Engraftment Potential of Different Sources of Human Hematopoietic Progenitor Cells in BNX Mice

By Curtis W. Turner, Andrew M. Yeager, Edmund K. Waller, John R. Wingard, and William H. Fleming

Human hematopoietic progenitor cells (HPCs) from mobilized peripheral blood mononuclear cells (PBMCs), adult bone marrow (ABM), and fetal bone marrow (FBM) were evaluated for their ability to produce multilineage human hematopoietic engraftment in vivo. Sublethally irradiated BNX (beige/nude/xid) mice were injected with either unfractionated cells or CD34+ cells purified from these sources. The presence of human cells in the mouse PB, BM, and spleen was evaluated by flow cytometry at either 6 to 8 weeks or 6 months postinjection. Recipients with ≥1% human cells in any of these tissues were considered chimeric. Of 26 mice injected with FBM, 4 showed up to 73% human cells in the BM or spleen at 6 months. The phenotypes of these cells included CD13/33+ myelomonocytic cells (38%), CD19+ B cells (67%), and CD34+ progenitor cells (28%). In contrast, ABM gave rise to a mean of 5% human cells in the PB in 2 of 42 (4%) recipients at 6 to 8 weeks. These mice were injected with either FBM, adult BM (ABM), or mobilized PB mononuclear cells (PBMCs). Evaluation of the PB, spleen, and BM of recipient mice indicates engraftment of human cells derived from all three sources for up to 6 months. PBMC injections predominately gave rise to polyclonal CD3+ human T cells. In contrast, FBM injections produced long-term engraftment of CD34+ progenitor cells, CD19+ B cells, and CD13,33+ myelomonocytic cells. Recipients of ABM showed a low frequency of human multilineage engraftment in this model system.

MATERIALS AND METHODS

Mice. Eight-week-old female homozygous beige nude xid (BNX) mice (Harlen Sprague Dawley, Indianapolis, IN) were used as recipients in these transplant experiments. Animals were housed in sterile microisolator cages and maintained on acidified water (pH 2.2) in the Rollins animal care facility at Emory University (Atlanta, GA). All experimental protocols were approved by the Institutional Animal Care Committee of Emory University School of Medicine.

Human hematopoietic cells. Tissue sources of human HPCs were obtained with informed consent and the approval of the Human Investigations Committee at Emory University. FBM cells were harvested from the femurs and the tibias of 16- to 20-week-old fetuses (Advanced Bioscience Resources, Inc, Alameda, CA). Single-cell circulating human cells were predominately CD3+, whereas CD13/33+ and CD34+ cells were detected in the BM for up to 6 months. A total of 18% of mice injected with PBMCs showed a mean of 36% human cells in the PB. Both the BM and spleens of PBMC-injected mice contained CD3+ cells in a proportion similar to that observed in the PB. These CD3+ cells were phenotypically mature CD4+, CD8+, or CD4+, CD8− T cells and coexpressed a variety of Vβ T-cell receptor (TCR) genes. The percentage of CD3+ cells in the circulation of chimeric recipients injected with either FBM, ABM, or PBMCs correlated well with the input CD3+ cell dose for each of these HPC sources (r = .99). The high levels of engraftment of CD3+ cells in recipients of PBMCs and the long-term multilineage engraftment of FBM recipients have important implications for developing strategies to study the regulation of these human cells in vivo.

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From the Bone Marrow Transplant Program, Departments of Medicine and Pediatrics, Emory University School of Medicine, Atlanta GA.

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Address reprint requests to William H. Fleming MD, PhD, Division of Hematology and Oncology, Emory University School of Medicine, Room 2125, 1639 Woodruff Circle, Atlanta, GA 30322.

