INITIATIVES IN CELL THERAPY

-TURNING INNOVATIVE SCIENCE INTO VALUE FOR PATIENTS-

R&D Meeting – December 13, 2018

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CAUTIONARY STATEMENT REGARDING FORWARD-LOOKING INFORMATION

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Information about pharmaceutical products (including products currently in development) which is included in this material is not intended to constitute an advertisement or medical advice.

PROGRAM

I

Cell Therapy

-A novel approach to treating disease-

II

Leading with Science

-Investigating pluripotent stem cell therapies-

III

ASP7317

-To offer the hope to regain lost sight-

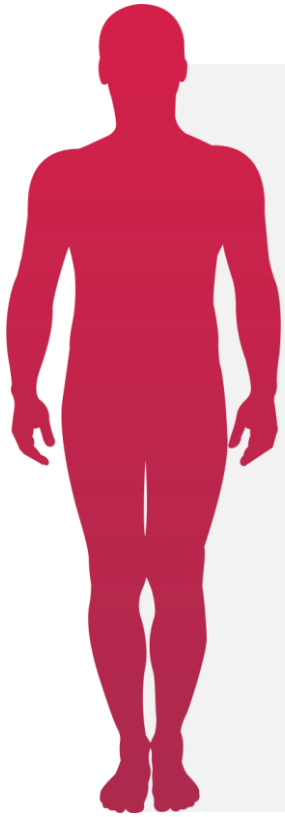
CELL THERAPY

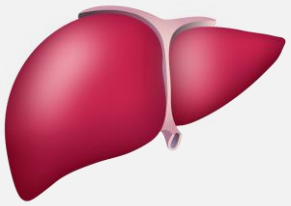
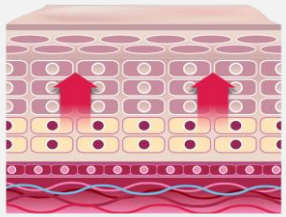
A novel approach to treating disease

Kenji Yasukawa, Ph.D
President and CEO

WHAT IS CELL THERAPY?

Cell therapy is a medical treatment using viable cells to regenerate functions of tissues or organs impaired by disease or injury



ORGAN	ORGAN BUD	TISSUE	CELLS
A part that has particular functions in the body (e.g. liver, heart)	Minimum set of cells of an organ	Aggregation of similar cells with a function (e.g. skin, cartilage)	Minimum constituent unit in the human body (e.g. nerve cells, cardiomyocytes)
			
			Central player in cell therapy

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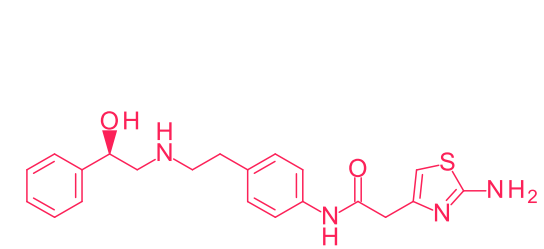
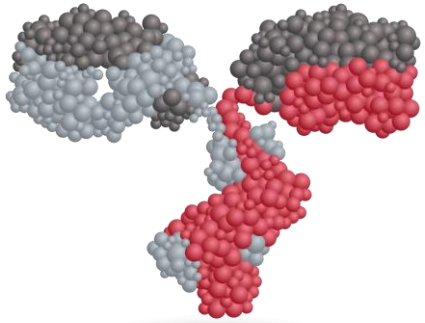
ADVANTAGES OF CELL THERAPY

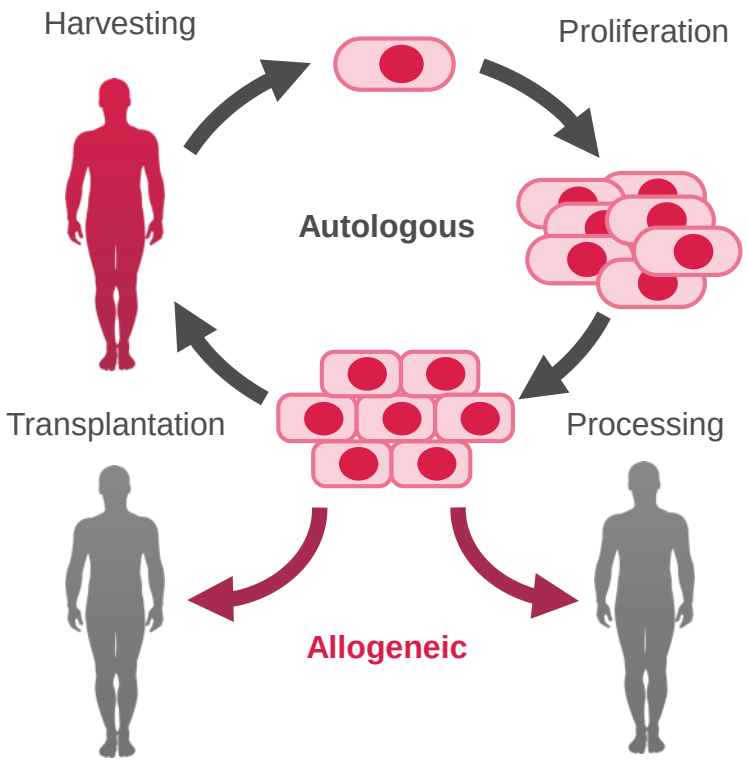
Multi-functional nature of cells offers high efficacy that existing therapies cannot deliver

	SYNTHETIC COMPOUNDS	BIOPHARMACEUTICALS	CELLS
			
MW SIZE	**<500**	**10K～150K (a few nm) (- Synthetic compounds x 3,000)**	**NA (10-30 μm） (- Bopharmaceuticals x 10,000)**
FUNCTION	**Single** *e.g. agonist, antagonist*	**Single** *e.g. agonist, antagonist, ADCC etc.*	**Multiple** *e.g. sensor, phagocytosis, secretion, antigen presentation, neurotransmission, metabolism*

MW: Molecular weight, ADCC: Antibody-dependent cellular cytotoxicity

TWO CATEGORIES OF THERAPEUTIC CELLS

Allogeneic cells may greatly expand potential impact



AUTOLOGOUS CELLS

- Individualized
  - Avoids immunological rejection
  - Costly
  - Requires a long period from harvesting to transplantation

ALLOGENEIC CELLS

- Commercialized cell therapy
  - Scalable
  - Requires countermeasure for immune rejection
  - Requires an established route for responsible cell acquisition

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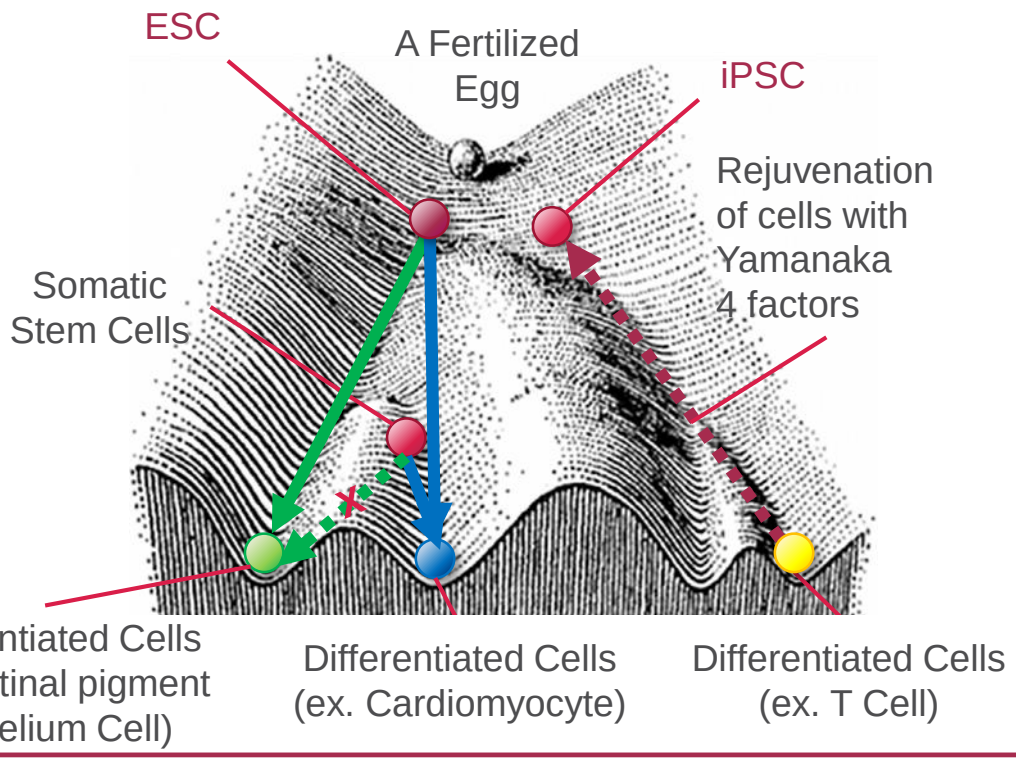
CELLS TO BE USED IN CELL THERAPY

Astellas will pursue commercialization of various cell therapy products using pluripotent stem cells (PSCs).

The key to this approach is establishment of efficient differentiation protocol

EPIGENETIC LANDSCAPE BY CONRAD WADDINGTON



KINDS OF STEM CELLS

PSC

- Embryonic stem cell (ESC)
- induced pluripotent stem cell (iPSC)
  - Derived from embryo or made by rejuvenation of cell
  - Differentiate to almost all kind of cells.

Somatic Stem Cell

- Somatic stem cell
  - Exist in the normal body
  - Differentiate to limited organs

Source: The Epigenetics Revolution: How Modern Biology is Rewriting Our Understanding of Genetics, Disease and Inheritance (Written by Nessa Carey)

ASTELLAS CELL THERAPY

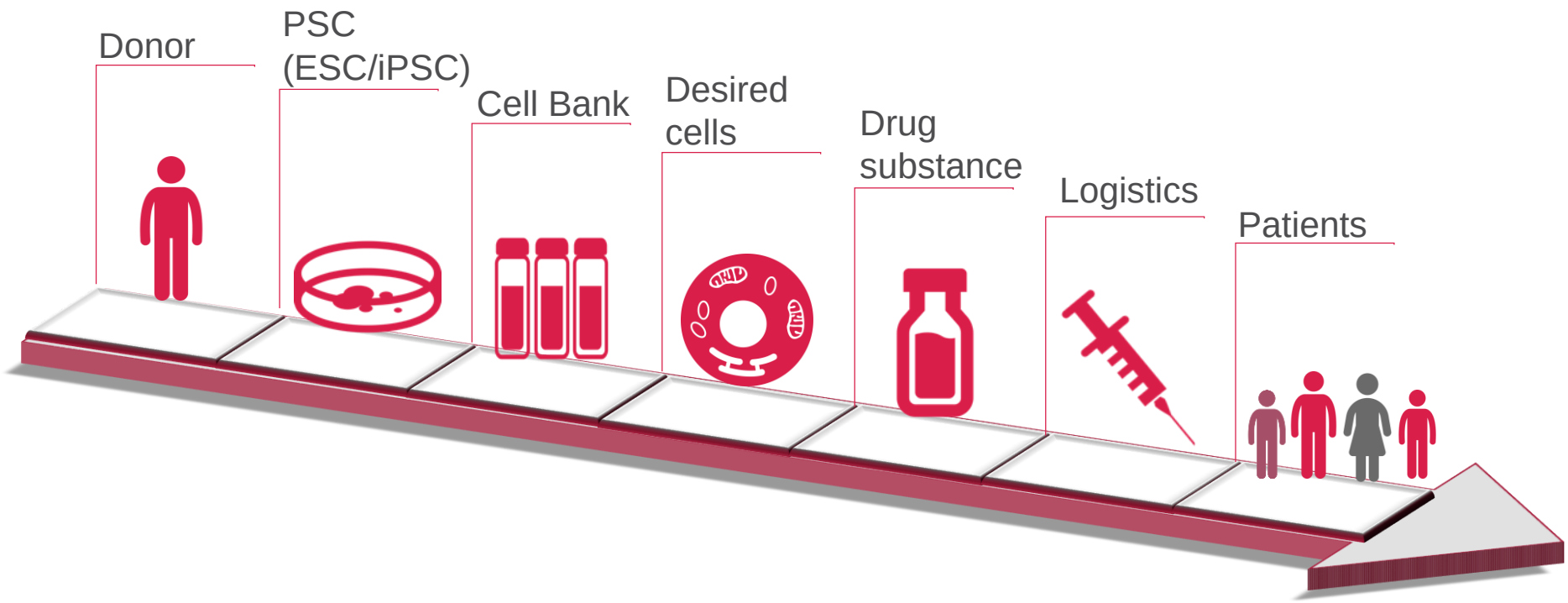
PSC-derived differentiated cells are most suitable for our business model

	AUTOLOGOUS CELLS	ALLOGENEIC CELLS	
		SOMATIC STEM CELLS-DERIVED DIFFERENTIATED CELL	PSC-DERIVED DIFFERENTIATED CELL
Immunological rejection	No	Yes	Yes
Applicable tissue	Limited*1	Limited	**Non-limited**
Inter-donor variability	NA	Yes	**No**
Scale (expandability)	NA	Scalable but limited	**Scalable**
Duration for preparation	Long time*2	Less time	**Less time**
Manufacturing cost	High	Middle	**Middle**

*1：Considering the time for generating autologous iPS cells, applicable tissue might be limited.
*2：Contain the time for generating autologous iPS cells.

