data and machine learning to create novel AAV capsids – the cell-targeting protein shells of viral vectors – designed to optimize tissue targeting and immune-evading properties, in addition to improving packaging capacity and manufacturability. Unlike traditional approaches, CapsidMap is uniquely well-suited to simultaneously optimize capsids for delivery across multiple organs, with the goal of enabling more effective whole-body treatment for many diseases. 12/01/2021 collaboration DI with Astellas worth 18M	Founders Adrian Veres, Alan Crane, Eric Kelsic,(CEO) George Church, Sam Sinai, Tomas Bjorklund
Based	Cambridge MA		
Ownership	**Private**		
Business Model			
Valuation			
Financials	Ser A raised 100M 05/2021 3 rounds raised 109M		
Lead Product			
Product Type	Novel AAV vectors		
Stage	Preclinical		
website			
	//www.dynotx.com		

Aviado Bio

		Key Events	Key People
Founded	2019	Spin out from Dementia Research Institute (DRI) Kings College, London	Professor Chris Shaw Co-Founder and Chief Scientific and Clinical Advisor
Based	London		
Ownership	**Private**	Dunged by New Enterprise Associate (NEA), with support from other Capital firms and charities.	Isa Deschamps, MB CEO since 10/2021. Prev CBO of Novartis Gene Therapies, Business head Neuroscience, Respiratory Franchise etc.
Business Model	For Profit	Prof Chris Shaw: rained as a Neurologist in New Zealand before comping to Cambridge, UK on a Wellcome Trust Fellowship and moving to King's College London in 1995. He is Director of the Maurice Wohl Clinical Neuroscience Institute, and Centre Director of the UK Dementia Research Institute at King's.	
Valuation	Market cap 1/28/2 80.76M	• His research team have discovered more amyotrophic lateral sclerosis (ALS) and frontotemporal dementia (FTD) genes than any other laboratory, enabling gene testing for patients and at-risk family members.	
Financials	Ser A 80M USD (70m GBP) 12/3/2021	• They have generated a large number of stem cell and transgenic mouse models that recapitulate key features of the human disease and have revealed important mechanistic insights.	
Lead Product		• Their focus for the future is to develop gene therapies for a wide range of neurodegenerative disorders <u>using adeno-associated viral gene vectors</u>	
Product Type			
Stage			
website			
	Aviadobio.com		

CODA Biotherapeutics

		Key Events	Key People
Founded	2014	Founders: Joseph Glorioso, Kenneth Greenberg, Nicholas Boulis CODA seeks to treat millions of people with intractable neurological diseases using innovative approaches to gene therapy. CODA Biotherapeutics' revolutionary chemogenetic platform aims to control the activity of neurons to treat disease. With chemogenetics, target neuronal populations are modified using gene therapy to express a tunable ligand-gated ion channel. These ligand-gated ion channels are engineered to be highly responsive to a specific proprietary small molecule but are otherwise inactive. The interaction of the small molecule and engineered receptor allow for exquisite, dose-dependent control of the neurons to generate therapeutic effect. CODA's engineered receptors can modulate the activity of multiple neuronal types, with expression determined by **adeno-associated virus (AAV) capsid and promoter selection. The result is the flexibility to treat many neurological disorders with varying underlying pathophysiology.**	Michael Narachi, MBA, President , Chief Executive Officer and Board Director Mike Naraghi i President and CEO. • as CEO and director at Orexigen Therapeutics. • Previously, he was at Amgen for more than 20 years • Board of Directors for Ultragenyx Pharmaceutical and for the Biotechnology Innovation Organization (BIO). • MS and a BS in genetics from the University of California (UC), Davis, MBA from the Anderson School of Management, UC, Los Angeles. Annahita Keravala, PhD , Senior Vice President, Gene Therapy and Translation Steven Dodson, PhD Senior Vice President, Development and Pharmacology
Based	South San Francisco		
Ownership			
Business Model	For profit		
Valuation	Market cap 8-23-23- 85.83M		
Financials	240M raised in total in four rounds. Ser A 11/2019: 34M 28M 12/2/2021 Market cap 1/28/22 M 4/7/22		
Lead Product			
Product Type			
Stage			
website			
	Codabiotherapeutics.com		