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suspensions of FBM were prepared by flushing the BM out of the femurs and tibiae into RPMI 1640 medium supplemented with 3% bovine serum albumin. ABM cells and PBMCs were obtained from allogeneic donors from the Bone Marrow Transplant Program at Emory University Hospital. Normal donors were treated with granulocyte colony-stimulating factor (G-CSF; 10 μg/kg/d) for 5 to 7 days, and PBMCs were collected by apheresis. Erythrocytes were depleted from all samples using 3% T-500 Dextran (Pharmacia, Biotech, Uppsala, Sweden), followed by hypotonic saline lysis. Red blood cell (RBC)-depleted cell products were resuspended in RPMI 1640, and aliquots were removed for methylcellulose cultures and phenotypic analysis.

**CD34** cell purification. Cells were washed with Hank’s balanced salt solution (HBSS) supplemented with 1% bovine serum albumin and incubated with a biotinylated 12.8 monoclonal antibody (MoAb). These labeled cells were then passed over a CEPRATE LC34 Column (Cell Pro Inc, Bothell, WA), and the CD34- cell fraction was recovered. The purity of the CD34+ cells postcolumn was determined by flow cytometry and ranged from 70% to 90%. The viability of these cells was greater than 95% using propidium iodide staining. Typically, 1 to 3 × 10^6 CD34+ cells isolated from FBM, ABM, or PBMCs were injected into each recipient mouse.

**Methylcellulose colony assays.** Cells obtained from ABM, FBM, or PBMCs were cultured in triplicate in Iscove’s methylcellulose Ready-Mix serum supplemented with erythropoietin (Terry Fox Laboratories, Vancouver, British Columbia, Canada), 50 μL of phytohemagglutinin-stimulated conditioned medium and 1% fetal bovine serum. 27 Tissue culture plates containing 1 × 10^6 or 1 × 10^5 input cells were incubated at 37°C and 5% CO₂ for 14 days. The number of colony-forming unit–granulocyte-macrophage (CFU-GM), CFU-erythroid, and burst-forming unit-erythroid colonies (>50 cells) were scored using an inverted microscope.

**Transplantation of human cells into BNX mice.** Mice received a single dose of 400 cGy using Gamma Cell 40 irradiator (Atomic Energy, Ottawa, Canada) at a dose rate of 100 cGy/min. RBC-depleted human cell preparations, (75 to 95 × 10^6 cells in a volume of 500 μL), were injected into the retro-orbital sinus of BNX mice under methoxyflurane anesthesia. For 4 weeks posttransplantation, recipient mice were maintained on antibiotic-supplemented water (neomycin sulfate, 1.1 g/L, and polymyxin B, 167 mg/L).

**Analysis of human cells in BNX mice.** Mice were analyzed for the presence of human cells in the PB at 6 to 8 weeks after transplantation and, again, at 6 months. The engraftment of human cells in the BM and spleen was also evaluated. Mice were anesthetized with methoxyflurane and 200 μL of PB was obtained from the retro-orbital sinus. RBCs were depleted using Dextran sedimentation and hypotonic lysis as described above. Spleens were mechanically disrupted, and BM cells were prepared by flushing the femurs and tibiae with HBSS containing 10 mmol/L HEPES and 3% fetal calf serum (modified HBSS). Cell suspensions were then passed through a nylon filter to remove connective tissue.

Engraftment of human myeloid cells (CD13/33), B cells (CD19), and T cells (CD3, CD4, CD8) was determined by 3-color flow cytometry using a FACSScan II (Becton Dickinson, San Jose, CA). MoAbs directed against human lineage-specific epitopes were purchased from Becton Dickinson. Antibodies to the α2V and β3 chains of the human T-cell receptor (TCR) were obtained from T Cell Diagnostics (Cambridge, MA). BM, PB, and spleen cells were suspended in modified HBSS, blocked with 10% normal mouse serum, and incubated at 4°C for 20 minutes with directly conjugated antibodies. Cells were then washed and resuspended in modified HBSS containing 1 μg/mL propidium iodide. Nonviable cells and mouse RBCs were excluded from analysis using forward scatter, side scatter, and propidium iodide staining. The MoAbs used to detect human cells in the BNX mice were all human-specific. Fresh normal human and BNX PB cells were used as positive and negative controls in each experiment. Nonspecific binding was evaluated using the appropriate isotype controls. For each sample, 20,000 to 50,000 events were analyzed, thus providing a sensitivity for the detection of human cells of 0.2% to 0.5%.