JOURNEY OF CELLS: LABORATORY TO PATIENTS

Living cells require a different pathway than conventional medicines



PSC: Pluripotent stem cell, ESC: Embryonic stem cell, iPSC: induced pluripotent stem cell

FUTURE OUTLOOK OF CELL THERAPY

Many patients will receive the benefits from broader application of cell therapy

OUTLOOK IN 2030
Allogeneic PSC-derived products are widely used.
Next generation cell-derived products, such as combination with gene editing technology, are developed and launched.
Infrastructures critical for commercialization of cell therapy, such as manufacturing cost reduction, improvement of distribution system, facility expansion, etc., are improved.
A sustainable business model of cell therapy is established.

ESTIMATED FUTURE MARKET SIZE

The regenerative medicine market is expected to be 38 trillion yen worldwide by 2050

22 STEM-CELL-DERIVED PRODUCTS CURRENTLY ON THE MARKET (JUN. 2017)

Black: Autologous cells, Red: Allogeneic cells

Japan
- Temcell(GVHD), Heart sheet (Heart Failure)

US
- Osteocel Plus(Bone Repair), Grafix (Wound healing)
- Trinity Evolution (361HCT/P, Musculoskeletal defect)
- Trinity ELITE (361HCT/P, Musculoskeletal defect)
- BIO4 (361HCT/P, Bone Repair)

EU
- Holoclar (Corneal epithelial stem cell deficiency)
- Strimvelis (ADA-SCID)

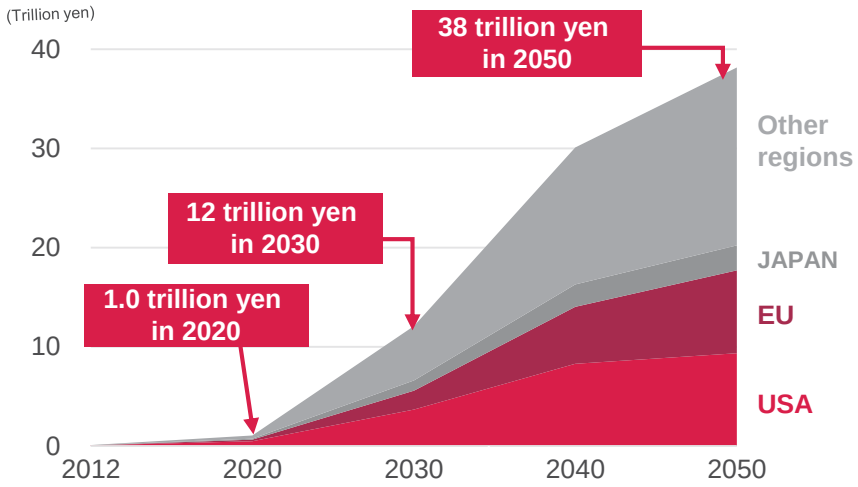
KOREA
- CARTISTEM (Osteoarthritis), Cupistem injection (Crohn's disease)
- Queencell (Subcutaneous fat tissue repair)
- NEURONATA-R inj (Near amyotrophic lateral sclerosis)
- Autostem (Subcutaneous fat tissue repair)
- Cellgram-AMI (Myocardial infarction), Ossron (Bone Repair)

INDIA
- Stempeucel (Limb ischemia), Ossron (Bone Repair)
- ReilNethra (Corneal epithelial stem cell deficiency)
- ReilNethra C (Composite conjunctival epithelial cell)
- CardioRel (Myocardial infarction)

OTHERS
- Prochymal (NZ&CA, GVHD)

Reprinted from the report by Japan Patent Office's

ESTIMATED FUTURE MARKET



Reprinted from the report by Ministry of Economy, Trade and Industry

GVHD: graft versus host disease, ICRS: International Cartilage Research Society,
ADA-SCID: Adenosine deaminase (ADA) deficiency severe combined immunodeficiency

NAVIGATING REGULATORY PATHWAYS

Authorities are rapidly establishing cell therapy specific regulatory processes

KEY POINTS

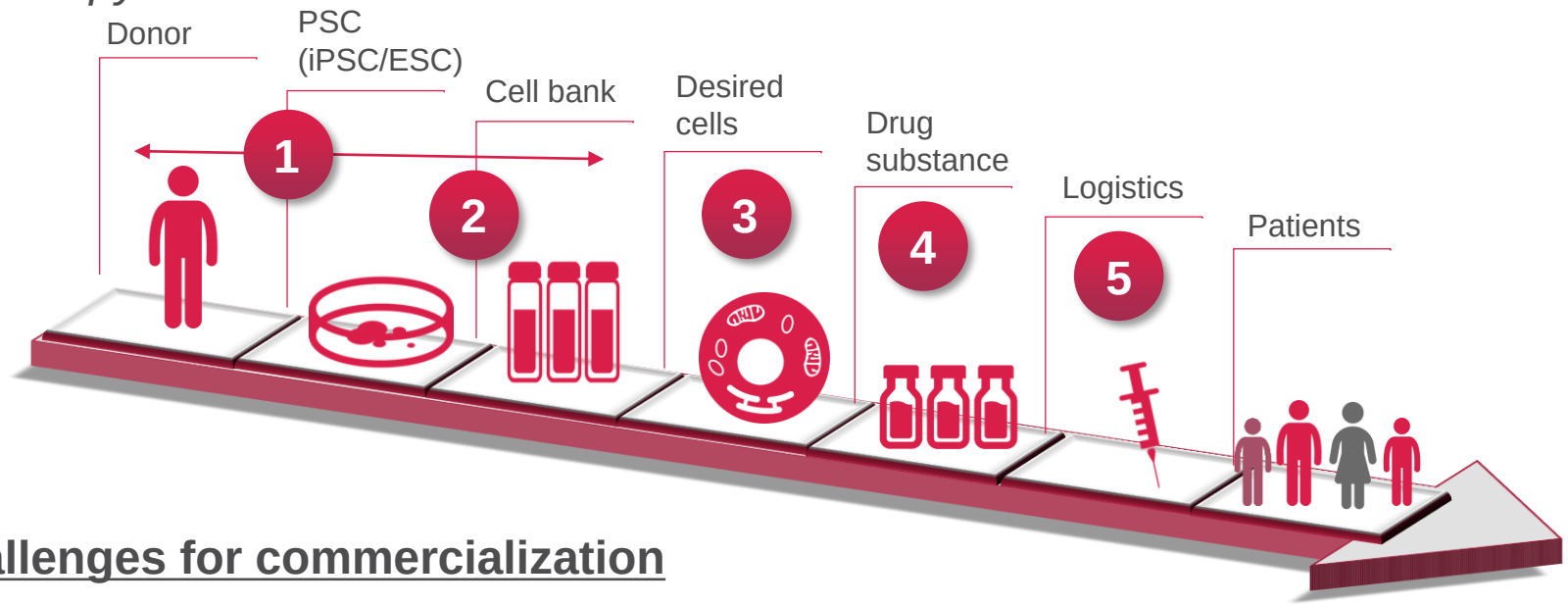
- **Issue of guidelines for the products categorized for cell therapy**
- **Issue of guidance for quality control and conducting non-clinical and clinical studies**
- **Quicker approval pathways**

	PRODUCT CATEGORY	PRODUCT	REGULATION	ACCELERATION
	Regenerative Medicine Product	Regenerative Medicine Product	➢ Pharmaceutical Affairs Law ➢ Technical Guidance for the Quality of Regenerative Medical Products (Human Cell Processed Products), and Implementation of Non-Clinical and Clinical Studies	Conditional & Time-limited Approval for Regenerative Medicine Products
	Biologics or Medical Device	351HCT/Ps*	21st Century Cures Act Part 1271	Regenerative Medicine Advanced Therapy (RMAT) Designation
	Pharmaceutical	Advanced Therapy Medicinal Products (ATMP)	Regulation (EC) No 1394/2007	

*Human Cells and Tissues and Cellular and Tissue-based Products Regulated Under Section 351 of the Public Health Service Act

KEY CAPABILITIES FOR CELL THERAPY

Over the past several years, we have acquired capabilities to realize the promise of cell therapy



Challenges for commercialization

1. **Secure own PSC line / banks with safety and pluripotency**
2. **Avoid immune rejection**
3. **Develop efficient differentiation protocols for desired cell types**
4. **Establish expertise and infrastructure for GMP cell manufacturing**
5. **Establish efficient logistics system**

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PSC: Pluripotent stem cell, iPSC: Induced pluripotent stem cell, ESC: Embryonic stem cells, GMP: Good manufacturing practice

LEADING WITH SCIENCE

Investigating pluripotent stem cell therapies

Yoshitsugu Shitaka, Ph.D.
President
Astellas Institute for Regenerative Medicine

AGENDA

1 **Snapshot of Astellas Cell Therapy**

2 **Strategy of Astellas Cell Therapy**

3 **Challenges of PSC-based cell therapies**

4 **Measurement & accomplishment for challenges**

5 **Future challenge & perspective**

1. SNAPSHOT OF ASTELLAS CELL THERAPY ~CENTERS OF INNOVATION AND EXCELLENCE~

180 employees are dedicated to cell therapy at 3 sites and expediting programs in collaboration with internal and external partners

Universal Cells Inc. (UCells)

- 2018 UCells acquisition
- CSO: Dr. D. Russell
- Hub of Astellas gene-editing
- AAV technology, UDC, etc.
- Internal programs
- Partnership programs
- Active participation and cooperation in industrial organization activities (ARM)

AIRM

- 2016 Ocata acquisition
- CSO: Dr. R. Lanza
- Hub of Astellas regenerative medicine
- Stem cell science and technology for differentiated cells
- GMP manufacturing
- Clinical development for ophthalmology
- Internal programs
- Collaborations (academia, biotech)

AIRM Satellite Office

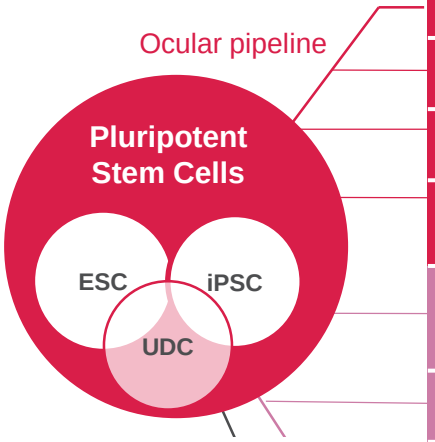
- Collaboration with functions specialized in Drug Discovery
- Collaborations in Japan
- Active participation and cooperation in industrial organization activities (FIRM)

*Granted patents/pending applications: US(30/22, others(61/144)
CSO: Chief Scientific Officer, AAV: Adeno-associated virus, UDC: Universal donor cell, ARM: Alliance for regenerative medicine,
AIRM: Astellas institute for regenerative medicine, GMP: Good manufacturing practice, FIRM: Forum for innovative regenerative medicine

PIPELINE

Focus on diseases-cell types with high unmet needs

- *4 programs in ophthalmology area (ASP7317 is in clinical stage)*
- *Enhanced pipeline by UCells acquisition and new external collaborations (especially peripheral diseases)*



Cell/ Program	ES /iPS	UDC Application	Potential Disease	Development Progress: Pre-clinical	Clinical: P1	Clinical: P2
Retinal pigment epithelium (RPE)	ES	Applicable	• Dry AMD • Other macular degeneration	ASP7317		
Photo-receptor progenitors (PhRPs)	ES /iPS	Applicable	• Retinitis pigmentosa • Macular degeneration			
Retinal ganglion progenitors (RGPs)	ES /iPS	Applicable	• Glaucoma • Optic neuropathies			
Corneal endothelium	ES /iPS	Applicable	• Corneal diseases • Corneal injuries			
Hemangioblast-derived MSCs (HMCs)	ES /iPS	Applicable	• Autoimmune diseases: Lupus Nephritis, Crohn's Disease	IND planned in 2020		
Vascular progenitors	ES /iPS	High priority	• Critical limb ischemia • Pulmonary hypertension			
Hematopoietic Stem Cells New	ES /iPS	High priority	• Leukemia/ Hematopoietic disorders			
Other various Cell Types New	ES /iPS	High priority	• Peripheral diseases			
NK New	ES /iPS	High priority	• Cancer			
Others (Partnering) New	ES /iPS	High priority				

New Added after the previous R&D meeting in December 2016.

AMD: Age-related macular degeneration. IND: Investigational new drug application

2. STRATEGY OF ASTELLAS CELL THERAPY ~STRATEGIC GOALS~

1st Wave	*2nd Wave*	*3rd Wave*
Establish a solid foothold in ophthalmology and build cell therapy foundation throughout value chain	Enrich cell therapy pipeline including non-ocular area by leveraging UDC technology	Create next generation cell product by combining stem cell technology and gene-editing technologies
Measures: • Intake of ASP7317 and stem cell technologies (incl. manufacturing) through Ocata acquisition • More efficient R&D by centralization at AIRM	**Measures:** • Intake of gene-editing technologies (incl. UDC) through UCells acquisition • New collaborations in the US, EU and Japan	**Measures:** • Enhancement of UCells capabilities • Pursuit of synergy between AIRM and UCells and value maximization of our technologies

Strategic Goals

UDC: Universal donor cell

WHY OPHTHALMOLOGY?

