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Recoding For The Future

January 2021 Company Presentation

LET'S RECODE THE STORY

NASDAQ: BLUE

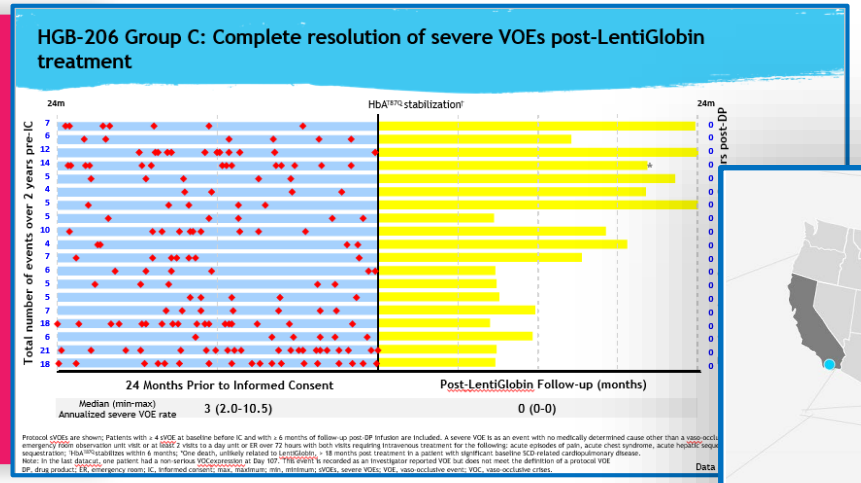
Forward-looking Statements

These slides and the accompanying oral presentation contain forward-looking statements and information. The use of words such as “may,” “might,” “will,” “should,” “expect,” “plan,” “anticipate,” “believe,” “estimate,” “project,” “intend,” “future,” “potential,” or “continue,” and other similar expressions are intended to identify forward-looking statements. For example, all statements we make regarding the initiation, timing, progress and results of our preclinical and clinical studies and our research and development programs, our ability to advance product candidates into, and successfully complete, clinical studies, the timing or likelihood of regulatory filings and approvals, and the timing and likelihood of entering into contracts with payors for value-based payments over time or reimbursement approvals, and our commercialization plans for approved products are forward looking. All forward-looking statements are based on estimates and assumptions by our management that, although we believe to be reasonable, are inherently uncertain. All forward-looking statements are subject to risks and uncertainties that may cause actual results to differ materially from those that we expected. These statements are also subject to a number of material risks and uncertainties that are described in our most recent quarterly report on Form 10-Q, as well as our subsequent filings with the Securities and Exchange Commission. Any forward-looking statement speaks only as of the date on which it was made. We undertake no obligation to publicly update or revise any forward-looking statement, whether as a result of new information, future events or otherwise, except as required by law.

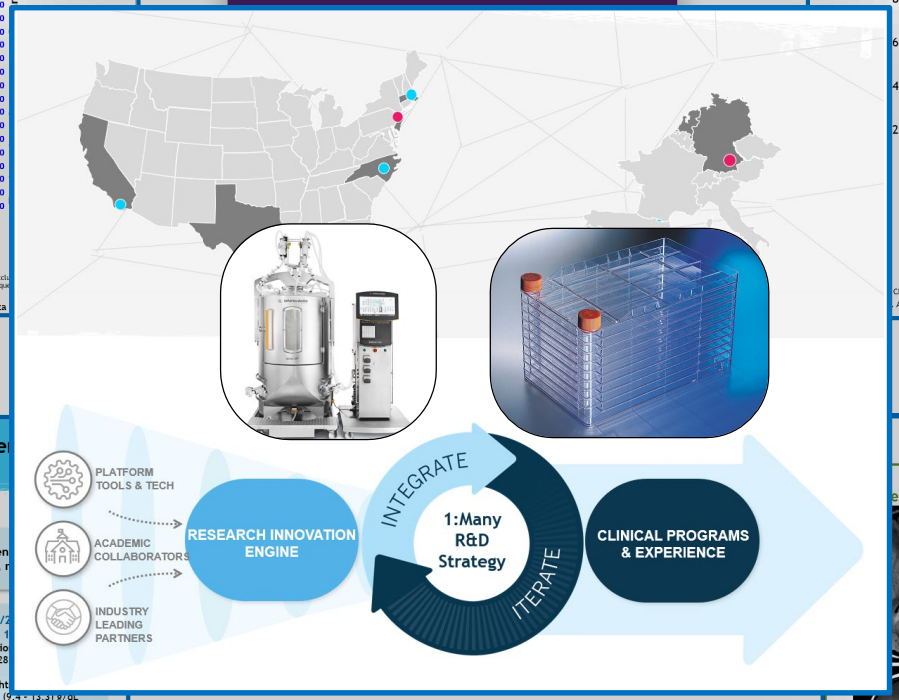
Our True North

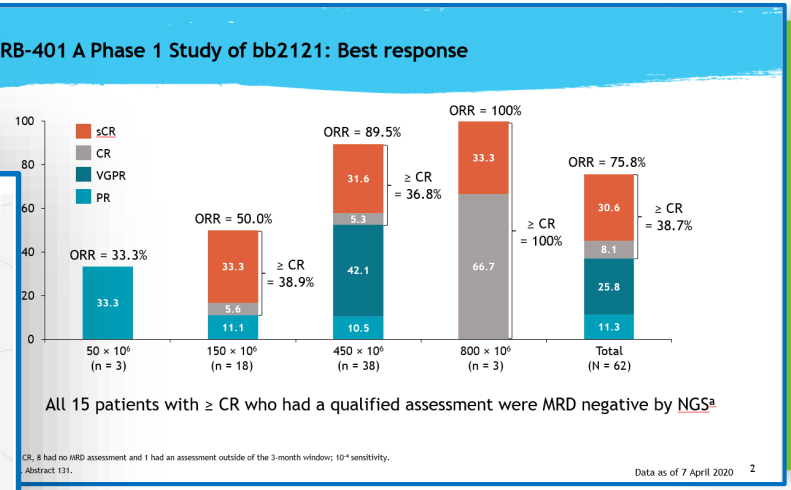
4 for 4: A Decade of Advancing Programs Through the Clinic to Deliver Life-Changing Medicines to Patients

LentiGlobin for SCD



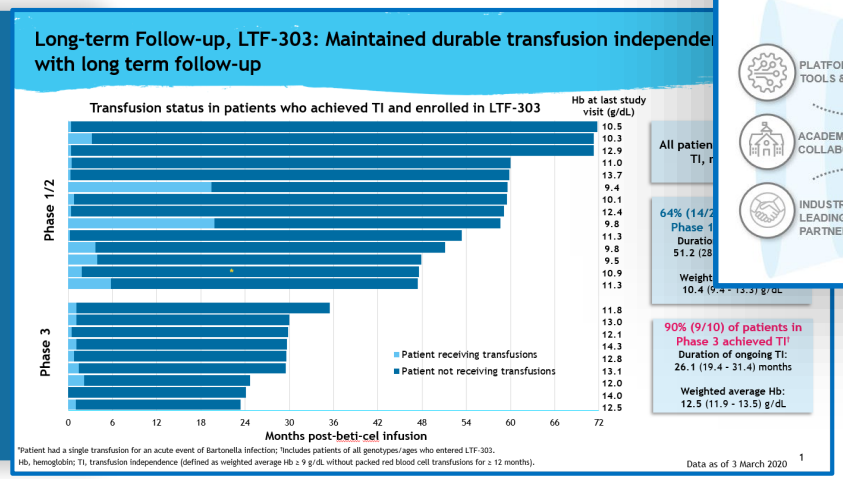
Robust Platform

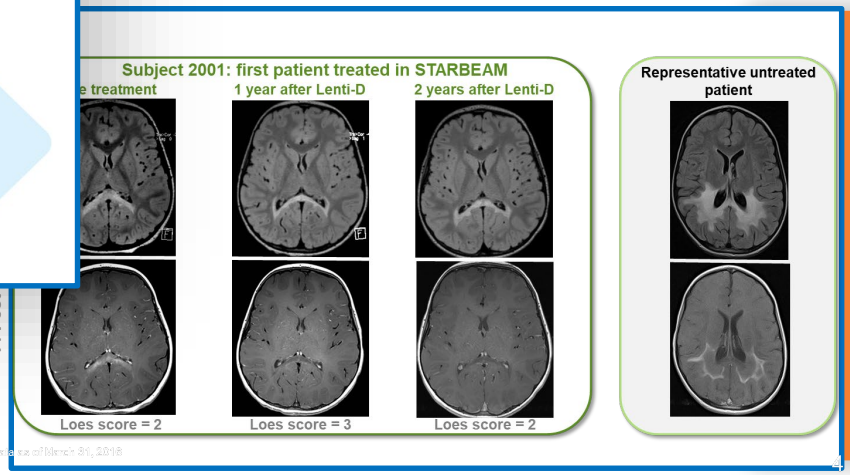




ide-cel (bb2121)