**RESULTS**

Phenotypic and functional characteristics of transplanted human cells. The engraftment potential of three different sources of human hematopoietic cells (PBMCs, ABM, and FBM) in BNX mice were compared and correlated with the dose of CD34+ progenitor cells and CD3+ T lymphocytes transplanted (Table 1). Although the mean nucleated cell dose for each source of human cells was similar (range, 75 to 95 × 10⁶ cells/recipient), the mean CD34+ and CD3- cell dose varied significantly. FBM contained 16 × 10⁶ CD34+ cells, whereas PBMCs and ABM contained 0.9 × 10⁶ and 1.7 × 10⁶ cells, respectively (Table 1). The content of T cells also varied substantially among the three cell sources. The CD3+ cell dose of the PBMC inoculum was 36 × 10⁶ cells, or 3.8-fold higher than that of ABM and at least 50-fold greater than that of FBM. To determine the in vitro functional characteristics of these different hematopoietic cell sources, committed HPC activity was evaluated using the methylcellulose colony assay. The PBMC, ABM, and FBM sources contained similar numbers of CFU-GM, with the infused dose ranging from 6.3 to 7.8 × 10⁴ CFU-GM per animal (Table 1). Although the total nucleated cell dose and number of committed progenitor cells as assayed by methylcellulose were similar, there were marked differences in the frequency of CD34+ cells and CD3- cells in these three unfractoned hematopoietic cell sources.

High levels of human cells are present in the PB of BNX mice transplanted with human PBMCs. To evaluate the percentage of human cells present in the circulation of recipient BNX mice 6 to 8 weeks after transplantation, PB was analyzed using MoAbs directed against the human CD45+ epitope (Fig 1). Recipient mice were considered to be chimeric if they had ≥1% nucleated human cells in the PB. Of 124 recipient mice, 12 were chimeric and in all cases these animals had been injected with unfractoned populations of human cells (Table 1 and Fig 1). Of 57 mice (17.5%) injected with PBMCs, 10 were chimeric. Significant variability in the level of circulating human cells was observed; the percentage of CD45+ cells ranged from 1% to 94% (mean, 36%). In contrast, injection of ABM led to engraftment in only 2 of 42 animals (4.7%), and the percentages of human cells in the PB of these 2 individual recipients were 10.8% and 11.1%, respectively. Although FBM had the highest content of CD34+ cells, none of 25 FBM recipients showed human cells in the PB at 6 to 8 weeks posttransplantation. A smaller group of animals were injected with CD34+ cells from FBM (n = 12), ABM (n = 9), and PBMCs (n = 3). None of these animals showed the presence of human cells in the PB 6 to 8 weeks posttransplantation.

**BNX recipients of human PBMCs engraft with human CD3+ cells.** To define the specific lineages of human
cells in the PB of recipient mice 6 to 8 weeks posttransplantation, 3-color flow cytometry was performed using human-specific MoAbs directed against T cells (CD3), B cells (CD19), and myelomonocytic cells (CD13/33; see Fig 2). In all cases examined, the CD45+ human cells in the PB of recipient mice consistently coexpressed the pan-T–cell marker CD3 but did not coexpress CD13/33. A small number of cells of CD19+ B cells were also detected in most recipients; however, the frequency of these cells was typically below 0.5%. These results indicate that, for up to 2 months after transplantation, the human cells in the circulation of these chimeric mice are predominately T lymphocytes.