CODA - Modulation in three parts:

1: LIGAND-GATED ION CHANNEL

- Minimally modified human receptors, engineered to interact with defined small molecules

2: AAV VECTOR

- Proprietary AAV vectors for delivering the gene encoding the engineered receptor to enable targeted neuronal control

3: SMALL MOLECULE

- Selective pharmacological agents targeting the engineered receptor administered to provide therapeutic benefit with minimal side effects

Sio Gene therapies

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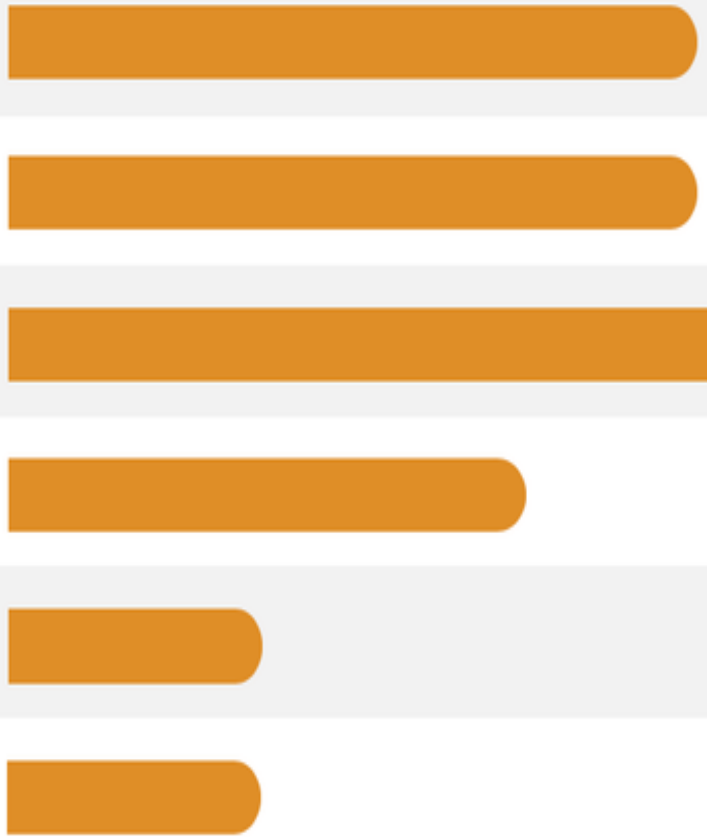
Founded		• 12/13/2020 Name change from Axovant to Sio Gene. The company was founded by former hedge fund analyst Vivek Ramaswamy[2] in 2014 as a wholly owned subsidiary of Roivant Sciences.[3] As of 2015 the company's most advanced drug candidate was intepirdine, a potential add-on treatment to donepezil for patients with Alzheimer's disease and patients with dementia with Lewy bodies.[4][2][7] Axovant acquired this molecule from GlaxoSmithKline in December 2014.[8] In July 2017, Axovant announced that the results of a Phase III trial indicated that the drug was not effective for treatment of Alzheimer's disease.[9][10] It also entered clinical trials for dementia with Lewy bodies,[11] which were unsuccessful as well. Consequently, Axovant announced in 2018 that it has discontinued development of this drug.[12] In 2018, David Hung resigned and Pavan Cheruvu became the new CEO.[19] In December 2018, Axovant added two gene therapy programs to treat GM1 gangliosidosis and Tay–Sachs and Sandhoff diseases. AXO-AAV-GM1 delivers a functional copy of the GLB1 gene via an adeno-associated viral (AAV) vector, AAV9, which is effective in crossing the blood-brain barrier and transducing neurons, with the goal of restoring β-gal enzyme activity for the treatment of GM1 gangliosidosis. The gene therapy is delivered intravenously, which has the potential to broadly transduce the central nervous system and treat peripheral manifestations. 11/25/2020 Investigation for potential securities	• David Nassif, Interim CEO (prev CEO), replaced Pawan Cheruwu (CEO since 2018) • Health Science Tech MIT and MD from Harvard, 2009 • 2 years management consultant with McKinsey
Based	Bermuda/London/NY		
Ownership	**NASDAQ SIOX**		
Business Model	For Profit		
Valuation	**Market Cap 4/7/22 50.89M**		
Financials	IPO 6/2015 raised $315 M 01/19/2020 announces pricing of public offering of 14 million shares: $3.75/share 2 rounds raised 129.7M		
Lead Product	See pipeline next page		
Product Type			
Stage	Clinical		

