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, and the timing or likelihood of regulatory filings and approvals 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 annual report on Form 10-K, 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 VISION:
Make Hope a Reality

OUR PATIENTS
TRUE BLUE

OUR PEOPLE
BLUE MOJO
World-class Gene Therapy Platform and Integrated Global Capabilities

THE GENE THERAPY PRODUCT COMPANY

∞ | Patient Impact

2+ Products on the Market

2+ Programs Nearing Commercialization

4+ Additional Programs in the Clinic
# bluebird Pipeline Overview

<table>
<thead>
<tr>
<th>Product Candidates</th>
<th>Program Area</th>
<th>Preclinical</th>
<th>Phase 1/2</th>
<th>Phase 2/3</th>
<th>Rights/Partner</th>
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<tbody>
<tr>
<td>Lenti-D™ Drug Product</td>
<td>CNS Diseases</td>
<td>Cerebral ALD</td>
<td>Green</td>
<td></td>
<td>Worldwide</td>
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<tr>
<td></td>
<td>Rare Hemoglobinopathies</td>
<td></td>
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<td>LentiGlobin® Drug Product</td>
<td></td>
<td>Transfusion-Dependent β-thalassemia</td>
<td>(Phase 3)</td>
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<td>Worldwide</td>
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<td></td>
<td></td>
<td>Severe Sickle Cell Disease</td>
<td></td>
<td></td>
<td>Worldwide</td>
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<tr>
<td></td>
<td>BCMA</td>
<td></td>
<td></td>
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<tr>
<td>bb2121</td>
<td></td>
<td>Multiple Myeloma</td>
<td>Orange</td>
<td></td>
<td>Celgene</td>
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<tr>
<td>bb21217</td>
<td></td>
<td>Multiple Myeloma</td>
<td>Orange</td>
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<td>Celgene</td>
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<tr>
<td>HPV-16 E6 TCR</td>
<td>Oncology</td>
<td>HPV-associated Cancers</td>
<td>Red</td>
<td></td>
<td>Kite Pharma</td>
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<tr>
<td>Viromed Target</td>
<td></td>
<td>Undisclosed</td>
<td>Red</td>
<td></td>
<td>Worldwide excluding Korea</td>
</tr>
<tr>
<td>Medigene Targets</td>
<td></td>
<td>Undisclosed</td>
<td>Red</td>
<td></td>
<td>Worldwide</td>
</tr>
<tr>
<td>Early Pipeline</td>
<td>Research</td>
<td>Undisclosed + Gene Editing</td>
<td></td>
<td></td>
<td>Worldwide</td>
</tr>
</tbody>
</table>

**COLLABORATORS**
How Do We Get There? Data, Execution and Development in 2017

DATA
- LentiGlobin, TDT Update @ EHA
- CRB-401 Study Data (bb2121) @ ASCO
- LentiD CALD Update @ TBD

EXECUTION
- Initiate HGB-212 Study of LentiGlobin
- Preparations for TDT EU MAA Filing

DEVELOPMENT
- LentiGlobin, TDT and SCD Update @ ASH
- File Next Generation BCMA IND (bb21217)
- Advance & Further Validate Gene Editing Platform
- Confirm LentiD, CALD Clinical/Regulatory Path
Despite Progress in Multiple Myeloma, There Remains a Need for New Therapies

Despite the availability of these classes of drugs for the treatment of MM, a recent analysis of patients with relapsed and refractory MM (RRMM) who were double refractory to a PI and an IMiD or had relapsed after ≥3 prior lines of therapy, including the novel agents pomalidomide (third-generation IMiD) and carfilzomib (second-generation PI), showed a median overall survival (OS) of 8 months.

Usmani, Blood 2016
# Current U.S. Standard of Care in 3rd/4th Line Multiple Myeloma

## Current U.S. Standards of Care

<table>
<thead>
<tr>
<th>Inclusion Criteria</th>
<th>Pomalyst and dex. (Pomalyst Product Monograph)</th>
<th>Daratumamab (Lancet 2016, Lonial, S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>452</td>
<td>106</td>
</tr>
</tbody>
</table>

- **Inclusion Criteria**
  - ≥2 prior therapies (including REVLIMID and bortezomib)
  - Relapsed and refractory multiple myeloma
  - Disease progression on or within 60 days of last therapy
  - Previously treated with at least three lines of therapy (including proteasome inhibitors and immunomodulatory drugs), or were refractory to both proteasome inhibitors and immunomodulatory drugs

| Prior Tx | 5 (2-14) | 5 (2-14) |

<table>
<thead>
<tr>
<th>CR Rate (%)</th>
<th>&lt;1%</th>
<th>~3%</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORR (%)</td>
<td>23.5%</td>
<td>29%</td>
</tr>
<tr>
<td>PFS (mos)</td>
<td>3.6 months</td>
<td>3.7 months</td>
</tr>
</tbody>
</table>