**Human CD3+ cells engrafted in BNX mice are polyclonal.** To evaluate whether the engrafted T cells in recipient mice were derived from the clonal expansion of a specific T-cell subpopulation, we analyzed the expression of CD4, CD8, and a variety of TCR α- and β-chain genes. Analysis of cells from the spleen of a representative chimeric mouse containing 38% human CD3+ cells is shown in Fig 3. Of the total nucleated cells in the spleen, 18% were CD8+, 19% were CD4+, and less than 1% were positive for both CD4 and CD8. We analyzed the CD3+ human cells to determine the frequency of the expression of different TCR α and β chains (Fig 3). In this representative example, the αV2 chain was expressed on only 2.9% of the CD3+ cells. The percentages of CD3+ cells expressing specific βV TCR were as follows: βV5c, 3.6%; βV6a, 1.9%; βV8a, 4.0%; and βV12a, 1.2%. These results indicate the presence of polyclonal human T cells in BNX recipients with a pattern of βV gene expression similar to that observed in normal peripheral human T cells.  

**The engraftment of human CD3+ cells in the PB is dose-dependent.** Significant variation existed in the CD3+ cell dose in PBMCs (36 ± 10^6), ABM (9.5 ± 10^6), and FBM (<0.7 ± 10^6). As shown in Fig 4, there was a direct correlation between the mean number of CD3+ cells infused and the mean percentage of CD3+ cells in the PB of chimeric recipients 6 to 8 weeks after transplantation (r = .99). This dose-dependent relationship was not evident when the long-term engraftment in PBMC BNX recipients was evaluated. Only 1 of 35 mice studied at 6 months post-transplantation showed human CD3+ cells in the spleen or BM, and CD3+ cells were not detected in the PB (Table 2).

**Long-term multilineage human hematopoietic engraftment in BNX mice.** To determine whether PBMCs, ABM, or FBM could give rise to long-term human hematopoietic engraftment, we examined the PB, BM, and spleen of recipient mice 6 months after transplantation. Of 26 mice (15%) injected with FBM, 4 were chimeric 6 months posttransplantation (Table 2 and Fig 5). A total of 3 of 13 mice injected with unfractionated FBM and 1 of 12 mice injected with CD34-enriched FBM were long-term chimeras. The PB in 2 of these recipient mice contained 1% human B cells (CD45+/CD19+). The level of engraftment of human CD45+ cells in the BM and spleen of FBM recipients ranged from 3.9% to 73%. Myelomonocytic markers (CD13/33) were present on 1% to 19% of cells, and CD19 was found on 2.4% to 48% of the cells in the BNX BM. A total of 16% to 24% of these CD45+ cells coexpressed the CD34 antigen. In contrast, the

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**Table 1. Engraftment of the PB of BNX mice at 6 to 8 Weeks Posttransplantation**

<table>
<thead>
<tr>
<th>Cell Source</th>
<th>Nucleated (× 10^6)</th>
<th>CD34+ (× 10^6)</th>
<th>CD3+ (× 10^6)</th>
<th>CFU-GM (× 10^6)</th>
<th>Transplant Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBMCs</td>
<td>95 ± 16</td>
<td>0.9 ± 1.0</td>
<td>36 ± 13</td>
<td>6.3 ± 1.1</td>
<td>Mice</td>
</tr>
<tr>
<td>ABM</td>
<td>89 ± 40</td>
<td>1.7 ± 0.9</td>
<td>9.5 ± 3.9</td>
<td>6.4 ± 3.4</td>
<td>57</td>
</tr>
<tr>
<td>FBM</td>
<td>75 ± 44</td>
<td>16 ± 3.2</td>
<td>&lt;0.7*</td>
<td>7.8 ± 4.7</td>
<td>10</td>
</tr>
</tbody>
</table>

Recipient mice were injected with unfractionated FBM (n = 25), ABM (n = 42), or PBMCs (n = 57). Chimerism was defined as ≥1% human CD45+ cells. The mean ± 1 SD is shown.

* The limit of detection was 0.2% nucleated cells in the PB.
Fig 2. Phenotypic analyses of human cells in the PB of BNX mice. Mononuclear cells were isolated from the PB of an untransplanted BNX mouse, a normal human volunteer, and a chimeric BNX-hu mouse and were stained with antihuman CD45-fluorescein isothiocyanate (FITC) and anti-CD13,33-phycoerythrin (PE) or anti-CD3-FITC and anti-CD19-PE. The percentage of lineage-specific positive cells is indicated. Six to eight weeks after transplantation, flow cytometric analyses of the PB of recipient mice detects human CD45+ cells that also express CD3 but do not express CD13/33. A low frequency of CD19+ cells is also observed (<0.5%).