1st WAVE : Pursue ophthalmology as an initial focus area for Astellas cell therapy

GENERAL ISSUES FOR CELL THERAPY

Difficulty in manufacturing large amount of cells ✖ **Immune rejection** ✖ **Need invasive surgery**

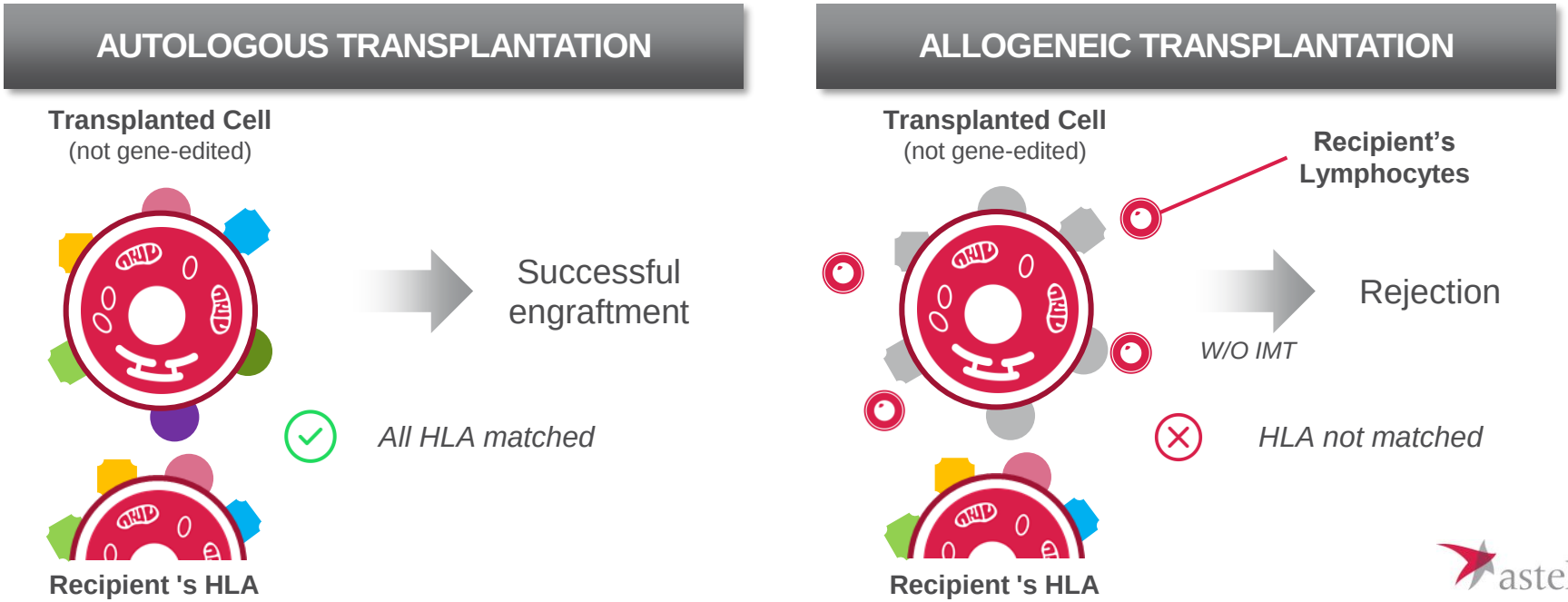
BENEFIT OF OPHTHALMOLOGY

Small amount of cells required for small organ ✖ **Immuno-privileged** ✖ **Easy access organ**

WHY UNIVERSAL DONOR CELLS (UDC)? (1/2)

Mechanism of immune rejection

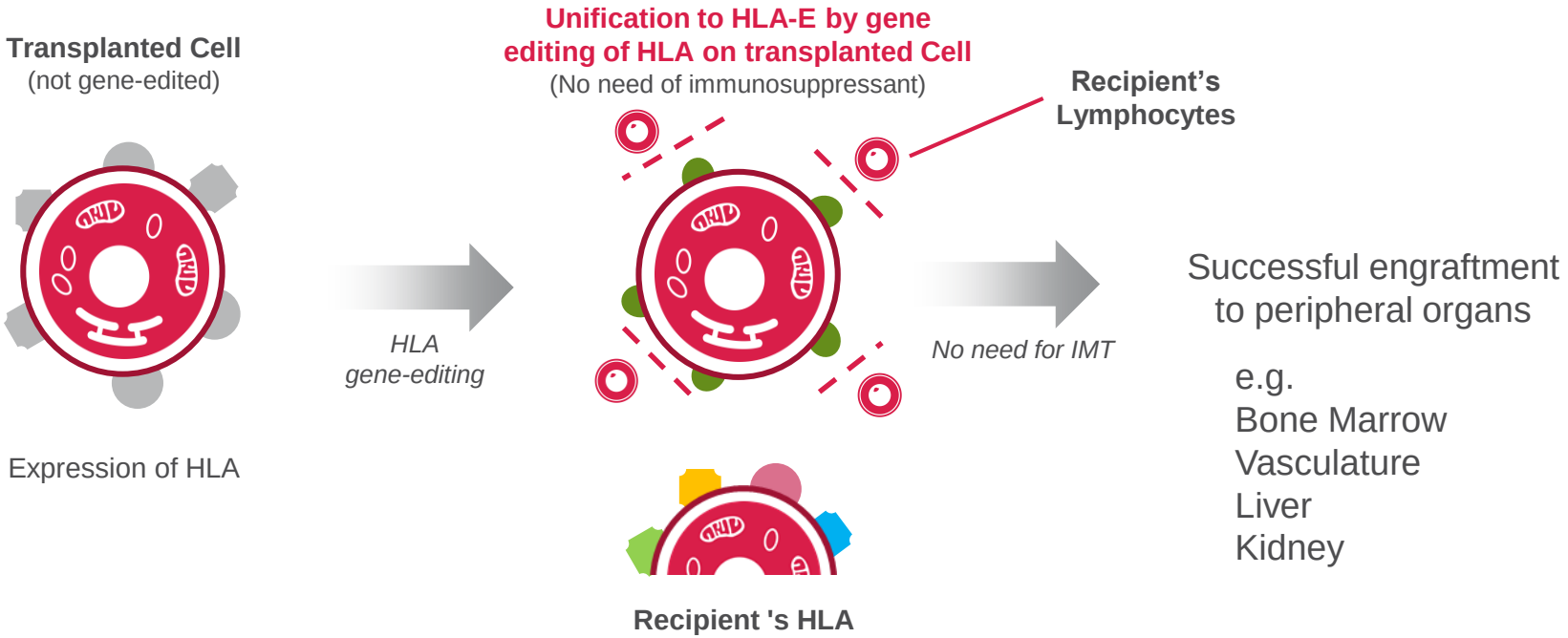
- The mechanism that distinguishes self from non-self, which is well-known in organ transplantation, is also equipped with cells.
- T cells, a type of leukocyte, recognize molecules called human leukocyte antigen (HLA) expressed on cell membrane, and exclude non-self cells if mismatched.
- Such a mechanism is indispensable for biological defense such as the elimination of bacteria, viruses and cancer cells, but on allogeneic cell transplantation, transplanted cells are subjected to immune rejection by lymphocytes. This could be a major barrier in cell therapy.



: human leukocyte antigen (HLA) , IMT: Immunosuppressant

WHY UDC? (2/2)

2nd WAVE: Expand to non-ophthalmology by leveraging UDC technology

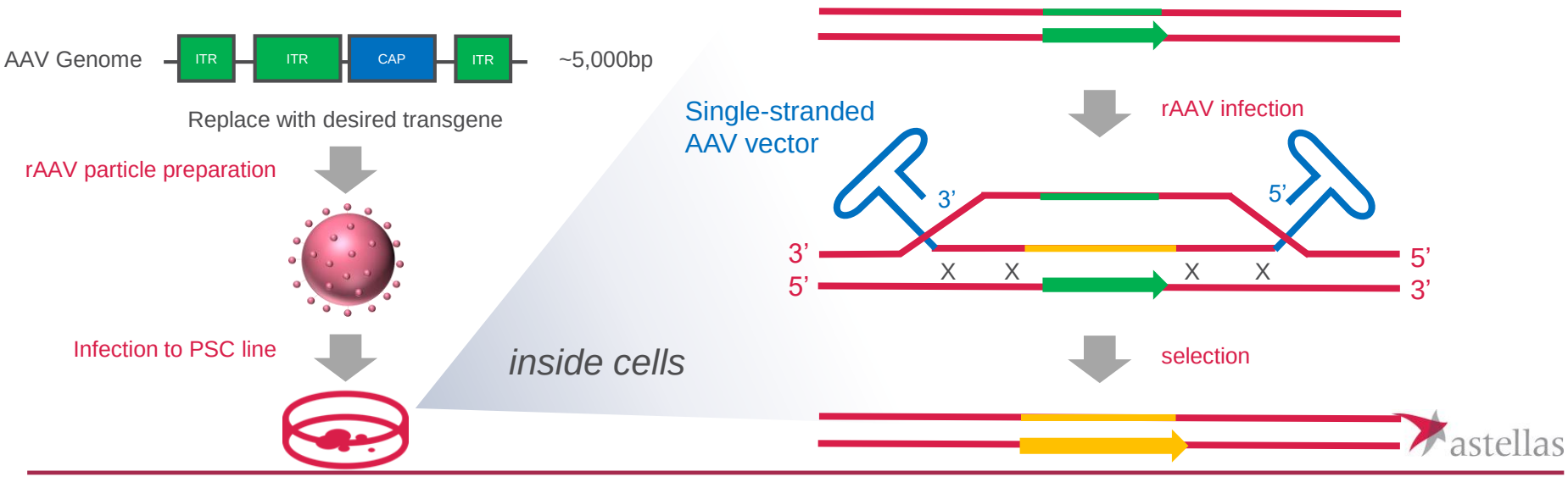


UDC: Universal donor cells, HLA: Human leucocyte antigen, IMT: Immunosuppressant

NEXT GENERATION ENHANCED CELL (1/2)

Advantages of AAV-based gene-editing technology by UCells

- Precise gene-editing by homologous recombination
- Low off-target mistakes
- No pathogenicity in wild-type AAV
- Applicable to both knock-in and knock-out→Broader applicability other than UDC
- Low integration frequency into host genome



AAV: Adeno-associated virus, rAAV: Recombinant adeno-associated virus

NEXT GENERATION ENHANCED CELL (2/2)

3rd WAVE : Create next generation enhanced cells combining cell therapy and gene-editing technologies

Application of gene-editing

AIRM

PSC technology

×

UCells

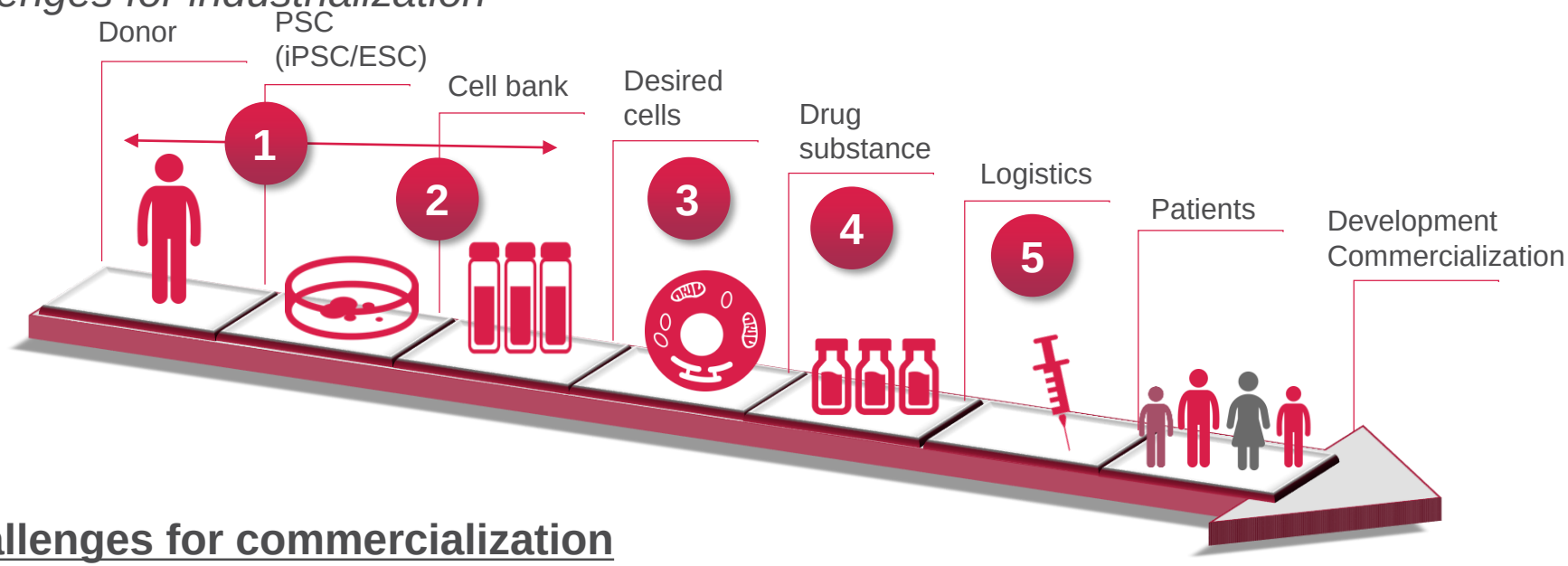
Gene-editing

	Next Generation enhanced cell product
Knock-out molecules responsible for immune rejection	Avoidance of Immune rejection (=UDC)
Gene-editing to secrete more beneficial factors	Enhance efficacy
Gene-editing to shorten differentiation period	Cost reduction
Gene-editing to enhance homing to affected legion	Reduction of cells
Install safety system for abnormal proliferation	Further safety