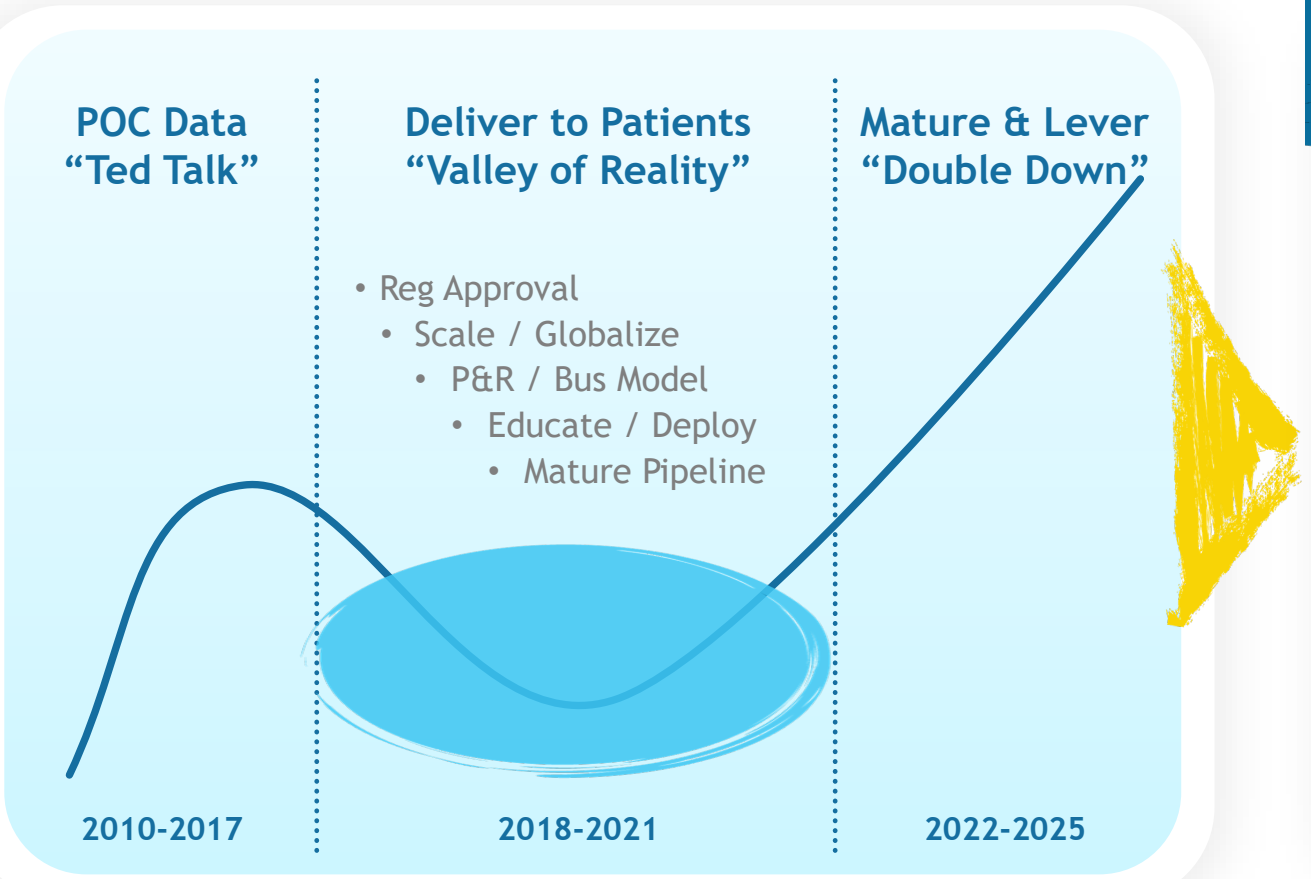
LentiGlobin for TDT





Lenti-D CALD

2020 Silver Lining: De-risked "Valley Crossing" and Ready to Deliver for Patients Across All Products



2020 - The Foundation is Laid

- ✓ **Data:** Consistent, durable, differentiating
- ✓ **Regulatory:** Clarified and de-risked execution plan
- ✓ **Capabilities:** Clinical and commercial manufacturing established
- ✓ **Pipeline:** Platform built, INDs on the horizon
- ✓ **Financial:** Well funded, revenues coming
- ✓ **Team:** Battle tested & digging in

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Unlocking Value for Patients and Shareholders

bluebird plans to separate into two companies

Optimize Needs
Support differentiated strengths and strategic needs

Sharpen Focus
Drive deeper commitment and capability to deliver on significant catalysts ahead

Dedicated Leadership
Fit for purpose and 100% committed therapeutic area expertise

Simplify Ops
Remove complexity and double down differentiated culture

BLUE SGD

SCD | TDT | CALD | Pipeline

- Deliver 3 potentially-curative products to patients
- Prove commercial model
- Scale, leverage, expand the product platform

BLUE ONCO

2121/7 | NextGen MM | NHL | AML | Solids

- Launch ide-cel to deliver for MM patients
- Advance MM earlier lines & next-gen
- Optimize product engine. Deliver 1-2 INDs per year

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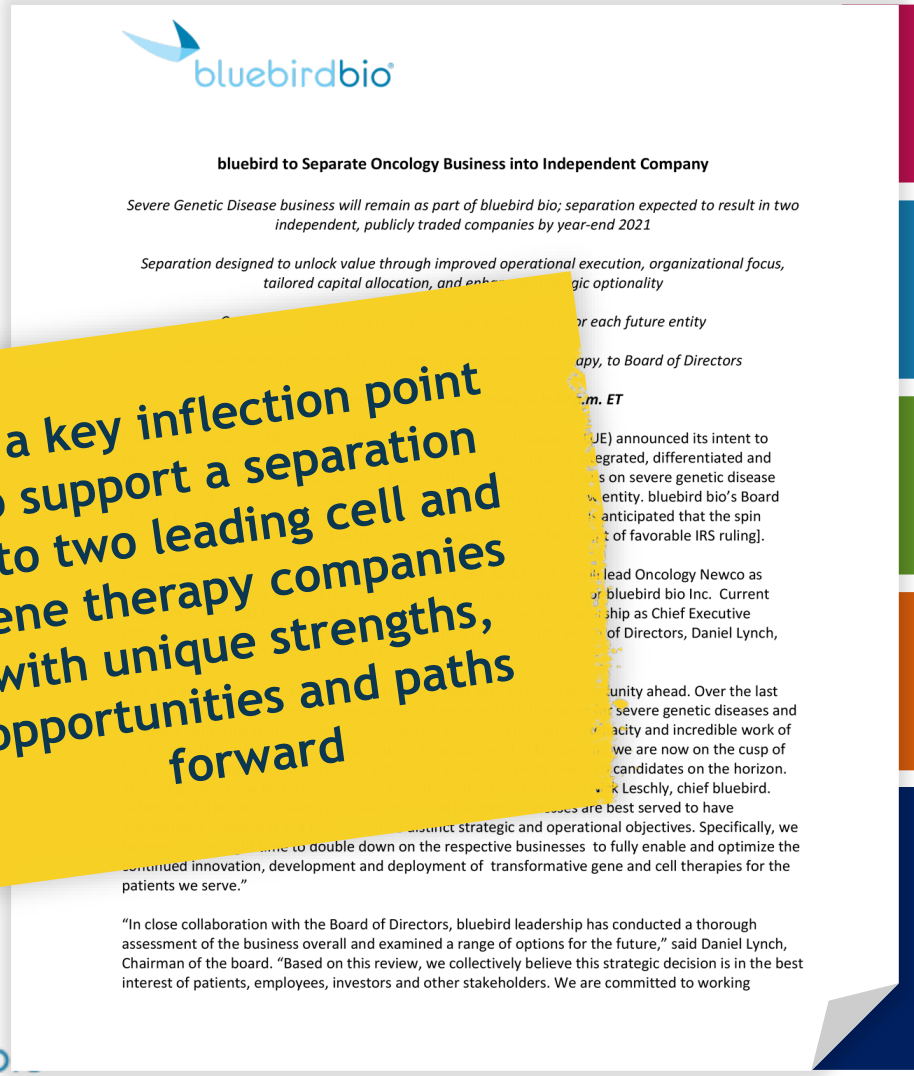
Launching Two Independent, Fully Integrated Commercial Stage Companies



