CALIFORNIA'S STEM CELL AGENCY

CALIFORNIA INSTITUTE FOR REGENERATIVE MEDICINE

Development Projects – Progress Update

Pre-Read for March 13, 2014 ICOC meeting

Agenda Item #10

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Senior Vice President, Research and Development

CIRM's Vision and Strategy

Mission

"To support and advance stem cell research and regenerative medicine under the highest ethical and medical standards for the discovery and development of cures, therapies, diagnostics, and research technologies to relieve human suffering from chronic disease and injury"

Explore (2004-2010)

- Fund broad number of diseases and projects
- Establish foundation for leadership in stem cell research

Focus (2011-2016)

- Prioritize projects and investments
- Drive clinical trials for patients to generate preliminary evidence of therapeutic benefit
- Develop partnerships

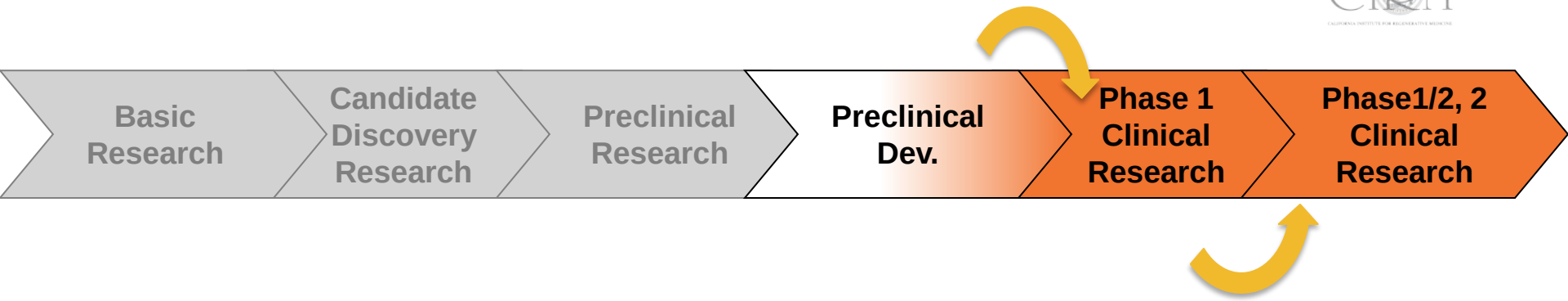
Deliver (2016+)

- Facilitate commercialization of therapies
- Advance therapies to patients
- Enable business model for stem cell-based therapies

CIRM progress towards our mission

- Approx 600 research and facilities awards to over 60 institutes and companies
- 12 new institutes and centers of regenerative medicine
- Over 1800 major scientific papers published
- Over 130 new major stem cell researchers in California
- Approx 90 translational/development projects
  - 63 Early Translation projects - research (preclinical) to show preclinical proof of concept/identify potential therapy candidates
  - 27 Development projects - on regulatory pathway to patients in clinical trials
- >$600 M towards translational programs of $1.8 B awarded

Disease Team Program
Strategic Partnership Program



Program Goal: Enable preclinical development to file IND with the FDA to enter clinical trials in patients and/or to complete clinical trial; for Strategic Partnership to attract industry engagement and investment

Outcomes: Within 4 years,

- Complete IND enabling studies to file IND to enter FIH and/or
- Complete clinical trial to establish feasible dose, delivery that is safe with evidence of biologic activity and/or clinical parameters of preliminary efficacy

CIRM helps development teams build product development experience

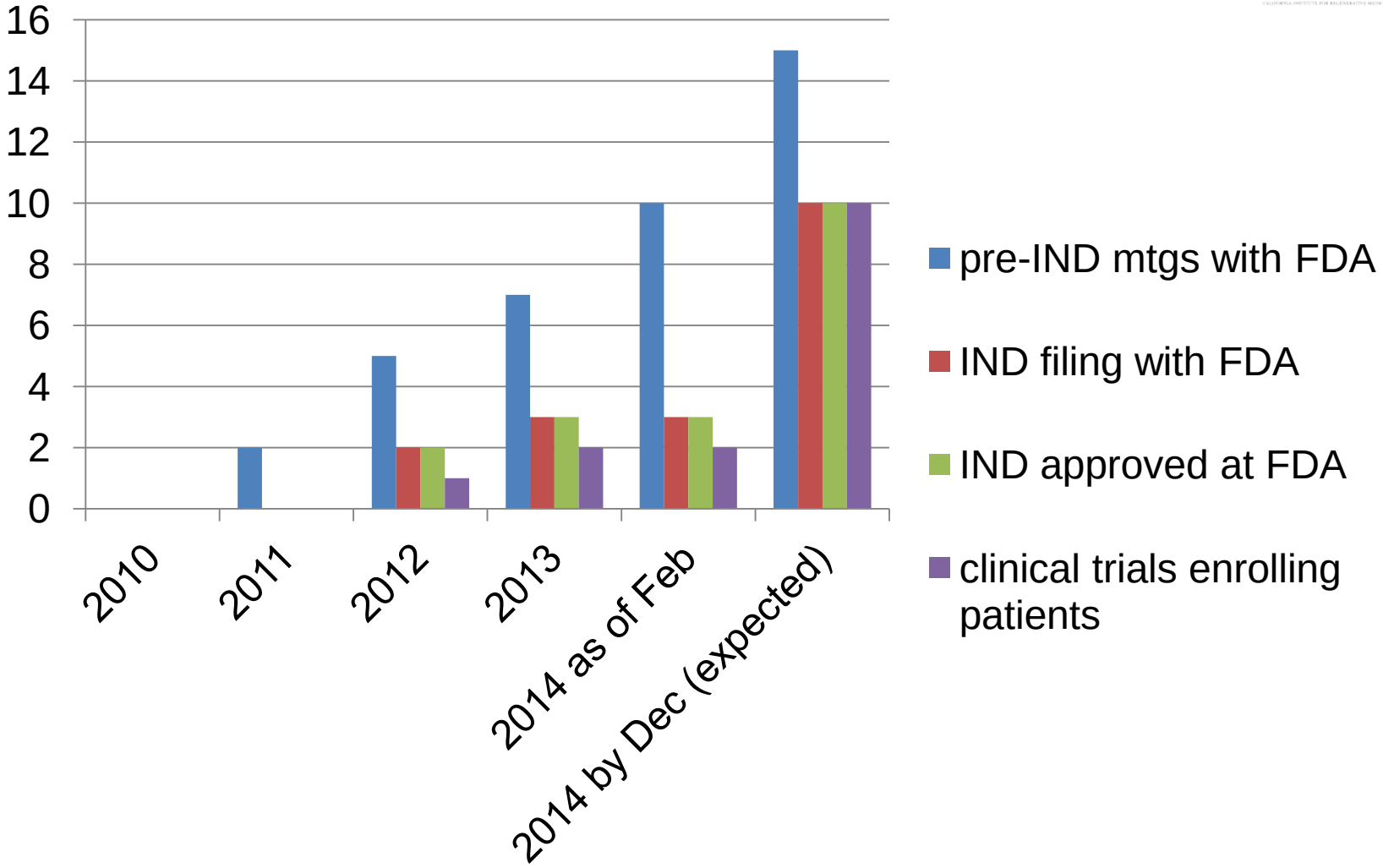
Programs driven by science and evidence, and regulatory considerations needed on development pathway

- Prior to award
  - Go, no go, progress milestones, and success criteria
- During research
  - review preclinical/clinical protocols, regulatory strategy, prep for interactions with FDA, attend team meetings, assess milestones
- Education and training of teams through CIRM/FDA webinars, roundtables, conferences, seminars

AP / Damian Dovarganes

Avoiding obstacles on the development pathway

CIRM's Development Teams are successfully advancing through milestones to enrolling patients



Development Team projects progressing to next stage

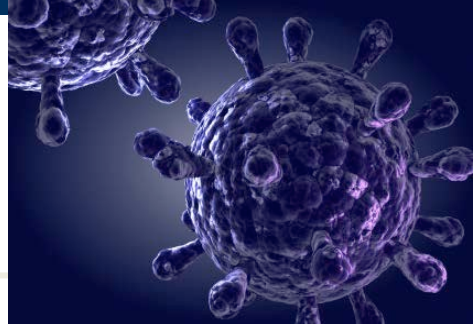
- Development teams successfully progressing through FDA meetings, enrolling patients in clinical trials
- 9 of first cohort of 14 disease teams successfully progressed and are either enrolling patients, or will be enrolling patients on clinical trials this year

Year funded	#	Pre-IND mtg	IND approved 2012/13	IND expected 2014	Clinical Trials enrolling 2013 expected 2014	Clinical trials awarded 2013/14
2010 DT	14	>70%	2/1	6	1 (2013)	8
2012 DT	10		1		1 (2013)	
2012/13 SP	2				1 (2014)	
2013 DT	6				5 (2014)	
2014	2			2	2 (2014)	

CIRM funded clinical trials – patients already enrolling or expected to be enrolling in 2014

- Patients with HIV/AIDS – enrolling now
- Patients with Congestive Heart Failure after a heart attack – enrolling now
- Patients with Cancer – solid tumors and leukemias
- Patients with Degenerative Eye Diseases – losing their vision
- Patients with Diabetes – impact on young and old, diverse ethnic background
- Patients with serious blood diseases – Sickle Cell Disease, beta-Thalassemia, particularly impacts at early age and in people with diverse ethnic backgrounds

CIRM funded clinical trials – patients with HIV/AIDS



- Burden of disease – medically, financially (CDC data 2010)
  - California 2nd highest of 50 states in reported AIDS cases
  - HIV/AIDS has claimed the lives of more than 550,000 Americans
  - About 1.1M Americans are living with HIV
  - Disproportionately affects Blacks/African Americans, and Hispanics/Latinos
  - $1.8 B lifetime treatment costs, based on new HIV diagnoses in California in 2009
- CIRM funded approaches
  - Calimmune team is blocking HIV entry by using RNA interference to re-engineer the patient's own blood stem cells/T cells to block the CCR5 gene from generating a protein. Patients with HIV/AIDS are enrolling on the clinical trial, assessing safety, feasibility, and exploring measures of activity
  - City of Hope team is mutating the CCR5 gene using zinc finger nuclease, which is essentially a pair of molecular scissors developed by Sangamo Biosciences that snips a spot on the CCR5 gene in the patient's own blood stem cells; clinical trial planned this year
  - 3 other approaches heading towards the clinic

CIRM funded clinical trials – patients with Heart Failure

- Burden of disease – medically, financially (CDC)
  - Approx 4.8M Americans have heart failure, most commonly caused by damage from a heart attack
  - Heart disease is the leading cause of death for most ethnicities in America
  - Estimated annual cost of heart failure in California is $1.5 B
- CIRM funded approaches
  - Capricor, California company, is injecting cardiospheres, derived from heart-specific stem cells from adult heart muscle, into blood vessels that feed the heart in patients with heart failure; enrolling patients onto phase 1/ 2 clinical trial. Completed phase 1 in 2013 with acceptable safety, now enrolling patients on the randomized phase 2, to determine if it reduces scarring of the heart and improves function
  - 8 other programs moving towards the clinic

CIRM funded clinical trials – patients with Cancer

- Burden of disease – medically/financially (NCI and CDC)
  - Approx 18.1M cancer survivors in 2020, 30% more than 2010
  - Costs of cancer care $157B; annual cost of cancer in California $15B
  - Growth and aging of American population is primary cause , affects all ethnicities, men and women
- CIRM funded approaches
  - Carson/Kipps team targeting Cancer Stem Cell with monoclonal antibody, ROR-1 in patients with Chronic Lymphocytic Leukemia – filing IND, clinical trial this year
  - Weissman team targeting Cancer Stem Cell with monoclonal antibody, anti-CD47, that impairs “don’t eat me” signal on solid tumors and blood cancers, filing IND, clinical trial this year
  - Slamon team targeting Cancer Stem Cell with small molecule targeting PLK4, in solid tumors, IND approved in US and Canada, clinical trial this year
  - 7 other approaches heading toward the clinic

CIRM funded clinical trials – patients with Degenerative Eye Diseases

- Burden of disease – medically, financially
  - Age related macular degeneration is a degenerative retinal disease
  - Affects the macula region of retina required for sharp central vision
  - Leading cause of blindness in people over age 55.
  - 1.8 M > 40 yo
  - AMD estimated to climb to almost 3M Americans by 2020
  - Annual costs to California exceed $4B; $1B from AMD
- CIRM funded approaches
  - Humayun team using human embryonic stem cells as a starting point to generate new retinal pigment epithelium on a synthetic scaffold, to replace cells that are lost and lead to vision loss in AMD; file IND and start clinical trial this year
  - 3 other approaches heading towards the clinic, including Klassen team developing therapy for patients with Retinitis Pigmentosa, rare genetic disease that leads to blindness in younger age group

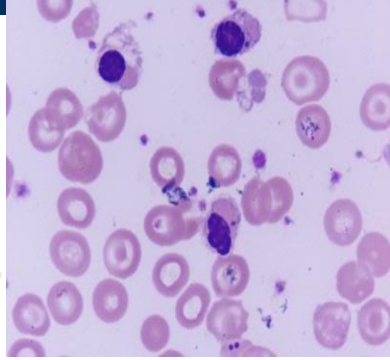
CIRM funded clinical trials – patients with Diabetes

- Burden of disease – medically, financially
  - Diabetes affects 25.8M, 8.3% of Americans; disproportionately affects Hispanics/Latinos and Blacks/African Americans
  - Americans ≥ 65 yo, 10.9 M (26.9%) and <20 yo, 215K
  - Leading cause of kidney failure, amputations, new cases of blindness, and major cause of heart disease and stroke
  - Annual costs in California $13.8B
- CIRM funded approaches
  - ViaCyte replacing hormone producing beta cells of the pancreas from human embryonic stem cells within a device that protects against destruction from the patient's host defense system, and is implanted under the skin; IND filing and clinical trial this year
  - Other funded approaches focused on complications of diabetes, including wound ulcers, vision loss, critical limb ischemia, heart disease, and stroke

CIRM funded clinical trials – patients with blood diseases: Sickle Cell Disease

- Burden of disease – medically, financially
  - >80K Americans have Sickle Cell Disease
  - Predominantly affects Blacks/African Americans and to a lesser extent, Hispanics/Latinos
  - Sickle shape of the cells cause clogging of blood vessels and produce episodes of excruciating pain; leads to progressive organ damage
  - Costs to California – ave of 75K hospitalizations betw 1989-93, costing approx $475M
- CIRM funded approaches
  - Kohn team is correcting the beta-globin gene defect in the patient's stem cells and re-infusing the corrected blood stem cells back into the patient, IND filing and clinical trial this year
  - 1 other approach by Kohn earlier in development

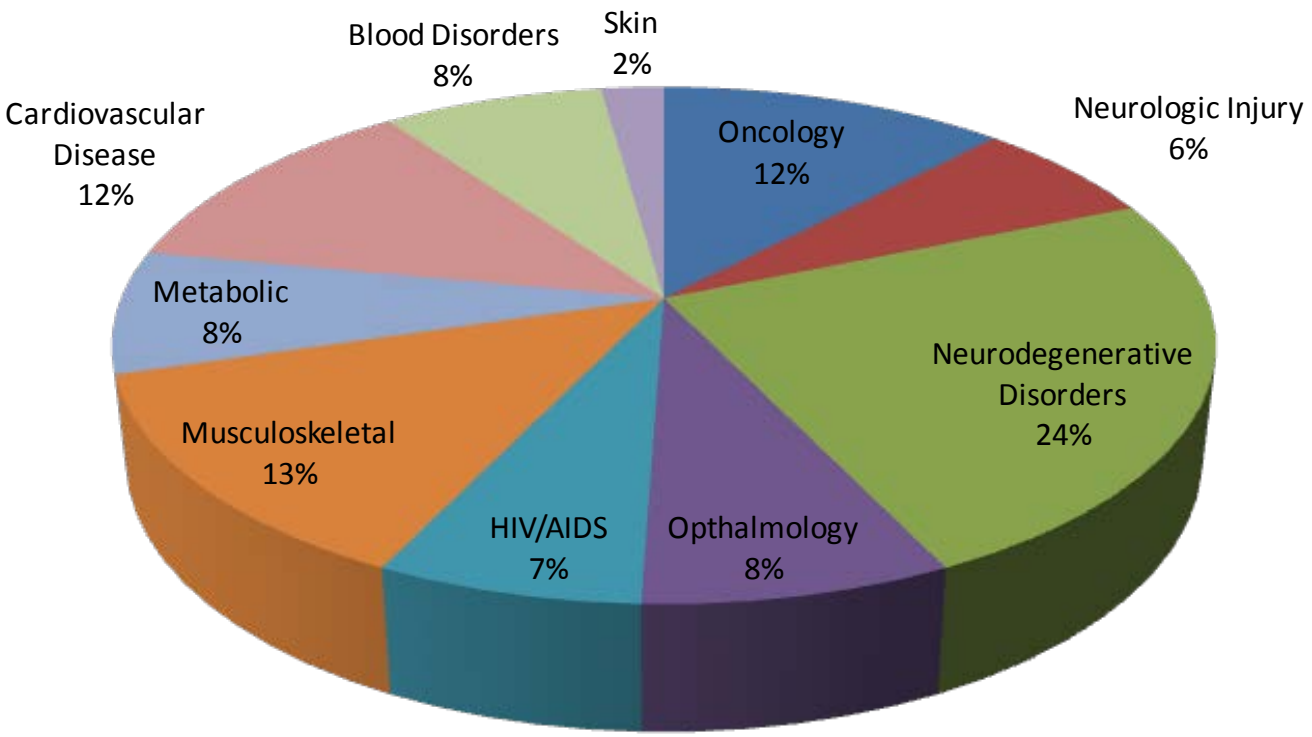
CIRM funded clinical trials – patients with blood diseases: beta-Thalassemia



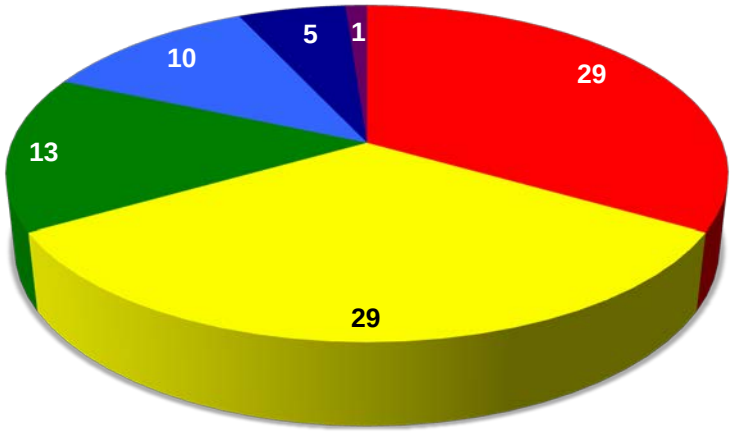
- Burden of disease – medically, financially
  - Incidence approx 1 in 100,000 in US, but more common in California due to immigration patterns, about 1/55,000 live births; prevalence in California about 696
  - Often fatal due to organ damage – the damage is a two-step process involving the disease itself and the therapy currently used to manage it. The frequent blood transfusions these patients receive can lead to a build up of iron in their blood, and if iron is not properly filtered out, it can lead to potentially lethal organ damage
  - Costs from UK data approx $800K per patient; direct annual medical costs in California approx $11M
- CIRM funded approach
  - Sangamo Biosciences is targeting the genome defect with zinc finger nuclease technology, and reinfusing the patient's corrected cells back into them; IND filing, clinical trial this year

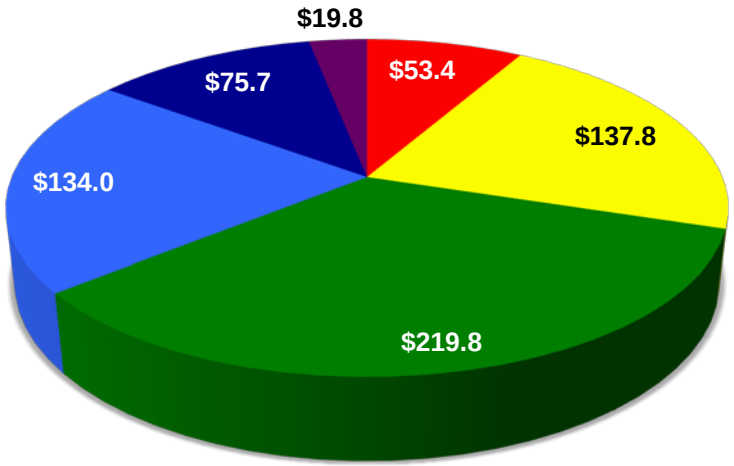
Therapeutic Areas and Goal of Projects

CIRM's Translational Portfolio: Therapeutic Areas



CIRM Translation Portfolio: Goals





87 Awards

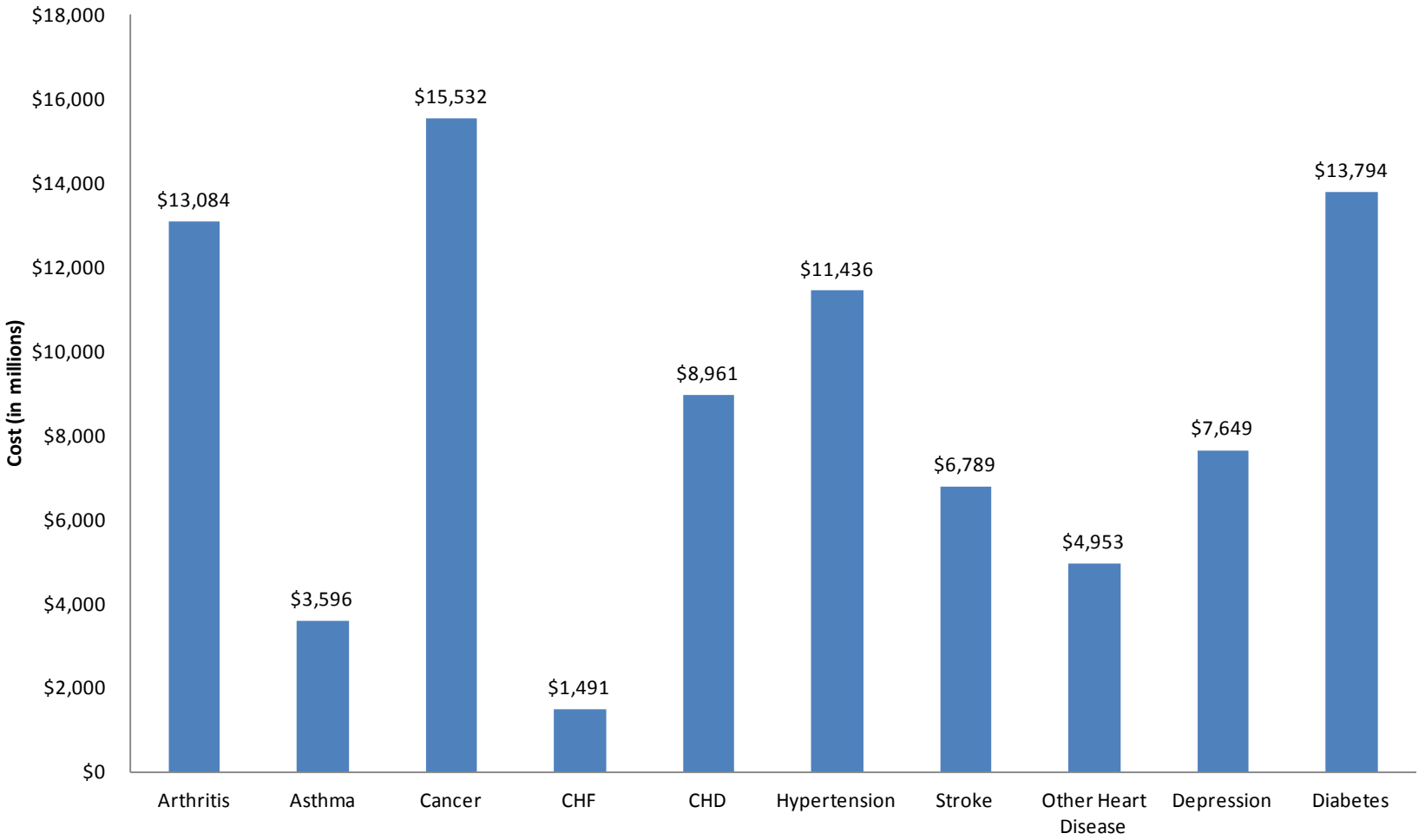
$640.5 MM of CIRM funds

- Preclinical proof of concept
- Preclinical dev't candidate
- IND filing to enter clinical trial
- Clinical Trial Phase 1
- Clinical Trial Phase 1/2
- Clinical Trial Phase 2