PSC: Pluripotent stem cell, UDC: Universal donor cells

3. CHALLENGE OF PSC-DERIVED ALLOGENEIC CELLS

PSC-derived allogeneic cells have a large potential opportunity but there are several challenges for industrialization



Challenges for commercialization

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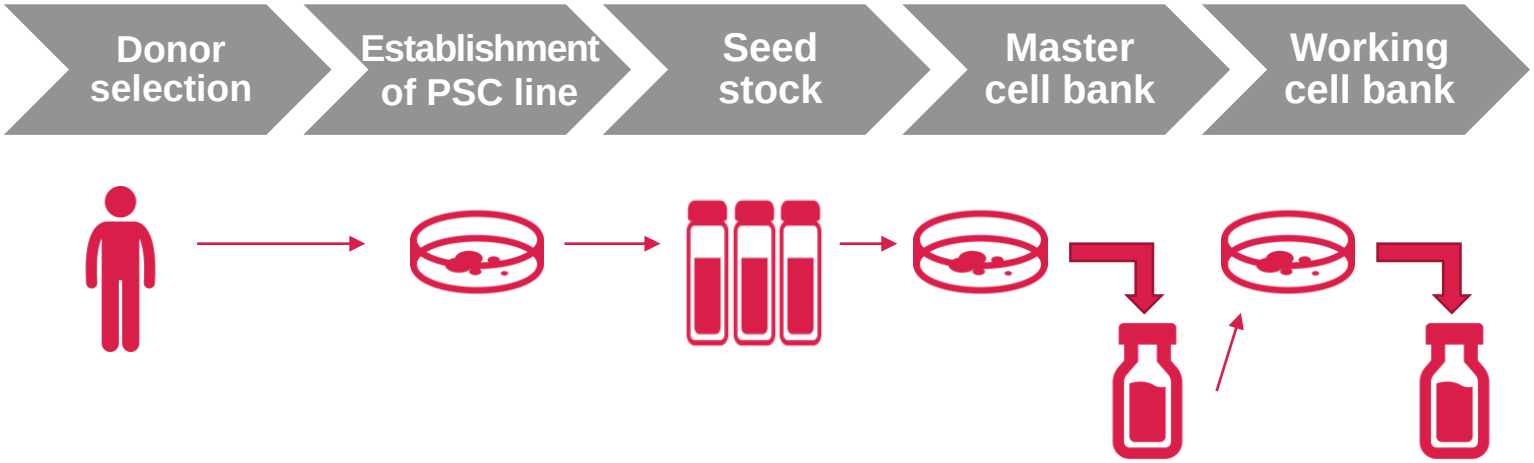
4. MEASUREMENT & ACCOMPLISHMENT FOR CHALLENGES ~SECURE OWN PSC LINE/BANKS WITH SAFETY AND PLURIPOTENCY(1/2)~

1 CHALLENGE	EXAMPLE
Secure own PSC line / banks with safety and pluripotency	- **Compliance to donor eligibility (virus inspection, etc.) which varies in different regions** - **Expansion culture maintaining and securing pluripotency and genome stability** - **Management of cell line as an important product raw material with an eye to commercial use: A new cell line is handled as a different product**



Donor eligibility (interview, virus inspection, Informed consent)

Creating cell bank after characterization of pluripotency and genome stability, etc.

Securing sufficient amount is important for consistent and sustainable product supply

Used for Drug Substance production

PSC: Pluripotent stem cell

SECURE OWN PSC LINE/BANKS WITH SAFETY AND PLURIPOTENCY (2/2)

Established multiple clinical and commercial grade PSC stocks that are compliant with the 3-region regulations. Securing high-quality and sufficient amount of seed stocks/commercial MCBs for future stable supply

Our capabilities and achievements

- In-house ability to establish clinical and commercial grade PSC strains from donor selection to cell banking, and have established multiple PSC strains compliant with the regulations of 3 regions
- Applying the experience over 15 years and expertise in ES cells to iPS cells. Possessing high-quality cell seed stocks with maintaining pluripotency and securing genome stability
- Manufacturing and managing commercial MCBs for each cell type from own PSC stock to secure future stable supply
- Continuously establishing new PSC stock (backup, next generation cell, etc.)

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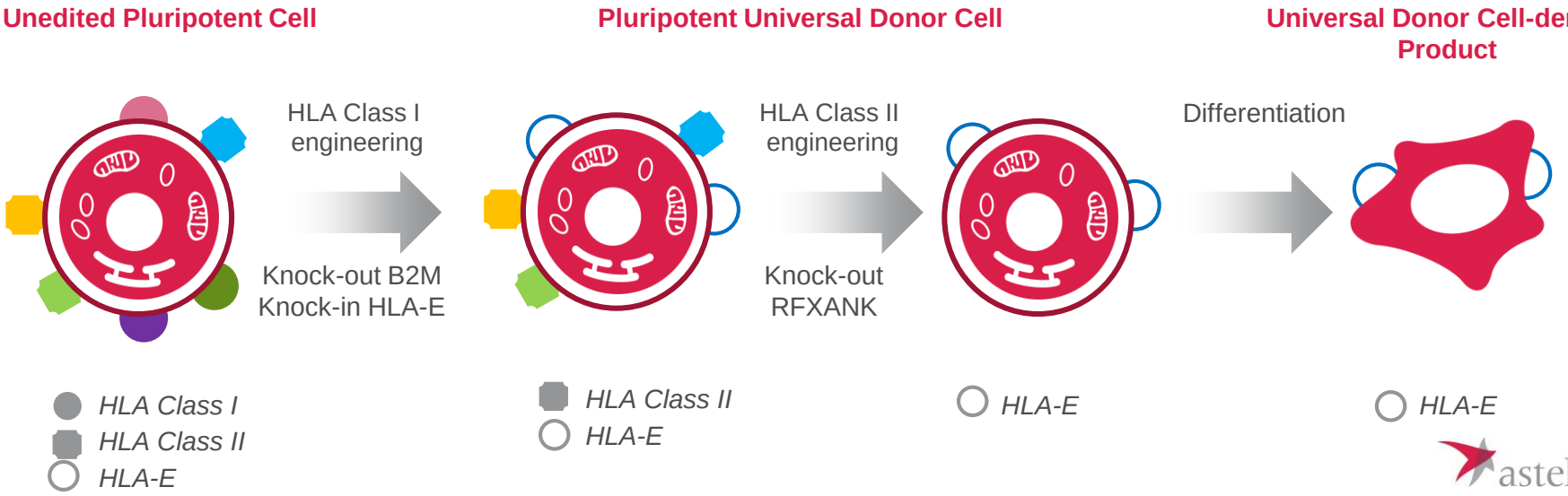
PSC: Pluripotent stem cell, MCB: Master cell bank

AVOID IMMUNE REJECTION (1/2)

2 CHALLENGE	EXAMPLE
Avoid immune rejection	- **When targeting long-term engraftment in peripheral tissues, it is necessary to avoid immune rejection** - **Depending on the immunogenicity of transplanted cells, it is difficult to administer cells multiple times** - **Concerns of handling increased numbers of cell lines if using HLA matched cell lines**

Flow of UDC creation



UDC: Universal donor cells, HLA: Human leucocyte antigen, B2M: Beta-2 Microglobulin

AVOID IMMUNOLOGICAL REJECTION (2/2)

Acquired UDC technology to avoid immune rejection. Expect enhancement of drug efficacy and cost reduction

Our capabilities and achievements

- Acquired UDC technology to avoid immune rejection
- Can be administered to any patient without limitation of HLA compatibility with expected benefits in the table below
- Increased number of researchers for broader application after acquisition of UCells

Table. Potential benefits from UDC technology

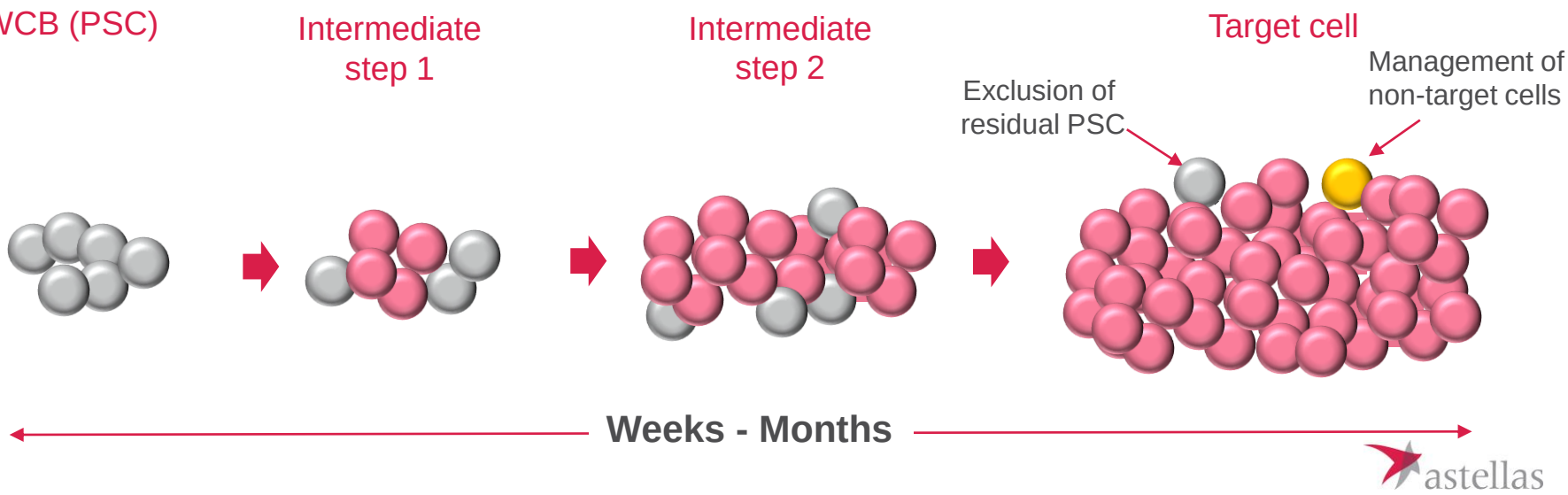
	Engraftment	IMT	Multiple dosing
UDC allogeneic cell	Available	Not necessary/lower dosage	Available
Non-UDC allogeneic cell	Difficult	Necessary	Difficult

UDC: Universal donor cells, IMT: Immunosuppressant

DEVELOP EFFICIENT DIFFERENTIATION PROTOCOLS FOR DESIRED CELL TYPES (1/4)

3 CHALLENGE	EXAMPLE
Develop efficient differentiation protocols for desired cell types	- Optimization / hardening of different processes for each cell type, securing of intellectual property - Process control over weeks to months (function of desired cells, residual PSC strains, non-target cells) - Requiring large amount of cells depending on cell type and indication (RPE-AMD: cell number of ~ 10^5 order / patient*1 vs. MSC-GVHD: cell number of ~ 10^8 or more / patient*2)

Flow from WCB to target cell (generalized)



*1:in-house clinical trial, *2: clinical trials conducted by other companies,
WCB: Working cell bank, PSC: Pluripotent stem cell, RPE-AMD: Retinal pigment epithelium cell-Dry aged related macular degeneration,
MSC-GVHD: Mesenchymal stem cells－Graft-versus-host disease

DEVELOP EFFICIENT DIFFERENTIATION PROTOCOLS FOR DESIRED CELL TYPES (2/4)

Established robust differentiation process for ASP7317 by utilizing in-house science base
Continue optimization for next programs to prepare for commercialization
Expanding types of peripheral cells through collaborative research