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bluebird to Separate Oncology Business into Independent Company

Severe Genetic Disease business will remain as part of bluebird bio; separation expected to result in two independent, publicly traded companies by year-end 2021

Separation designed to unlock value through improved operational execution, organizational focus, tailored capital allocation, and enh… gic optionality

…r each future entity

…apy, to Board of Directors

…m. ET

…UE) announced its intent to …egrated, differentiated and …s on severe genetic disease …entity. bluebird bio's Board …anticipated that the spin …t of favorable IRS ruling].

…lead Oncology Newco as …r bluebird bio Inc. Current …ship as Chief Executive …of Directors, Daniel Lynch,

…unity ahead. Over the last …severe genetic diseases and …acity and incredible work of …we are now on the cusp of …candidates on the horizon. …k Leschly, chief bluebird.

…ses are best served to have …distinct strategic and operational objectives. Specifically, we …me to double down on the respective businesses to fully enable and optimize the continued innovation, development and deployment of transformative gene and cell therapies for the patients we serve."

"In close collaboration with the Board of Directors, bluebird leadership has conducted a thorough assessment of the business overall and examined a range of options for the future," said Daniel Lynch, Chairman of the board. "Based on this review, we collectively believe this strategic decision is in the best interest of patients, employees, investors and other stakeholders. We are committed to working

At a key inflection point to support a separation into two leading cell and gene therapy companies with unique strengths, opportunities and paths forward

- Spin out bluebird oncology
- Create two independent publicly traded companies
- Anticipated tax-free transaction to close by EOY 2021
- With ~$1.3B in cash, intent is for both companies to have sufficient runway at separation
- BLUE SGD: CEO - Andrew Obenshain; Exec Chair - Nick Leschly
- BLUE ONCO: CEO - Nick Leschly; Chair - Dan Lynch

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SGD Snapshot

Deliver For Patients Now.

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Opportunity to Unlock Value with Increased Focus on Path to Patients & Commercialization

SGD Principles

- **FOCUS: Execute near-term catalysts.** Filings & launches.
- **DELIVER: Prove commercial model.** Novel pricing and reimbursement model for revenues in EU and US.
- **GENERATE: Optimize COGS and reduce costs.** Leaner operations fit for commercialization.
- **EXPAND: Leverage & expand.** Current indications and future expansion.

Execute to Plan

- ✓ Dedicated leadership and team
- ✓ Refined scope and reduced operational complexity
- ✓ Well-funded through anticipated major inflections
- ✓ Enhanced strategic flexibility and optionality to optimize potential

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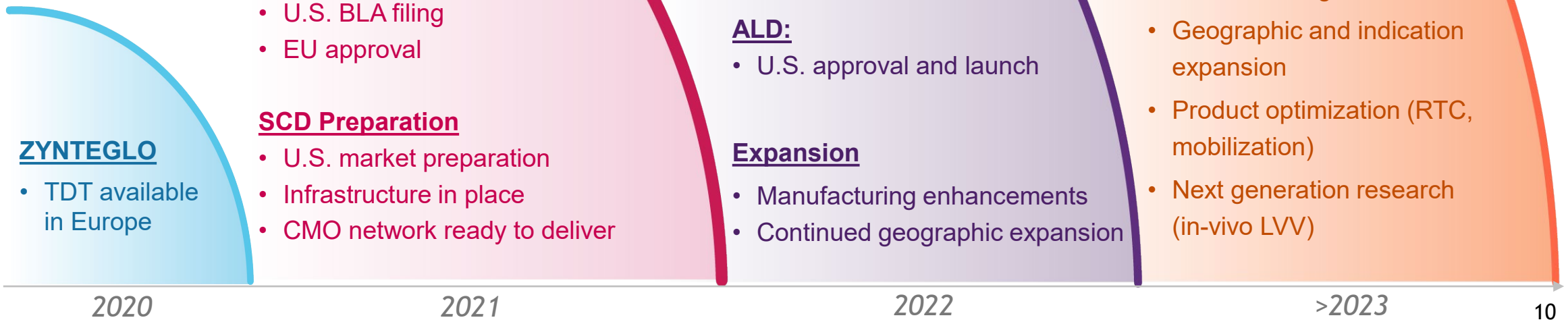
Vision to Set the Standard for Successful Gene Therapy Commercialization

A highly leverageable commercial model through anticipated milestones: additional geographies, label expansion and new product approvals

DELIVER for PATIENTS



2020

ZYNTEGLO
- TDT available in Europe

2021

ZYNTEGLO
- U.S. BLA filing, all ages and genotypes
- TDT EU expansion

ALD
- U.S. BLA filing
- EU approval

SCD Preparation
- U.S. market preparation
- Infrastructure in place
- CMO network ready to deliver

2022

SCD:
- U.S. BLA filing
- Launch ready

ZYNTEGLO:
- U.S. approval and launch

ALD:
- U.S. approval and launch

Expansion
- Manufacturing enhancements
- Continued geographic expansion

>2023

2023+ Gene-Therapy Leadership
- U.S. SCD launch
- Platform scale: Clinical, Commercial, Manufacturing
- Geographic and indication expansion
- Product optimization (RTC, mobilization)
- Next generation research (in-vivo LVV)

Foundational Building Blocks in Place with a De-risked Business Plan

TODAY'S STRATEGIC FOUNDATION...