CD3+ cells were not detected in the PB, BM, or spleen of chimeric FBM recipients.

One of 32 mice transplanted with unfractionated PBMCs and 0 of 3 mice injected with CD34-enriched PBMCs showed chimerism at 6 months (Table 2). Although human cells were not detected in the PB of this recipient, the spleen and BM contained 32% and 1.6% CD45+ cells, respectively. These CD45+ cells coexpressed CD3, but other lineage markers were absent. A total of 1 of 9 mice receiving CD34-enriched ABM and 0 of 32 mice transplanted with unfractionated ABM showed chimerism at 6 months. Engraftment in this animal was restricted to the BM that contained 18.3% CD45+ cells. In contrast to our findings in PBMC recipients, multilineage engraftment was present, and the CD45+ cells coexpressed CD34 (16%), CD19 (66%), or CD13/33 (14%). Unlike that in the long-term PBMC recipients, CD3+ cells were not detected. These results show that both ABM and FBM can give rise to long-term multilineage hematopoietic engraftment in BNX mice, whereas both short-term and long-term engraftment with PBMCs appear to be predominately of the T-cell lineage.

Engraftment of BNX mice with human cells is not donor-specific. We evaluated whether the frequency of engraftment of human cells in recipient BNX mice was dependent on characteristics of individual donors (Table 3). Of the mice that received PBMCs, 17% were chimeric, and chimerism was observed in recipient mice transplanted with cells from 5 of 10 PBMC donors. When individual PBMC donors were examined, the percentage of chimeric mice per donor was, on average, 28%. Similarly, 3 of 34 (9%) ABM donors gave rise to 3 chimeric mice, with an average frequency of engraftment of 9%. Also, 4 of 5 FBM donors gave rise to 4 long-term chimeric mice, with an average frequency of 25%. These results indicate that the engraftment frequencies observed with PBMCs, ABM, or FBM are not simply because of high levels of engraftment of human cells associated with specific donors.
HUMAN CELL ENGRAFTMENT OF BNX MICE

DISCUSSION

The results of this study indicate that the source of transplantable hematopoietic cells dramatically influences both the frequency and the phenotype of the human cells engrafted in recipient BNX mice. This finding may, in part, be related to the phenotype of the cells injected. Although the doses of both CFU-GM and total nucleated cells were similar in all three cell sources, the phenotype of the injected cells differed significantly. The content of CD34+ progenitor cells in the FBM was 18-fold higher than that in the PBMCs and 9-fold higher than that in ABM (Table I). The CD3 T-cell content of the PBMCs was at least 50-fold higher than that in FBM and 3.8-fold higher than that in ABM. The differences observed in the content of both CD34+ progenitors and CD3+ cells in these tissues are similar to previously reported values.28,29