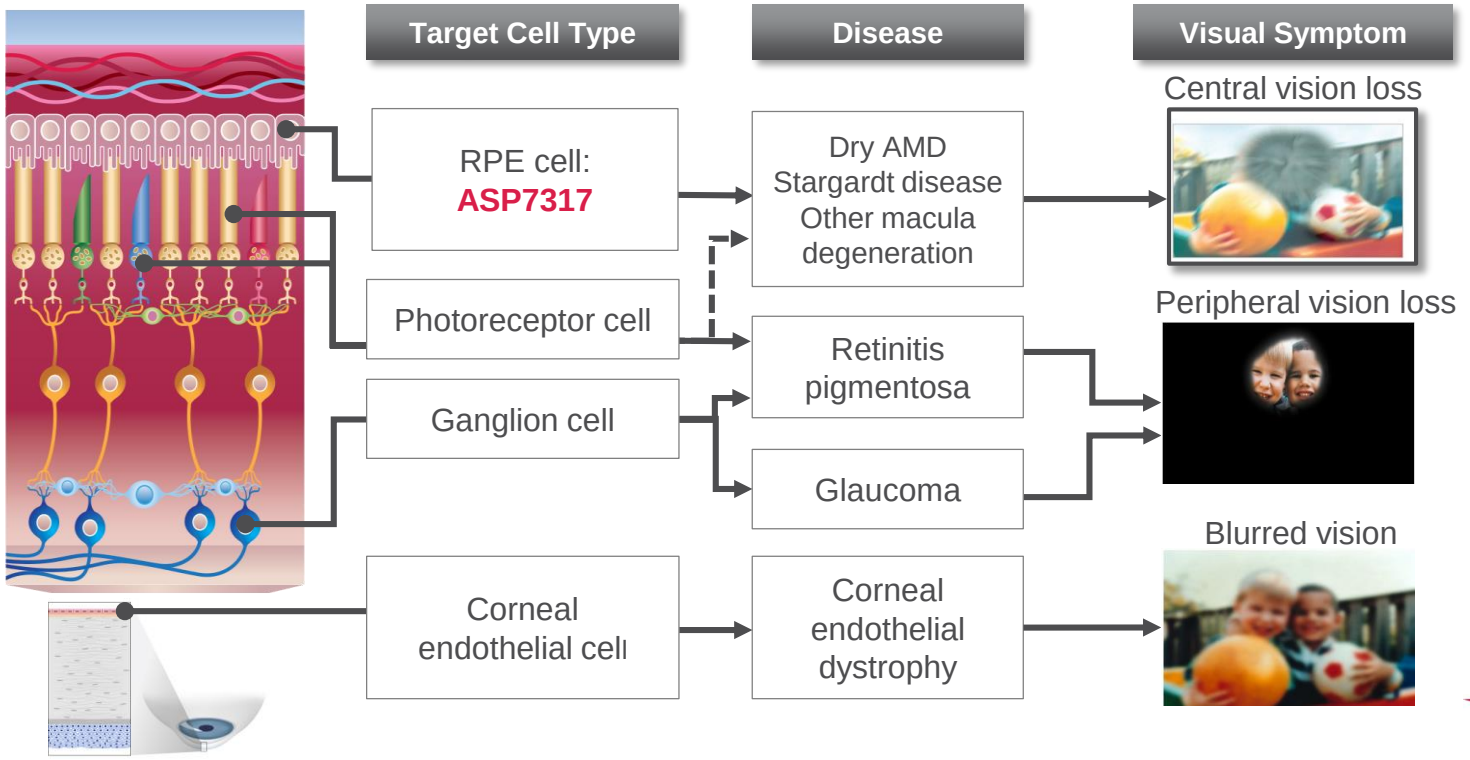
Our capabilities and achievements

- Consolidated researchers with strong expertise in stem cell science/ development biology in AIRM and UCells. Established and optimized differentiation process in-house
- For ASP7317, established robust differentiation process. Succeeded in reproducing cells conforming to standards (drug function, purity, etc.) with good reproducibility by controlling complicated processes over several months
- For next programs, continue optimization to prepare for commercialization
- Utilizing network with Academia / Biotech to expand collaborative research on peripheral cell types
- Ongoing development of automation / mass production technology using bioimaging and bioreactor etc.

DEVELOP EFFICIENT DIFFERENTIATION PROTOCOLS FOR DESIRED CELL TYPES (3/4)

Ophthalmology program

ASP7317 clinical trial is ongoing
Other 3 programs are preclinical and differentiation methods are optimized in-house
The 4 programs can cover broad range of ocular indications with unmet needs

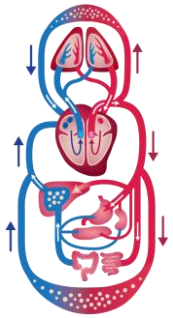


RPE: Retinal pigment epithelium cell, AMD: Age-related macular degeneration.

DEVELOP EFFICIENT DIFFERENTIATION PROTOCOLS FOR DESIRED CELL TYPES (4/4)

Non-ophthalmology program and UCells program

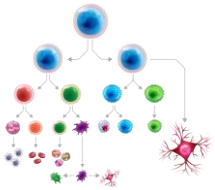
Expanding peripheral programs by utilizing collaborative research
UCells internal programs are also being expanded



Circulatory/Vascular Progenitor Cells
- Brigham and Women's Hospital
- Stanford School of Medicine
- Brigham and Women's Hospital
- panCELLa
- Stanford School of Medicine
- Osaka University

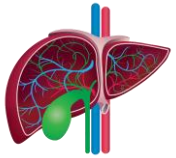
Hemangioblast-derived Mesenchymal Stem Cells

PSC



Hemaopoietic Stem Cells
- Angiocrine

Renal Progenitor Cells
- Brigham and Women's Hospital



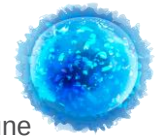
Liver Progenitor Cells
- University of Edinburgh

Natural Killer Cells

Other Undisclosed Cells

RPE Cells
- Healios

T Cells
- Adaptimmune



In-house program

Collaborative program

UCells

PSC: Pluripotent stem cell, RPE: Retinal pigment epithelium cell

ESTABLISH EXPERTISE AND INFRASTRUCTURE FOR GMP CELL MANUFACTURING (1/3)

4 CHALLENGE	EXAMPLE
Establish expertise and infrastructure for GMP cell manufacturing	- Construction of GMP production system specialized for cells (quality assurance system, standards / quality inspection, etc.) - Compliance to different standards (raw materials, manufacturing facilities) in each region - Concern on outsourcing: time to transfer technology, inability to accumulate know-how in-house etc.

Capabilities needed for GMP cell manufacturing

- Worker training and certification system
- Quality assurance system
- Quality management system
- Raw material management
- Sterility guarantee system
- Supply chain management

GMP: Good manufacturing practice

ESTABLISH EXPERTISE AND INFRASTRUCTURE FOR GMP CELL MANUFACTURING (2/3)

Established a GMP cell manufacturing system compliant to each region's regulations to enable global cell supply. Completed to secure CTM cell of ASP7317

Our capabilities and achievements

- Established a GMP cell production regime through ASP7317 manufacturing (Table 1)
- Succeed in supplying CTM cell to US and UK. Discussing with PMDA in Japan
- Secured sufficient quality of CTM cell for ASP7317 in multiple lots
- Strengthening GMP manufacturing function by acquiring new facilities (next page)

Table 1. Status of establishment for GMP cell manufacture system

Item	Establishment
Worker training and certification system	Completed
Quality Assurance System	Completed
Quality management system	Completed
Raw material management	Completed
Sterility guarantee system	Completed
Supply Chain Management	Completed

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GMP: Good manufacturing practice, CTM: Clinical trial material, PMDA: Pharmaceuticals and medical devices agency

ESTABLISH EXPERTISE AND INFRASTRUCTURE FOR GMP CELL MANUFACTURING (3/3)

The new facility enhances GMP manufacturing function and accelerates to POC
Early commercial production is available

Purpose of AIRM R&D- CMC complex (tentative name)

- To ensure smoother and more stable CTM supply
- Accelerate early clinical CMC work from late preclinical through early collaboration with R&D, UCells and future partners
- Response to initial commercial production

Location:	**Massachusetts, USA**
Total floor area:	**approximately 24,000 m^2 (two stories above ground)**
Specification (GMP part):	**Seven clean rooms with independent air conditioning that can handle various cell manufacturing. Secure extended space**
Total construction cost:	**Approximately 14 billion yen**
Schedule:	**Construction started in September 2018, scheduled completion in January 2020**

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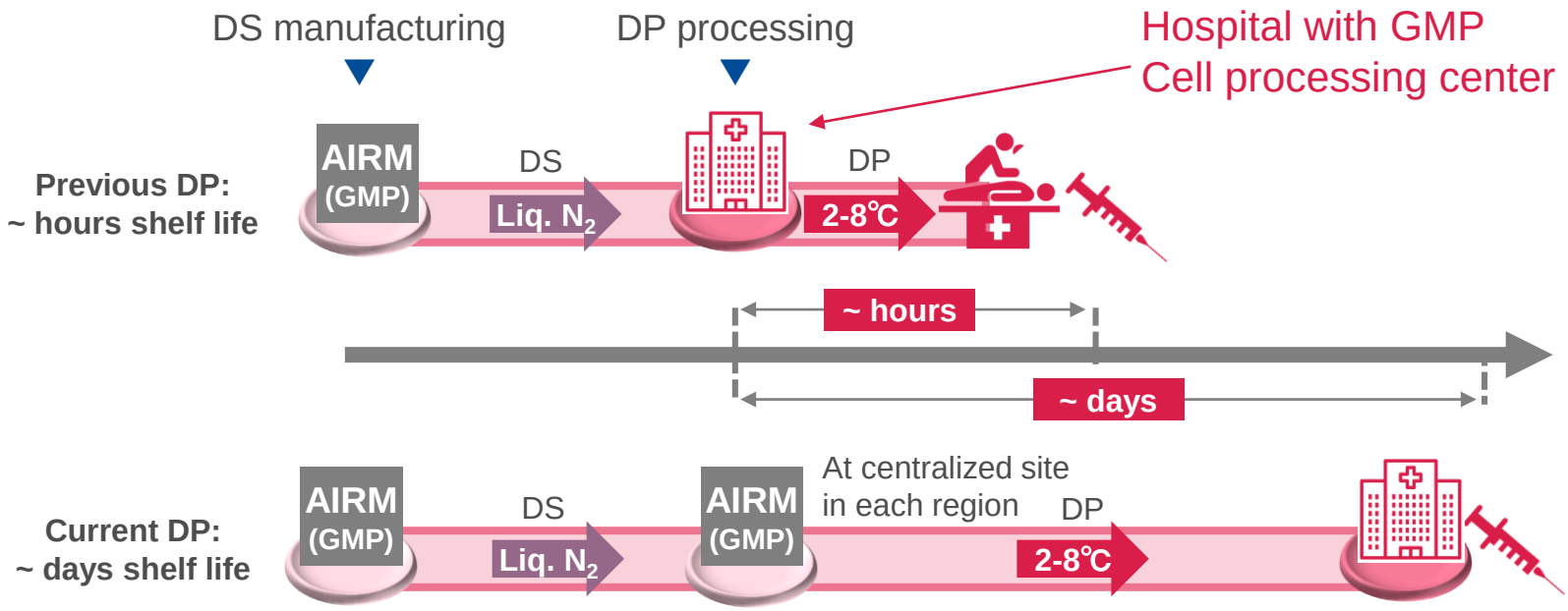
GMP: Good manufacturing practice, POC: Proof of concept, CMC: Chemistry, manufacturing and control, CTM: Clinical trial material

ESTABLISH EFFICIENT LOGISTICS SYSTEM (1/2)

5 CHALLENGE	EXAMPLE
Establish efficient logistics system	- Determination of transport conditions according to the nature of the cell type, transport (compliance with quality) - Depending on cell type indication, response to short quality retention period - Construction of efficient logistics system realizing cost reduction and logistics increase

Flow from DP formulation to hospital (example of in-house upgrade)



DP: Drug Product, DS: Drug Substance, Liq. N_2: Liquid nitrogen

ESTABLISH EFFICIENT LOGISTICS SYSTEM (2/2)

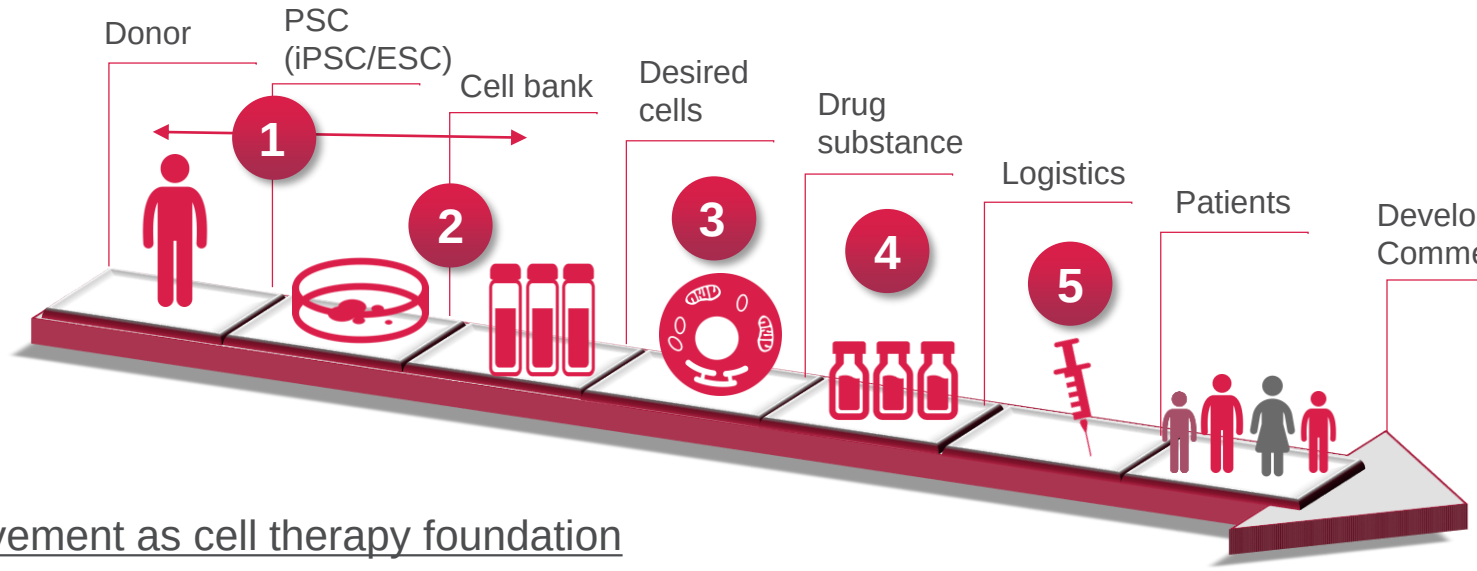
The new DP formulation enables AIRM to make logistics efficient, ensure quality of DP, decrease costs and increase distribution

Our capabilities and achievements

- For ASP7317, DP composition was changed after Ocata acquisition. Quality retention period was changed to several days solving multiple problems on logistics (guarantee of quality through centralization of preparation site, reduction of burden on hospital side etc.)
- Completed verification test of packing method, container, temperature change, vibration, atmospheric pressure, etc. in the transfer process. Completed training for taking cell package at the clinical sites
- Expect to increase capacity in future by reduction of burden on hospital side