- Durability of Clinical Data
- Regulatory Clarity
- Manufacturing Network
- Commercial Infrastructure
- Pricing and Reimbursement Model
- Advocacy & Relationships

... CREATES ROADMAP FOR FUTURE SUCCESS

Deliver & Commercialize

- SCD approval and launch
- TDT approval and launch for all ages and genotypes
- CALD approval and launch
- Multiple label expansion opportunities

Growth & Innovation

- Reduced toxicity conditioning (Forty Seven/GILD)
- Enhanced mobilization (Magenta)
- Continued geographic expansion
- In-Vivo therapies
- Platform Scale (Commercial, Manufacturing, Clinical)

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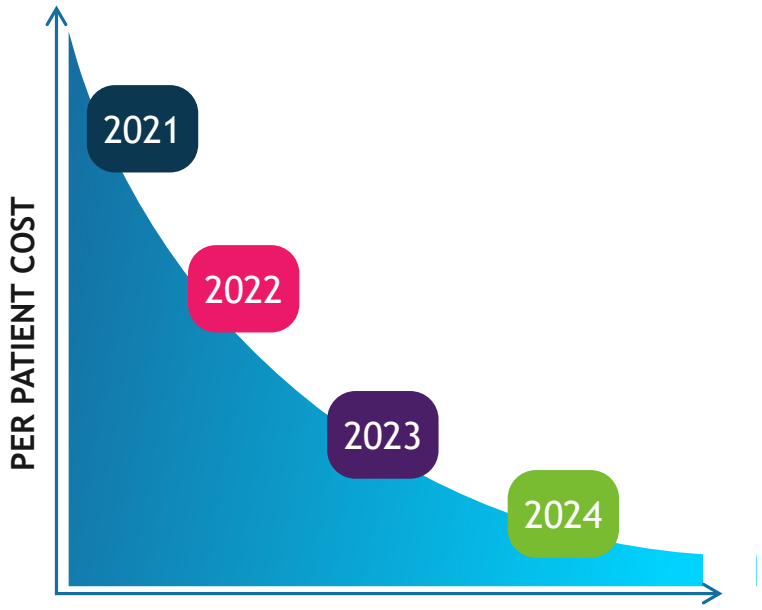
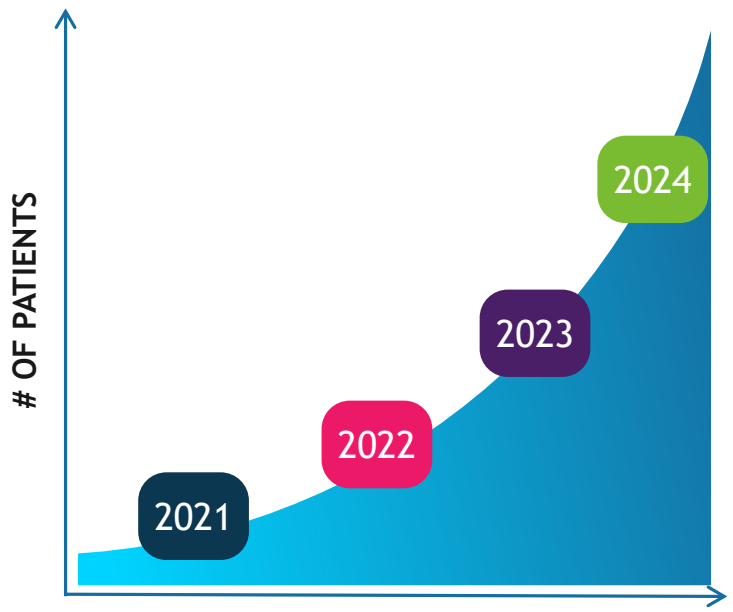
Transformative Treatments. Compelling Business.

Multi-billion dollar market opportunity

Manufacturing and Commercial Leverage



Eligible Patients Anticipated on Label



Meaningful competitive advantages in TDT and SCD:

- Significantly longer safety follow up
- Significantly longer durability data
- Regulatory clarity
- Experience with manufacturing scale-up
- Commercial infrastructure in place
- SCD efficacy that will be extremely difficult to improve upon

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Oncology Snapshot

Launch Time.
ide-cel Just
The Beginning.

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Oncology Vision: Taking Flight

blue ONCOLOGY

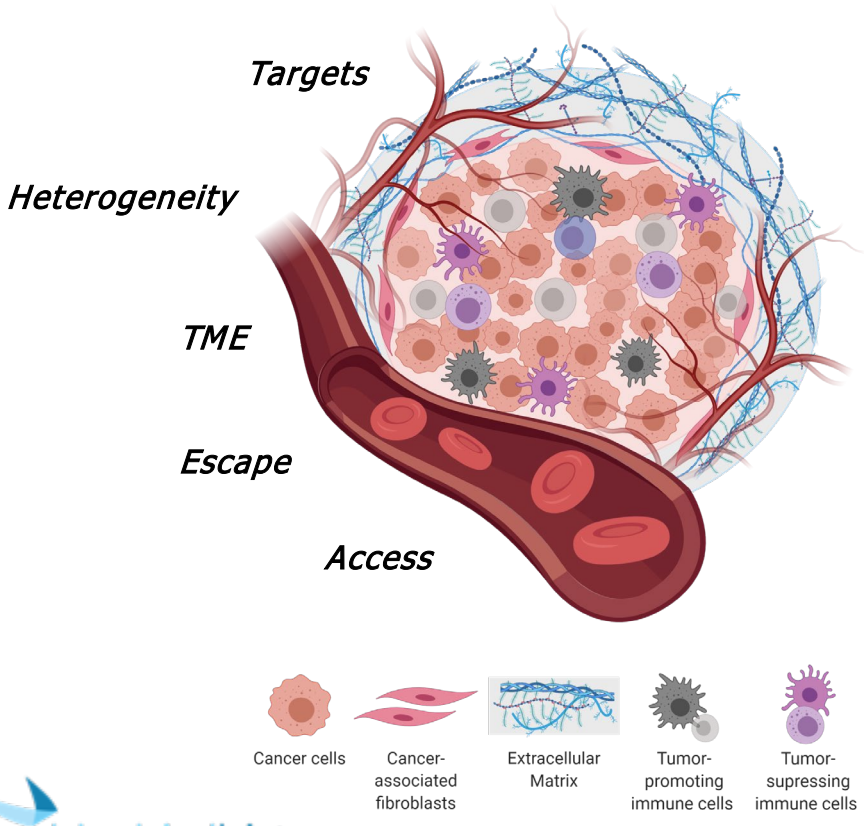
Obsessed with disruptive next-gen product cycle to create cures for cancer patients

1. LAUNCH: **Deliver ide-cel** for multiple myeloma patients
2. DISRUPT: **Advance** multiple myeloma into earlier lines and next-gen therapies
3. CREATE: **Optimize** product engine to **deliver 1-2 INDs per year**
4. CRACK **the solid tumors code:** Deliver differential layered tech portfolio with best of breed partners
5. BUILD & PARTNER: **Mobilize cutting edge capabilities** to enable launch goals (e.g., manufacturing)

Unlocking the Full Potential for Cellular Therapy in Oncology

Complex problem…..

…..demands a multi-part solution



Broad integrated tech & Cellular process development enables designed solutions

Clinical & correlative data educating biological hypothesis

World-class LVV, mRNA & DP manufacturing capabilities

Platforms & Technology

Rules "The Rosetta Stone"