Sio Gene Therapies Pipeline

PROGRAM	GENE	INDICATION	RESEARCH	PRE-CLINICAL	CLINICAL	MARKETED
AXO-AAV-GM1	*GLB1*	GM1 gangliosidosis				
AXO-AAV-GM2	*HEXA/HEXB*	Tay-Sachs and Sandhoff diseases (GM2 gangliosidosis)				
AXO-LENTI-PD	*AADC/TH/CH1*	Parkinson's disease				
AXO-AAV-OPMD	*PABPN1*	Oculopharyngeal muscular dystrophy				
AXO-AAV-ALS	*C9orf72*	Amyotrophic lateral sclerosis				
AXO-AAV-FTD	*C9orf72*	Frontotemporal dementia				



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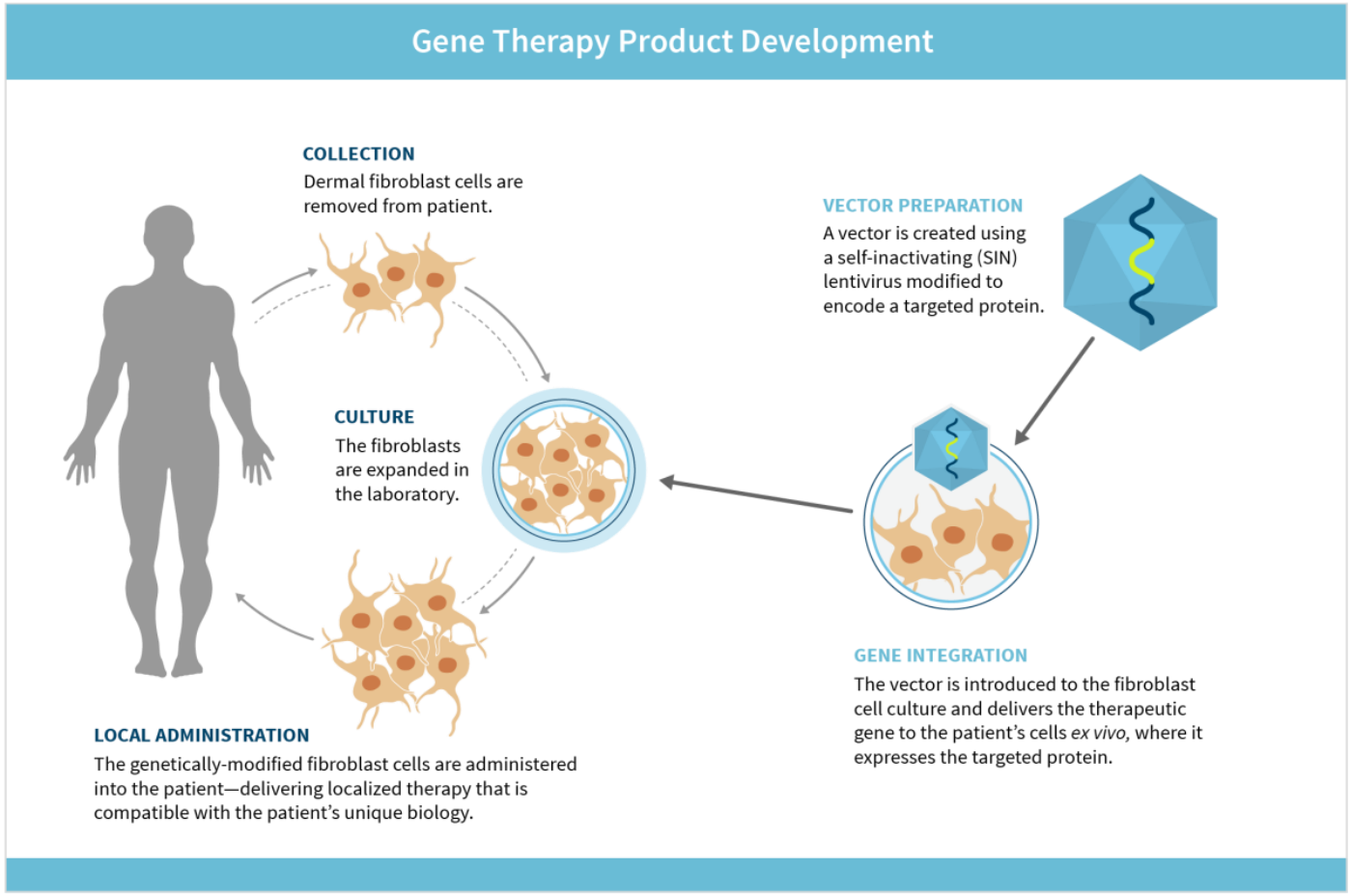
Fibrocell Science Inc