DP: Drug Product

SUMMARY OF ACHIEVEMENTS



Achievement as cell therapy foundation

	Research					Manufacturing			Supply chain		Development			Commercial	
	❶ PSC sourcing	❷ UDC	❷ Gene-editing	❸ Differentiation	❹ Standardization	❹ QA	❹ Facility	Freeze-thaw tech.	❺ Formulation	Operation	RA	IMT regimen	Specialized platform	Business model
Post-Ocata Acquisition	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Post-UCells Acquisition		●	●											
Current AIRM	●	●	●	●	●	●	●	●	●	●	●	●	●	●

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●: Established, ●: Underway, ●: Not Established / To be considered,
PSC: Pluripotent stem cell, iPS: Induced pluripotent stem cell, ES: Embryonic stem cells,
UDC: Universal donor cell, QA: Quality assurance , RA: Regulatory affairs, IMT: Immunosuppressant

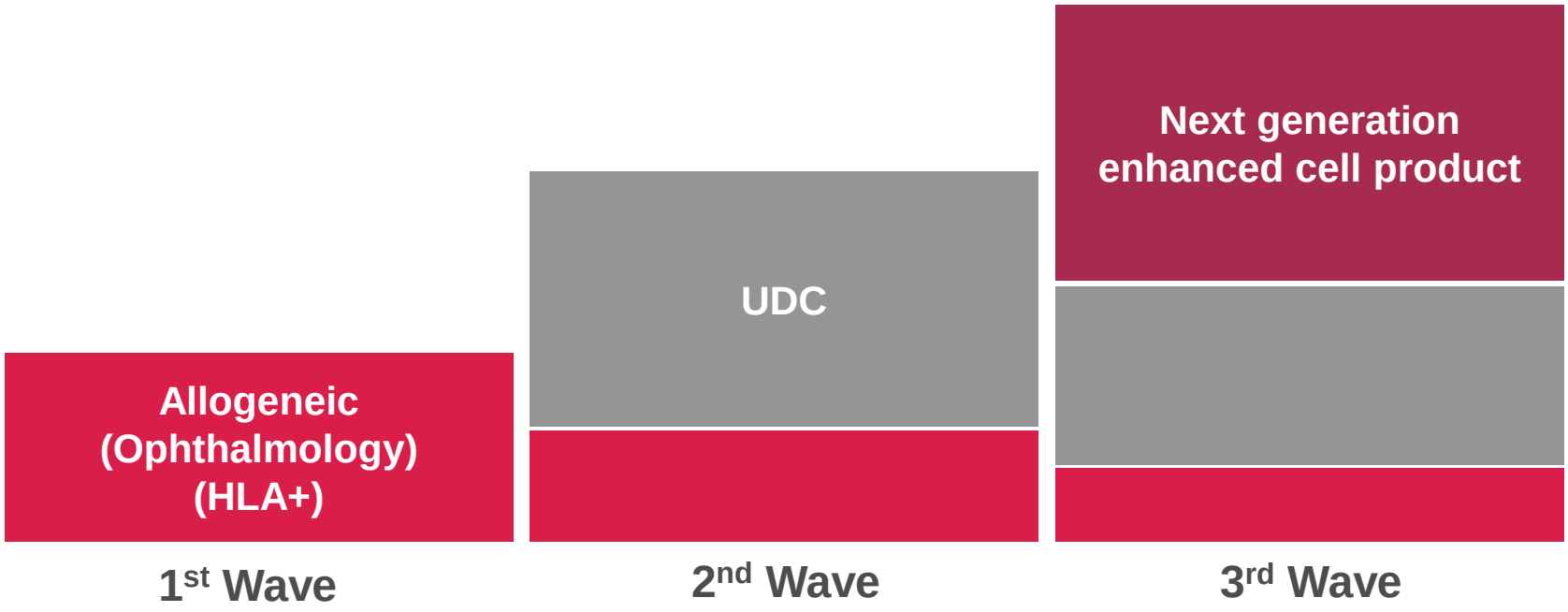
5. FUTURE CHALLENGES AND PERSPECTIVE

- Expedite ASP7317 development using accelerated regulatory pathways (e.g. RMAT designation) in each region
- Promote next programs and explore new collaborations by leveraging established capabilities
- Maximize and further reinforce current technologies
- Establish more efficient logistics
- Develop ecosystem for downstream commercialization
- Establish sustainable business model

RMAT: Regenerative medicine advanced therapy

FUTURE PIPELINE (ILLUSTRATIVE)

Develop market through allogeneic cell (ophthalmology) and UDC and further expand the market through next generation enhanced cells to establish sustainable business



UDC: Universal donor cell

SUMMARY

- Three bases in US and Japan collaborating with internal/external stakeholders for cell therapy. Expanding pipeline led by ASP7317 in ophthalmology (P1b/2)

- Astellas' cell therapy strategy:
  Establish a solid foothold in ophthalmology and build cell therapy medicine foundation throughout value chain
  →Enrich cell therapy pipeline including non-ocular area by leveraging UDC technology
  →Create next generation cell product by combining stem cell technology and gene-editing technologies

- Overcame multiple technological challenges for industrialization by leveraging acquisitions effectively

- Future challenges are implementation of current strategy, establishment of ecosystem for commercialization and development of sustainable business model

UDC: Universal donor cell

ASP7317

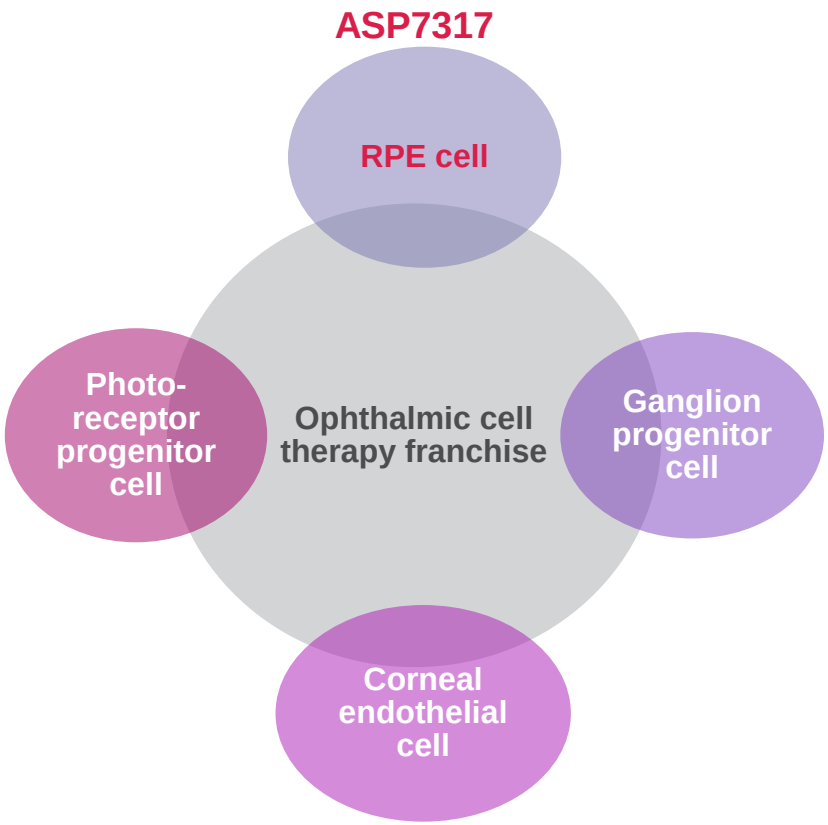
To offer the hope to regain lost sight

Eddy Anglade, MD
Ophthalmology Therapeutic Area Head, Development

OUR FOCUS IN OPHTHALMOLOGY: VISION THREATENING EYE DISEASE

To free patients from the fear of vision loss and offer the hope to regain lost sight

An estimated **1.3 billion people** worldwide live with some form of vision impairment*



*World Health Organization. Blindness and vision impairment – Key Facts. 10-11-2018.
RPE: Retinal Pigment Epithelium

AGE-RELATED MACULAR DEGENERATION (AMD)

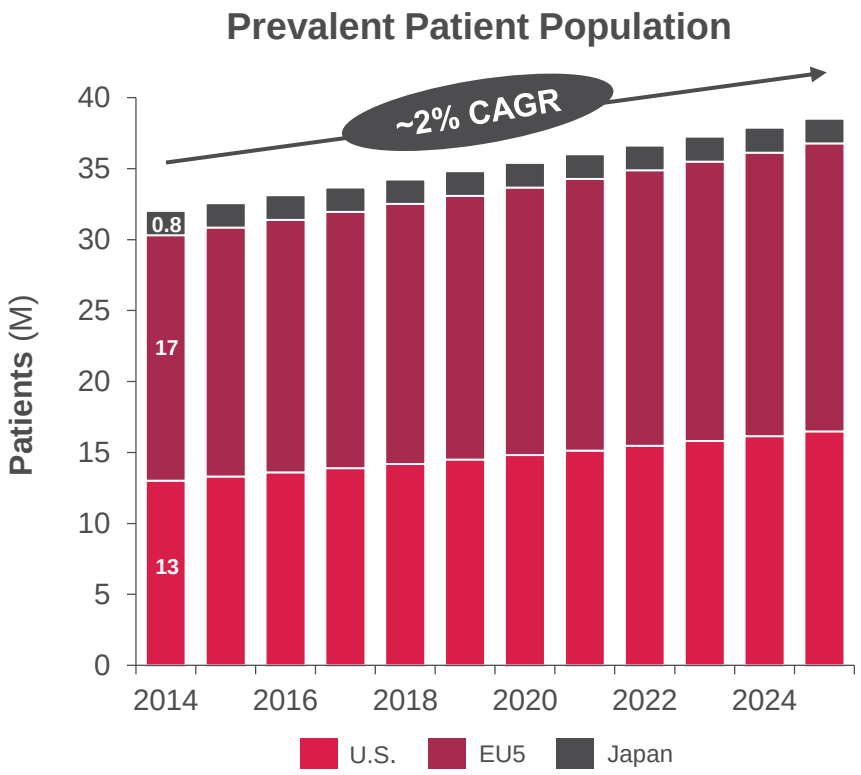
AMD is a leading cause of visual disability in individuals over 55 years old in advanced countries

- AMD is a progressive degenerative disease affecting the central portion of the retina (i.e., RPE and photoreceptors in the macula) that results in loss of central vision.
- Symptoms of AMD:
  - Straight lines start to appear distorted, or the center of vision becomes distorted
  - Increased difficulty adapting to low light levels, such as in a theater or dimly lit restaurant
  - Reduced central vision in one or both eyes
  - Decreased intensity or brightness of colors

Photos: National Eye Institute, National Institutes of Health

DRY AMD: PREVALENT PATIENT POPULATION

Approximately 37 million people in advanced countries have Dry AMD, prevalence is expected to increase due to aging populations



- Age is a risk factor, and the aging population will expand the Dry AMD population
- Prevalence of late stage Dry AMD varies from ~0.05% in 40 – 49 year olds to ~12% in individuals ≥80 years of age

High unmet medical needs:

- Disease progression results in irreversible damage to the photoreceptors of the retina
- The ability to restore vision would have a significant impact on patients' quality of life.
- There are no safe and effective treatments available to stop or slow the progression of Dry AMD.

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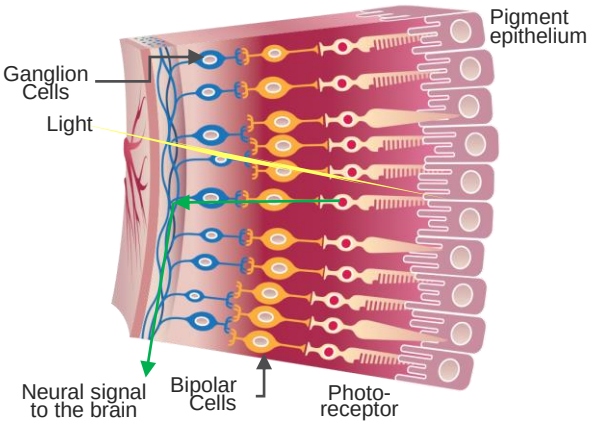
Friedman. *Arch Ophthal.* 2004;122:564; Physician Interviews; ClearView Analysis.
EU5: UK, France, Germany, Italy, Spain, CAGR: Compound annual growth rate, M: million

THESIS OF CELL THERAPY APPROACH TO RPE TRANSPLANTATION

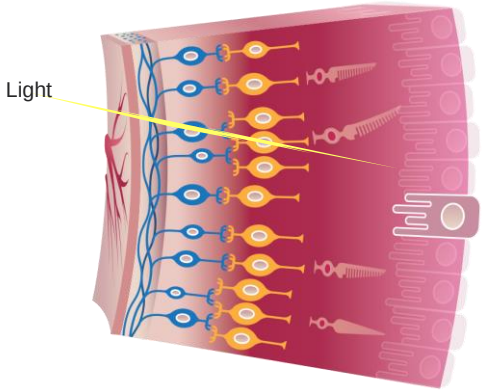
Replacement of RPE to potentially restore visual function