Pie slices are $ MM or # awards

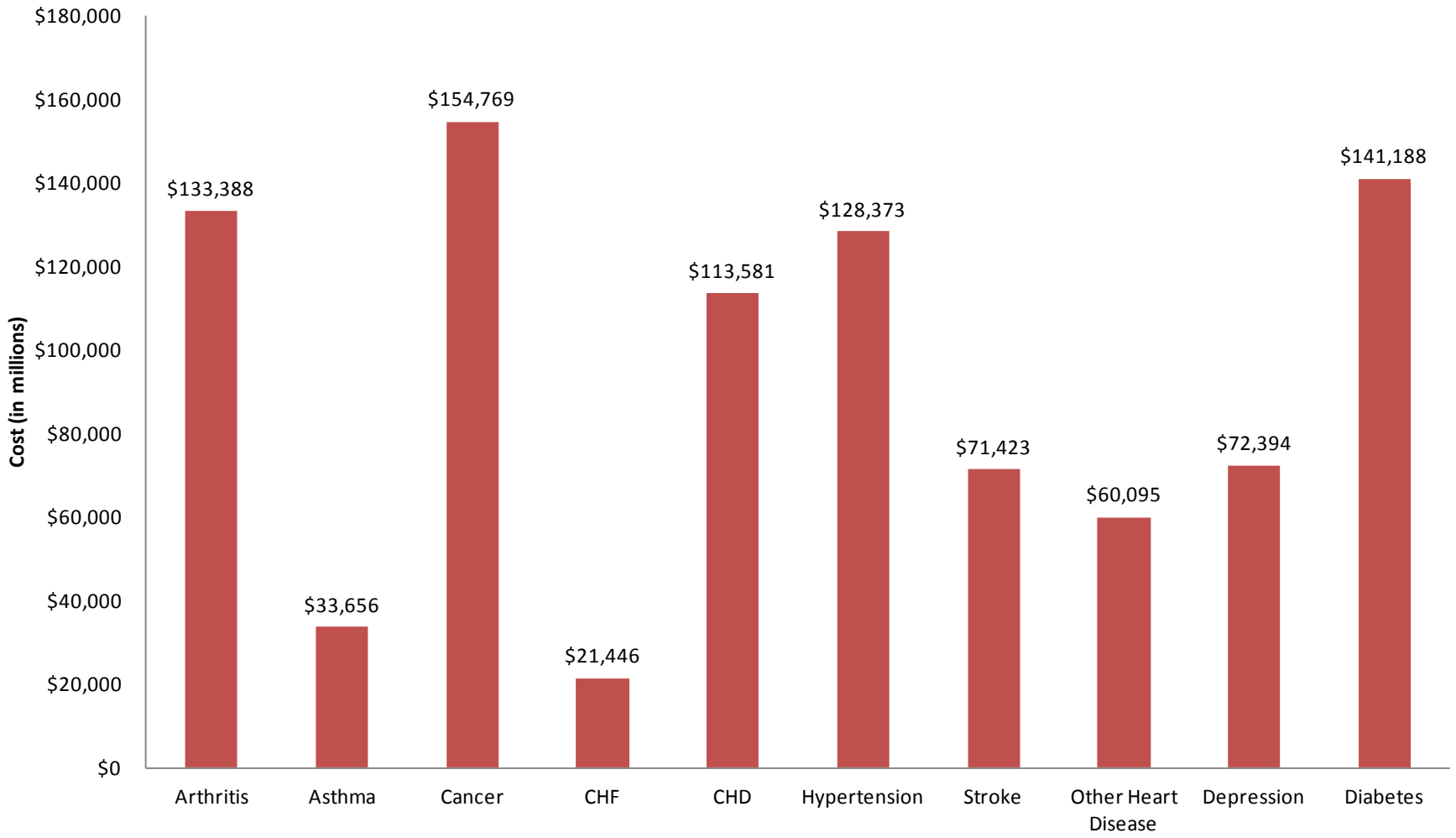
Projected and Expected Costs to California and U.S. of Chronic Diseases

Estimated Annual Cost of Chronic Diseases to California



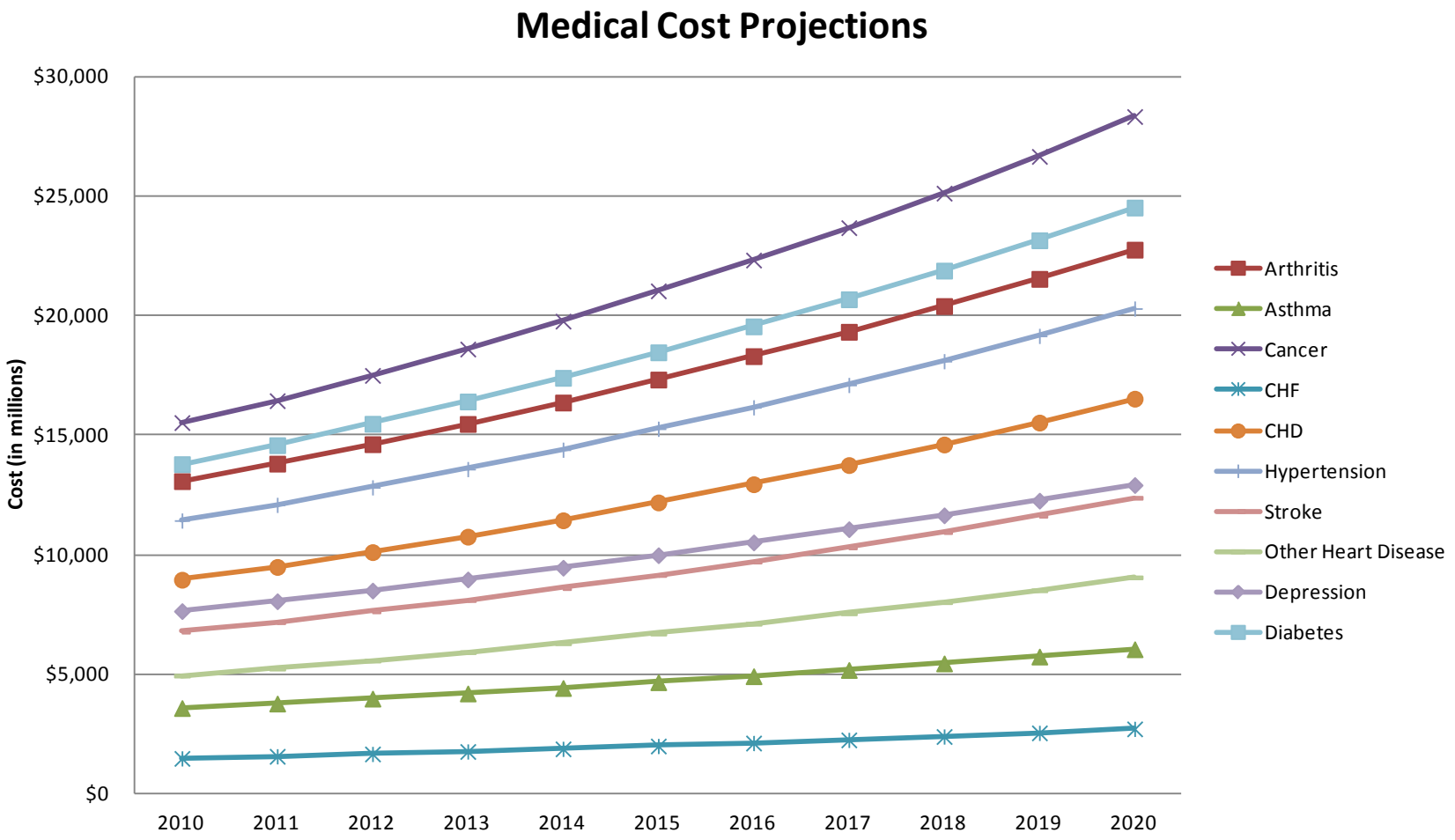
Source: Centers for Disease Control and Prevention and RTI International, CHRONIC DISEASE COST CALCULATOR.

Estimated Annual Cost of Chronic Diseases to US



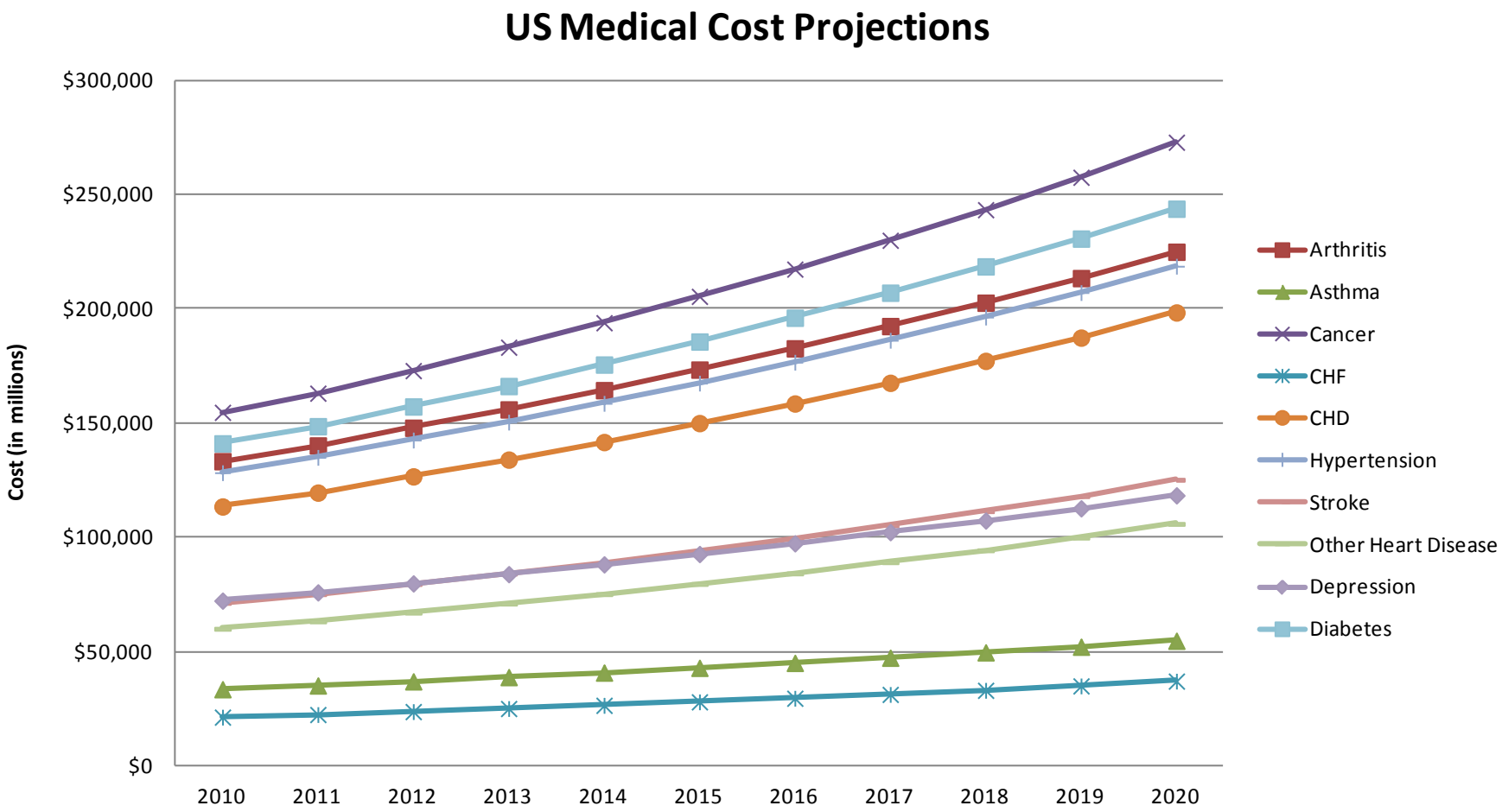
Source: Centers for Disease Control and Prevention and RTI International, CHRONIC DISEASE COST CALCULATOR.

Projected Costs of Chronic Diseases to California Through 2020



Source: Centers for Disease Control and Prevention and RTI International, CHRONIC DISEASE COST CALCULATOR.

Projected Costs of Chronic Diseases to US Through 2020



Source: Centers for Disease Control and Prevention and RTI International, CHRONIC DISEASE COST CALCULATOR.

CIRM works with FDA, external advisors, and investigators

CIRM works with FDA and other agencies on regulatory pathways for cell therapy

Regulatory Pathways: International Workshop on Cell Therapies

CIRM-led workshop Sept 2013; N. American, European, and Japanese regulatory frameworks for developing cell-based therapies

CIRM webinars, roundtables and workshops topics:

cell characterization, preclinical animal studies, imaging technology, immune response, scaffolding, clinical trials

http://www.cirm.ca.gov/our-funding/regenerative-medicine-consortium

CIRM works with external advisors on individual development projects at key milestones

- Clinical Development Advisors complement CIRM's interactions with development teams
  - Experts in product development, e.g., preclinical and clinical, cell process and manufacturing, regulatory, stem cell/disease-specific biology, disease-specific clinical expertise and commercial relevance
- Yearly meetings with each Development team to assess key milestones
- Advice helps informs CIRM decisions
  - Continue forward progress; refine approach e.g., modify milestones, timelines, budgets; convert the project to an earlier phase with reduced scope and budget, or terminate the project

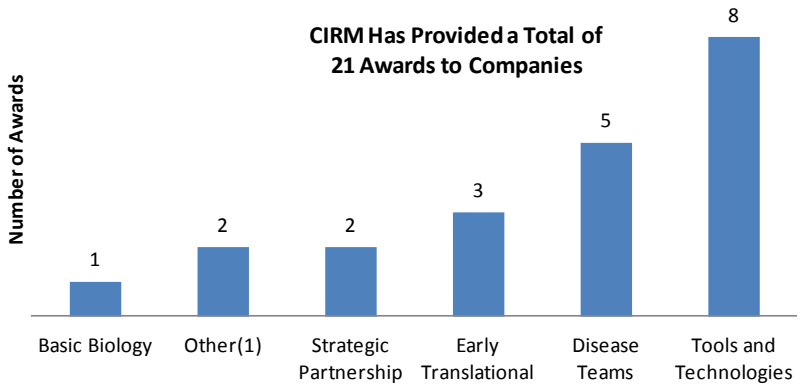
CIRM works with external advisors on strategy for translational portfolio

- July 2013 meeting to identify attributes of what would constitute a competitive translational portfolio for developing effective therapies, and advice on strategies to get there
- Discussion on critical attributes separated by target diseases (therapeutic areas) and product characteristics; early endpoints and POC issues in clinical trials, and issues in commercialization
- CIRM implementing recommendations

CIRM's collaborations with companies

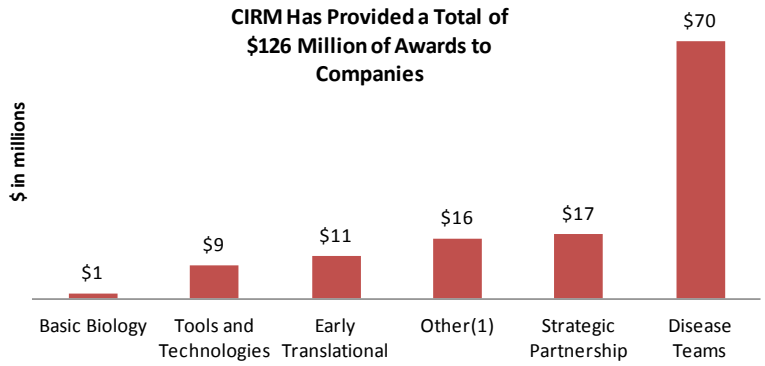
Summary of CIRM's industry engagement

Number of CIRM Awards to For-Profits



Note: Includes multiple awards to the same Company. Does not include terminated awards or Disease Team Planning Awards.
(1) "Other" includes: hiPSC Derivation and Transplantation Immunology.

Value of CIRM Awards to For-Profits



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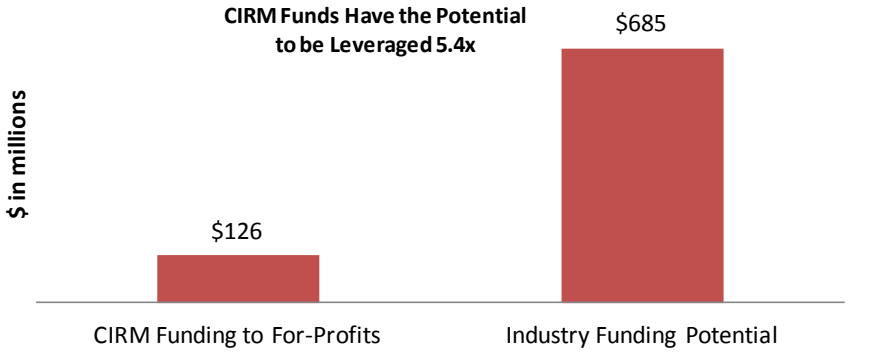
Industry Leverage



Note: "Industry Funding Potential" includes matching requirements associated with CIRM awards and payments associated with industry transactions which includes upfront and future milestone payments.

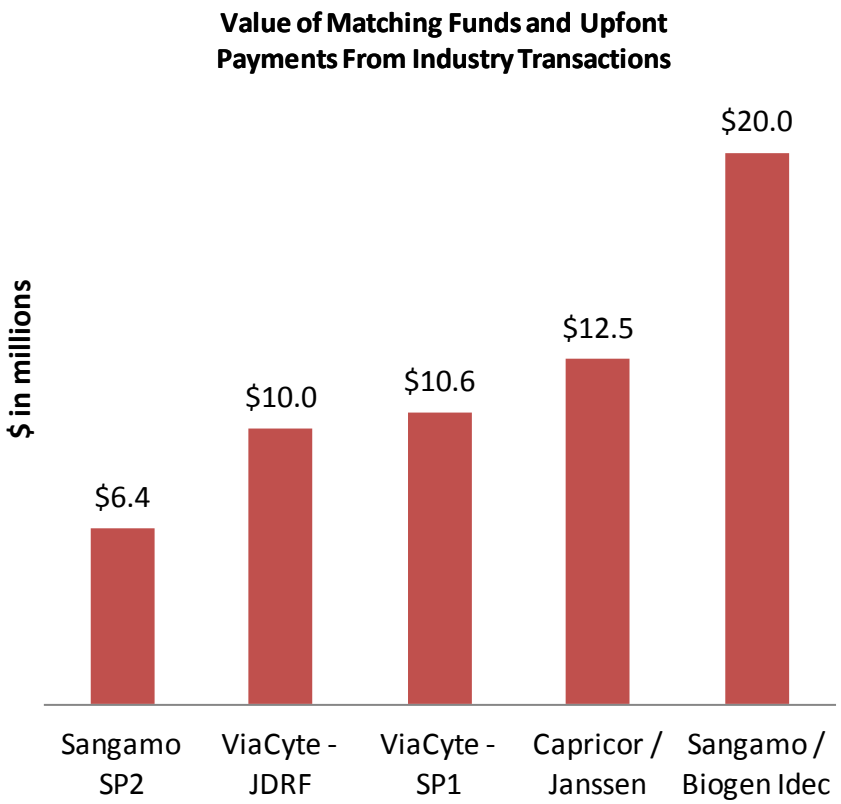
CIRM Teams with a company as the principal investigator

For-Profit Grantee	Total Amount	Number of Awards	Type of Award
BioTime, Inc.	$4,721,706	1	Early Translational I award - $4,721,706
Calimmune	$8,278,722	1	Disease Team Research I - $8,278,722
Capricor	$19,782,136	1	Disease Team II- $19,782,136
Cellular Dynamics International	$16,000,000	1	hiPSC Derivation - $16,000,000
Escape Therapeutics, Inc	$1,453,040	1	Transplantation Immunology - $1,453,040
Fluidigm Corporation	$2,693,424	2	Tools & Technology I - $749,520; Tools & Technology II - $1,943,904
GMR Epigenetics	$1,452,693	1	Tools & Technologies II - $1,452,693
iPierian, Inc.	$1,458,000	1	Basic Biology II - $1,458,000
Numerate, Inc.	$1,333,795	1	Early Translations Awards IV - $1,333,795
Sangamo	$6,374,150	1	Strategic Partnership II - $6,374,150
Stem Cells, Inc.	$19,300,000	1	Disease Team II (Alzheimer's) - $19,300,000
TriFoil Imaging, Inc. (Gamma Medical)	$2,478,347	2	Tools & Technology I - $949,748; Tools & Technology II - $1,528,599
Vala Sciences, Inc.	$906,629	1	Tools & Technology I - $906,629
ViaCyte	$39,356,426	5	Early Translational I - $5,405,397; Tools & Technology I - $827,072; Disease Team Planning - $48,950; Disease Team I - $19,999,937; Strategic Partnership- $10,075,070; Supplementary Funding to DT1 - $3,000,000
VistaGen Therapeutics, Inc.	$971,558	1	Tools & Technology I - $971,558
Total = 15	**$126,560,626**	**21**	

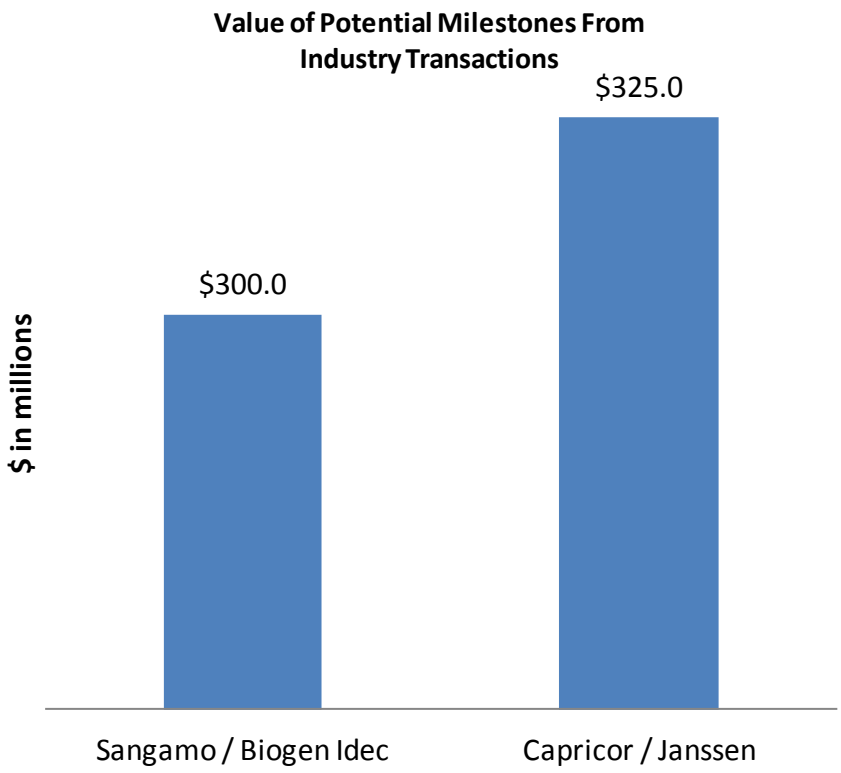
Note: Does not include terminated awards or Disease Team Planning Awards.