		Key Events	Key People
Founded	1993	1. reached an agreement to acquire Exton, PA-based Fibrocell Science, Inc., a cell and gene therapy company focused on transformational autologous cell-based therapies for skin and connective tissue diseases. 2. With the resources of CCP Holdings' subsidiary, Castle Creek Pharmaceuticals Fibrocell's gene therapy platform can be advanced into additional areas of high, unmet need with the potential to develop multiple, promising new therapies. 3. "Our current licensing and development collaboration with Fibrocell, which began in April 2019, has cemented a shared focus on delivering the first approved therapies for families who are impacted by rare dermatologic conditions like epidermolysis bullosa (EB), a chronic, painful and debilitating disease that leads to severe blistering starting early in life and can only be treated with palliative care including extensive bandaging," said Greg Wujek, chief executive officer of Castle Creek. 4. "As one company, we will be in a strong position to push forward initially with two late-stage clinical development programs targeting different types of EB with investigational gene and topical therapies, ".	• John Maslowski Former Exec Officer, President Sr VP
Based	Exton Pennsylvania		
Ownership			
Business Model			
Valuation	**Dec 16 2016: Announcement of agreement to be acquired by castle Creek Pharma for 63.3 M**		
Financials	Total funding 34.7 M		
Lead Product	See pipeline next page		
Product Type			
Stage	Clinical		

Fibrocell Gene Therapy



Fibrocell Pipeline

Program	Condition	Target	Research	Pre-Clinical	Phase 1/2 Clinical Trials	FDA Regulations
FCX-007	Recessive Dystrophic Epidermolysis Bullosa (RDEB)	Type VII Collagen				✓ Orphan Drug ✓ Rare Pediatric Disease ✓ Fast Track
FCX-013	Moderate to Severe Localized Scleroderma	MMP-1				✓ Orphan Drug ✓ Rare Pediatric Disease ✓ Fast Track
Research	Arthritis and Related Conditions	TBD				

Lysogene S.A.