PATHOGENESIS OF DRY AMD

Normal

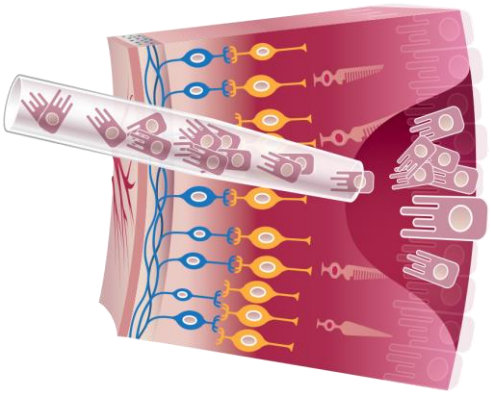


Macular Degeneration

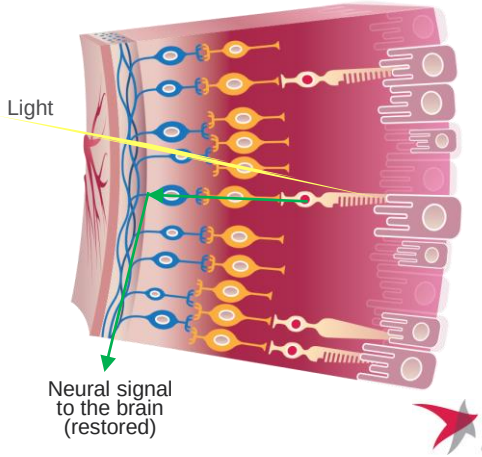


RESTORE RPE CELL FUNCTION BY CELL THERAPY

RPE transplantation



Neural signal restored

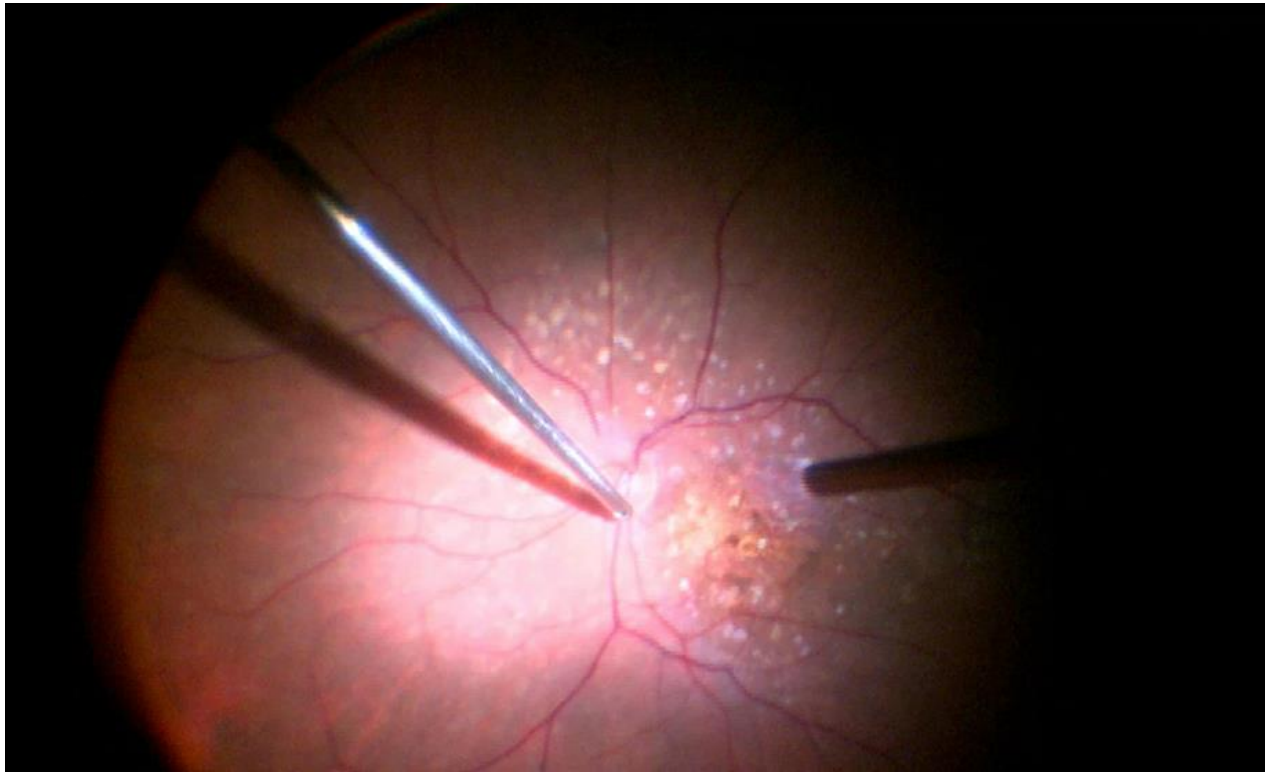


RPE: Retinal pigment epithelium

RPE CELL TRANSPLANTATION: SUBRETINAL INJECTION

Surgical technique used commonly by posterior segment surgeons

1. 23-27 gauge pars plana vitrectomy
2. Posterior vitreous detachment induction
3. Sub-retinal hESC-RPE injection
4. Bleb confirmation
5. Optional air-fluid exchange



hESC: human embyonic stem cell, RPE: Retinal pigment epithelium

RPE PROGRAM OVERVIEW

38 patients have been successfully transplanted with hESC-derived RPE, and the clinical trial is ongoing with new cell line

Previous cell line: MA09-hRPE

- Three Phase 1/2 clinical trials for Dry AMD and Stargardt disease (STGD)
  - US: 13 patients treated (Dry AMD)
  - 13 patients treated (STGD)
  - UK: 12 patients treated (STGD)

THE LANCET

- First-ever report of the safety of hESC-RPE in human with any disease[1]
- Follow-up data 12 months post-transplantation[2]

ARVO

The Association for Research in Vision and Ophthalmology

- Follow-up data 36 months post-transplantation[3]

Established new cell line: ASP7317

- Phase-1b/2 dose-ranging and POC trial for dry AMD is ongoing with a new cell line and formulation

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1: Schwartz SD. *et. al.*, Lancet 2012; 379: 713-20, 2: Schwartz SD. *et. al.*, Lancet 2015; 385: 509-16, 3: Schwartz SD. *et. al.*, ARVO 2018
Dry AMD: Age-related macular degeneration, POC: Proof of Concept

PHASE 1/2 STUDY (MA09-hRPE): STUDY DESIGN

Efficacy and safety have been investigated up to 36 months

P1/2 study
NCT01344993
NCT01345006
→ Transplantation

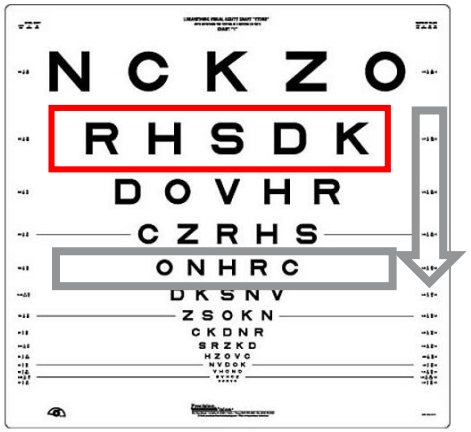
Long term follow up study
NCT0246334
NCT02445612
→ 12M → 36M

Safety surveillance study*
NCT03167203
→ 60M

Phase 1/2 study	
Design	Open-label, sequential dose-escalating studies
Patient population	**Low vision group:** ETDRS Best corrected visual acuity (BCVA) ≤ 20/400 Four cohorts (50,000, 100,000, 150,000, 200,000 cells) **Better vision group:** ETDRS Best corrected visual acuity (BCVA) ≤ 20/100 a single 100,000 cells cohort
Enrollment	13 pts (AMD), 13 pts (STGD)
Primary endpoints	**Safety:** • Incidence of grade 2 or greater TEAEs • Evidence of graft failure or rejection and engraftment
Secondary endpoints	**Exploratory Efficacy:** • BCVA • Area of atrophy on autofluorescence and color fundus photographs • 25-item National Eye Institute Visual Function Questionnaire (NEI-VFQ-25) • Reading speed (AMD study only)

*: A safety surveillance study has implemented in accordance with regulatory obligations
US: 15-year follow-up from the date of transplant for enrolled US subjects

Best corrected visual acuity (BCVA)



- A measure of the spatial resolution of the vision whilst using corrective lenses to maximize the visualization ability
- 3 Lines improvement in BCVA is considered clinically meaningful by FDA

Image : National Eye Institute, National Institutes of Health
ETDRS: Early treatment diabetic retinopathy study, AMD: Age-related macular degeneration, STGD: Stargardt disease ,
TEAEs: Treatment-emergent adverse events

PHASE 1/2 STUDIES (MA09-hRPE): SAFETY

Subretinally transplanted hESC-derived RPE cells were well tolerated at all dose up to 3 years post -transplantation

- The proportion of subjects with ocular treatment-emergent adverse events (TEAEs) in the treated eye was similar in the AMD (36.4%) and in the STGD (38.5%) cohorts over the follow-up period.
- No evidence of graft failure or rejection.
- There were two serious infectious TEAEs (appendicitis and urinary tract infection), one serious neurologic TEAE (syncope), two events of squamous cell cancer, and one event of basal cancer.
- Hyperpigmented areas of varying sizes, which increased in size and in apparent pigmentation for the first 6–12 months and persisted for up to 3 years, were observed in 21 of 26 subjects (81%).
  - Size of the area of hyperpigmentation did not correlate with cell dose or visual acuity outcomes.
  - Optical coherence tomography shows that the hyperpigmentation is at the level of the RPE.

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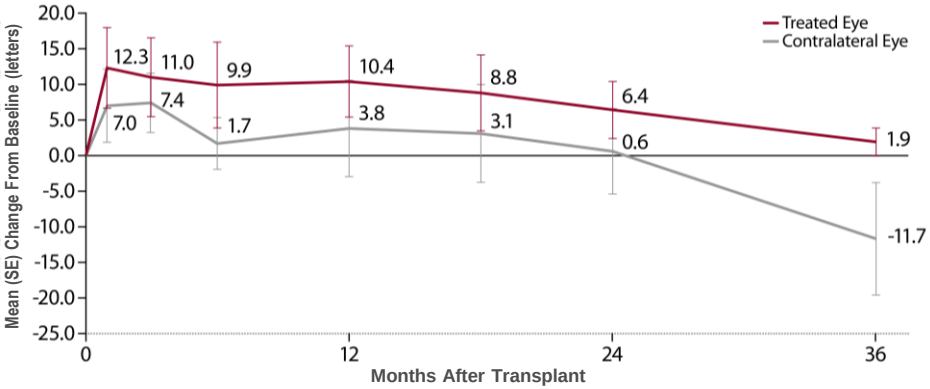
Schwartz SD. *et. al.*, ARVO 2018, TEAEs: Treatment-emergent adverse events, AMD: Age-related macular degeneration, STGD: Stargardt disease, hESC: human embyonic stem cell, RPE: Retinal pigment epithelium

PHASE 1/2 STUDY (MA09-hRPE): EFFICACY IN DRY AMD

Initial gains in vision followed by gradual loss in patients with late stage AMD

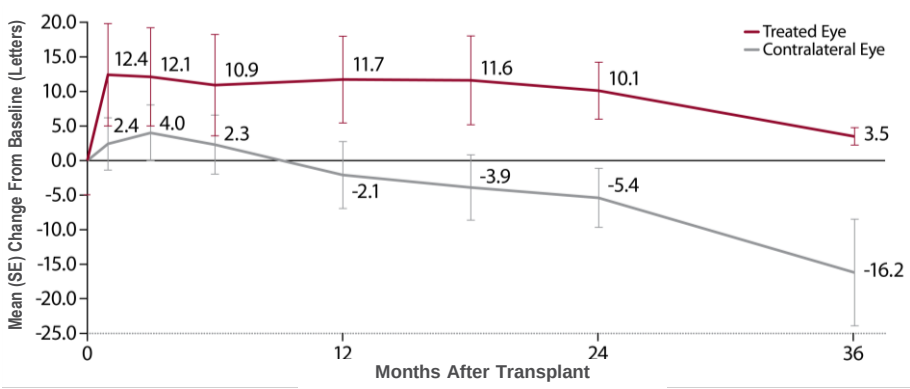
Mean Change in ETDRS BCVA in the 36 Months Post-Transplantation in the Low Vision Group (AMD)

All Subjects with AMD



Note: Months 1 to 24, n=9; Month 36, n=7. One of the 10 subjects with advanced AMD did not enter the long-term follow-up study.

Subjects with AMD Excluding Two Subjects With Significant Cataracts or Posterior Capsule Opacification



Note: Months 1 to 24, n=7; Month 36, n=6.