The percentage of human T cells in the PB of chimeric BNX mice correlates with the dose of CD3+ cells infused (Fig 4). PBMCs contained a mean of 38% CD3+ cells and resulted in circulating CD3+ cells in 17.5% of the recipients at 6 to 8 weeks posttransplantation. In contrast, the content of CD3+ cells in FBM was at or below the limit of detection (0.2%, or 0.7 \times 10^5 cells), and human CD3+ cells were not detected in the PB, BM, or spleen of recipient mice. ABM contained an intermediate dose of CD3+ cells and produced circulating CD3+ cells in the PB of 4.7% of recipients. These results establish a dose-dependent engraftment of CD3+ cells in the PB of BNX mice for up to 2 months posttransplantation. When recipient mice were examined 6 months posttransplantation, only 2.8% of recipients showed engraftment of CD3+ cells. These findings are similar to the T-cell engraftment pattern observed in SCID-hu mice implanted with fetal liver and thymus or PB lymphocytes, in which the percentage of CD3+ cells in the circulation has been reported to be less than 5%.6,12,14,20 Recently, G-CSF–mobilized PBMCs have been injected into unirradiated SCID mice, and these cells gave rise to less than 2% human cells in the PB.26 In the current study, chimeric BNX mice receiving G-CSF–mobilized PBMCs show a mean level of 36% CD3+ human T cells in the PB (Fig 1). These results indicate that irradiated BNX mice injected with PBMCs consistently show high levels of human T-cell engraftment in the PB.
Fig 4. Dose-dependent engraftment of human CD3+ cells. The mean number of CD3+ cells contained in PBMCs (A), ABM (B), and FBM (C) correlates with the level of circulating human T lymphocytes in chimeric BNX mice at 6 to 8 weeks posttransplantation (r = .991). The percentage of human CD3+ cells in the PB is shown.

To determine whether the engraftment of CD3+ cells in the BNX recipients was the result of an oligoclonal expansion of specific T-cell clones present in the PBMC inoculum, the proliferation of immature T-cell progenitors, or the expansion of mature polyclonal T cells, we examined the expression CD4, CD8, and a number of different TCR aV and bV chains. Our results show that the large numbers of phenotypically mature human CD3+ cells in the PB and spleen of BNX mice represent a polyclonal T-cell population (Fig 3). These findings suggest that the CD3+ cells present in these recipients are the result of the engraftment and the expansion of mature postthymic T cells. Previous studies on the clonality of T-cell engraftment have focused on human thymic implants in SCID mice. Polyclonal T cells with a Vb repertoire similar to that observed in normal mature T cells were also detected in these studies. Our data indicate that the sublethally irradiated BNX mouse supports the growth of mature polyclonal T cells for up to 2 months and, therefore, may represent an in vivo model system to study the interaction of these T-cell subsets.

Long-term multilineage engraftment of human cells occurred in 15% of BNX recipients cells infused with FBM (Table 2). Six months posttransplantation, human cells represented a mean of 23% of the nucleated cells in the BNX BM and spleen. Further subtyping of these cells showed significant numbers of CD19+, CD13/CD33-, and CD34+ cells. The BM of these recipients was found to contain up to 24% CD34+ progenitor cells. In addition, 50% of chimeric recipients showed the presence of CD19+ cells in their PB. Although it has been suggested that the presence of human cytokines is required for multilineage engraftment, our findings show that significant long-term multilineage engraftment occurs for up to 6 months in the absence of either a human hematopoietic microenvironment or the addition of exogenous growth factors. Recently, Kollman and colleagues have shown that infusions of FBM cells give rise to human CD34+, CD19+, and CD13,33+ cells in the BM of sublethally irradiated SCID mice for up to 2 months. Umbilical cord blood, which is thought to represent a more developmentally immature source of progenitor cells, has also recently been shown to engraft in the BM of SCID recipients for up to 2 months without the addition of exogenous cytokines. It is also of interest to note that the addition of human cytokines in that study did not influence of percentage of human cells engrafted in these recipients. Taken together, the results of these recent studies show that engraftment of human cells in the SCID model persists for at least 2 months without the addition of human cytokines. Whether the SCID model system will support long-term multilineage engraftment has not yet been determined.

In contrast to that for FBM, very low levels of engraftment occurred with the infusion of ABM (Tables 1 and 3). These results and the results of recent studies suggest a hierarchy of engraftment potential of human HPCs, perhaps related to their ontogeny, ie, FBM > umbilical cord blood > ABM.