Industry Provides a Source of Leverage for CIRM Funded Technology

Matching Funding and Upfront Payments

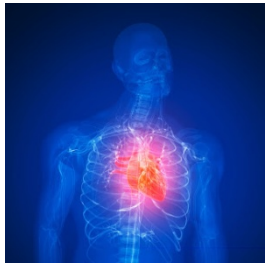


Potential Future Milestone Payments



Capricor and Janssen Enter Collaboration and Exclusive License Option

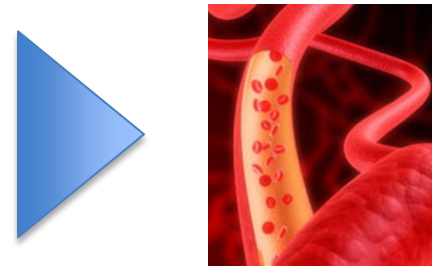
- Capricor was awarded a CIRM Disease Team award of $20 million for the completion of a Phase 2 clinical trial for patients who have suffered a large myocardial infarction
- Janssen has the right to enter into an exclusive license agreement for CAP-1002 following delivery results from Phase 2 ALLSTAR trial
  - $12.5 million upfront and up to $325 million in additional milestone payments
  - Janssen will collaborate on elements of cell manufacturing development



- CAP-1002, Capricor's lead product candidate, is an allogeneic adult stem cell therapy for the treatment of heart disease, derived from donor heart tissue

Sangamo BioSciences Collaboration with Biogen Idec for Hemoglobinopathies

- Sangamo was awarded a $6.4 million grant under CIRM's Strategic Partnership Award, and 1-1 required matching funds
- Announced collaboration with Biogen Idec for hemoglobinopathies (Beta-Thalassemia and Sickle Cell Disease)
  - $20 million upfront plus reimbursement of R&D-related costs; milestones of up to $300 million based on development, regulatory, commercialization and sales milestones



"Building upon emerging science related to fetal hemoglobin regulation, we intend to develop Sangamo's novel gene-editing technology to create a single approach that has the potential to functionally cure both sickle cell disease and beta-thalassemia."

– Douglas Williams, Ph.D., EVP of R&D, Biogen Idec

ViaCyte Successfully Matches $10 Million CIRM Strategic Partnership Award

- ViaCyte was awarded a $10.1 million grant under CIRM's Strategic Partnership Award
- ViaCyte successfully matched the funds with $10.6 million from a private financing from Johnson & Johnson Development Corporation, Sanderling Ventures and Asset Management Company

- Funds used to support clinical evaluation of VC-01, ViaCyte's encapsulated cell-therapy product being developed as a transformative therapy for patients with type 1 and insulin-dependent type 2 diabetes
- JDRF previously provided funding in conjunction with CIRM and also recently announced another $7 million investment to support development of VC-01

Inception 3 Created Based on CIRM Funded Technology from Stanford

- October 10, 2012 – Roche entered into an exclusive partnership with Versant Ventures and Inception Sciences to create a drug discovery incubator, Inception 3, for the treatment of sensorineural hearing loss
- ***Inception 3 will incorporate an innovative technology platform from Stanford University that was previously funded by CIRM***
  - Funding Type: Comprehensive Grant (RC1-00119)
  - Grant Title: Generation of inner ear sensory cells from human ES cells toward a cure for deafness
  - Investigator: Stefan Heller
  - CIRM Funds Committed: $2.5M
- Versant will provide equity financing and Roche will fund the research based on a series of milestones
- Roche retains an exclusive option to acquire Inception 3 upon a first lead compound reaching the filing stage of an IND

Elsevier BusinessIntelligence

"The Pink Sheet" DAILY

OCTOBER 10, 2012

Roche Enters Hearing-Loss Space In Risk-Sharing Venture With Inception, Versant

The newly formed Inception 3 will work to bring small molecule candidates for hearing loss, based on technology licensed from Stanford University, to IND-filing stage, at which point Roche will have the option to buy out the program.

A drug-hunting venture borne out of the Bristol-Myers Squibb Co./Amira Pharmaceuticals Inc. buyout in 2011 has resulted in a new opportunity for Roche. Under a novel collaboration structure involving big pharma, venture capital and biotech, Inception Science will create a third company – called Inception 3 Inc. – to discover and develop small molecule drug candidates for sensorineural hearing loss based on technology licensed from Stanford University.

Roche, which will fund Inception 3's work with milestone-based R&D payments, will hold an option to acquire the program upon the filing of the first IND based on the Stanford technology. Inception's backer Versant Ventures, meanwhile, will provide the equity financing for the new company, under an agreement announced Oct. 10.

Inception consists of two current small biotechs (Inception 1 Inc. and Inception 2 Inc.) focused on neurology and oncology, founded by former Amira execs after Bristol acquired Amira for $325 million upfront in July 2011 ("BMS Bets On Amira's IPF Drug In $325M Acquisition" — "The Pink Sheet" DAILY, Jul. 22, 2011). Bristol's focus was on idiopathic pulmonary fibrosis candidate AM152 and it spun out much of Amira's remaining intellectual property into new companies called FLAP LLC and Pannira Pharmaceuticals LLC[See Deal]. Meanwhile, backed by Versant, former Amira CEO Peggi Prasit, known around the biopharma industry for his "drug-hunting" acumen, established Inception ("After Complex Sale, Amira Scientist And VC Team Up Again For Discovery Start-up" — "The Pink Sheet" DAILY, Jul. 27, 2011).

Luca Santarelli, global head of neuroscience at Roche, said his company saw hearing loss as a significant untapped market but one in which its internal R&D personnel was not equipped to lead innovation. Meanwhile, Roche had prior positive experience with Versant from their work together after central nervous system-focused biotech Synosia Therapeutics Inc. was acquired by Biotie Therapies Corp. ("Biotie To Combine With Synosia To Form A "Global Leader" In CNS Drug Development" — "The Pink Sheet" DAILY, Jan. 11, 2011).

"There is only a limited set of targets and programs that we can [investigate] internally," Santarelli explained in an interview. "We are constantly looking for possibilities to access innovation on the outside in ways that enable us to eventually apply our strength of translational drug development at an appropriate time while at the same time tapping into areas that offer promise and unmet medical need, as well as areas where the mechanism of disease biology is better clarified."

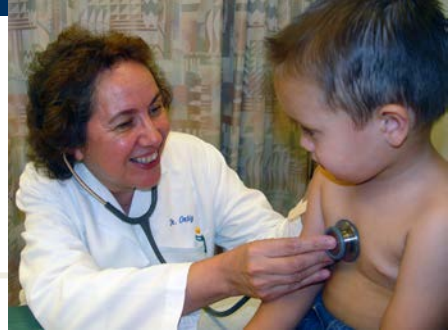
"The reason we didn't go for a straightforward collaboration with academia here ... is that the fact that it brings in a team of drug-hunters with a great track record of discovering drug candidates for intractable targets and then driving those to the IND stage," added Shafique Virani, head of neuroscience partnering at Roche. "We have the operational component of a drug-development team in addition to a major pharma and exciting best-in-class technology from Stanford."

Combined Capabilities Should Produce Rapid Progress

The various parties are not disclosing any financial details about the collaboration nor providing any sense of a timeline to the potential IND filing at FDA. However, Clare Ozawa, chief business officer at Inception and a

Looking Forward….

Building quality clinical capacity: Stem cell clinic network – June 2014



- CLINICAL TRIALS**:** Develop resources for effective, efficient design and execution of clinical trials for investigational stem cell tx
- DELIVERY OF THERAPIES: Become a center of excellence for delivering stem cell-based tx that have been proven safe and effective
- DATA AND INFORMATION: Centralize information about clinical trial experience and outcomes, and data to inform research, clinical, regulatory and reimbursement decisions
- INFORM THE PUBLIC: Education, outreach and training about clinical trials and available therapies, and potential dangers of unproven procedures
- HEALTHCARE ECONOMICS: Develop evidence base to support the development of sustainable business models, including reimbursement strategies

Continuing to progress the pipeline of therapies to patients

- Accelerated Development Pathway – March 2014 program announcement soliciting proposals from teams already funded to complete clinical trials, that with access to additional expertise and financial resources could accelerate time to achieve evidence of clinical benefit for patients; expect future grantees to have future opportunities to compete into the pathway
- Development Teams – Continue to actively manage currently funded projects; new proposals to take projects to early phase clinical trials
  - Strategic Partnerships – concept at today's ICOC; emphasis on industry, leveraging expertise and resources
    Disease Teams – open to researchers from academia and industry; concept for the Fall ICOC
- Preclinical development projects - Advance most promising preclinical projects in the pipeline, as well as those with commercial partners, towards FDA interactions on development pathway – concept at today's ICOC

Background slides for reference

Disease Team 1 Status

Grant/PI	Disease	Award	Current Status
DR1-01461/Marban	Heart fail	5.6M	IND approved 6/2012; clinical trial PI Smith (Capricor) DR2-05735
DR1-01431/Chen DR1-06893/Symonds	HIV	20M	Chen converted to ET; Calimmune IND approved, clinical trial PI Symonds
DR1-01490/Zaia	HIV	14.6M	Continue
DR1-01477/Slamon	Solid ca	20M	Continue, awarded DT3 Dec 2013
DR1-01421/Aboody	Brain ca	18 M	Continue
DR1-01426/Berger	Brain ca	19.2M	Terminated NoGo milestone
DR1-01485/Weissman	leukemia	19.3M	Continue, awarded DT3 Dec 2013
DR1-01430/Carson	leukemia	20M	Continue, awarded DT3 Dec 2013
DR1-01452/Kohn	Sickle	9.2M	Continue, awarded DT3 Dec 2013
DR1-01454/A.Lane	Skin dis	11.7M	Wind down 2014
DR1-01444/Humayun	Eye dis	16M	Continue, ICOC approved $3M suppl – awarded DT3 Dec 2013
DR1-01423/Robins	Diabetes	20M	Continue, ICOC approved $3M suppl; awarded SP1 (Foyt)
DR1-01480/Steinberg	Stroke	20M	Continue
DR1-01471/Goldstein	ALS	11.5M	Converted to ET

Disease Team 2 and Strategic Partnership 1,2 Status

Grant/PI	Disease	Award	Current Status
DR2-05302/N.Lane	osteoporosis	20 M	Continue
DR2-05320/Svendsen	ALS	17M	Continue
DR2-05415/Wheelock	Huntington's	17.8M	Continue
DR2-05423/Laird	Limb ischemia	14.2M	Continue
DR2-05739/Klassen	Eye dis	17M	Continue
DR2-05735/Smith	Heart failure	19.8M	Continue
DR2-05394/Wu	Heart failure	20M	Starting – CDAP later this yr
DR2-05416/Capela	Alzheimer's Dis	20M	Starting – CDAP later this yr
DR2-05365/Shizuru	immunodef	20M	Starting – CDAP later this yr
DR2-05309/Ribas	melanoma	20M	Pre-funding admin review
DR2-05426/Nelson	Muscular dystr		Converted to ET
SP1-06513/Foyt	Diabetes	10M	Continue
SP2-06902/Urnov	Thalassemia	6.4M	Starting – CDAP later this yr

Disease Team 3 Status

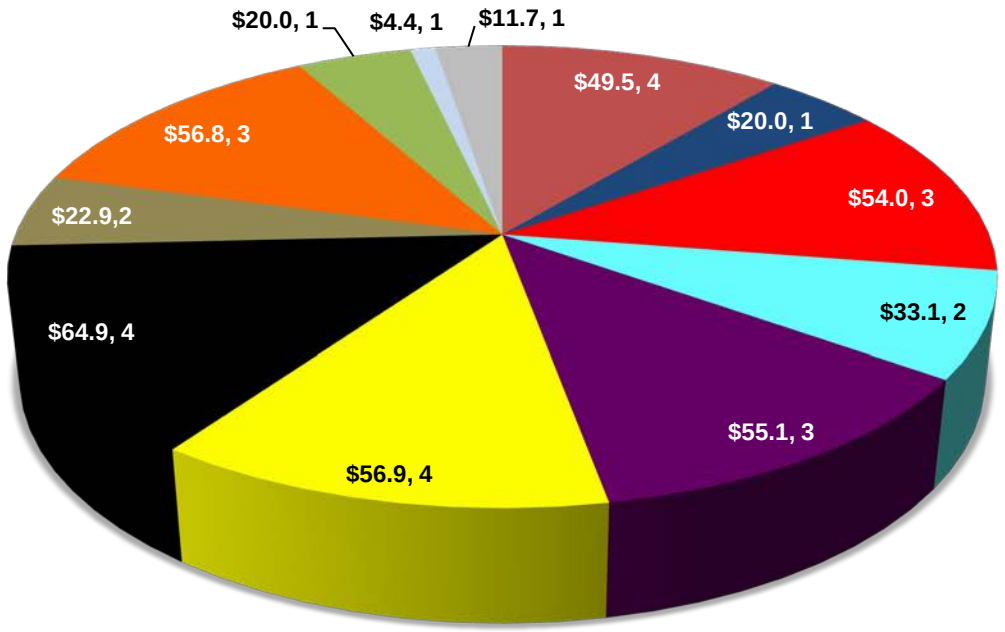
Grant/PI	Disease	Award	Current Status
DR3-06924/Kipps	Leukemia	4.18 M	Prefund adm review
DR3-06965/Weissman	Leukemia/Solid CA	12.7M	Prefund adm review
DR3-07067/Slamon	Solid CA	6.9M	Prefund adm review
DR3-07438/Humayun	Eye disease	18.9M	Prefund adm review
DR3-06945/Kohn	Sickle cell dis	13.9M	Prefund adm review
DR3-07281/Belafsky	Respiratory dis	4.4M	Prefund adm review

Financial Overview

Program	Original Award amount $M	Current Award amount $ M	Total spent $M (last report)	Recovered $M
Disease Team 1	233.5	208.8	175.8	20.8
Disease Team 2	185.0	182.2	16.0	
Disease Team 3	61.1	TBD	0	
S. Partnership 1	10.1	10.1	TBD	
S. Partnership 2	6.4	6.4	TBD	

CIRM Development Portfolio: Disease areas

Disease Teams & Strategic Partnerships, $449.3 MM

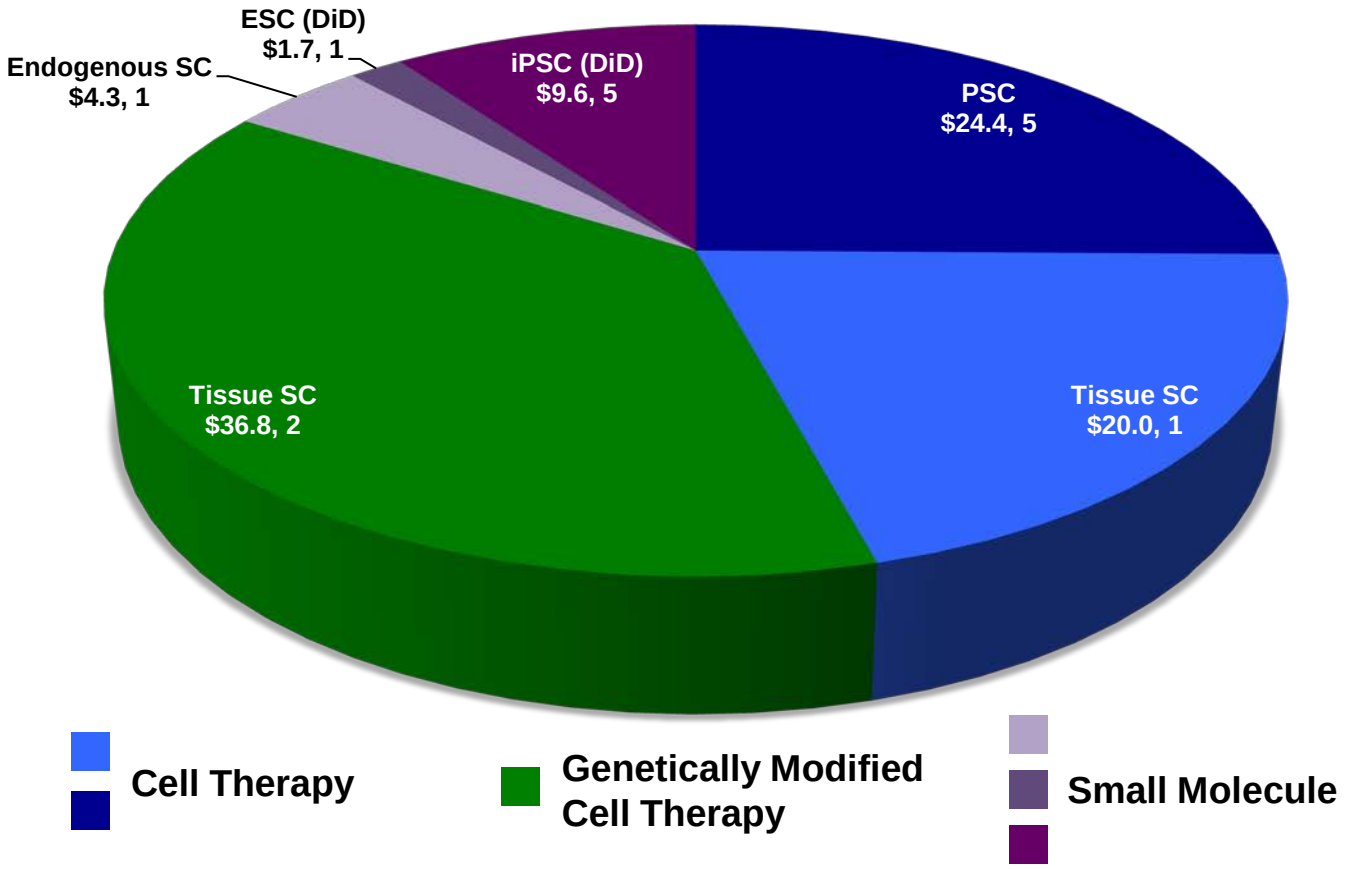


Pie slices are
$ MM, # awards

- Blood Disorders
- Bone Disorders
- Cardiovascular Disorders
- Endocrine Disorders
- Eye Disorders
- Hematologic Cancers
- Solid Cancers
- HIV/AIDS
- Neurodegenerative Disorders
- Neurologic Injuries
- Respiratory Disorder
- Skin Disorder

CIRM Translation Portfolio: Neurodegenerative Disorders

15 Active Awards, $96.8 MM



Shading of pie slice reflects the approach. For example, a shade of blue is a cell therapy using the cell type indicated in the slice.