Ecosystem

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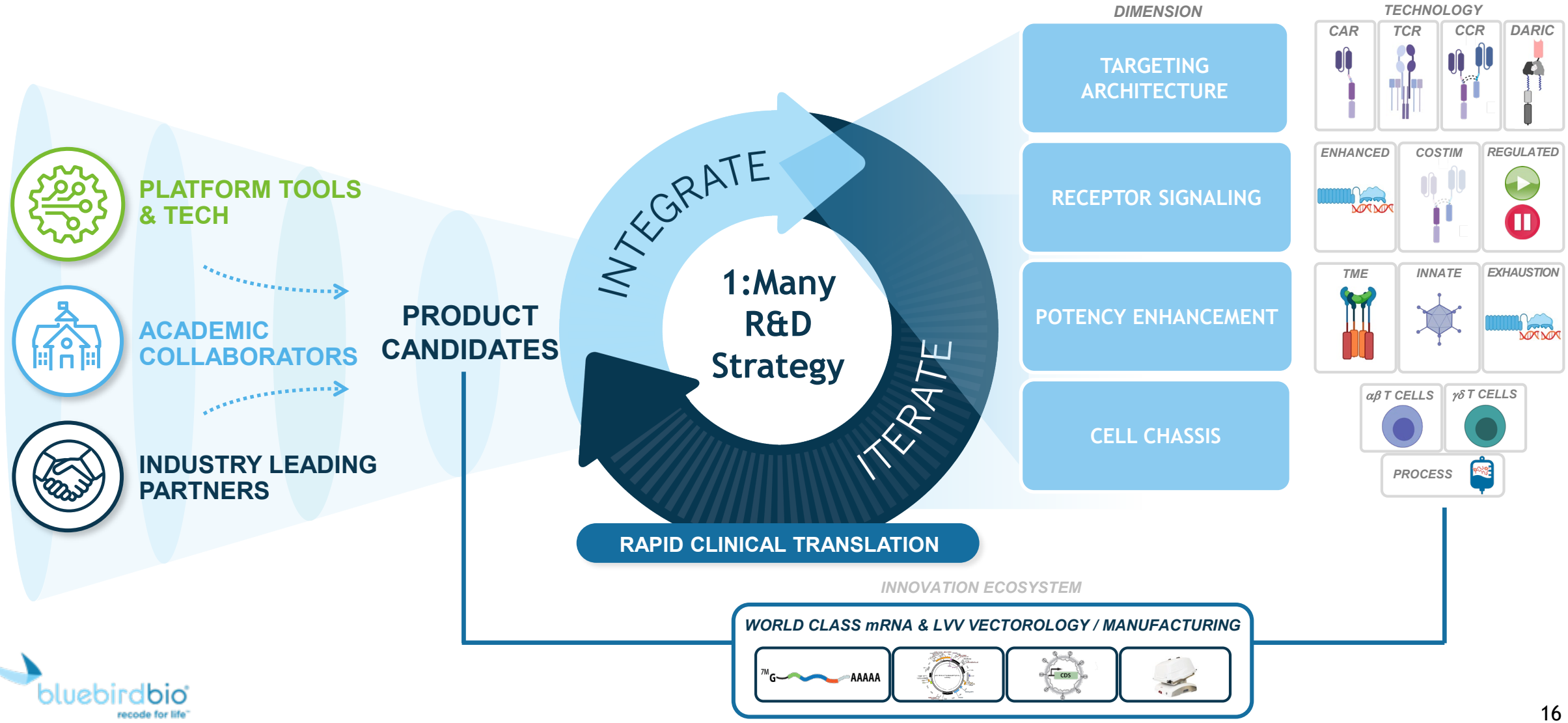
One-to-Many Strategy: Recoding Traditional R&D

Nextgen Product Cycling Engine Designed to Rapidly Build, Test, Learn, and Improve



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Oncology: Deep Pipeline of Potentially Transformative Medicines

MULTIPLE MYELOMA

PRODUCT CANDIDATES	PROGRAM AREA	PRECLINICAL	PHASE 1/2	PHASE 2/3
ide-cel (bb2121)*	*KarMMa: Multiple Myeloma ≥3 Prior Lines*			
	KarMMa-2: Multiple Myeloma Second Line (1 Prior)			
	KarMMa-3: Multiple Myeloma Third Line (2-4 Prior)			
	KarMMa-4: MM First Line			
	CRB-401: Multiple Myeloma ≥3 Prior Lines			
	KarMMa-7: Multiple Myeloma Combinations Basket Study			
	KarMMa-8: Multiple Myeloma 1-3 Prior Lines (2L Registrational)			
	KarMMa-9: Multiple Myeloma NDMM (Registrational)			

PRODUCT CANDIDATES	PROGRAM AREA	PRECLINICAL	PHASE 1/2
bb21217*	*CRB-402: Multiple Myeloma ≥3 Prior Lines*		
NG MM CAR T	*NextGen CAR T - 4 approaches*		

OTHER HEME AND SOLID TUMORS

PRODUCT CANDIDATES	PROGRAM AREA	PRECLINICAL	PHASE 1/2
MCC1 TCR**	*Merkel Cell Carcinoma*		
bbT369	*bNHL*		
DARIC33	*Pediatric AML*		
DARIC NextGen	*Adult AML*		
MAGE-A4 TCR	*MAGE-A4+ve Solid Tumors*		
Multiple Early Programs	*Ovarian (UNC – Academic Collab)*		
	Multiple		

1-2 INDs in 2021 and 2022

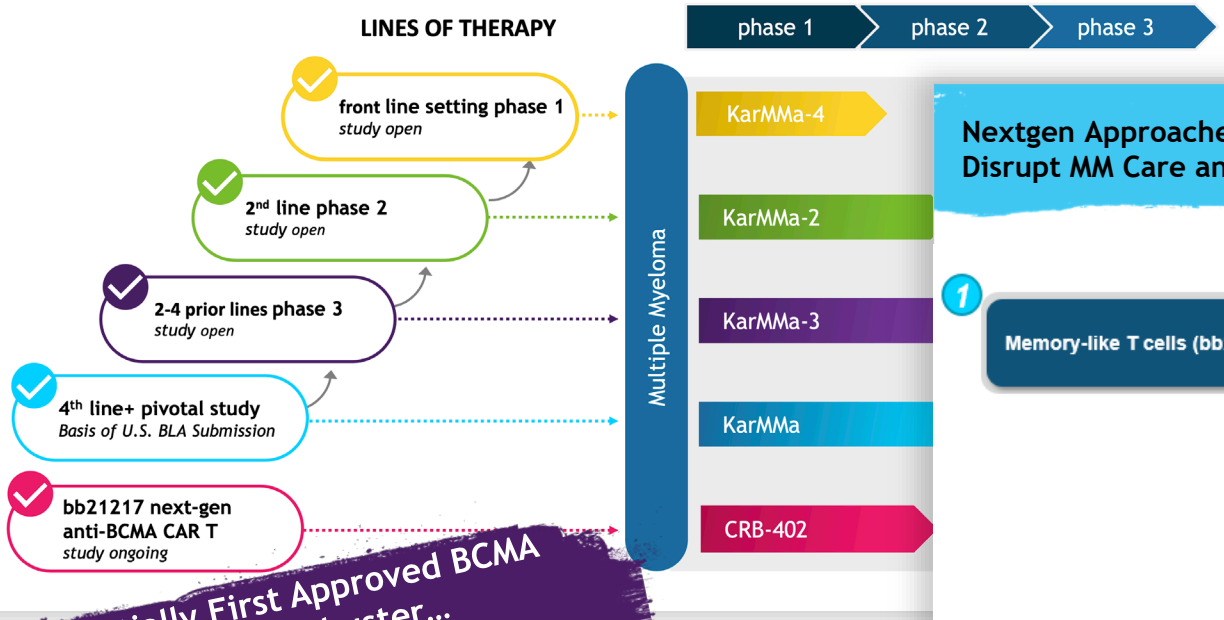
Our pipeline combines first near commercial MM CAR T cell product (ide-cel) and fast follower (bb21217) with multiple highly differentiated and internally developed candidates entering clinical testing

*ide-cel (bb2121) and bb21217 development in collaboration with BMS; MAGE-A4 development in collaboration with Regeneron and Medigene.