- The existing SOC outcomes for 3rd/4th line are limited in efficacy and durability leaving a need for new options for patients in need of better results

- Deep MRD negative responses are desirable in earlier lines of therapy and have demonstrated a benefit in long term outcomes
CRB-401 Open-label Phase 1 Clinical Study of bb2121

**Study Status**
- Consented N=35
- Cells Collected N=24
- Dosed N=21
- 1 Month Response Evaluation N=18

* bb2121 Successfully manufactured for all patients collected

**3 + 3 Dose Escalation of CAR + T Cells**

- CRB-401 is a phase 1 dose-escalation and dose response study in relapsed / refractory MM
- Objectives: Determine preliminary safety and efficacy and recommended phase 2 dose
- 50 patients planned, standard 3 + 3 dose escalation followed by expansion cohort
- Key eligibility criteria
  - Relapsed / refractory MM with ≥ 3 prior lines of therapy (including PI and IMiD), or double refractory
  - Measurable disease
  - ≥ 50% BCMA expression by IHC
  - Adequate bone marrow (ANC ≥1,000, platelet count ≥50,000), adequate renal and hepatic function
21 patients have received bb2121 as of the data cut-off of May 4, 2017. Median follow-up is 15.4 weeks (range 1.4 to 54.4).

### Demographics and Clinical Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Statistic</th>
<th>N=21 Dosed Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age years</td>
<td>Median (range)</td>
<td>58 (37-74)</td>
</tr>
<tr>
<td>Male gender</td>
<td>N (%)</td>
<td>13 (62%)</td>
</tr>
<tr>
<td>Time since diagnosis (years)</td>
<td>Median (range)</td>
<td>5 (1-16)</td>
</tr>
<tr>
<td>ECOG¹ = 0</td>
<td>N (%)</td>
<td>10 (48%)</td>
</tr>
<tr>
<td>ISS² Stage</td>
<td>N (%)</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>6 (29%)</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>11 (52%)</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>4 (19%)</td>
<td></td>
</tr>
<tr>
<td>High-risk cytogenetics (del17p, t(4;14), t(14;16), 1q, del 13)</td>
<td>N (%)</td>
<td>14 (67%)</td>
</tr>
</tbody>
</table>

¹ ECOG: Eastern Cooperative Oncology Group Performance Score
² ISS: International Staging System
³ SCT: Stem Cell Transplant

### MM Treatment History

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Statistic</th>
<th>N=21 Dosed Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior lines of therapy</td>
<td>Median (range)</td>
<td>7 (3-14)</td>
</tr>
<tr>
<td>Prior autologous SCT³</td>
<td>N (%)</td>
<td>21 (100%)</td>
</tr>
<tr>
<td>Prior Therapies</td>
<td>Exposed</td>
<td>Refractory</td>
</tr>
<tr>
<td>Bortezomib</td>
<td>100%</td>
<td>67%</td>
</tr>
<tr>
<td>Carfilzomib</td>
<td>91%</td>
<td>57%</td>
</tr>
<tr>
<td>Lenalidomide</td>
<td>100%</td>
<td>86%</td>
</tr>
<tr>
<td>Pomalidomide</td>
<td>91%</td>
<td>71%</td>
</tr>
<tr>
<td>Daratumumab</td>
<td>71%</td>
<td>48%</td>
</tr>
<tr>
<td>Cumulative Exposure</td>
<td>Exposed</td>
<td>Refractory</td>
</tr>
<tr>
<td>Bort / Len</td>
<td>100%</td>
<td>67%</td>
</tr>
<tr>
<td>Bort / Len / Car</td>
<td>91%</td>
<td>48%</td>
</tr>
<tr>
<td>Bort / Len / Pom</td>
<td>91%</td>
<td>57%</td>
</tr>
<tr>
<td>Bort / Len / Car / Pom</td>
<td>86%</td>
<td>43%</td>
</tr>
<tr>
<td>Bort / Len / Car / Pom / Dara</td>
<td>71%</td>
<td>29%</td>
</tr>
</tbody>
</table>
**bb2121 Generally Well Tolerated**

**Treatment-Emergent Adverse Events in >2 Patients (N=21 Patients Dosed)**

- No dose-limiting toxicities (DLTs) observed as of data cut-off
- Cytopenias related to Cy/Flu lymphodepletion
- 1 unrelated death due to cardio pulmonary arrest in a patient with an extensive cardiac history, the event occurred over 4 months after bb2121 infusion. The patient had achieved a stringent CR at 1 month and remained in remission at time of event
- 11 patients experienced 1 or more SAEs. SAEs occurring in more than 1 patient were CRS* Grade 1-2 that required hospitalization per protocol (N=4) and pyrexia (N=2)

*CRS uniformly graded according to Lee et al., Blood 2014;124:188-195
Cytokine Release Syndrome Readily Manageable

- **15/21 (71%) with cytokine release syndrome (CRS)**
  - 2 patients with Grade 3 CRS that resolved in 24 hours
  - 4 patients received tocilizumab, 1 (Grade 2 CRS) with steroids
  - CRS grade does not appear related to tumor burden

- **CRS-related symptoms mostly Grade 1-2**

- **No Grade 3/4 neurotoxicity**
All Patients in Active Dose Cohorts Achieved an Objective Response, Duration up to 54 Weeks

- High tumor burden (>50% bone marrow involvement)
- Includes unscheduled assessments.