Pie slices are $ MM, # Awards, Stem Cell Class (Origin)

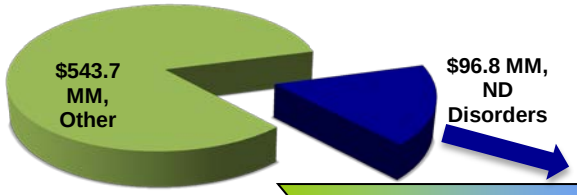
Translation Portfolio: Neurodegenerative Disorders

DISEASE	AWARD # PI, Institution	GOAL	APPROACH
ALS	DR2A-05320 Svendson, Cedars-Sinai	IND, Ph 1	Allogeneic neural progenitor cells genetically modified with GDNF
	TRX-01471 Goldstein, UCSD	DC	hESC-derived neural stem cells
	TR3-05676 Yeo, UCSD	DCF	Small molecule that corrects proposed aberrant RNA "signature" in iPSC- derived neurons from patients with defects in RNA processing
	TR4-06693 Finkbeiner, Gladstone	DCF	Small molecule that stimulates autophagy identified by screening on iPSC-derived motor neurons form patients with ALS
Alzheimer's Disease	DR2A-05416 Capela, Stem Cells Inc.	IND	Neural stem cell transplantation for neuroprotection
	TR3-05577 Goldstein, UCSD	DCF	Small molecule identified through screens on purified hiPSC-derived brain cells from patients that have rare and aggressive hereditary forms of Alzheimer's Disease
	TR3-05669 Schubert, Salk	DCF	Small molecule for neuroprotection & neurogenesis identified using hESC-derived neural precursors

Translation Portfolio: Neurodegenerative Disorders

DISEASE	AWARD # PI, Institution	GOAL*	APPROACH
Autoimmune Disease / Multiple Sclerosis	TR3-05603 Lane, UC Irvine	DC	Human pluripotent stem cell-derived neural progenitor cells
	TR3-05617 Schultz, Scripps	DC	Small molecule that acts on oligodendrocyte precursors in the CNS to induce differentiation to oligodendrocytes to stimulate remyelination
Huntington's Disease	DR2A-05415 Wheelock, UC Davis	IND, Ph 1	MSC genetically engineered to express BDNF
	TR2-01841 Thompson, UC Irvine	DC	Allogeneic hESC-derived neural stem or progenitor cells
	TR4-06847 Griffin, Numerate, Inc.	DCF	Small molecules, identified using iPSC-derived human striatal neurons from HD patients, that disrupt the shape and reverse the neurotoxicity of the mutant huntingtin (mHtt) protein
Parkinson's Disease	TR1-01267 Snyder, Sanford-Burnham	DC	The best hNSC derived from either tissue, ESC, or iPSC
	TR2-01856 Zeng, Buck Inst.	DC	Allogeneic hPSC-derived dopaminergic neurons
	TR2-01778 Gage, Salk	DCF	Small molecule identified by screening in a neuron/astrocyte/microglia co-culture differentiated from patient-derived iPSCs

CIRM Translation Portfolio: Neurodegenerative Disorders



Candidate Discovery Research | Preclinical Research | Preclinical Dev. | Phase 1 Clinical Research | Phase 2 Clinical Research

POC | Select Development Candidate | File IND

ALS

- $1.7 MM, DCF, Small Molecule iPSC (DiD)
- $2.3 MM, DCF, Small Molecule iPSC (DiD)
- $4.4 MM, DC, Cell Therapy APC, NPC, or NSC
- $17.8 MM, Ph 1 GMCT, NPC/NSC

Alzheimer's Disease

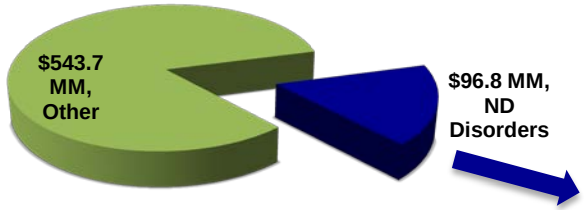
- $1.9 MM, DCF, Small Molecule iPSC (DiD)
- $1.7 MM, DCF, Small Molecule ESC (DiD)
- $3.6 MM, DC, Cell Therapy NSC
- $20.0 MM, IND, Cell Therapy NSC

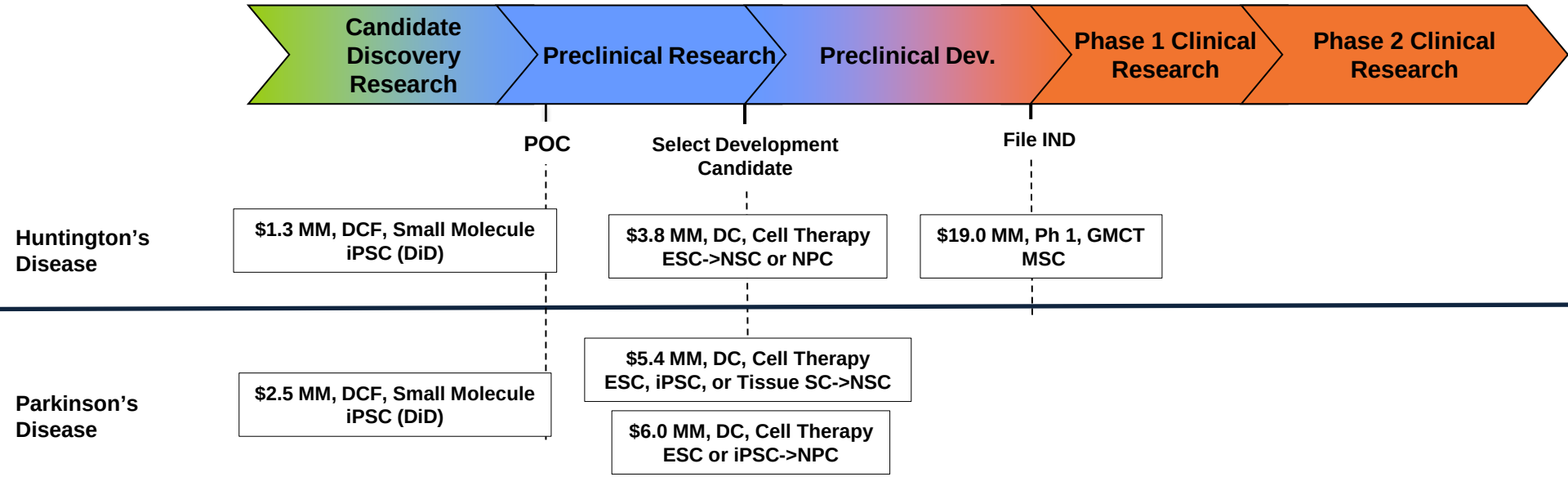
Autoimmune Disease/ Multiple Sclerosis

- $4.8 MM, DC, Cell Therapy ESC->NSC
- $4.3 MM, DC, Small Molecule Endog SC

Award#, Funding, Approach, Cell Used

CIRM Translation Portfolio: Neurodegenerative Disorders



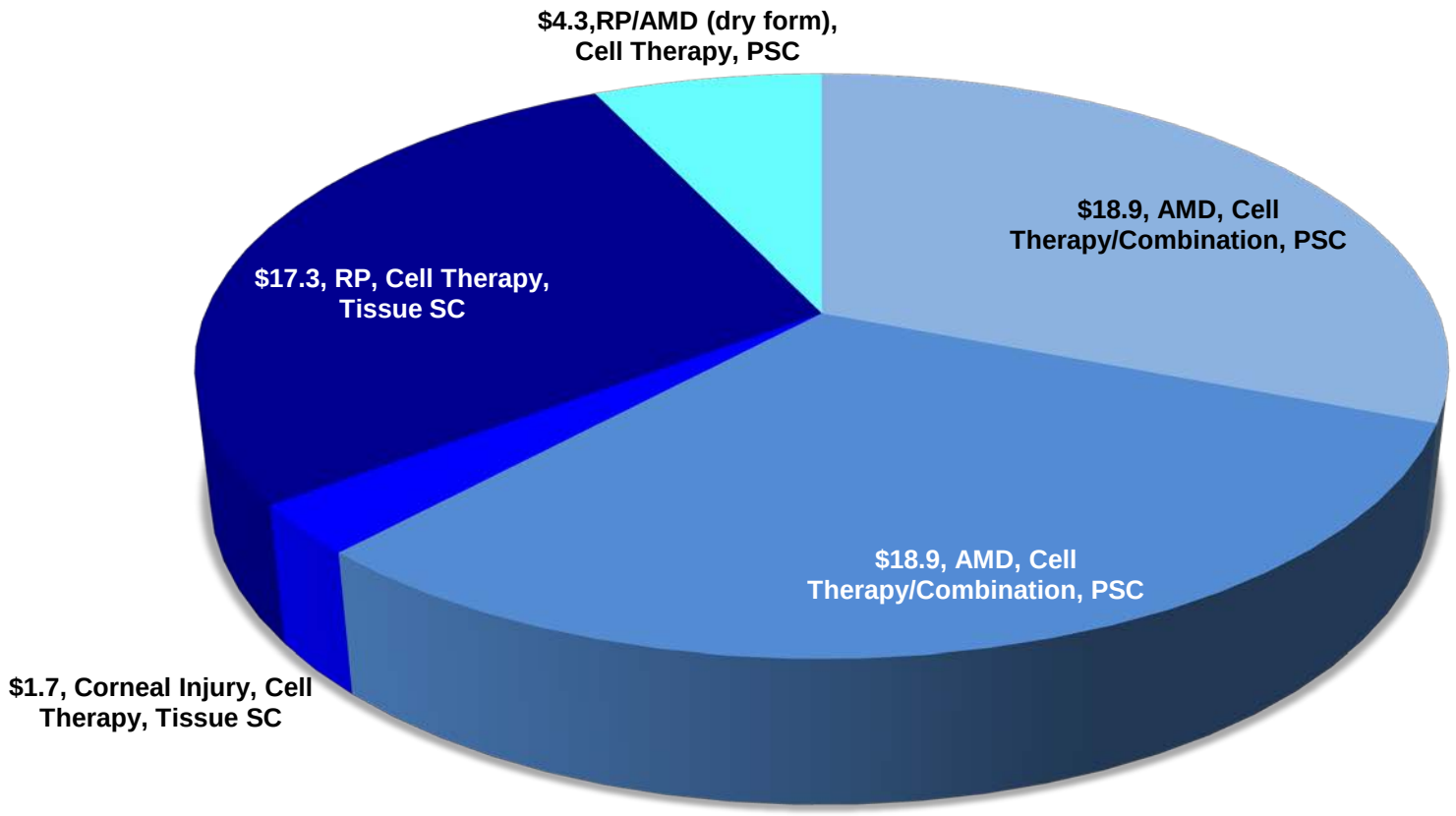


Award#, Funding, Approach, Cell Used

GMCT = Genetically Modified Cell Therapy

CIRM Translation Portfolio: Eye Disorders

5 Active Awards, $61.1 MM

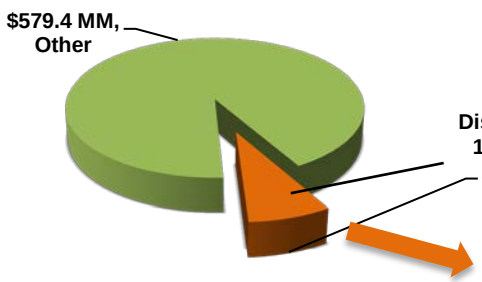


Pie slices are $ MM, Indication, Approach, Stem Cell Class (Origin)

Translation Portfolio: Eye Disorders

AWARD # PI, Institution (Active)	GOAL*	DISEASE/INJURY	APPROACH
DR2A-05739 Klassen, UC Irvine	IND, Ph 1/2	Retinitis Pigmentosa	Allogenic retinal progenitor cells
DR3-07438 Humayun, USC	Ph 1	Age-related macular degeneration (dry form)	Allogeneic functionally polarized hESC-derived RPE monolayers on synthetic substrate implanted sub-retinally
DR1-01444 Humayun, USC	IND	Age-related macular degeneration (dry form)	Allogeneic functionally polarized hESC-derived RPE monolayers on synthetic substrate implanted sub-retinally
TR4-06648 Seiler, UC Irvine	DC	Retinitis Pigmentosa, Age-related macular degeneration (dry form)	Allogeneic hESC-derived 'sheet' of retinal progenitor cell (RPC) & retinal pigmented epithelium (RPE)
TR2-01768 Deng, UCLA	DCF	Corneal Injury	Ex vivo expansion of corneal epithelial stem/progenitor cells, also known as limbal stem cells

CIRM Translation Portfolio Highlights: Eye Disorders



Candidate Discovery Research | Preclinical Research | Preclinical Dev. | Phase 1 Clinical Research | Phase 2 Clinical Research

POC | Select Development Candidate | File IND

Age-related Macular Degeneration (AMD)

- TR4-06648, $4.3 MM, Cell Therapy, hESC
- DR1-01444, $18.9 MM, Cell Therapy+ Scaffold, ESC->RPE
- DR3-07438, $18.9 MM, Cell Therapy+ Scaffold, ESC->RPE

Corneal Injury

- TR2-01768, $1.7 MM, Cell Therapy, LSC

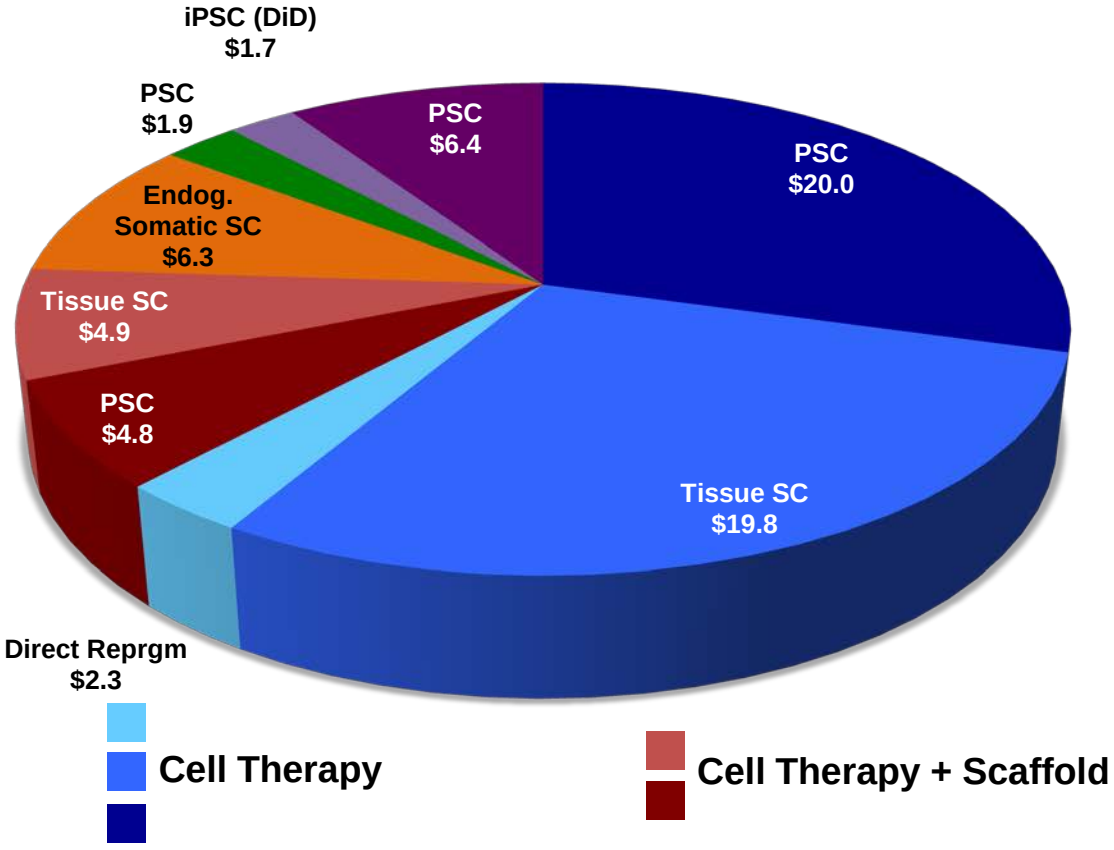
Retinitis Pigmentosa

- $4.7 MM, DC, Cell Therapy, RPC → DR2A-05739, $17.3 MM, Cell Therapy, RPC

Award#, Funding, Approach, Cell Used

CIRM Translation Portfolio: Cardiovascular Disorders

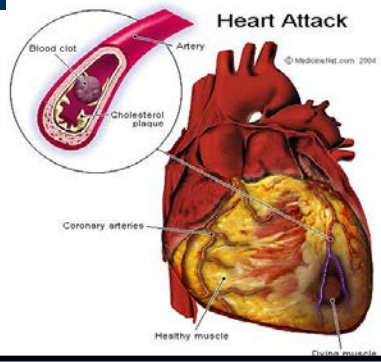
9 Active Awards
$68.1 MM



Shading of pie slice reflects the approach. For example, a shade of blue is a cell therapy using the cell type indicated in the slice.

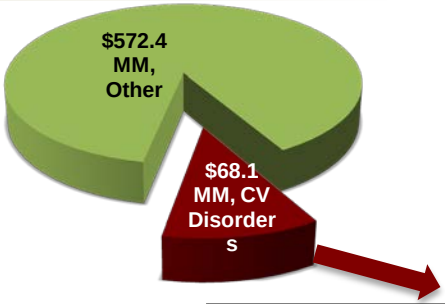
Pie slices are $ MM, Stem Cell Class (Origin)

Translation Portfolio: Cardiovascular/Vascular



AWARD # PI, Institution (Active)	GOAL	DISEASE/INJURY	APPROACH
DR2A-05735 Smith, Capricor Inc.	Ph 2	Heart dysfunction after MI/Chronic heart failure	Allogeneic cardiac-derived stem cells
DR2A-05394 Wu, Stanford	IND	End stage heart failure with LVAD	Allogeneic hESC-derived cardiomyocytes
TR3-05556 Wu, Stanford	DC	Cardiovascular Disease	hESC-derived cardiomyocytes seeded in a tissue engineered patch
TR3-05593 Srivastava, Gladstone	DC	Cardiovascular Disease	Direct reprogramming of endogenous cardiac fibroblasts into functional cardiomyocytes by gene transfer
TR3-05626 Boyd, UC Davis	DC	Cardiovascular Disease	Allogeneic human bone marrow-derived MSCs embedded in a biological scaffold
TR4-06857 Cashman, Human Biomolecular Research Institute	DC	Ventricular Arhythmias	Small molecule optimized using iPSC-derived cardiomyocytes from patients
TR3-05559 Xu, UCSD	DCF	Cardiovascular Disease	hESC-derived cardiomyocytes genetically modified to evade allogeneic immune rejection
TR3-05568 Belmonte, Salk	DCF	Cardiovascular, Vascular Disease	Multipotent vascular progenitors derived by direct conversion of somatic cells
TR3-05687 Adler, UCSD	DCF	Cardiovascular Disease (Danon Disease)	Small molecule leads identified by correction of autophagy on Danon patient iPSC-derived lines
DR2A-05423 Laird, UC Davis	IND, Ph 1	Critical limb ischemia	Allogeneic MSC engineered to express VEGF delivered by intramuscular injection

CIRM Translation Portfolio: Cardiovascular/Vascular Disorders



Funding, Goal, Approach, Cell Used

Candidate Discovery Research | Preclinical Research | Preclinical Dev. | Phase 1 Clinical Research | Phase 2 Clinical Research

POC | Select Development Candidate | File IND

Cardiovascular Disease

- $1.9 MM, DCF, GMCT ESC->CM
- $4.8 MM, DC, Cell Therapy+Scaffold ESC->CM
- $2.3 MM, DCF, Direct Reprgm Somatic Cells->VPCs
- $6.3 MM, DC, Gene Xfer for Direct Reprgm Endogenous Somatic Cells
- $4.9 MM, DC, Cell Therapy+Scaffold MSC

Danon Disease

- $1.7 MM, DCF, Small Molecule iPSC (DiD)

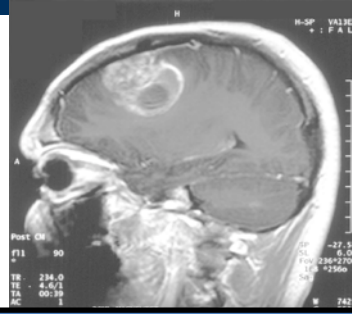
End stage heart failure with LVAD

- $20.0 MM, IND, Cell Therapy ESC->CM

Heart dysfunction after MI/Chronic heart failure / Ventricular arrythmias

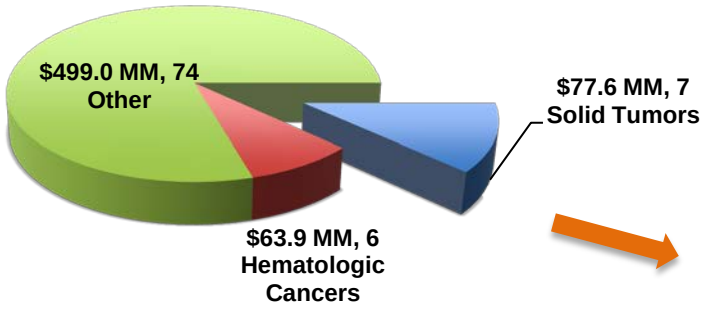
- $6.4 MM, DC, Small Molecule iPSC-derived CMs
- $5.6 MM, IND, Cell Therapy CDC
- $20.0 MM, Ph 2, Cell Therapy CDC

Translation Portfolio: Solid Cancers



AWARD # PI, Institution (Active)	GOAL	DISEASE/INJURY	APPROACH
DR3-07067 Slamon, UCLA	Ph 1	Solid tumors	Small molecule mitotic inhibitor targeting serine/threonine kinase to eliminate both tumor cells and tumor initiating cells
DR2A-05309 Ribas, UCLA	IND, Ph 1	Melanoma	Autologous HSCs and T cells genetically modified to express an anti-tumor T cell receptor
DR1-01477 Slamon, UCLA	IND	Colon, ovarian cancers, glioblastoma	Small molecules specific for each of two drug targets in cancer stem cells
DR1-01421 Aboody, City of Hope	IND	Glioblastoma	Allogeneic hNSC line to target tumor, engineered ex vivo to deliver carboxylesterase to locally convert CPT-11 to more potent SN-38
TR2-01791 Kasahara, UCLA	DC	Glioblastoma	Allogeneic hMSC to target tumor, engineered to produce replication competent retrovirus encoding a prodrug activator to locally convert a pro-drug to a potent chemotherapeutic
TR3-05641 Forman, Beckman Inst.	DC	Glioblastoma	A mixture of autologous central memory T cells engineered to each express a chimeric antigen receptor (CAR) targeting one of three proteins on glioma-initiating cancer stem cells
TR4-06867 Reiter, UCLA	DC	Prostate cancer	Monoclonal antibodies against N-cadherin positive cancer stem cells