Delivering to Patients: Our Broad and Deep Approach in Multiple Myeloma

1

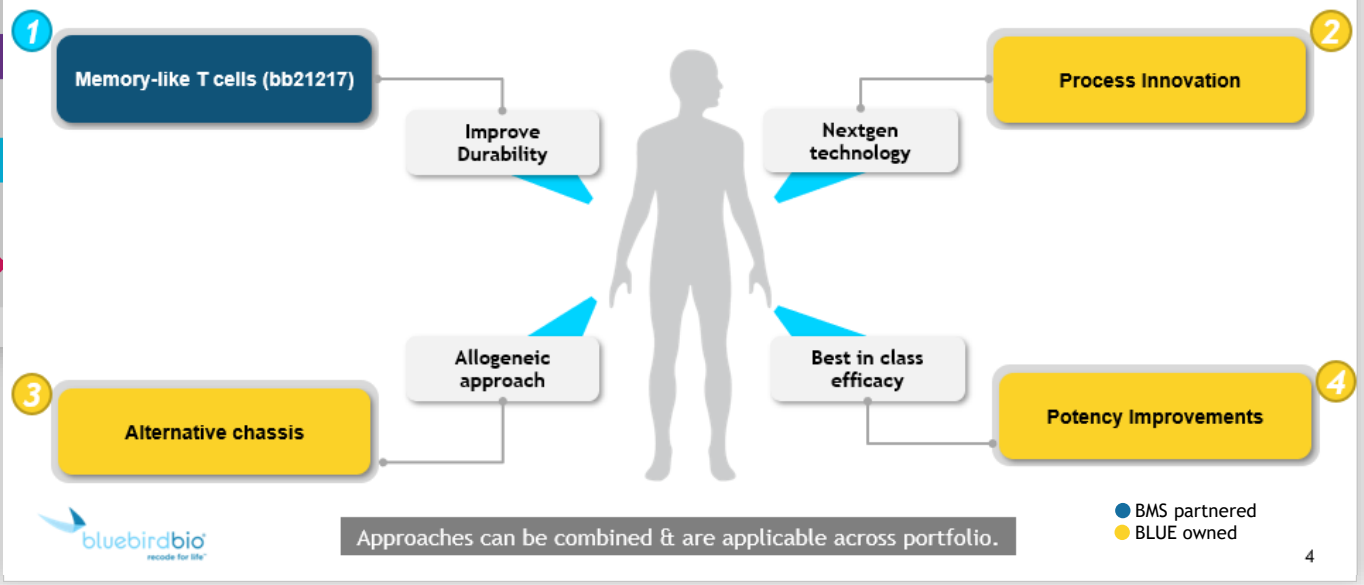
Advancing into earlier lines of therapy and continuing to innovate



Potentially First Approved BCMA CAR-T Blockbuster…
ide-cel PDUFA: 3/27/21

2

Nextgen Approaches Focused on Solving Meaningful and Definable Problems to Disrupt MM Care and Ide-cel



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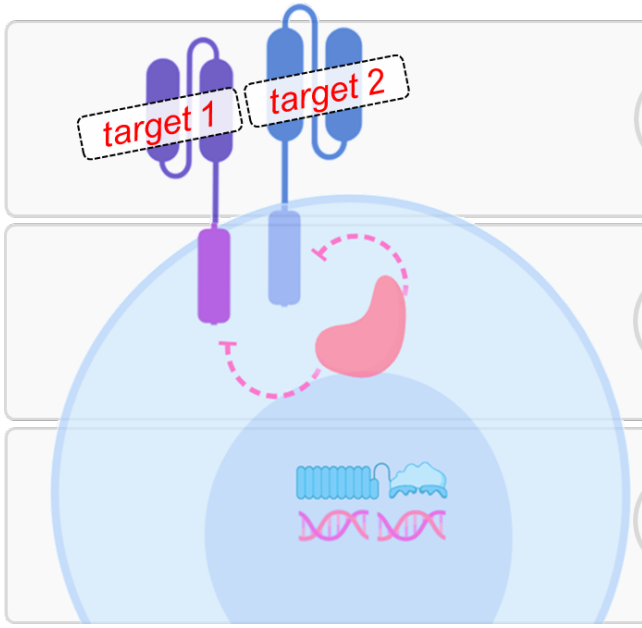
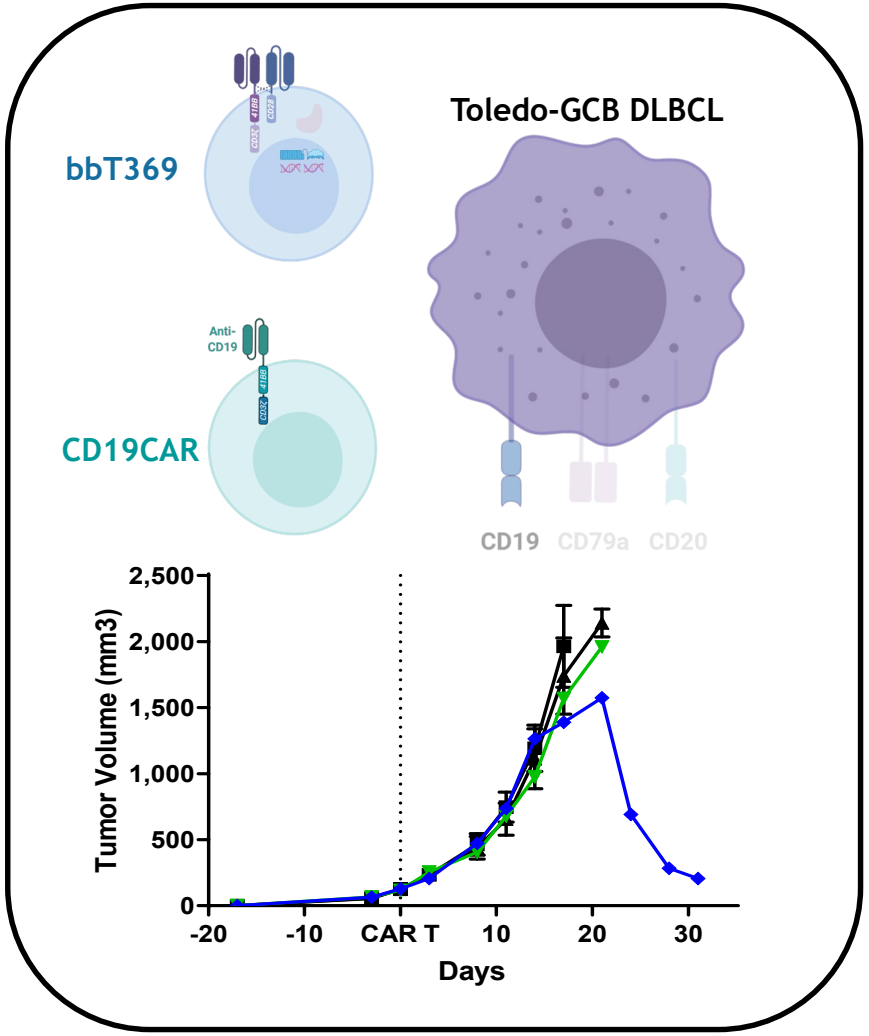
bbT369: Multi-layered Enhancements to Deliver Improved Potency and Patient Outcomes in bNHL



	Layer	Purpose
1	dual-targeting	Target tumor driver and passenger proteins to limit DLBCL escape
2	signal extension	Unique CAR construction integrated with dual target technology to enhance T cell activation
3	signal amplification	Gene edit intended to improve persistence of CAR T cell activity

Product designed to overcome mechanisms thought to limit efficacy of existing CAR T therapies and mediate potent anti-tumor activity with the goal of driving deep and durable responses in B-NHL patients



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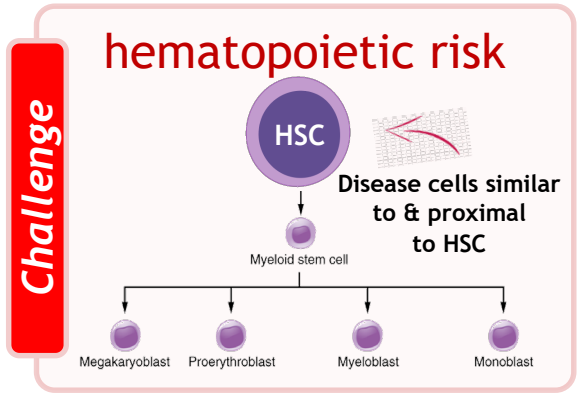
CD33 Targeted Regulatable CAR T (DARIC33)