MRD - † deceased

u = unconfirmed response

Includes unscheduled assessments.
**Summary**

- **bb2121 has induced durable and deepening responses in a heavily pre-treated population with relapsed/refractory multiple myeloma, including:**
  - 100% ORR, 73% VGPR or better, 27% CR (at doses > 50 x 10^6)
  - MRD negative results in all evaluable patients (N=4)
  - No disease progression in patients treated with doses > 50 x 10^6, with 1 patient past 1 year and 8 patients past 6 months

- **To date, the safety profile of bb2121 has been manageable through doses as high as 800 x 10^6**
  - The 2 reported events of grade 3 CRS resolved within 24 hours
  - No grade 3/4 neurotoxicity reported

- **These results will inform identification of the dose(s) to bring forward into the expansion phase of the study in future development**
LentiGlobin TDT Clinical Studies

**NORTHSTAR (HGB-204)**
- Phase 1/2 multicenter study; all genotypes
- All 18 patients treated, with ≥ 6 months follow-up
- 2 patients have completed 2-year analysis

**HGB-205 (TDT and SCD)**
- Phase 1/2 single-center study; all genotypes
- 4 TDT patients treated, with 11 – 33 months follow-up

**NORTHSTAR-2 (HGB-207)**
- Phase 3, global, multi-center study; non-β^0/β^0 genotypes
- N=15 adults and adolescents, and N=8 pediatric patients
  - Open and enrolling

**NORTHSTAR-3 (HGB-212)**
- Phase 3, multi-center, global study; β^0/β^0 genotypes
- N=15 adults, adolescents and pediatric patients
  - Initiation planned for 2017

Data as of Sept 16, 2016
Data as of Nov 30, 2016
Exploratory in vitro analysis conducted at research scale
EU and U.S. Registration Strategies

**EU**

Pursue **CONDITIONAL APPROVAL** in patients with non-$\beta^0/\beta^0$ genotypes on the basis of data from ongoing Northstar & HGB-205 studies, as well as available data from Northstar-2 study.

**U.S.**

Pursue **approval** in adults and adolescents based on data from ongoing pivotal HGB-207 trial.

Pediatric population to be included as a cohort of HGB-207, rather than separate study.

Submission for approval in $\beta^0/\beta^0$ patients to be based on planned HGB-212 study.

**BREAKTHROUGH THERAPY DESIGNATION**

**ADAPTIVE PATHWAYS**

**PRIME DESIGNATION**
Follow up (Months) | 1301 | 1303 | 1304 | 1306 | 1308 | 1309 | 1310 | 1204
|---|---|---|---|---|---|---|---|
| Hb (g/dL) | 7.9% | 16.5% | 30.0% | 14.2% | 18.3% | 22.8% | 18.7% | 48% Anti-sickling Hb

Data as of Sept 9, 2016 [HGB-205] and Nov 9, 2016 [HGB-206]
Vector Copy Number (VCN) in Drug Product and Peripheral Blood

VCN drop from drug product to peripheral blood in HGB-206

Peripheral blood VCN over time

Data as of Sept 9, 2016 [HGB-205] and Nov 9, 2016 [HGB-206]
Protocol and Process Changes to Potentially Improve Outcomes in SCD Patients

- **Hypoxic, inflamed marrow**: Pre-harvest transfusions to reduce marrow inflammation, hypoxia
- **Low yield harvest**: Additional changes to manufacturing process to increase cell dose
- **Poor transduction**: VCN Enhancers (Process 2)
- **Inadequate myeloablation**: Increased exposure to myeloablative agent
- **Apheresis (vs. bone marrow)**: Utilize Plerixafor for mobilization and collection
LentiGlobin Manufacturing Process with Transduction Enhancers Increases DP VCN in SCD CD34+ Cells

Percent of cells transduced: 83%

Data as of Nov 30, 2016
### Design
- 15 patients (18 enrolled)
- Age ≤ 17
- Gad Positive
- Loes Score 0.5 – 9
- NFS ≤ 1
- No HLA-matched sibling donor

### Primary Endpoint
- % of Boys With Major Functional Disabilities at 24 Months After Transplant

### Secondary Endpoints
- Neurological Functional Score (NFS)
- Gad +/-
- Loes Score
- Safety

---

**Open label, multi-center, single arm, global study**

∞ | Patient Impact

2+ Products on the Market

2+ Programs Nearing Commercialization

4+ Additional Programs in the Clinic
Bringing & Valuing Hope
Go TRUE BLUE

2022 – We Must
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