CIRM Translation Portfolio: Solid Cancers



Select Development Candidate

File IND

Complete Ph1

TR4-06847, $4.1 MM, MAb, CSC

TR2-01791, $3.4 MM, GMCT+Small Molec. MSC

TR3-05641, $5.2 MM, GMCT, Memory T cells

DR1-01477, $20.0 MM, Small Molec., CSC

DR1-01421, $20.0 MM, GMCT+Small Molec, NSC

DR2A-05309, $20.0 MM, GMCT, HSC

DR3-07067, $6.9 MM, Small Molec., CSC

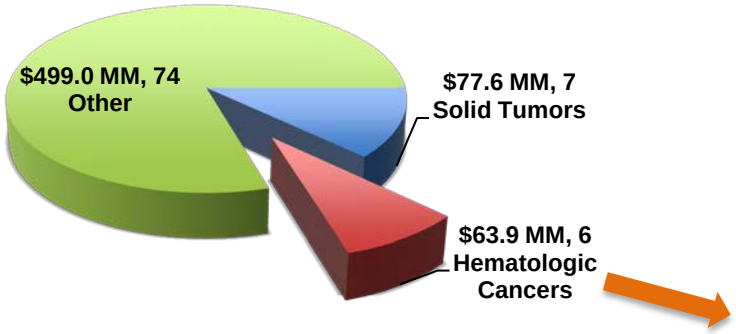
Award#, Funding, Approach, Therapeutic Cell if applicable

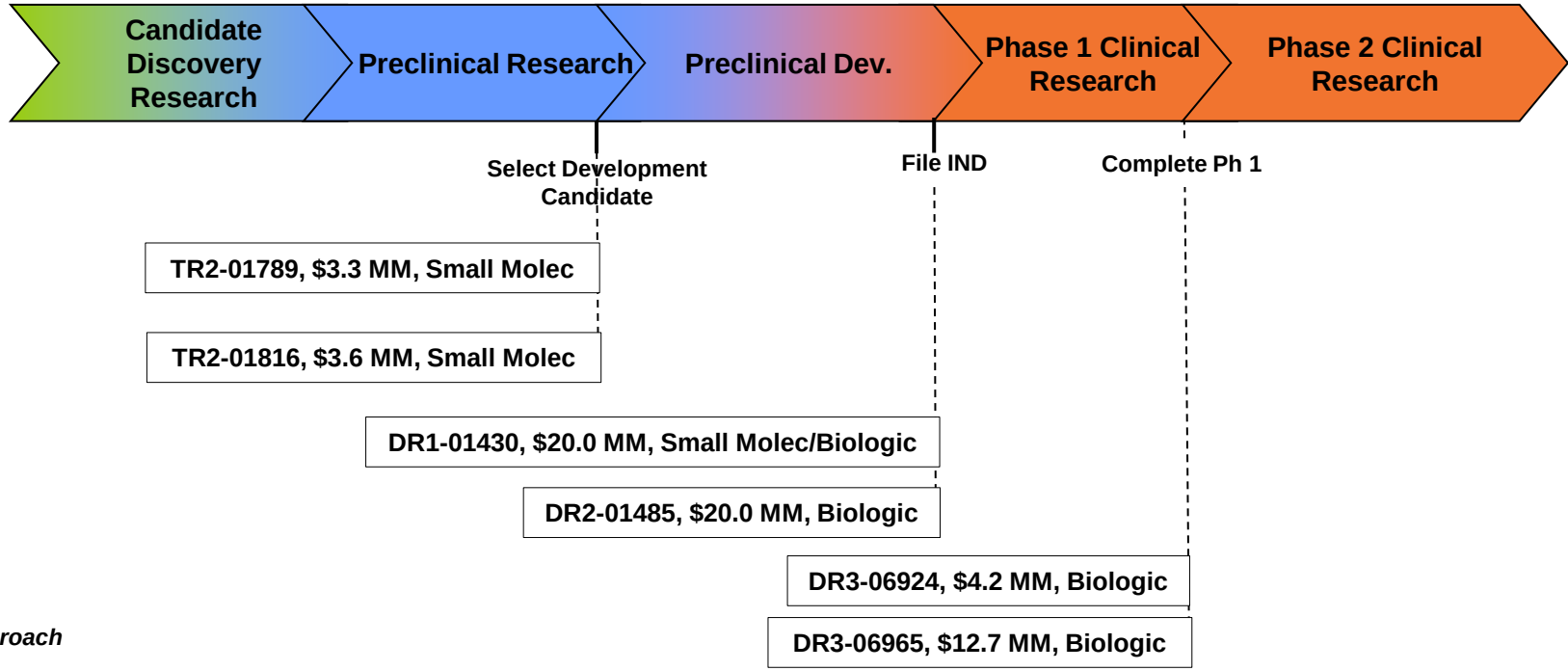
GMCT = Genetically Modified Cell Therapy

Translation Portfolio: Hematologic Cancers

AWARD # PI, Institution (Active)	GOAL	DISEASE/INJURY	APPROACH
DR3-06924 Kipps, UCSD	Ph 1	CLL	Monoclonal antibody (anti-ROR1) targeting CLL cancer stem cells
DR3-06965 Weissman, Stanford	Ph 1	AML	Monoclonal antibody against CD47 – “Don’t eat me” antigen that is expressed on leukemia stem cells
DR1-01485 Weissman, Stanford	IND	AML	Monoclonal antibody against CD47 – “Don’t eat me” antigen that is expressed on leukemia stem cells
DR1-01430 Carson, UCSD	IND	AML, CLL	A monoclonal antibody (anti-ROR1) targeting CLL and AML cancer stem cells, respectively
TR2-01789 Jamieson, UCSD	DC	CML	Small molecule pan BCL-2 inhibitor targeting cancer stem cells
TR2-01816 Müschen, CHLA	DC	AML, ALL	Small molecule inhibitor of BCL6 targeting cancer stem cells

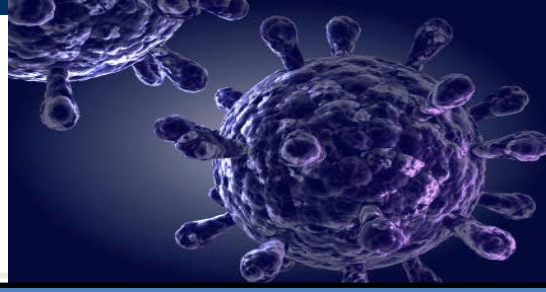
CIRM Translation Portfolio: Hematologic Cancers





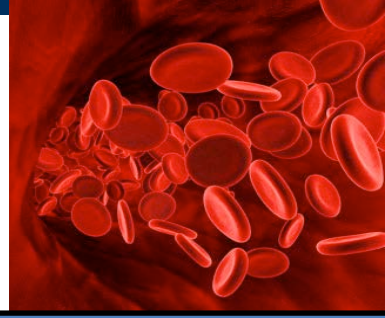
Award#, Funding, Approach

Translation Portfolio: HIV/AIDS



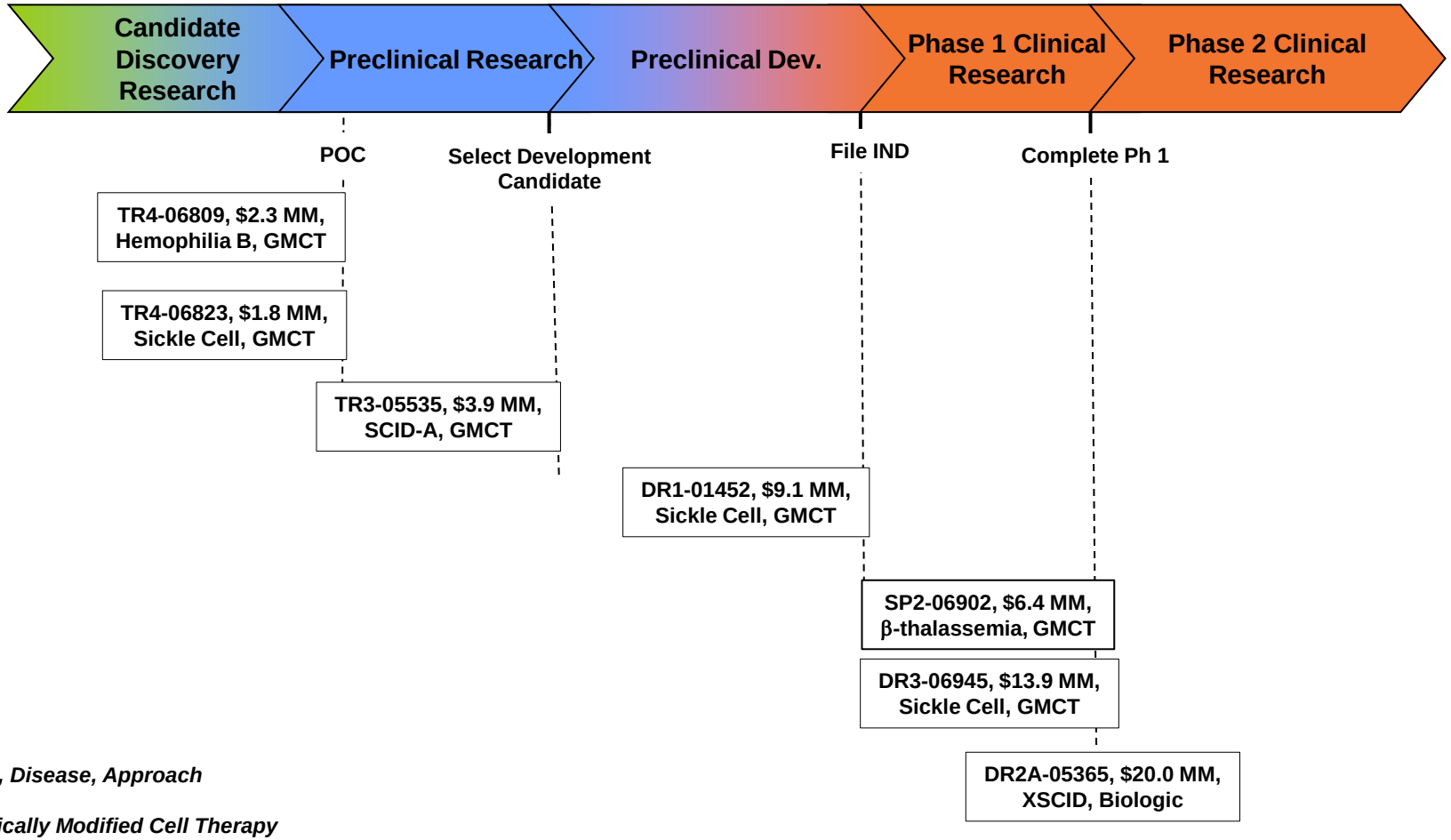
AWARD # PI, Institution	PROGRAM (Active)	GOAL	APPROACH
DR1-06893 Symonds, Calimmune	Disease Team I	Ph 1/2	Autologous HSC transduced ex vivo with a lentiviral vector engineered to express an shRNA against CCR5 & a fusion inhibitor.
DR1-01490 Zaia, City of Hope	Disease Team I	IND	Autologous HSC transduced ex vivo with non-integrating vector engineered to express a zinc finger nuclease targeting CCR5
TR2-01771 DiGiusto, City of Hope	Early Translation II	DC	Autologous HSC genetically modified with multiple anti-HIV resistance genes and a drug resistance gene
TRX-01431 Chen, UCLA	Early Translation	DC	Autologous HSC transduced ex vivo with a lentiviral vector engineered to express shRNAs against CCR5 & another target in the HIV life cycle.
TR4-06895 Zack, UCLA	Early Translation IV	DC	Autologous HSC and/or T memory stem cells genetically modified *ex vivo* with a lentiviral vector engineered to express a chimeric antigen receptor and other gene reagents against HIV

Translation Portfolio: Blood Disorders



AWARD # PI, Institution (Active)	GOAL	DISEASE/INJURY	APPROACH
DR3-06945 Kohn, UCLA	Ph 1	Sickle Cell Disease	Autologous HSC, genetically corrected ex vivo by lentiviral vector mediated addition of a hemoglobin gene that blocks sickling
DR1-01452 Kohn, UCLA	IND	Sickle Cell Disease	Autologous HSC, genetically corrected ex vivo by lentiviral vector mediated addition of a hemoglobin gene that blocks sickling
TR4-06823 Kohn, UCLA	DCF	Sickle Cell Disease	Autologous HSC, genetically modified ex vivo to correct the mutation in the β-globin gene
SP2-06902 Urnov, Sangamo Biosciences, Inc.	IND, Ph 1	β-thalassemia	Autologous HSC genetically modified ex vivo using a novel gene-editing technology to re-activate fetal gamma-globin expression
DR2A-05365 Shizuru, Stanford	IND, Ph 1/2	Conditioning regimen for allogeneic HSC transplantation for X-SCID	MAb that depletes endogenous HSC
TR3-05535 Cowan, UCSF	DC	SCID-A	Autologous HSC genetically corrected ex vivo by lentiviral vector mediated delivery of the Artemis gene
TR4-06809 Verma, Salk	DCF	Hemophilia B	Genetically corrected autologous iPSC-derived hepatocytes

CIRM Translation Portfolio: Blood Disorders



Funding, Goal, Disease, Approach

GMCT= Genetically Modified Cell Therapy

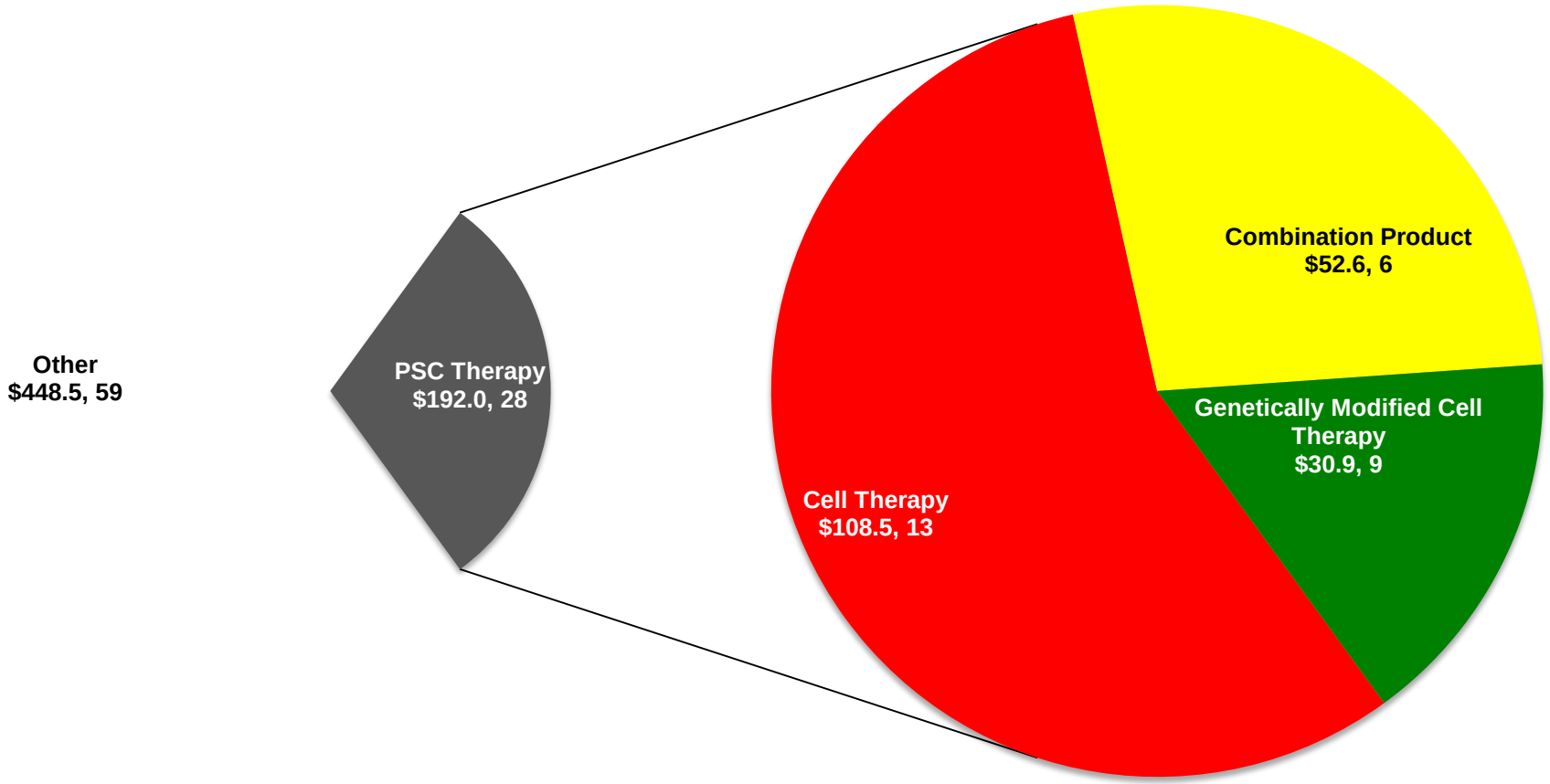
Translation Portfolio: Pediatric Disorders

Class of Disorder	AWARD # PI, Institution	GOAL (Active)	DISEASE/INJURY	APPROACH
Blood Disorders	DR2A-05365 Shizuru, Stanford	IND, Ph 1/2	Conditioning regimen for allogeneic HSC transplantation for X-SCID	MAb that depletes endogenous HSC
	SP2-06902 Urnov, Sangamo Biosciences, Inc.	IND, Ph 1	β-thalassemia	Autologous HSC genetically modified ex vivo using a novel gene-editing technology to re-activate fetal gamma-globin expression
	DR1-01452 Kohn, UCLA	IND	Sickle Cell Disease	Autologous HSC, genetically corrected ex vivo by lentiviral vector mediated addition of a hemoglobin gene that blocks sickling
	TR3-05535 Cowan, UCSF	DC	SCID-A	Autologous HSC genetically corrected ex vivo by lentiviral vector mediated delivery of the Artemis gene
	TR4-06823 Kohn, UCLA	DCF	Sickle Cell Disease	Autologous HSC, genetically modified ex vivo to correct the mutation in the β-globin gene
	TR4-06809 Verma, Salk	DCF	Hemophilia B	Genetically corrected autologous iPSC-derived hepatocytes
Congenital Liver Disease	TR3-05488 Miki, USC	DCF	Liver Disease, Congenital	Human amniotic epithelial cell-derived hepatic cells
	TR4-06831 Lipshutz, UCLA	DCF	Urea Cycle Disorders	Genetically corrected, autologous iPSC-hepatocytes for enzyme replacement

Translation Portfolio: Pediatric Disorders

Class of Disorder	AWARD # PI, Institution	GOAL*	DISEASE/INJURY	APPROACH
Pediatric Neurological Disorders	TR3-05476 Schwartz, CHOC	DC	Lysosomal Storage Disease	Immune matched human neural stem cells transplantation subsequent to hematopoietic stem cell transplantation
	TR2-01832 Shi, Beckman	DCF	Canavan Disease	Autologous iPSC-derived neural or oligodendrocyte progenitors, genetically modifed to correct mutant aspartoacylase (ASPA) gene
	TR2-01749 Alvarez-Buylla, UCSF	DCF	Refractory epilepsy	hESC-derived progenitors of inhibitory interneurons
	TR2-01814 Muotri, UCSD	DCF	Autism Spectrum Disorder (ASD)	Neurons from ASD (and control) iPSC for phenotype screening, assay development and validation, drug screening and biomarker identification
	TR4-06747 Muotri, UCSD	DCF	Autism Spectrum Disorder (ASD)	Small molecule identified by screening on iPSC-derived astrocytes from ASD patients
Skeletal Muscle Disorders	TRX-05426 Nelson, UCLA	DCF	Duchenne muscular dystrophy	Combination therapy of an antisense oligonucleotide that promotes exon skipping and a small molecule that enhances its efficiency
	TR2-01756 Calos, Stanford	DCF	Duchenne muscular dystrophy	Autologous skeletal muscle stem/precursor cells derived from human iPSC genetically modifed to correct the dystrophin gene
	TR4-06711 Calos, Stanford	DCF	Limb Girdle Muscular Dystrophy Type 28	Autologus skeletal muscle stem/precursor cells derived from human iPSC genetically modifed to correct the mutant dysferlin gene
Skin Disorders	DR1-01454 Lane, Stanford	IND	Epidermolysis bullosa	Epidermal sheets from expanded autologous genetically corrected (to express wild type COL7A1) iPSC-derived keratinocytes

CIRM Translation Portfolio: Pluripotent SC Approaches



Pie slices are Approach, $ MM, # Awards

Translation Portfolio: PSC Cell Therapies

DISEASE AREA	AWARD# PI / Institution	GOAL	DISEASE/INJURY	APPROACH
Blood Disorder	TR4-06809 Verma, Salk	DCF	Hemophilia B	Genetically corrected autologous iPSC-derived hepatocytes
Cardiovascular Disease	DR2A-05394 Wu, Stanford	IND	End stage heart failure with LVAD	Allogeneic hESC-derived cardiomyocytes
	TR3-05556 Wu, Stanford	DC	Cardiovascular Disease	hESC-derived cardiomyocytes seeded in a tissue engineered patch
	TR3-05559 Xu, UCSD	DCF	Cardiovascular Disease	hESC-derived cardiomyocytes genetically modified to evade allogeneic immune rejection
Endocrine Disorder	SP1-06513 Foyt, ViaCyte Inc.	IND, Ph 1/2	Diabetes: Type 1	Allogeneic hESC-derived pancreatic cell progenitors in a device implanted subcutaneously
	DR1-01423 Robins, ViaCyte Inc	IND	Diabetes: Type 1	Allogeneic hESC-derived pancreatic cell progenitors in a device implanted subcutaneously
Eye Disorder	DR3-07438 Humayun, USC	Ph 1	Age-related macular degeneration (dry form)	Allogeneic functionally polarized hESC-derived RPE monolayers on synthetic substrate implanted sub-retinally
	DR1-01444 Humayun, USC	IND	Age-related macular degeneration (dry form)	Allogeneic functionally polarized hESC-derived RPE monolayers on synthetic substrate implanted sub-retinally
	TR4-06648 Seiler, UC Irvine	DC	Retinitis Pigmentosa, Age-related macular degeneration (dry form)	Allogeneic hESC-derived 'sheet' of retinal progenitor cell (RPC) & retinal pigmented epithelium (RPE)
Kidney/Urinary Disease	TR3-05569 Reijo Pera, Stanford	DC	Urinary Incontinence	Autologous iPSC-derived smooth muscle precursor cells and smooth muscle cells, potentially delivered in a matrix

