**Supplemental Methods**

***Cell culture conditions***

Tumor cells and T cells were cultured in RPMI 1640 (Gibco 11875-085) supplemented

with 10% heat inactivated fetal calf serum (FCS), 100U/ml penicillin, 100ug/ml

streptomycin sulfate, and 1% L-glutamine (complete cell culture medium).

***Isolation, bead activation, transduction, and expansion of primary human T***

***lymphocytes***

Primary human CD4+ T and CD8+ T cells were isolated from healthy volunteer donors

following leukopheresis by negative selection using RosetteSep kits (Stem Cell Technologies, Vancouver, Canada). All specimens were collected using a University Institutional Review Board-approved protocol. CD4+ and CD8+ T cells were mixed at a 1:1 ratio, and cultured in complete cell culture medium. They were stimulated with magnetic beads coated with anti-CD3/anti-CD28 at a 1:3 cell to bead ratio without the addition of exogenous IL-2. T cells were transduced with lentiviral vectors at an MOI of approximately 5. Cells were counted and fed with complete cell culture medium every 2 days. Once they appeared to become quiescent as determined by both decreased growth kinetics and cell size, they were used either for functional assays or cryopreserved. A small portion of expanded cells were stained for flow cytometry confirmation of successful Ly95 transduction using the Vβ13.1 TCR chain antibody.

***Generation of the target lung cancer cell line***

The human lung cancer cell line A549-CBG was generated by stably transducing the A549 cell line (ATCC CCL185) with a lentiviral vector encoding Click Beatle Green luciferase (CBG) and GFP (CBG-T2A-GFP). GFP positivity was used to flow-sort for cells that were successfully transduced. CBG was used in measuring T cell cytolytic assays. The sorted A549-CBG cell line was then transduced by a retroviral vector encoding NY-ESO-1-T2A-HLA-A2. The transduced A549-CBG cells were subjected to limiting dilution at 0.5 cell per well in 96-well plates. Resulting clones were tested by flow cytometry for HLA-A2 expression. HLA-A2 positive clones were selected and tested by co-culture with T cells expressing the NY-ESO-1 TCR. The clones expressing HLA-A2 that could stimulate NY-ESO-1 TCR-expressing T cells to secrete IFNγ were pooled to generate the A549-NY-ESO-1-A2-CBG (A549-A2-ESO) cell line. The A549-A2-ESO cell line was authenticated by ATCC by utilizing Short Tandem Repeat profiling. This was done to confirm that in the process of transducing, enriching, and sorting the A549-A2-ESO cell line, the fundamental cell line was identical to the base A549 cell line. (<http://www.atcc.org/Services/Testing_Services/Cell_Authentication_Testing_Service.aspx>)

***FACS Analysis***

Analysis of target tumor cells was conducted using APC-conjugated antibody against HLA-A2 (BD Biosciences, CA), and a primary monoclonal antibody against NY-ESO-1 (Life Technologies, NY), followed by a PE-conjugated goat anti-mouse secondary antibody (BD Biosciences, CA). Analysis of expression of T cell surface markers was conducted using fluorochrome-conjugated antibodies against CD45, CD8, CD4, PD-1 (BD Biosciences, CA), Tim-3 (eBioscience, CA), and Lag-3 (R&D systems, MN). Cells were stained in standard 5 ml round-bottom Falcon FACS tubes (BD Biosciences, CA) and analyzed on a 9-channel CyAnTM ADP Analyzer (Beckman Coulter, CA).

***Flow Cytometric T cell Activation Assay***

Analysis of T cell activation upon stimulation by target tumor cells was performed by plating Ly95 T cells with A549-A2-ESO or control A549-A2 cells at 1:2 E:T ratio in round-bottom 96-well plates. Fluorochrome-conjugated antibodies against CD107a, granzyme B, and CD25 (BD Biosciences, CA) were added to wells and incubated for 1 hour at 37oC and 5% CO2 in the dark prior to the addition of Golgi StopTM (BD Biosciences, CA). Measurement of IFNγ was performed using standard intracellular cytokine staining protocols.

***Measurement of Ly95 T cell IFNγ secretion by ELISA***

Supernatants from 18hr tumor killing co-culture assays were prepared at different dilutions and measured for levels of IFNγ by standard ELISA protocol. (Biolegend, CA).

***Statistical Analysis:***

All results were expressed as means +/- SEM as indicated. For studies comparing two groups, the Student’s t test was used. For comparisons of more than two groups, we used one-way ANOVA with appropriate *post hoc* testing. Differences were considered significant when *p* <0.05.

***Animals***

All animal experiment protocols were approved and conducted in accordance with the Institutional Animal Care and Use Committee. NOD/scid/IL2rγ-/- (NSG) mice were bred in the Animal Services Unit of the Wistar Institute and the Children’s Hospital of Philadelphia. Female mice were used for experiments at 10 to 16 weeks of age.