		Key Events	Key People
Founded	2009	• LYSOGENE was founded in 2009, by Karen Aiach and Olivier Danos, with a focused scientific development plan, pragmatic approach and a bold mission. The company was built on a comprehensive understanding of the impact of neurodegenerative diseases on patients and families. • Lysogene has generated five non-cumulative years of clinical safety data to show the efficiency of a direct delivery route to the CNS with its initial gene therapy trial for MPS IIIA. Lysogene has recently completed the enrollment for the first multi-national observational study in MPS IIIA which will function as the non-concurrent control for the first pivotal trial for MPS IIIA in Q1 2018. Lysogene also plans a clinical trial for GM1 Gangliosidosis for 2019. Lysogene has obtained orphan drug designation from the EMA and FDA and rare pediatric designation by the FDA for both programs. • <u>MPS IIIA Phase I Pivotal Ph. 2-3 to start late 2018</u> • 10/2018: Long-term Follow-up of MPS IIIA Patients Treated by Intracerebral LYS SAF301 Gene Therapy licensing deal with Sarepta on US rights to gene therapy, LYS-SAF302, to treat Mucopolysaccharidosis type IIIA (MPS IIIA).	• Karen Aiach • **Founder, Chief Executive Officer** • Ms. Aiach is also the mother of a child with MPS IIIA. She has a strong business background starting her career with Arthur Andersen specializing in audit and transaction services. Her entrepreneurial experience includes founding and running a financial business consultancy. From 2008 to 2009, Ms. Aiach served as a Member of the Pediatric Committee at the European Medicines Agency (EMA), established in accordance with the European Pediatric Regulation, as a patient representative. In 2008, she also served on the French Ethical Review Board CCPPRB at Ambroise Paré Hospital.
Based	Paris, France		
Ownership	FR0013233475 / LYS Listed on: Euronext Stock Exchange **EPA LYS**		
Business Model	For Profit		
Valuation	**Market Cap 1/28/22 29.62M**		
Financials	5/2014 Ser.. A $22 M Sofinnova Investments 3 rounds raised 30.3M		
Lead Product			
Product Type			
Stage	Phase 1		
Indications			
website	www.lysogene.com		

Abeona Therapeutics

		Key Events	Key People
	1989	• Abeona Therapeutics Inc. is a clinical-stage biopharmaceutical company developing gene therapies for life-threatening rare genetic diseases. Abeona's lead programs include: • ABO-102 (AAV-SGSH), an adeno-associated virus (AAV) based gene therapy for Sanfilippo syndrome type A (MPS IIIA) and EB-101 (gene-corrected skin grafts) for recessive dystrophic epidermolysis bullosa (RDEB). • Abeona is also developing ABO-101 (AAV-NAGLU) for Sanfilippo syndrome type B (MPS IIIB), • ABO-201 (AAV-CLN3) gene therapy for juvenile Batten disease (JNCL), ABO-202 (AAV-CLN1) for treatment of infantile Batten disease (INCL), • EB-201 for epidermolysis bullosa (EB), • ABO-301 (AAV-FANCC) for Fanconi anemia (FA) disorder • ABO-302 using a novel CRISPR/Cas9-based gene editing approach to gene therapy for rare blood diseases. • In addition, Abeona has a proprietary vector platform, AIM™, for next generation product candidates.	• **r**. Vishwas (Vish) Seshadri, Ph.D., M.B.A., joined Abeona as Head of Research & Clinical Development in June 2021 and was appointed President and Chief Executive Officer, and member of the Company's Board of Directors, in October 2021. • at Celgene Corporation, now a subsidiary of Bristol-Myers Squibb Company (BMS), where he focused on development and commercialization of novel therapies in hematology and oncology. Most recently, he led the team responsible for the launch of Breyanzi® (lisocabtagene maraleucel; liso-cel), an autologous CD19-directed chimeric antigen receptor (CAR) T cell therapy for relapsed or refractory large B-cell. • Ph.D. in Microbiology, Immunology & Molecular Biology and his post-doc in epigenetics at University of Arizona, MBA vfrom Wharton School of the University of Pennsylvania.
Based	Cleveland, OH		
Ownership	**NASDAQ ABEO**		
Business Model	For Profit		
Valuation	**Market Cap 11/28/22 24.23 M**		
Financials	Total cash raised: $232.2 M 11 rounds raised 334.7M		
Lead Product			
Product Type			
Stage	Ph. 1-2 (3 drugs)		
Indications	See next column		
website	www.abeonatherapeutics.com/		