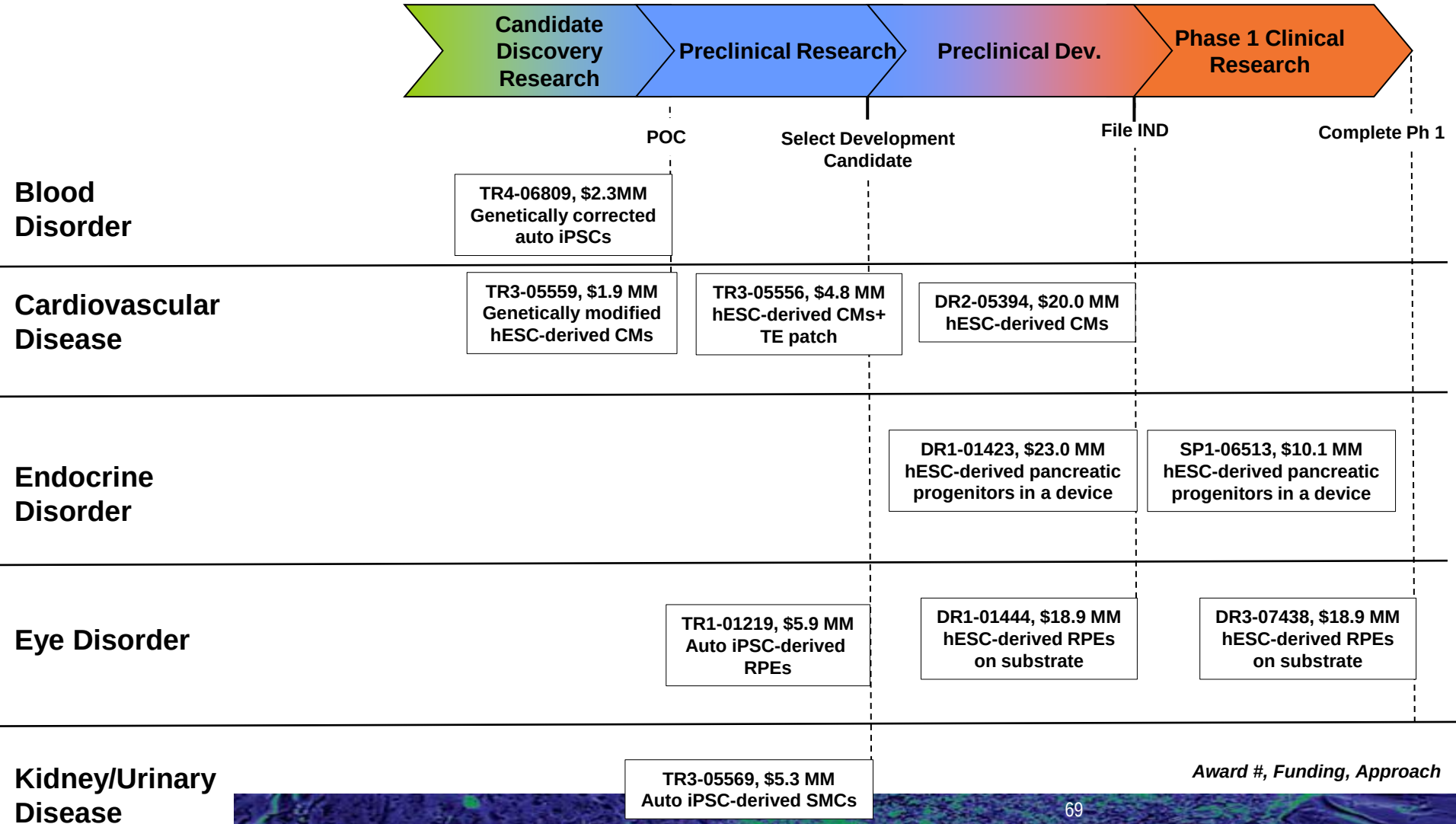
Translation Portfolio: PSC Cell Therapies

DISEASE AREA	AWARD# PI / Institution	GOAL	DISEASE/INJURY	APPROACH
Liver Disease	TR2-01857 Zern, UC Davis	DC	Liver Disease (acute liver failure and as a bridge following large liver resections)	Allogeneic genetically modified hESC-derived hepatocytes
	TR4-06831 Lipshutz, UCLA	DCF	Urea Cycle Disorders	Genetically corrected, autologous iPSC-hepatocytes for enzyme replacement
Neurodegenerative Disorder	TRX-01471 Goldstein, UCSD	DC	ALS	hESC derived astrocyte precursor cells
	TR3-05603 Lane, UC Irvine	DC	Autoimmune Disease / Multiple Sclerosis	Human pluripotent stem cell-derived neural progenitor cells
	TR2-01841 Thompson, UC Irvine	DC	Huntington's Disease	Allogeneic hESC-derived neural stem or progenitor cells
	TR2-01856 Zeng, Buck Inst.	DC	Parkinson's Disease	Allogeneic hPSC-derived dopaminergic neurons
	TR1-01267 Snyder, Sanford-Burnham	DC	Parkinson's Disease	The best hNSC derived from either tissue, ESC, or iPSC
Skeletal Muscle Disorder	TR2-01756 Calos, Stanford	DCF	Duchenne muscular dystrophy	Autologous skeletal muscle stem/precursor cells derived from human iPSC genetically modifed to correct the dystrophin gene
	TR4-06711 Calos, Stanford	DCF	Limb Girdle Muscular Dystrophy Type 28	Autologus skeletal muscle stem/precursor cells derived from human iPSC genetically modifed to correct the mutant dysferlin gene
Skin Disorder	DR1-01454 Lane, Stanford	IND	Epidermolysis bullosa	Epidermal sheets from expanded autologous genetically corrected (to express wild type COL7A1) iPSC-derived keratinocytes

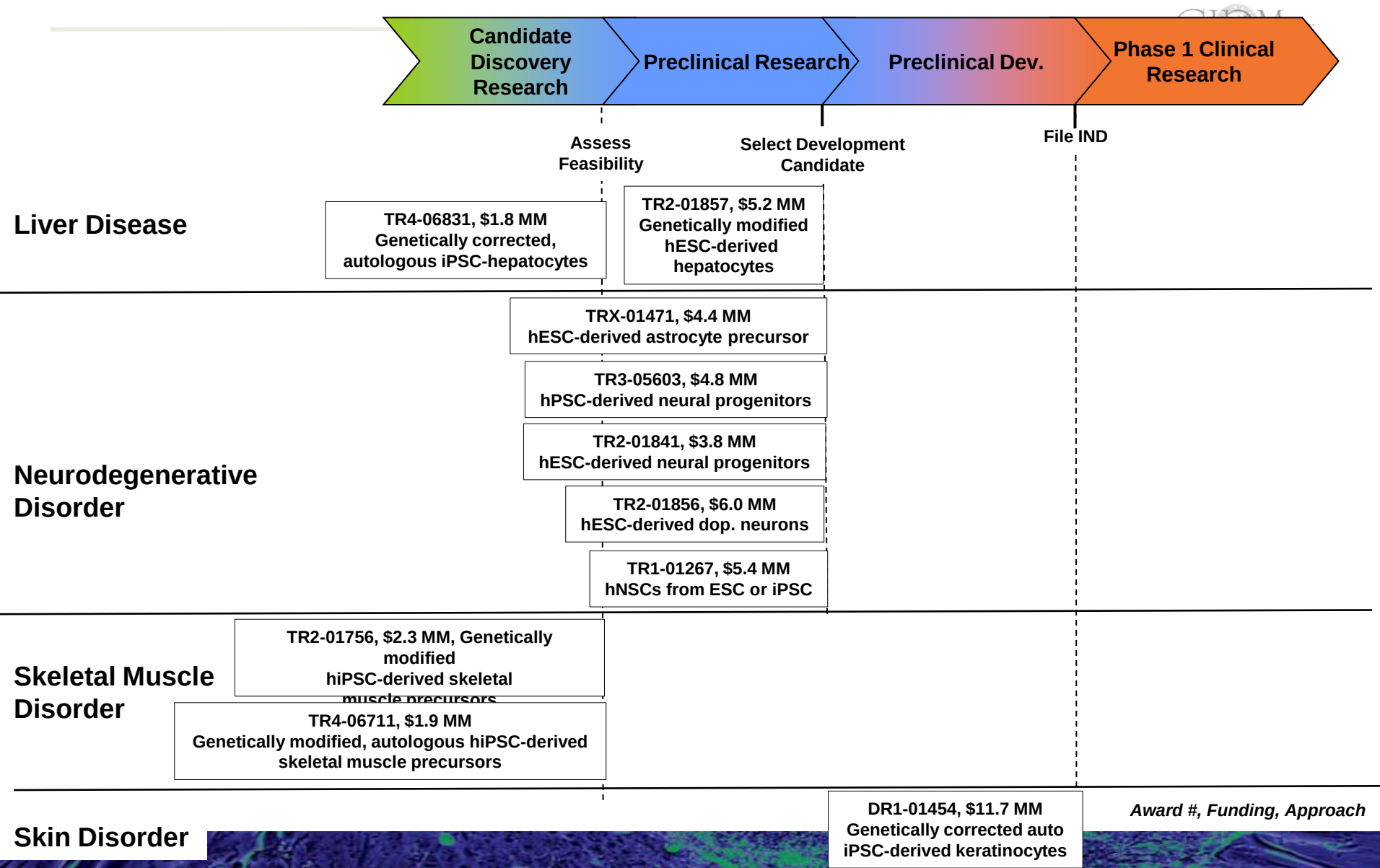
Translation Portfolio: PSC Cell Therapies

DISEASE AREA	AWARD# PI / Institution	GOAL	DISEASE/INJURY	APPROACH
Neurologic Injury	DR1-01480 Steinberg, Stanford	IND	Stroke	Allogeneic hESC-derived NSC
	TR3-05628 Tuszynski, UCSD	DC	Spinal Cord Injury	hESC-derived neural stem cells in a scaffold
	TR3-05606 Kriegstein, UCSF	DCF	Spinal Cord Injury	hESC-derived progenitors of inhibitory interneurons
	TR2-01767 Cummings, UC irvine	DCF	Traumatic Brain Injury	Allogeneic hESC-derived NSC
	TR2-01785 Havton, UC Irvine	DCF	Spinal Cord Injury (conus medullaris, cauda equina)	hESC-derived motor and autonomic precursor neurons
	TR4-06788 Lipton, Sanford-Burnham	DCF	Stroke	hESC-derived neural stem cells genetically modifed to transiently express MEF2C
Pediatric Neurological Disorder	TR2-01832 Shi, City of Hope	DCF	Canavan Disease	Autologous iPSC-derived neural or oligodendrocyte progenitors, genetically modifed to correct mutant aspartoacylase (ASPA) gene
	TR2-01749 Alvarez-Buylla, UCSF	DCF	Refractory epilepsy	hESC-derived progenitors of inhibitory interneurons

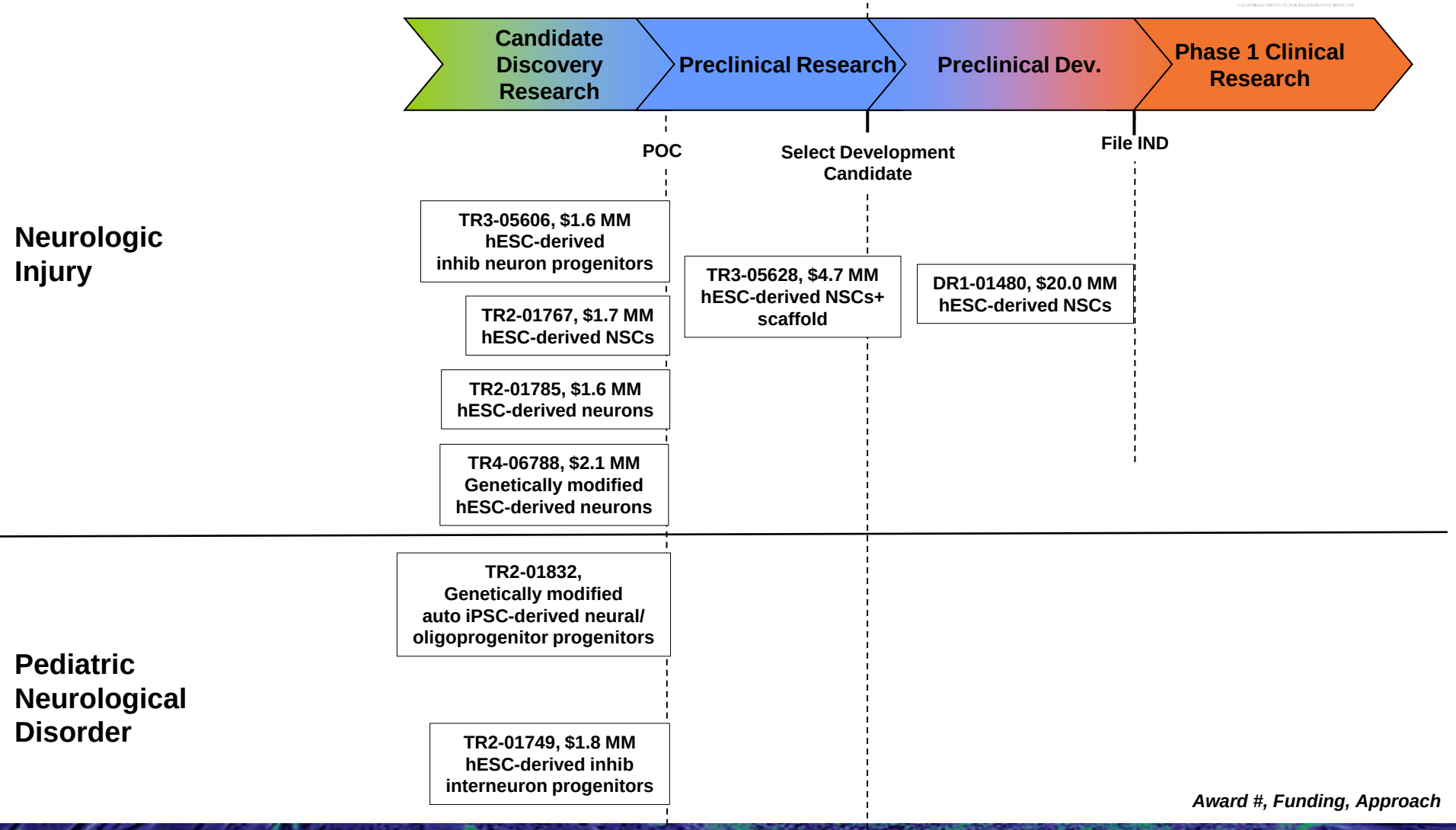
CIRM Translation Portfolio: Pluripotent SCs



CIRM Translation Portfolio: Pluripotent SCs

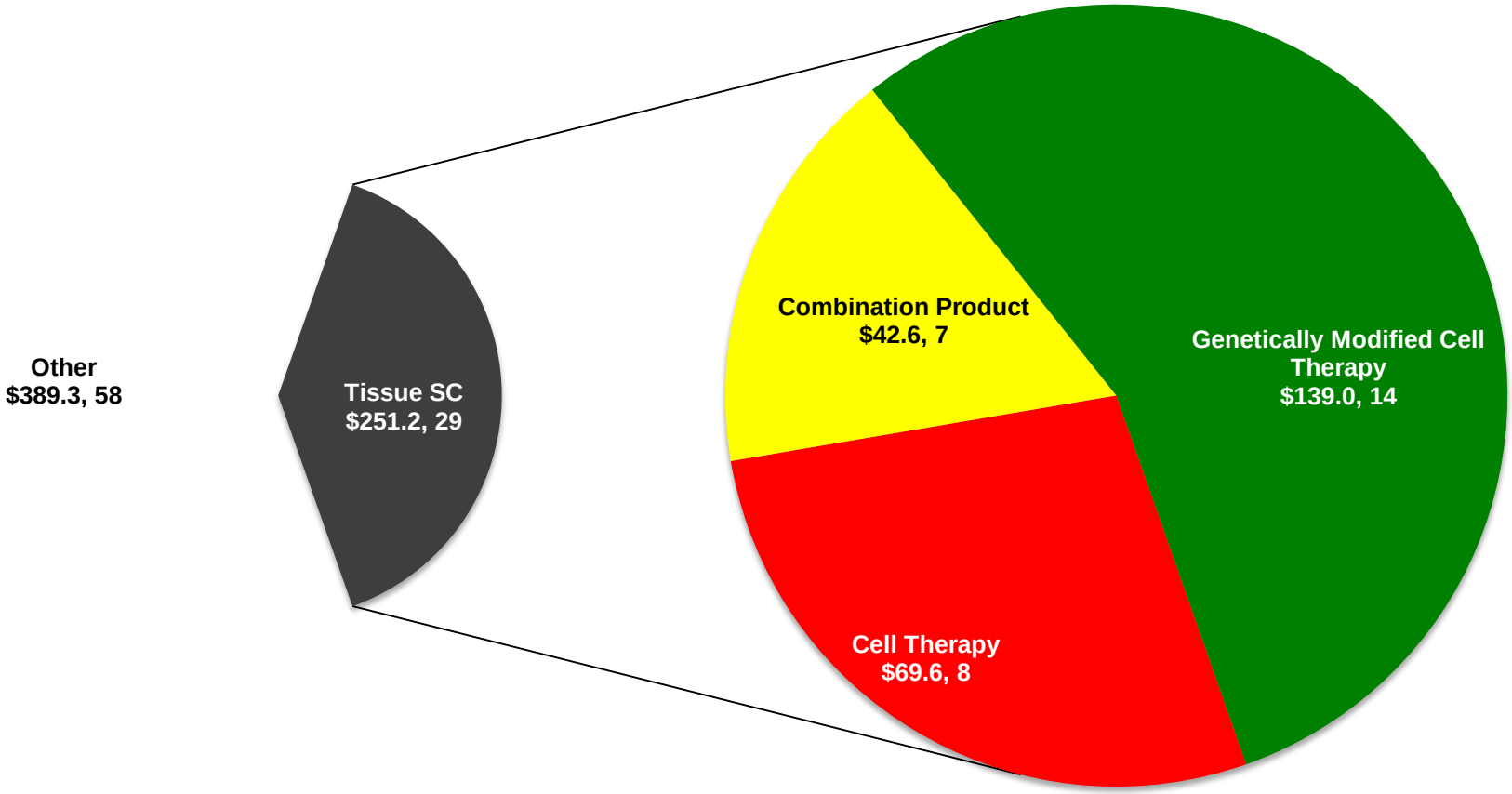


CIRM Translation Portfolio: Pluripotent SCs



Award #, Funding, Approach

CIRM Translation Portfolio: Tissue SCs Approaches



Pie slices are $ MM, # Awards, Approach

Translation Portfolio: Tissue SC Therapies

DISEASE AREA	AWARD# PI / Institution	GOAL	DISEASE/INJURY	APPROACH
Blood Disorder	DR3-06945 Kohn, UCLA	Ph 1	Sickle Cell Disease	Autologous HSC, genetically corrected ex vivo by lentiviral vector mediated addition of a hemoglobin gene that blocks sickling
	SP2-06902 Urnov, Sangamo Biosciences, Inc.	IND, Ph 1	β-thalassemia	Autologous HSC genetically modified ex vivo using a novel gene-editing technology to re-activate fetal gamma-globin expression
	DR1-01452 Kohn, UCLA	IND	Sickle Cell Disease	Autologous HSC, genetically corrected ex vivo by lentiviral vector mediated addition of a hemoglobin gene that blocks sickling
	TR3-05535 Cowan, UCSF	DC	SCID-A	Autologous HSC genetically corrected ex vivo by lentiviral vector mediated delivery of the Artemis gene
	TR4-06823 Kohn, UCLA	DCF	Sickle Cell Disease	Autologous HSC, genetically modified ex vivo to correct the mutation in the β-globin gene
Bone Disorder	TR2-01821 Peault, UCLA	DC	Spinal fusion	Autologous adult perivascular stem cells (MSC) and an osteoinductive protein (CLL) on a FDA-approved acellular scaffold
	TR2-01780 Gazit, Cedars-Sinai	DCF	Osteoporosis-related vertebral compression fractures	MSC in combination with PTH (parathyroid hormone)
Cardiovascular, Vascular Disorder	DR2A-05735 Smith, Capricor Inc.	Ph 2	Heart dysfunction after MI/Chronic heart failure	Allogeneic cardiac-derived stem cells
	DR2A-05423 Laird, UC Davis	IND, Ph 1	Critical limb ischemia	Allogeneic MSC engineered to express VEGF delivered by intramuscular injection
	TR3-05626 Boyd, UC Davis	DC	Cardiovascular Disease	Allogeneic human bone marrow-derived MSCs embedded in a biological scaffold

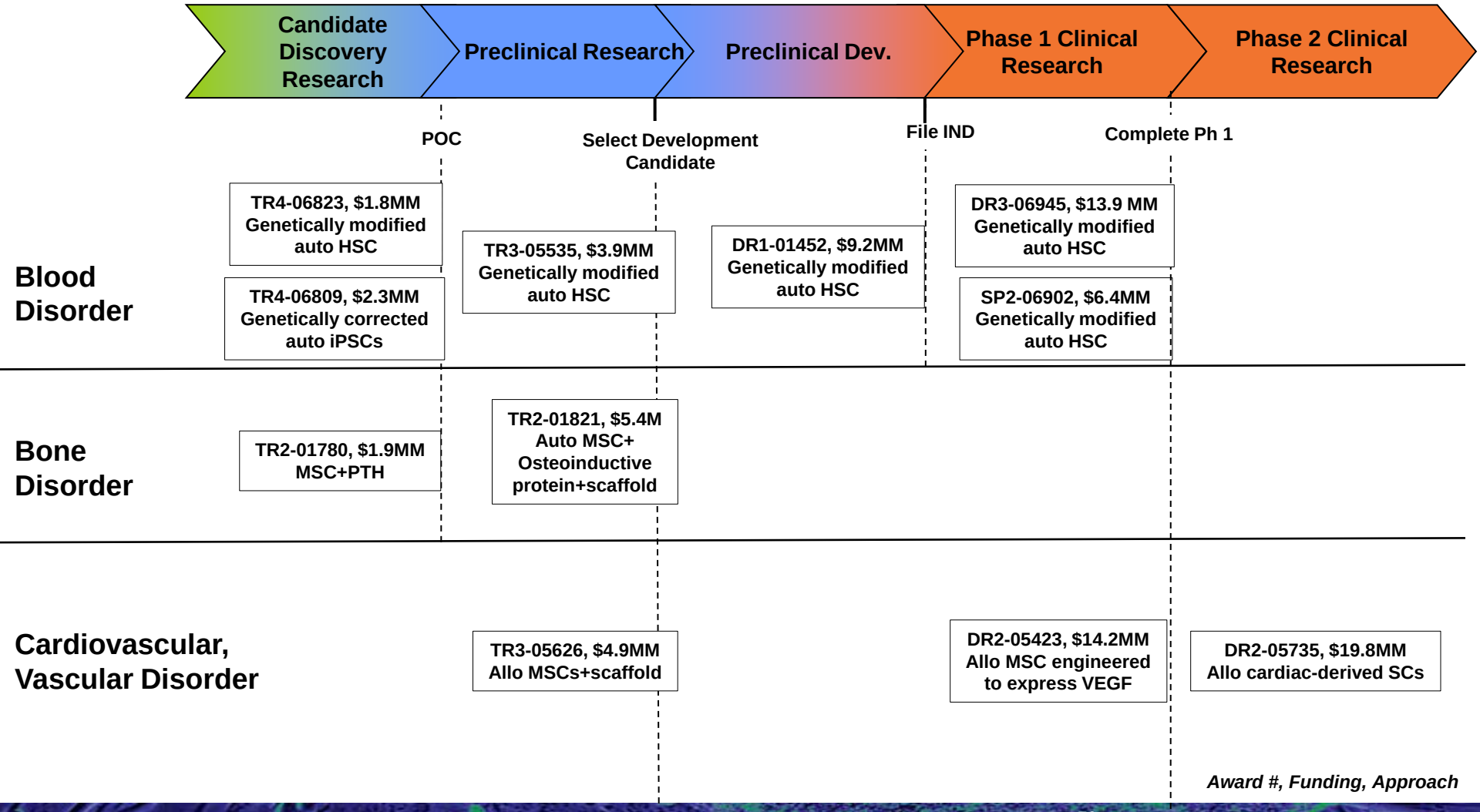
Translation Portfolio: Tissue SC Therapies