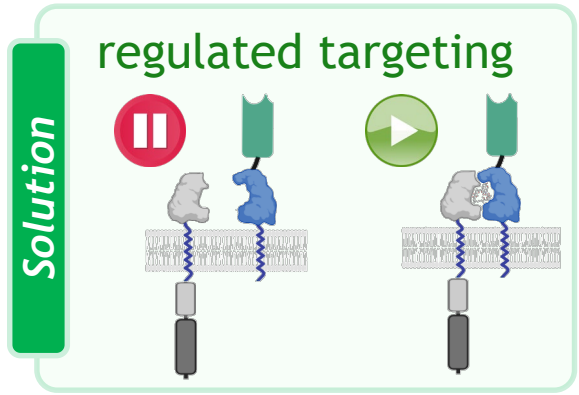
Problem

- Substantial unmet need in AML
- Proximity of disease to HSCs = hematopoietic risk
- *CAR T cell that spares HSCs could transform AML*

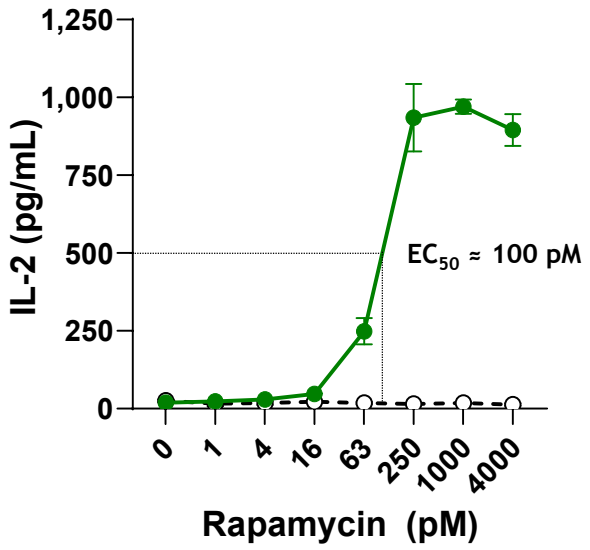
Hypothesis

- Targets are well described/validated, but…
- …aggressively targeting AML requires 'pausing'
- *DARIC enables drug-controlled ON/OFF state*

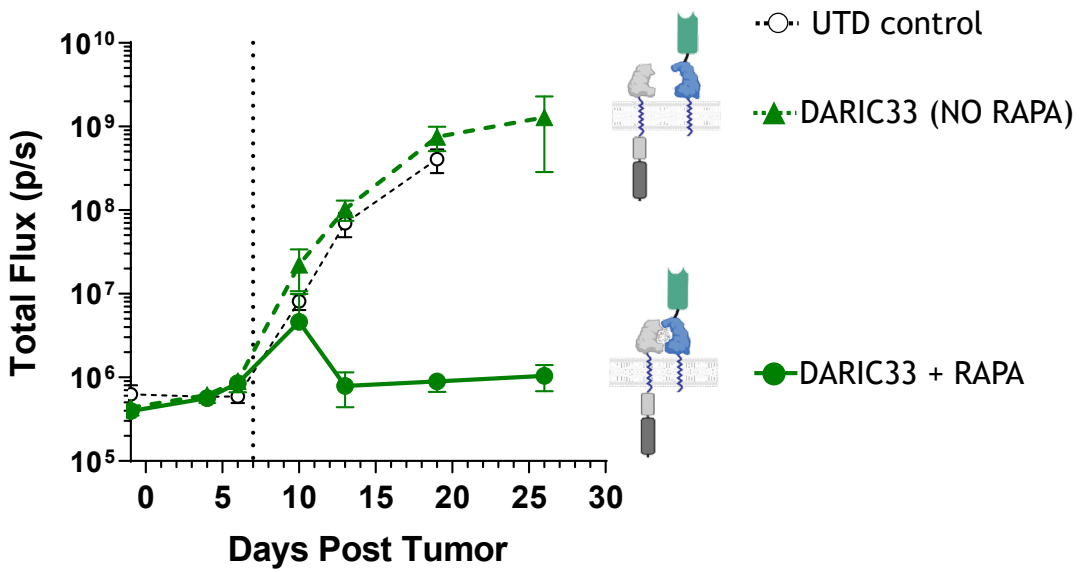




Strict rapamycin dependence



RAJI-CD33 tumor model



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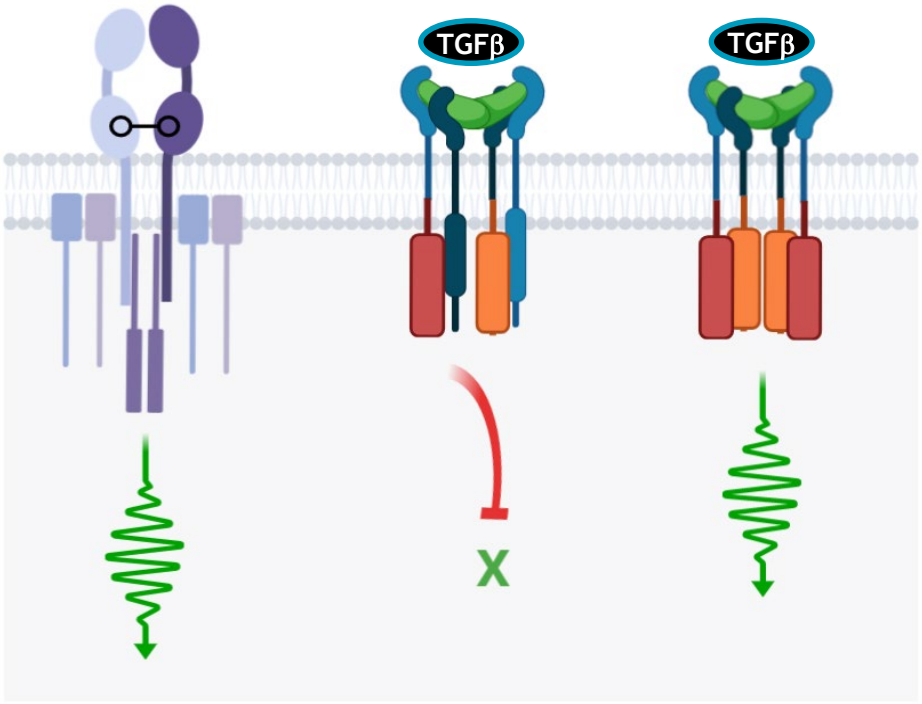
Earlier Product Concept: Superior MAGE-A4 TCR + TGFβ Switch Receptor*

Product Concept

Engineered TCR with enhanced potency

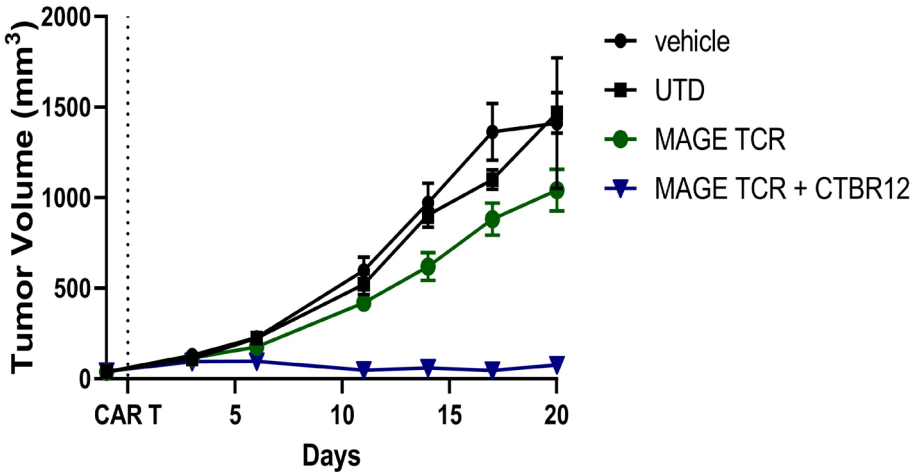
Switch Receptor neutralizes TGFβ

Switch Receptor activates IL12R signaling



Validating Data

MAGEA4 TCR + Switch Receptor provides tumor control in a human melanoma mouse model