**Table 2. Phenotypic Analysis of BNX-hu Chimeras 6 Months Posttransplantation**

<table>
<thead>
<tr>
<th>Mouse No.</th>
<th>Input Cells</th>
<th>BM</th>
<th>Spleen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CD45</td>
<td>CD3</td>
<td>CD19</td>
</tr>
<tr>
<td>1</td>
<td>FBM*</td>
<td>73</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>FBM</td>
<td>12.5</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>FBM</td>
<td>4.9</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>FBM</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>ABM*</td>
<td>18.3</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>PBMCs</td>
<td>1.6</td>
<td>1.6</td>
</tr>
</tbody>
</table>

A total of 99 recipient mice were evaluated, ie, unfractionated FBM (n = 13), CD34+ FBM (n = 12); unfractionated ABM (n = 32), CD34+ ABM (n = 9); and unfractionated PBMCs (n = 30), CD34+ PBMCs (n = 3). Percentage of human cells refers to the percentage of total nucleated cells positive for the indicated cell surface markers. The level of detection was 0.2%.

* Recipients transplanted with enriched CD34+ cells.
Fig 5. Long-term multilineage engraftment of human cells in the BM of BNX recipients. CD34+ cells isolated from FBM were transplanted into BNX mice, and the recipient BM was analyzed 6 months later by flow cytometry. The number in each quadrant represents the percentage of total cells that express the indicated lineage marker.

Higher levels of engraftment by cells isolated at earlier stages of development may in part be caused by the autocrine production of cytokines by these cells. Alternatively, BM stromal cells may be found with an increased frequency in these more immature cell populations and, thus, may support the engraftment of human hematopoietic cells. In either case, the murine BM microenvironment is sufficient to support long-term engraftment of human cells derived from FBM, umbilical cord blood, and, in rare cases, ABM.

In summary, the sublethally irradiated BNX model system may be used to design strategies to study the developmental potential of early human HPCs. In addition, the infusion of PBMC cells into BNX mice gives rise to a polyclonal population of human T cells in a dose-dependent manner.

Table 3. Engraftment of BNX Mice is Not Donor-Dependent

<table>
<thead>
<tr>
<th>Donor No.</th>
<th>Input Cells</th>
<th>Chimeric/Injected</th>
<th>Weeks Engrafted</th>
<th>Tissues Engrafted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PBMCs</td>
<td>3/10</td>
<td>7</td>
<td>PB</td>
</tr>
<tr>
<td>2</td>
<td>PBMCs</td>
<td>2/10</td>
<td>6</td>
<td>PB</td>
</tr>
<tr>
<td>3</td>
<td>PBMCs</td>
<td>1/11</td>
<td>6</td>
<td>PB</td>
</tr>
<tr>
<td>4</td>
<td>PBMCs</td>
<td>3/5</td>
<td>7</td>
<td>PB</td>
</tr>
<tr>
<td>5</td>
<td>PBMCs</td>
<td>1/4</td>
<td>31</td>
<td>BM, SP</td>
</tr>
<tr>
<td>6</td>
<td>ABM</td>
<td>1/11</td>
<td>7</td>
<td>PB</td>
</tr>
<tr>
<td>7</td>
<td>ABM</td>
<td>1/14</td>
<td>7</td>
<td>PB</td>
</tr>
<tr>
<td>8</td>
<td>ABM</td>
<td>1/3</td>
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<td>BM</td>
</tr>
<tr>
<td>9</td>
<td>FBM</td>
<td>1/4</td>
<td>30</td>
<td>BM</td>
</tr>
<tr>
<td>10</td>
<td>FBM</td>
<td>1/4</td>
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<td>BM</td>
</tr>
<tr>
<td>11</td>
<td>FBM</td>
<td>1/4</td>
<td>29</td>
<td>SP</td>
</tr>
<tr>
<td>12</td>
<td>FBM</td>
<td>1/3</td>
<td>29</td>
<td>BM</td>
</tr>
</tbody>
</table>

BNX mice were injected with the unfractionated hematopoietic cell sources derived from individual donors. At the time points indicated, the PB, BM, and spleen were assayed for the presence of human cells by flow cytometry. The number of chimeric mice (=1% human cells) and the tissues that were engrafted are indicated.

Abbreviation: SP, spleen.

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Engraftment potential of different sources of human hematopoietic progenitor cells in BNX Mice

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