DISEASE AREA	AWARD# PI / Institution	GOAL	DISEASE/INJURY	APPROACH
Cartilage Disorder	TR3-05709 Athanasiou, UC Davis	DCF	Articular cartilage defects	Autologous adult (dermis isolated) stem cell-derived tissue engineered product
Eye Disease	DR2A-05739 Klassen, UC Irvine	IND, Ph 1/2	Retinitis Pigmentosa	Allogenic retinal progenitor cells
	TR2-01768 Deng, UCLA	DCF	Corneal Injury	Ex vivo expansion of corneal epithelial stem/progenitor cells, also known as limbal stem cells
HIV/AIDS	DR1-06893 Symonds, Calimmune	Ph 1/2	HIV/AIDS	Autologous HSC transduced ex vivo with a lentiviral vector engineered to express an shRNA against CCR5 & a fusion inhibitor.
	DR1-01490 Zaia, City of Hope	IND	AIDS Lymphoma	Autologous HSC transduced ex vivo with non-integrating vector engineered to express a zinc finger nuclease targeting CCR5
	TRX-01431 Chen, UCLA	DC	AIDS Lymphoma	Autologous HSC transduced ex vivo with a lentiviral vector engineered to express shRNAs against CCR5 & another target in the HIV life cycle.
	TR2-01771 DiGiusto, City of Hope	DC	AIDS Lymphoma	Autologous HSC genetically modified with multiple anti-HIV resistance genes and a drug resistance gene
	TR4-06845 Zack, UCLA	DC	HIV/AIDS	Autologous HSC and/or T memory stem cells genetically modified ex vivo with a lentiviral vector engineered to express a chimeric antigen receptor (CAR) and other gene reagents against HIV
Liver Disease	TR3-05488 Miki, USC	DCF	Liver Disease, Congenital	Human amniotic epithelial cell-derived hepatic cells

Translation Portfolio: Tissue SC Therapies

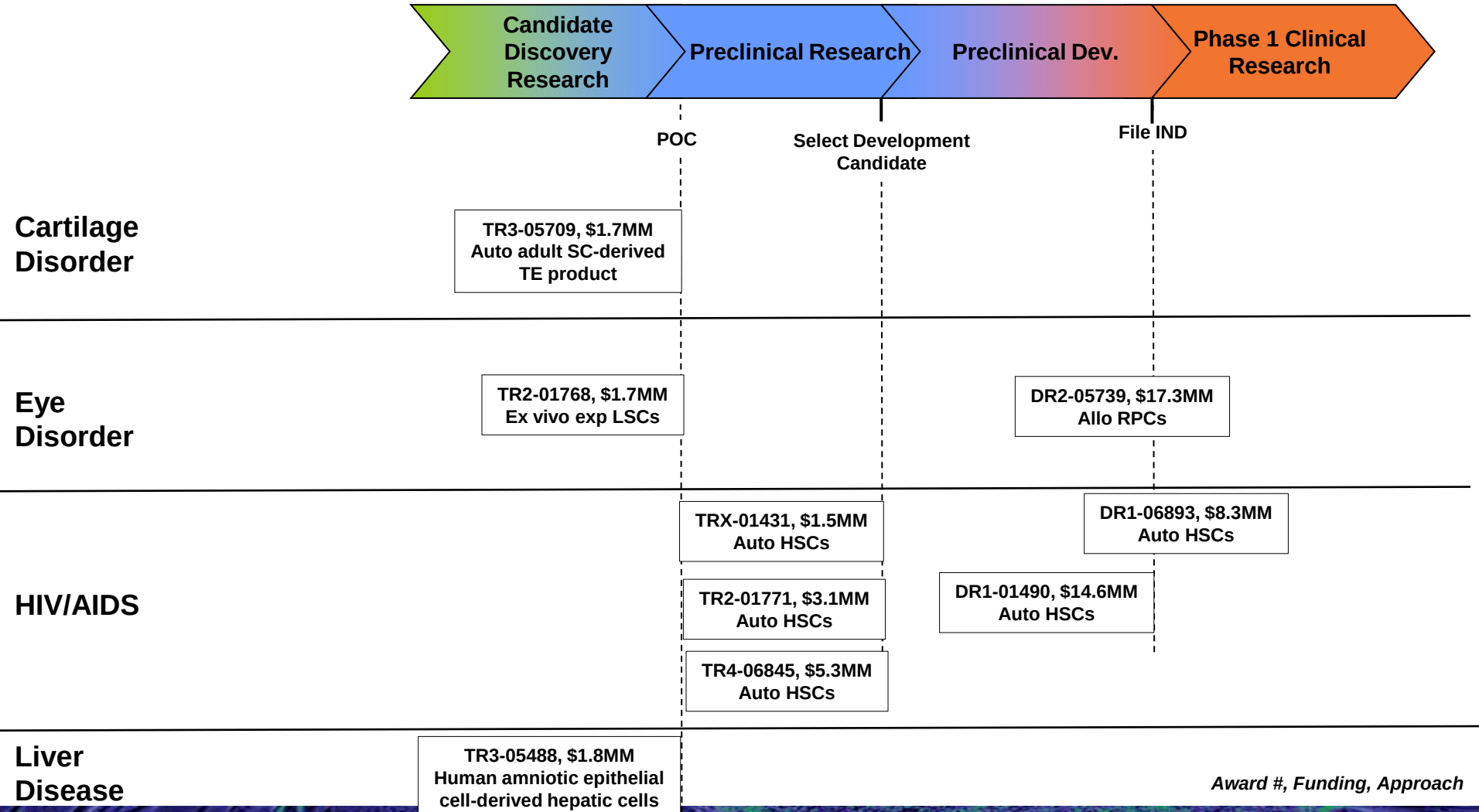
DISEASE AREA	AWARD# PI / Institution	GOAL	DISEASE/INJURY	APPROACH
Neurodegenerative Disorder	DR2A-05320 Svendson, Cedars-Sinai	IND, Ph 1	ALS	Allogeneic neural progenitor cells genetically modified with GDNF
	DR2A-05416 Capela, Stem Cells Inc.	IND	Alzheimer's Disease	Neural stem cell transplantation for neuroprotection
	DR2A-05415 Wheelock, UC Davis	IND, Ph 1	Huntington's Disease	MSC genetically engineered to express BDNF
Respiratory	DR3-07281 Belafsky, UC Davis	IND	Airway stenosis	An engineered trachea comprised of autologous stem/progenitor cells on a biologic scaffold
Skeletal Muscle Disorder	TR3-05501 Blau, Stanford	DCF	Age-related Muscle Atrophy	Autologous human muscle stem/progenitor cells rejuvenated and expanded ex vivo using a combined bioengineering and small molecule treatment
Skin Disorder	TR2-01787 Isseroff, UC Davis	DC	Chronic Diabetic Foot Ulcers	Allogenic hMSC on a dermal regeneration scaffold
Solid Cancer	DR2A-05309 Ribas, UCLA	IND, Ph 1	Melanoma	Autologous HSCs and T cells genetically modified to express an anti-tumor T cell receptor
	DR1-01421 Aboody, City of Hope	IND	Glioblastoma	Allogeneic hNSC line to target tumor, engineered ex vivo to deliver carboxylesterase to locally convert CPT-11 to more potent SN-38
	TR2-01791 Kasahara, UCLA	DC	Glioblastoma	Allogeneic hMSC to target tumor, engineered to produce replication competent retrovirus encoding a prodrug activator to locally convert a pro-drug to a potent chemotherapeutic

CIRM Translation Portfolio: Tissue SCs



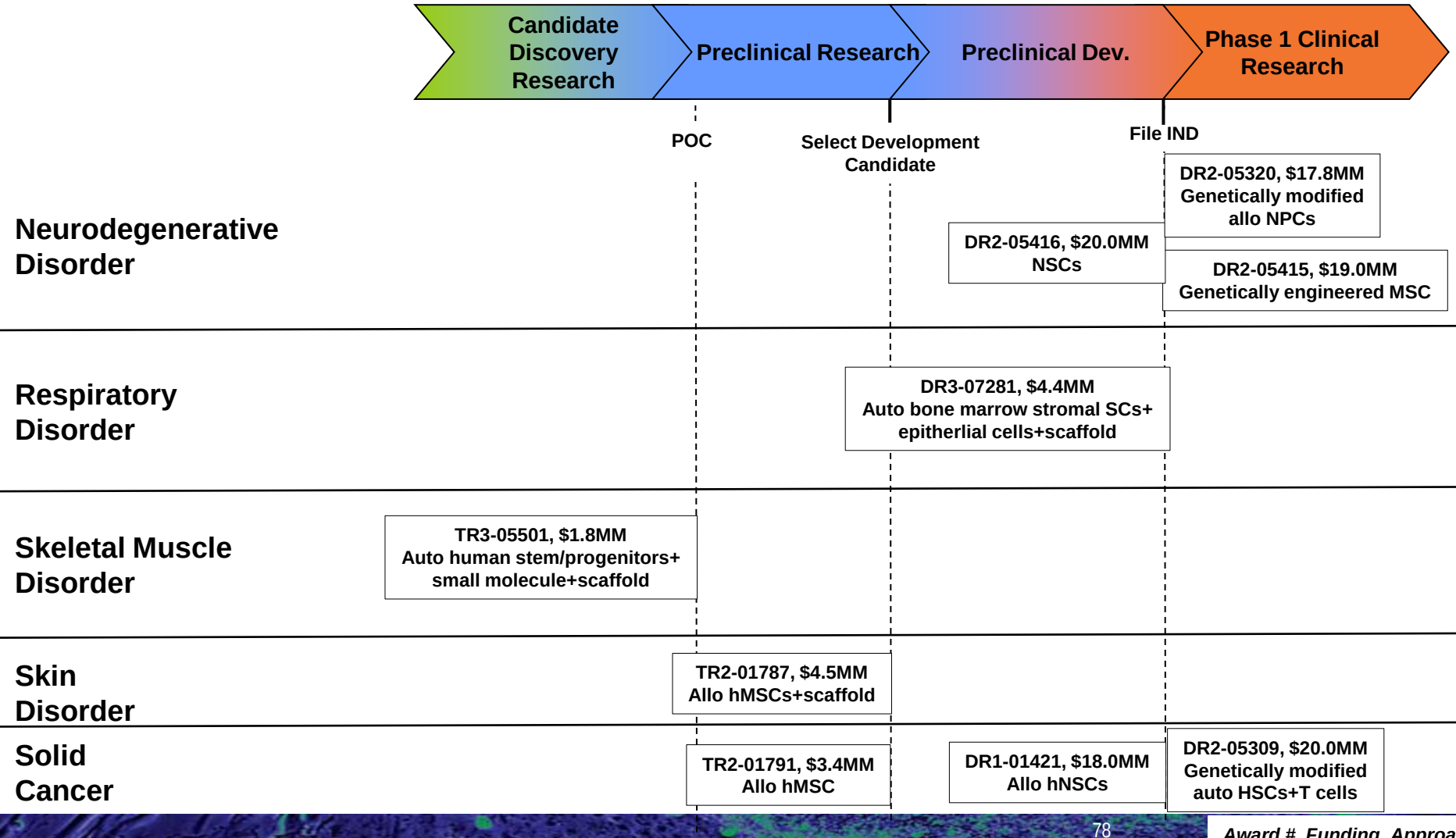
Award #, Funding, Approach

CIRM Translation Portfolio: Tissue SCs



Award #, Funding, Approach

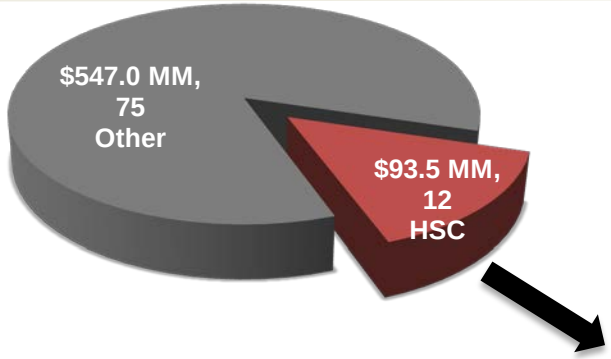
CIRM Translation Portfolio: Tissue SCs

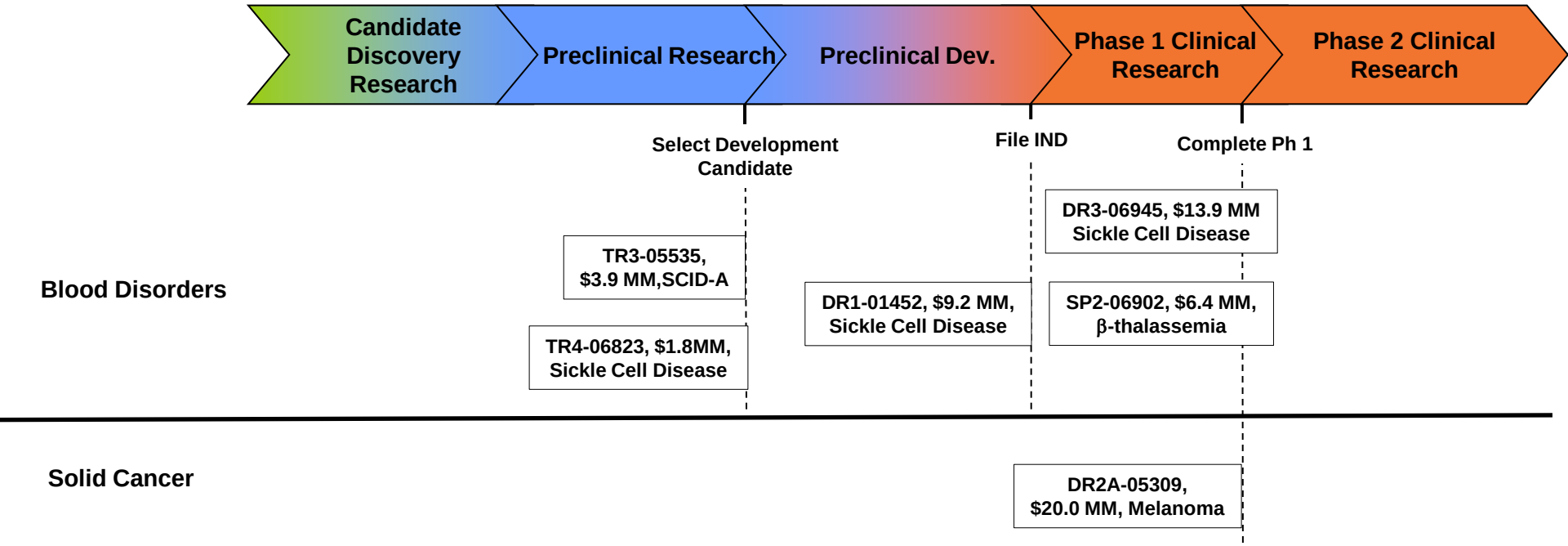


Translation Portfolio: Hematopoietic SCs

DISEASE AREA	AWARD # PI, INSTITUTION	GOAL	DISEASE/INJURY	APPROACH
Solid Cancer	DR2A-05309 Ribas, UCLA	IND, Ph 1	Melanoma	Autologous HSC genetically modified to produce an anti-tumor T cell receptor and a PET reporter gene
HIV/AIDS	DR1-06893 Symonds, Calimmune	Ph 1/2	HIV/AIDS	Autologous HSC transduced ex vivo with a lentiviral vector engineered to express an shRNA against CCR5 & a fusion inhibitor.
	DR1-01490 Zaia, City of Hope	IND	AIDS Lymphoma	Autologous HSC transduced ex vivo with non-integrating vector engineered to express a zinc finger nuclease targeting CCR5
	TRX-01431 Chen, UCLA	DC	AIDS Lymphoma	Autologous HSC transduced ex vivo with a lentiviral vector engineered to express shRNAs against CCR5 & another target in the HIV life cycle.
	TR2-01771 DiGiusto, Beckman	DC	AIDS Lymphoma	Autologous HSC genetically modified with multiple anti-HIV resistance genes and a drug resistance gene
	TR4-06845 Zack, UCLA	DC	HIV/AIDS	Autologous HSC and/or T memory stem cells genetically modified ex vivo with a lentiviral vector engineered to express a chimeric antigen receptor (CAR) and other gene reagents against HIV
Blood Disorder	DR3-06945 Kohn, UCLA	Ph 1	Sickle Cell Disease	Autologous HSC, genetically corrected ex vivo by lentiviral vector mediated addition of a hemoglobin gene that blocks sickling
	SP2-06902 Urnov, Sangamo Biosciences, Inc.	IND, Ph 1	β-thalassemia	Autologous HSC genetically modified ex vivo using a novel gene-editing technology to re-activate fetal gamma-globin expression
	DR1-01452 Kohn, UCLA	IND	Sickle Cell Disease	Autologous HSC, genetically corrected ex vivo by lentiviral vector mediated addition of a hemoglobin gene that blocks sickling
	TR3-05535 Cowan, UCSF	DC	SCID-A	Autologous HSC genetically corrected ex vivo by lentiviral vector mediated delivery of the Artemis gene
	TR4-06823 Kohn, UCLA	DCF	Sickle Cell Disease	Autologous HSC, genetically modified ex vivo to correct the mutation in the β-globin gene

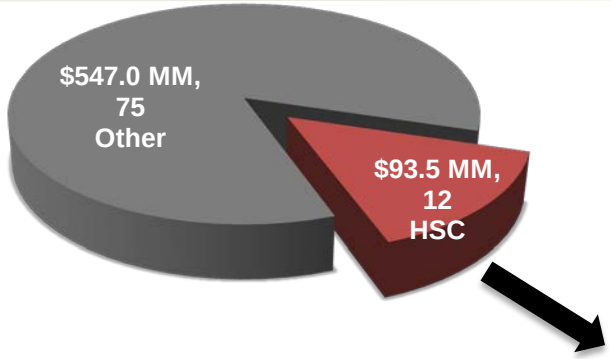
CIRM Translation Portfolio: Hematopoietic SCs