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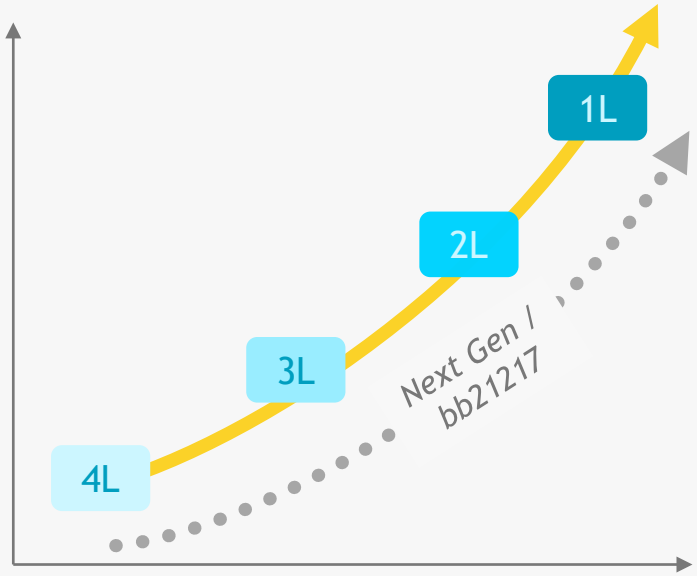
** In collaboration with Regeneron and Medigene*

BLUE Oncology Vision: An Innovative Cell Therapy R&D Company with First-in-Class BCMA Potential Blockbuster

1 The Cornerstone

First Approved BCMA CAR-T with Blockbuster Potential

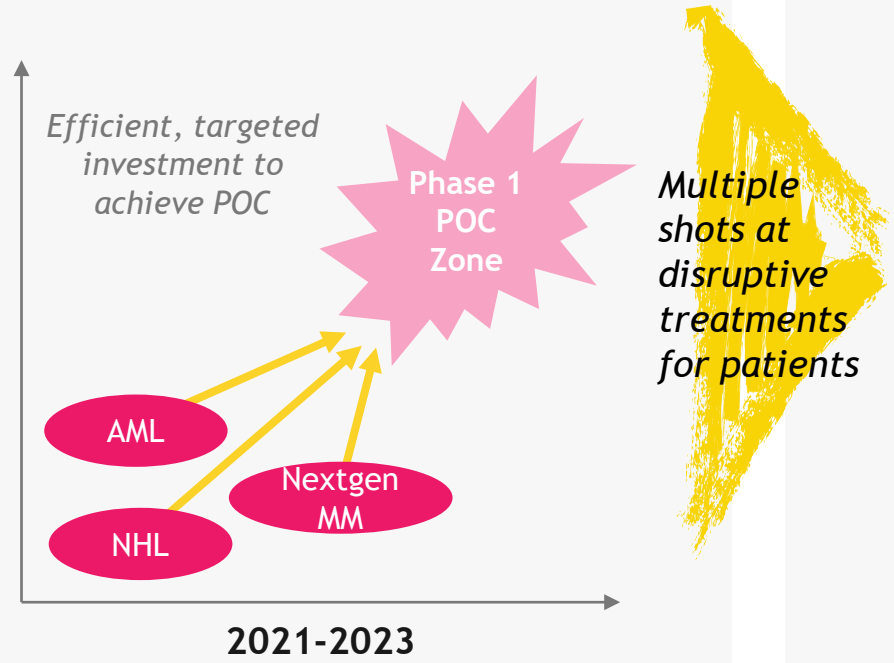


Free cash flow

Insight-based design

2 The Crown Jewel

IND Engine: Lighting the Fuse on Un-incremental Treatments



Multiple shots at disruptive treatments for patients

3 BLUE Oncology

By 2025, the leading oncology cell therapy company

- Significant and growing ide-cel revenue
- Path to financial sustainability
- Strategic optionality

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Time to Run in 2021…

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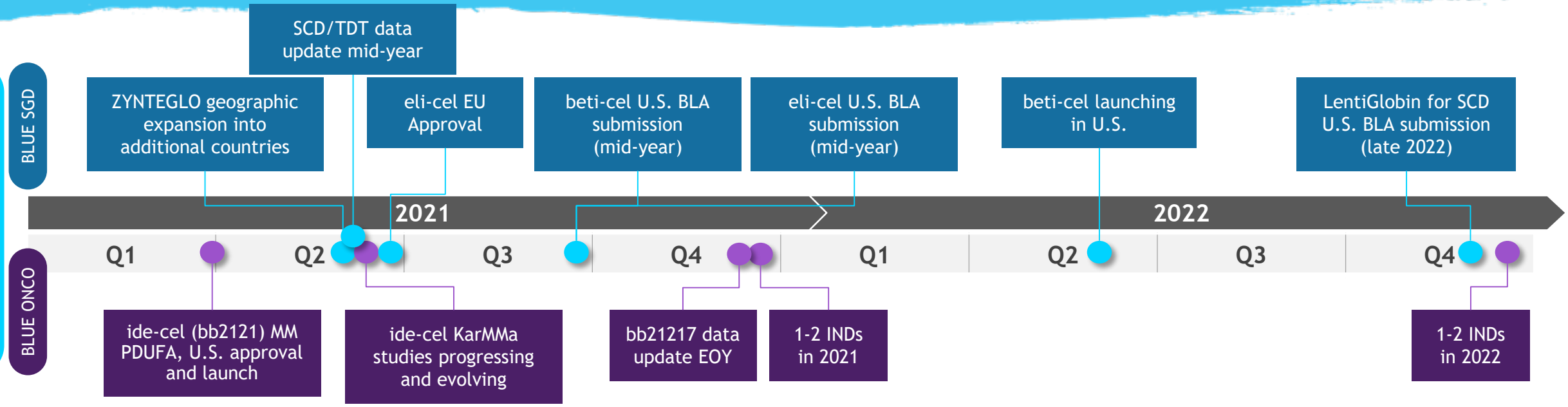
Significant Near-term Catalysts Ahead for Each Company

Near Term Catalysts



5-Year Vision

A HIGHLY LEVERAGEABLE PLATFORM AND COMMERCIAL MODEL

- 3 products successfully to market
- Global footprint
- Path to profitability and capital markets independence

BEST IN CLASS PROGRAMS & THERAPIES

- Multiple products and next-gen innovation
- Multiple shots at disruptive treatments for patients
- Strategic optionality

Financial Overview: Launching Each Business from a Position of Financial Strength

JAN 2021

- **Strong starting position**
  - $1.3B cash
  - $0 Debt
  - Significant R&D cost share support from oncology partners (BMS/Regeneron)
  - Global rights to SGD products
  - Emerging commercial products and revenues

Q2 / Q3

- **Deliver on Major Milestones**
  - ide-cel approval and launch (US)
  - CALD launch (EU)
  - TDT and CALD Filings (US)
- **Preparing For Separation**
  - Shape each business to be fit for purpose
  - Establish leadership teams and boards
  - Ensure each business has sufficient cash runway to achieve value-creating milestones in 2022 and beyond

SEPARATION ~EOY 2021

BLUE SGD

BLUE ONCO

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Re-shaping bluebird to Deliver over Next Five Years

MAXIMIZE IMPACT

- Deliver deeper therapeutic expertise
- Disruption and focus favors patients

ENGAGE AND ENABLE

- Optimize diverging business needs
- Operational simplification & focus
- Rejuvenated and committed

DELIVER VALUE

- Strategy clarity and optionality
- Dedicated value creation

The Next 5 YEARS

START NOW

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Simple Vision; Profound Mission

RADICAL CARE

We care in a way that's intense and truly sets us apart.

THIS IS PERSONAL

Gene therapy is about saving lives one person at a time. And we are, each of us, personally all in.

PIONEERS WITH PURPOSE

We're exploring new frontiers for the sake of patients.

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