Schwartz SD. *et. al.*, ARVO 2018

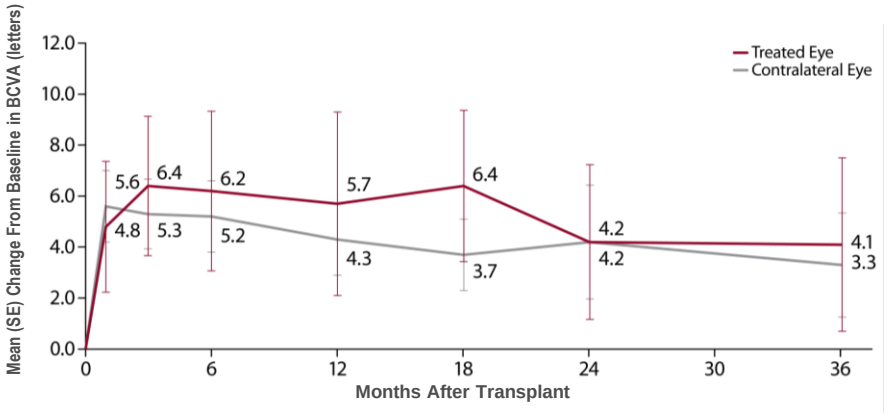
AMD: Age-related macular degeneration, ETDRS: Early treatment diabetic retinopathy study, BCVA: Best corrected visual acuity

PHASE 1/2 STUDY (MA09-hRPE): EFFICACY IN STARGARDT DISEASE

Initial Gains in Vision followed by Gradual Loss in Patients with Late Stage STGD

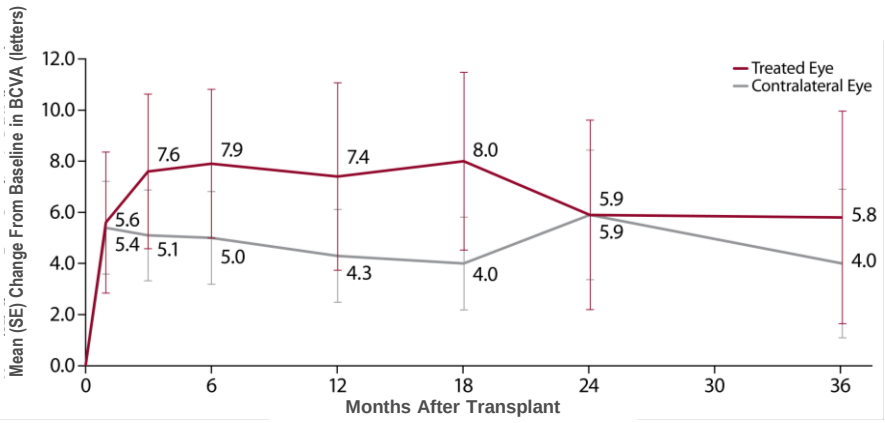
Mean Change in ETDRS BCVA in the 36 Months Post-Transplantation in the Low Vision Group (STGD)

All Subjects with STGD



Note: Months 1 to 24, n=9; Month 36, n=7. One of the 10 subjects with advanced STGD did not have ETDRS BCVA data for the first 9 months of the study.

Subjects with STGD Excluding Two Subjects With Significant Cataracts or Posterior Capsule Opacification



Note: Months 1 to 24, n=7; Month 36, n=5.

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Schwartz SD. *et. al.*, ARVO 2018

STGD: Stargardt disease, BCVA: Best corrected visual acuity, ETDRS: Early treatment diabetic retinopathy study.

NEW CELL LINE

ASP7317

ASP7317: CELL LINE AND FORMULATION CHANGE FOR FURTHER DEVELOPMENT AND COMMERCIALIZATION

A new cell line (ASP7317) and an enhanced formulation were developed, providing higher quality cells in anticipation of successful commercialization

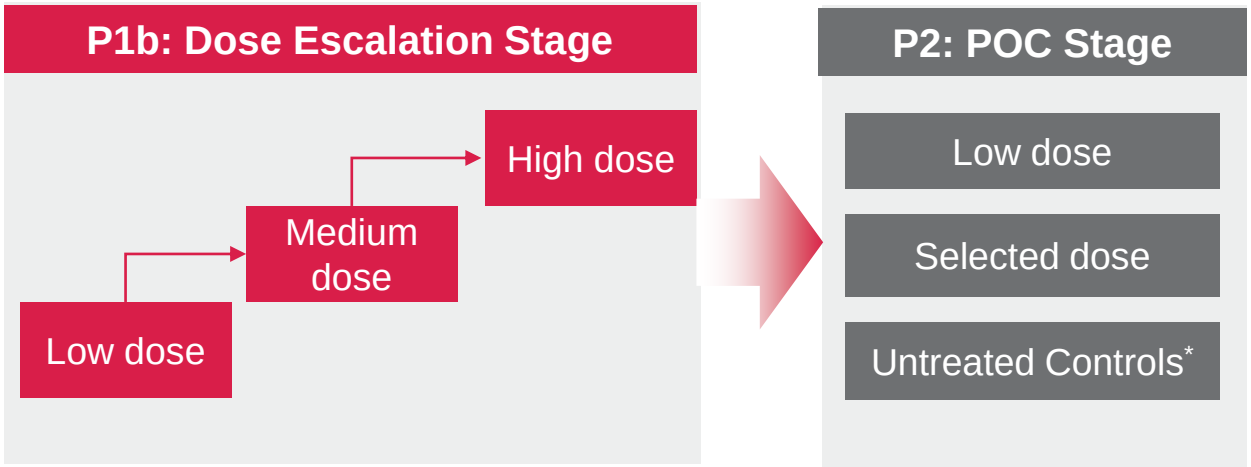
Advantages of new cell line and formulation

- Compliant with the regulations/guidance in each region (i.e. FDA tissue donor compliance regulations）
- Larger cell bank ensures a stable supply for clinical trial and commercialization
- Longer shelf-life
  - Enables centralized drug product (DP) preparation for clinical trial materials and products
  - Extended shelf-life could provide the flexibility of time management at clinical sites
- Non-xenogeneic product eliminates xenogeneic required blood sampling and archiving
- Protective effect on cells which reduce cell loss during extrusion and debris at injection site

To evaluate the efficacy and safety of the new cell line, a new Phase 1b/2 study has been initiated

ASP7317: PHASE 1b/2 STUDY DESIGN

Initiated clinical trial for Dry AMD in July 2018



*If POC is demonstrated, eligible patients in untreated cohorts of POC part enroll to extension part of P1b/2 study

	Dose escalation	POC
Indication	Severe Dry AMD with Geographic Atrophy	
Enrollment number	9 (3 pts/cohort)	141 (47 pts/cohort)
Study period	• 2 months screening prior to single administration of ASP7317 • 26 weeks (primary study period) • Up to 60 months for safety and evaluation of graft failure/rejection (ASP7317 treated subjects only)	
Endpoint	Safety	Primary: Change from baseline in BCVA score at Week 26
		Secondary: Multiple efficacy and safety endpoints

AMD: Age-related macular degeneration, POC: Proof of Concept, BCVA: Best corrected visual acuity

ASP7317: DEVELOPMENT STRATEGY

Accelerate the development of ASP7317 by seeking expedited regulatory pathway

Phase 1b/2 study

- Determine optimal safe dose in P1b Dose Escalation Stage with potential to observe an early efficacy signal
- Confirmation of efficacy and safety in POC stage

Regulatory Strategy

- If the results of P1b/2 study are positive, seek expedited regulatory pathway in regenerative medicine (e.g. RMAT designation) for accelerated/conditional approval in each region to deliver ASP7317 to patients sooner

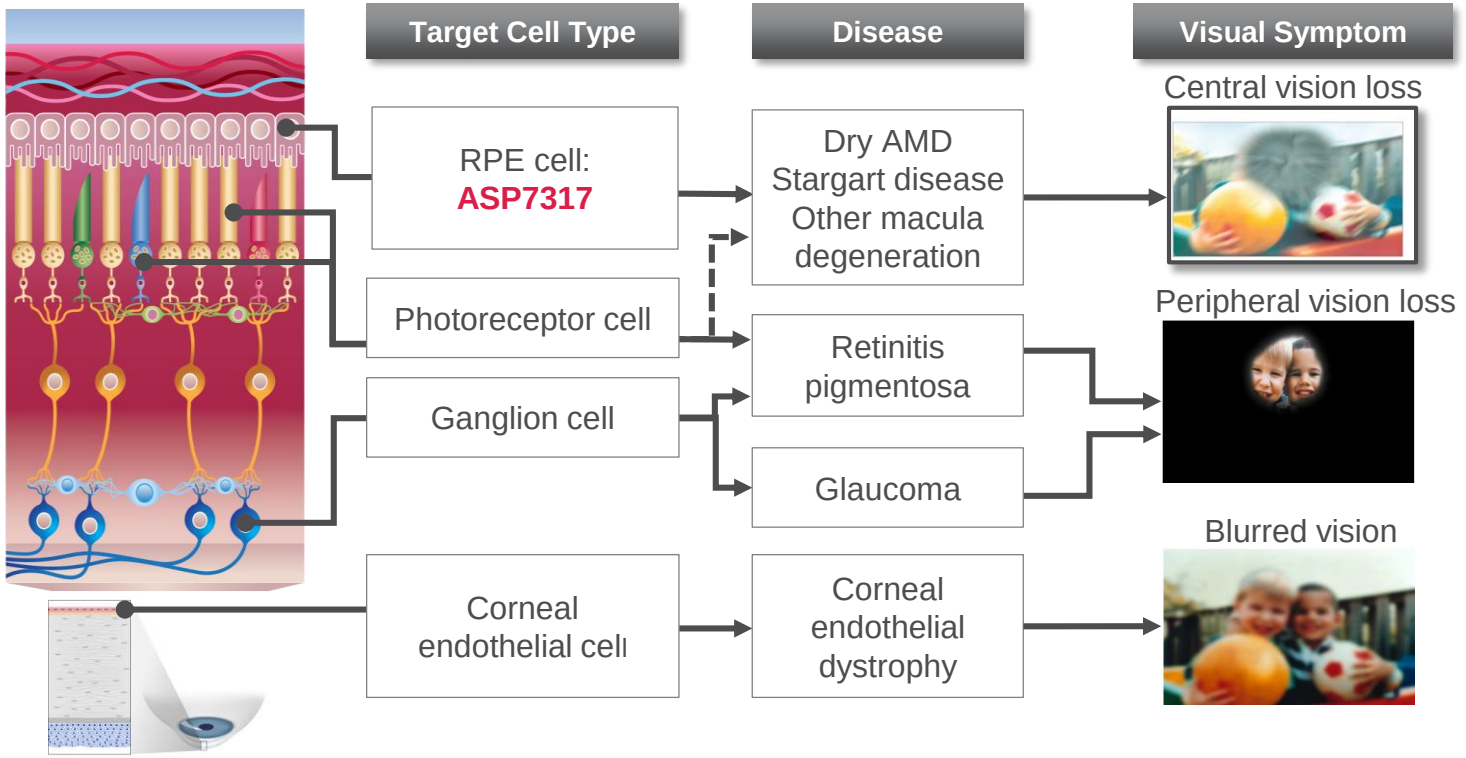
Expansion to Other forms of Macular Degeneration

- Broaden clinical development program to include less severely affected patients with Dry AMD and other forms of macular degeneration (e.g. Stargardt disease)

AMD: Age-related macular degeneration, POC: Proof of Concept, RMAT: Regenerative medicine advanced therapy

ASP7317 AND BEYOND

Experience and knowledge gained with ASP7317 can advance and expand R&D capabilities in cell therapy development



- Building on a foundation of innovative science and technology
- Strengthen understanding, enhanced study operations in cell therapy and development speed
- Establish a robust ophthalmic disease cell therapy franchise

Photos：National Eye Institute, National Institutes of Health
RPE: Retinal pigment epithelium, AMD: Age-related macular degeneration

CONTINUED EFFORTS TO DELIVER VALUE FOR PATIENTS WITH VISION IMPAIRMENT

The ASP7317 program is the first of multiple cell therapy programs intended by Astellas to address major unmet clinical needs in ophthalmology

ASP7317

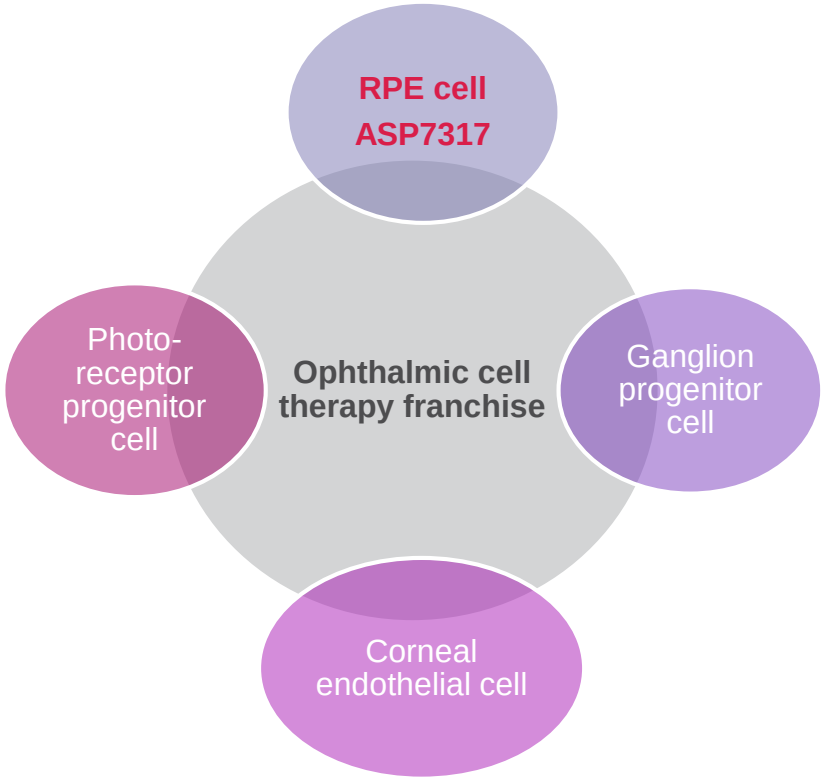
Broaden clinical development program to moderate AMD and other forms of macular degeneration

POC for severe Dry AMD

Initiated a Phase 1b/2 program in Dry AMD

Long-term safety data from the prior cell line remains encouraging

BEYOND ASP7317



AMD: Age-related Macular Degeneration, POC: Proof of Concept

Turning innovative science
into value for patients by

maximizing the potential of cell therapy