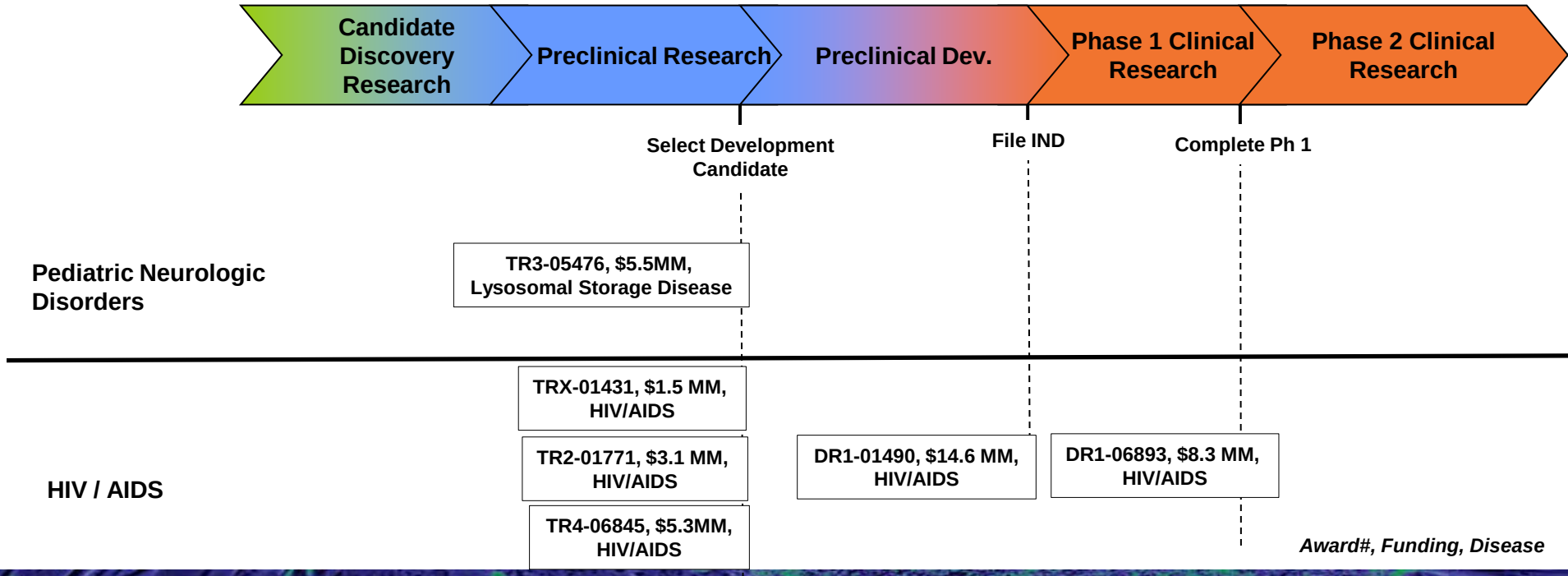




Award #, Funding, Disease

CIRM Translation Portfolio: Hematopoietic SCs

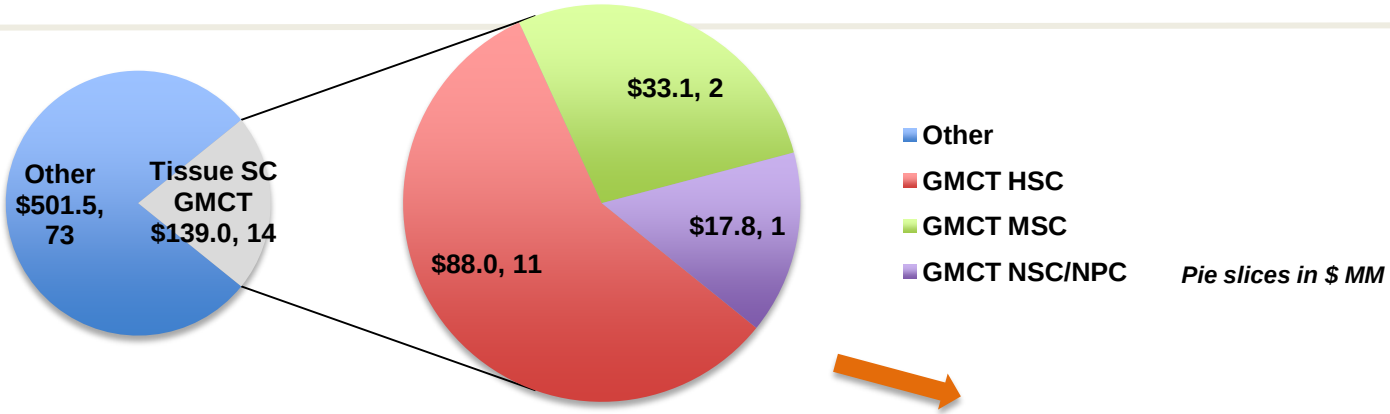


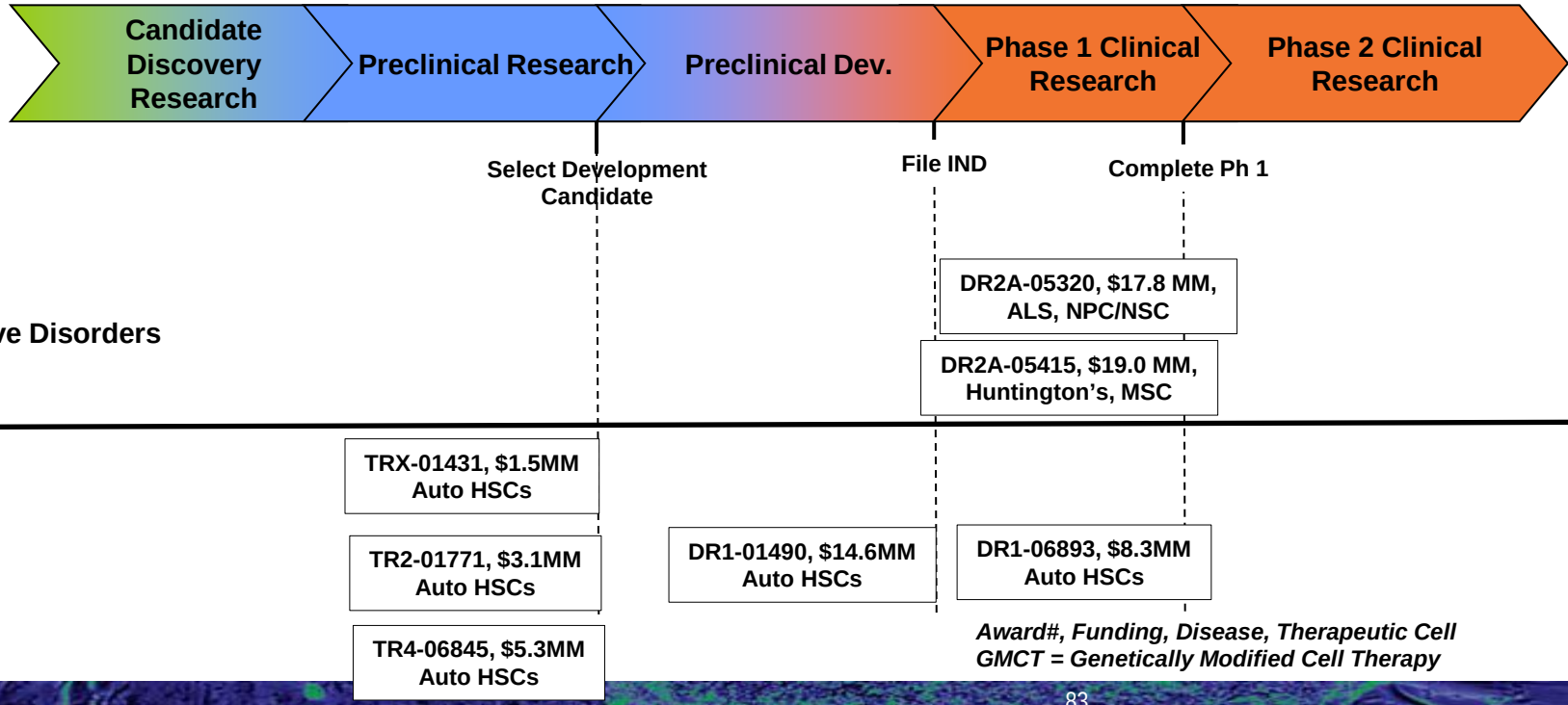


Translation Portfolio: Genetically Modified Tissue SCs

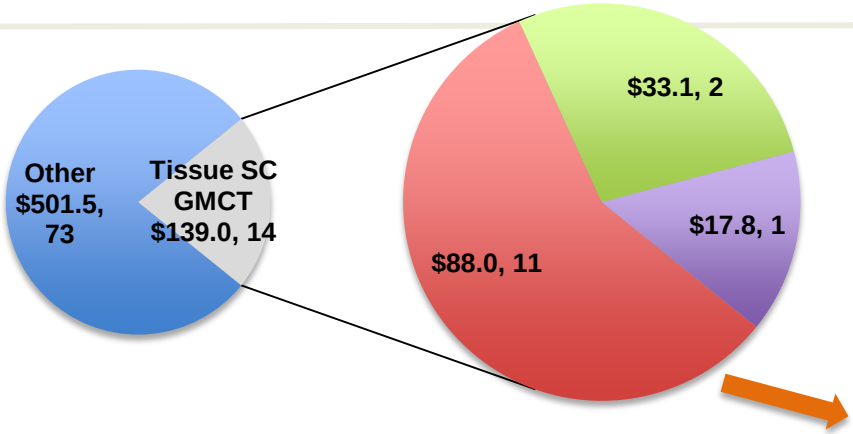
DISEASE AREA	AWARD # PI, Institution	GOAL*	DISEASE/INJURY	APPROACH
Solid Cancer	DR2A-05309 Ribas, UCLA	IND, Ph 1	Melanoma	Autologous HSC genetically modified to produce an anti-tumor T cell receptor and a PET reporter gene
Neurodegenerative Disorders	DR2A-05320 Svendson, Cedars-Sinai	IND, Ph 1	ALS	Allogeneic neural progenitor cells genetically modified with GDNF
	DR2A-05415 Wheelock, UC Davis	IND, Ph 1	Huntington's Disease	MSC genetically engineered to express BDNF
HIV / AIDS	DR1-06893 Symonds, Calimmune	Ph 1/2	HIV/AIDS	Autologous HSC transduced ex vivo with a lentiviral vector engineered to express an shRNA against CCR5 & a fusion inhibitor.
	DR1-01490 Zaia, City of Hope	IND	AIDS Lymphoma	Autologous HSC transduced ex vivo with non-integrating vector engineered to express a zinc finger nuclease targeting CCR5
	TRX-01431 Chen, UCLA	DC	AIDS Lymphoma	Autologous HSC transduced ex vivo with a lentiviral vector engineered to express shRNAs against CCR5 & another target in the HIV life cycle.
	TR2-01771 DiGiusto, Beckman	DC	AIDS Lymphoma	Autologous HSC genetically modified with multiple anti-HIV resistance genes and a drug resistance gene
	TR4-06845 Zack, UCLA	DC	HIV/AIDS	Autologous HSC and/or T memory stem cells genetically modified ex vivo with a lentiviral vector engineered to express a chimeric antigen receptor (CAR) and other gene reagents against HIV
Blood Disorders	SP2-06902 Urnov, Sangamo Biosciences, Inc.	IND, Ph 1	β-thalassemia	Autologous HSC genetically modified ex vivo using a novel gene-editing technology to re-activate fetal gamma-globin expression
	DR3-06945 Kohn, UCLA	Ph 1	Sickle Cell Disease	Autologous HSC, genetically corrected ex vivo by lentiviral vector mediated addition of a hemoglobin gene that blocks sickling
	DR1-01452 Kohn, UCLA	IND	Sickle Cell Disease	Autologous HSC, genetically corrected ex vivo by lentiviral vector mediated addition of a hemoglobin gene that blocks sickling
	TR3-05535 Cowan, UCSF	DC	SCID-A	Autologous HSC genetically corrected ex vivo by lentiviral vector mediated delivery of the Artemis gene
	TR4-06823 Kohn, UCLA	DCF	Sickle Cell Disease	Autologous HSC, genetically modified ex vivo to correct the mutation in the β-globin gene
CV, Vascular Diseases	DR2A-05423 Laird, UC Davis	IND, Ph 1	Critical limb ischemia	Allogeneic MSC engineered to express VEGF delivered by intramuscular injection

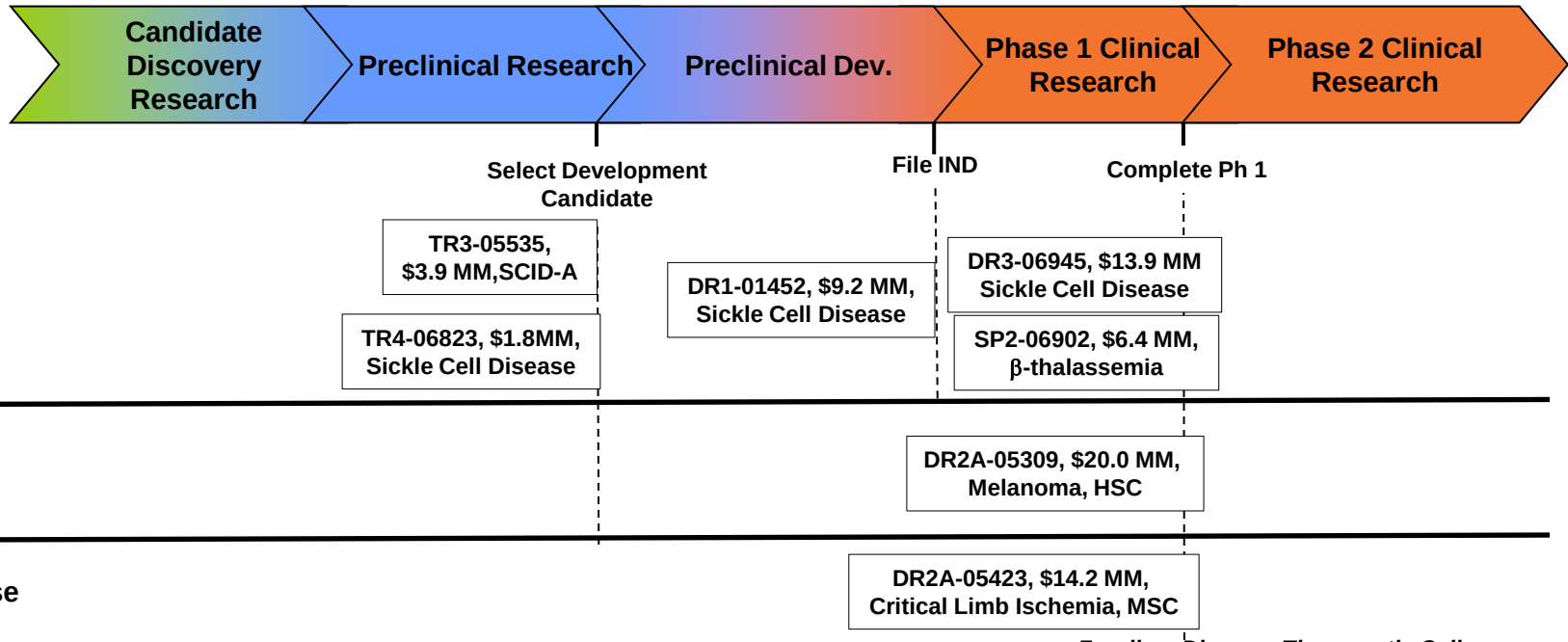
CIRM Translation Portfolio
Genetically Modified Cell Therapies with Tissue SCs



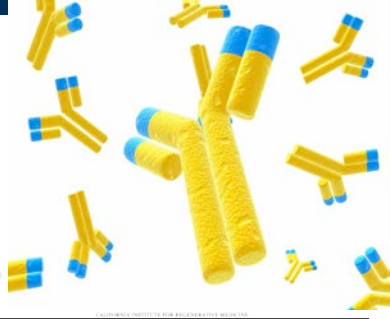


CIRM Translation Portfolio: Genetically Modified Cell Therapies with Tissue SCs



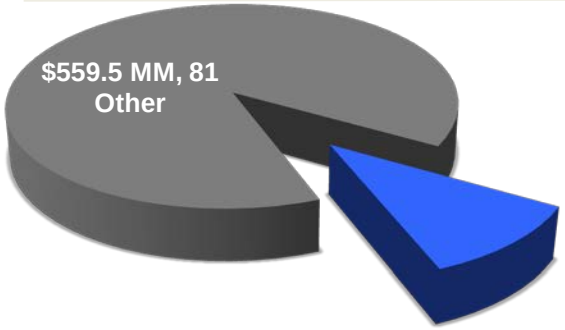


Translation Portfolio Technology: MAb



AWARD # PI, Institution	GOAL	DISEASE / INJURY	APPROACH
DR3-06924 Kipps, UCSD	Ph 1	CLL	Monoclonal antibody (anti-ROR1) targeting CLL cancer stem cells
DR3-06965 Weissman, Stanford	Ph 1	AML	Monoclonal antibody against CD47 – “Don’t eat me” antigen that is expressed on leukemia stem cells
DR2A-05365 Shizuru, Stanford	IND, Ph 1/2	Conditioning regimen for allogeneic HSC transplantation for X-SCID	MAb that depletes endogenous HSC
DR1-01430 Carson, UCSD	IND	AML, CLL	A monoclonal antibody (anti-ROR1) targeting CLL and AML cancer stem cells,respectively
DR1-01485 Weissman, Stanford	IND	AML	Monoclonal antibody against CD47 – “Don’t eat me” antigen that is expressed on leukemia stem cells
TR4-06867 Reiter, UCLA	DC	Prostate cancer	Monoclonal antibody against N-cadherin positive cancer stem cells

CIRM Translation Portfolio Technology: MAb



$81.0 MM, 6
MAb

Preclinical Research | Preclinical Dev. | Phase 1 Clinical Research | Phase 2 Clinical Research

Select Development Candidate | File IND | Complete Ph 1

Prostate Cancer

TR4-06847, $4.1 MM

AML and/or CML

DR1-01430, $20.0 MM

DR3-06924, $4.2 MM

DR1-01485, $20.0 MM

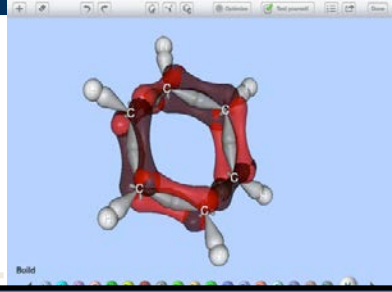
DR3-06965, $12.7 MM

X-SCID

DR2A-05365, $20.0MM

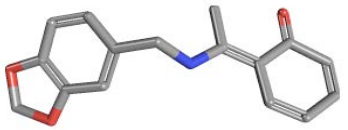
Award #, Funding

Translation Portfolio Technology: Small Molecule



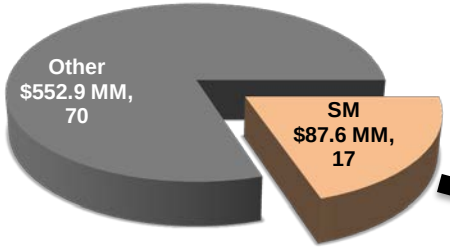
Disease Area	AWARD # PI, Institution	GOAL*	DISEASE/INJURY	APPROACH
Bone Disorder	DR2A-05302 Lane, UC Davis	IND, Ph 1/2	Osteoporosis	Synthetic molecule, LLP2A-Ale, to enhance homing of endogenous bone marrow MSCs to bone surface
Cartilage Disorder	TR2-01829 Schultz, Scripps	DC	Osteoarthritis	Optimized small molecule of lead molecule PRO1 that induces chrondrocyte differentiation of resident hMSC
Neurodegenerative Disorder	TR3-05617 Schultz, Scripps	DC	Autoimmune Disease / Multiple Sclerosis	Small molecule that acts on oligodendrocyte precursors in the CNS to induce differentiation to oligodendrocytes to stimulate remyelination
	TR3-05676 Yeo, UCSD	DCF	ALS	Small molecule that corrects proposed aberrant RNA "signature" in iPSC- derived neurons from patients with defects in RNA processing
	TR3-05577 Goldstein, UCSD	DCF	Alzheimer's Disease	Small molecule identified through screens on purified hiPSC-derived brain cells from patients that have rare and aggressive hereditary forms of Alzheimer's Disease
	TR3-05669 Schubert, Salk	DCF	Alzheimer's Disease	Small molecule for neuroprotection & neurogenesis identified using hESC-derived neural precursors
	TR2-01778 Gage, Salk	DCF	Parkinson's Disease	Small molecule identified by screening in a neuron/astrocyte/microglia co-culture differentiated from patient-derived iPSCs
	TR4-06693 Finkbeiner, Gladstone	DCF	ALS	Small molecule that stimulates autophagy identified by screening on iPSC-derived motor neurons form patients with ALS
	TR4-06847 Griffin, Numerate, Inc.	DCF	Huntington's Disease	Small molecules, identified using iPSC-derived human striatal neurons from HD patients, that disrupt the shape and reverse the neurotoxicity of the mutant huntingtin (mHtt) protein

Translation Portfolio Technology: Small Molecule



DISEASE AREA	AWARD # PI, Institution	GOAL	DISEASE/INJURY	APPROACH
Cardiovascular Disorder	TR3-05687 Adler, UCSD	DCF	Cardiovascular Disease - Danon disease	Small molecule leads identified by correction of autophagy on Danon patient iPSC-derived lines
	TR4-06857 Cashman, Human Biomolecular Research Institute	DC	Ventricular Arhythmias	Small molecule optimized using iPSC-derived cardiomyocytes from patients
Pediatric Neurologic Disorder	TR2-01814 Muotri, UCSD	DCF	Autism Spectrum Disorder (ASD)	Neurons from ASD (and control) iPSC for phenotype screening, assay development and validation, drug screening and biomarker identification
Hematologic Cancers	TR2-01789 Jamieson, UCSD	DC	CML	Small molecule pan BCL-2 inhibitor targeting cancer stem cells
	TR2-01816 Müschen, CHLA	DC	AML, ALL	Small molecule inhibitor of BCL6 targeting cancer stem cells
Solid Cancer	DR3-07067 Slamon, UCLA	Ph 1	Solid tumors	Small molecule mitotic inhibitor targeting serine/threonine kinase to eliminate both tumor cells and tumor initiating cells
	DR1-01477 Slamon, UCLA	IND	Colon, ovarian cancers, glioblastoma	Small molecules specific for each of two drug targets in cancer stem cells
Skeletal Muscle Disorder	TRX-05426 Nelson, UCLA	DCF	Duchenne muscular dystrophy	Combination therapy of an antisense oligonucleotide that promotes exon skipping and a small molecule that enhances its efficiency

Translation Portfolio Technology: Small Molecule



Candidate Discovery Research → Preclinical Research → Preclinical Dev. → Phase 1 Clinical Research

POC | Select Development Candidate | File IND | Complete Ph 1

Bone Disorder

- DR2A-05302, $20.0 MM, OP, Endog. SC

Cartilage Disorder

- TR2-01829, $6.8 MM, OA, Endog SC

Neurodegenerative Disorder

- TR3-05676, $1.7MM, ALS, DiD
- TR3-05577, $1.9MM, AD, DiD
- TR3-05669, $1.7MM, AD, DiD
- TR3-5617, $4.3MM, MS, Endog SC
- TR2-01778, $2.5 MM, PD, DiD
- TR4-06693, $2.3 MM, ALS, DiD
- TR4-06847, $1.3 MM, HD, DiD

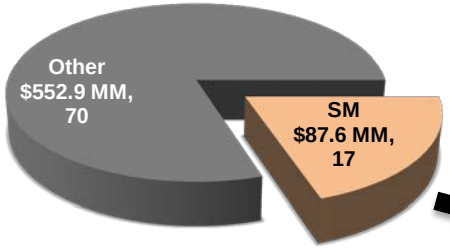
Pediatric Neurodegenerative Disorder

- TR2-01814, $1.5 MM, ASD, DiD

Award #, Funding Disease, SC Target

DiD = Disease in a Dish

Translation Portfolio Technology: Small Molecule



Candidate Discovery Research → Preclinical Research → Preclinical Dev. → Phase 1 Clinical Research

POC | Select Development Candidate | File IND | Complete Ph 1

Cardiovascular Disorder

- TR3-05687, $1.7 MM, Danon, DiD
- TR4-06857, $6.4 MM, Ventricular Arrythmias, iPSC-CMs

Hematologic Cancer

- TR2-01789, $3.3 MM, CML, CSC
- TR2-01816, $3.6 MM, AML/ALL, CSC

Solid Cancer

- DR1-01477, $20.0 MM, Colon/Ovarian/GBM, CSC
- DR3-07067, $6.9 MM, Solid Tumors, CSC

Skeletal Muscle Disorder

- TRX-05426, $1.8 MM, DMD, DiD

Award #, Funding Disease, SC Target

DiD = Disease in a Dish