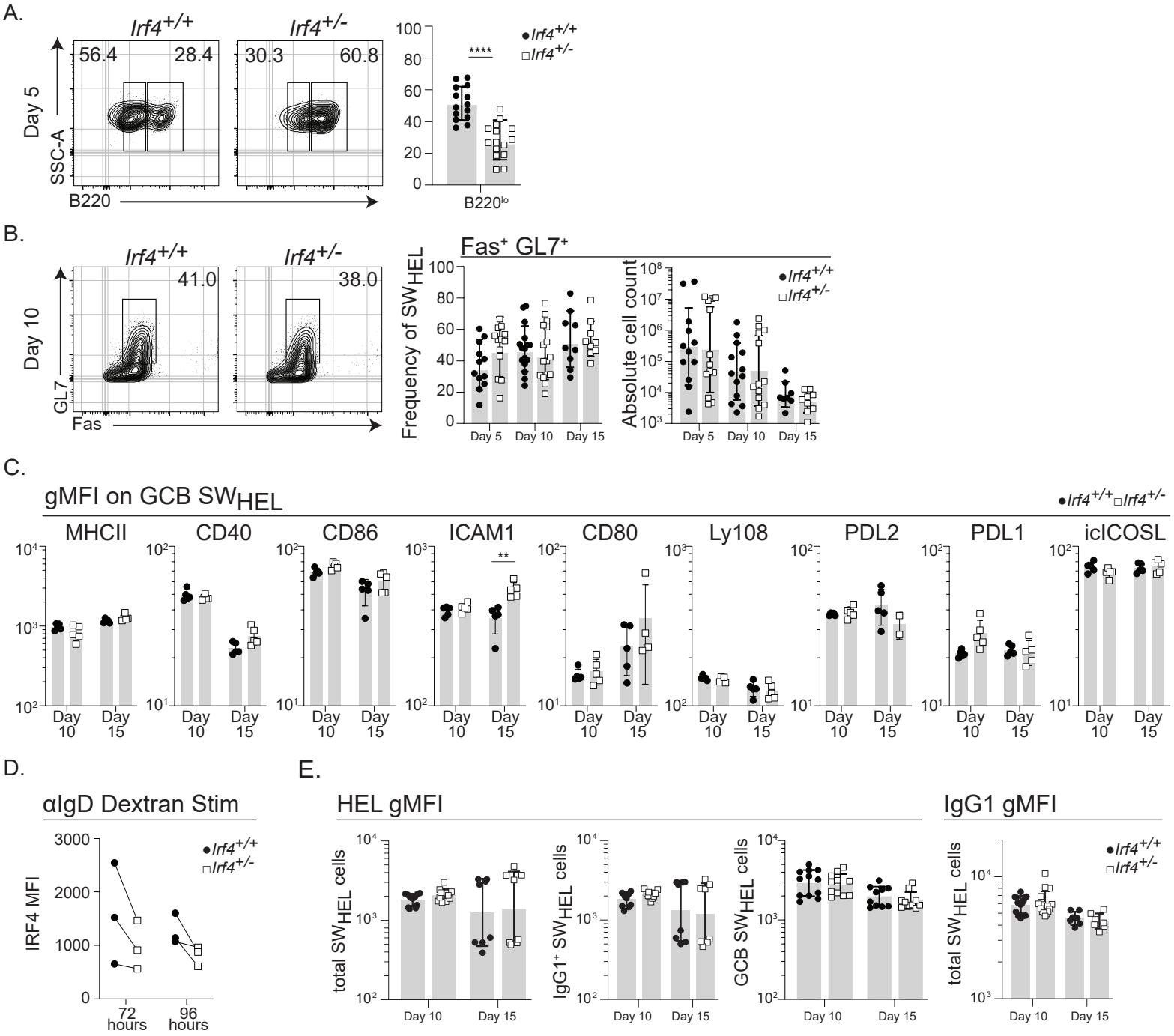
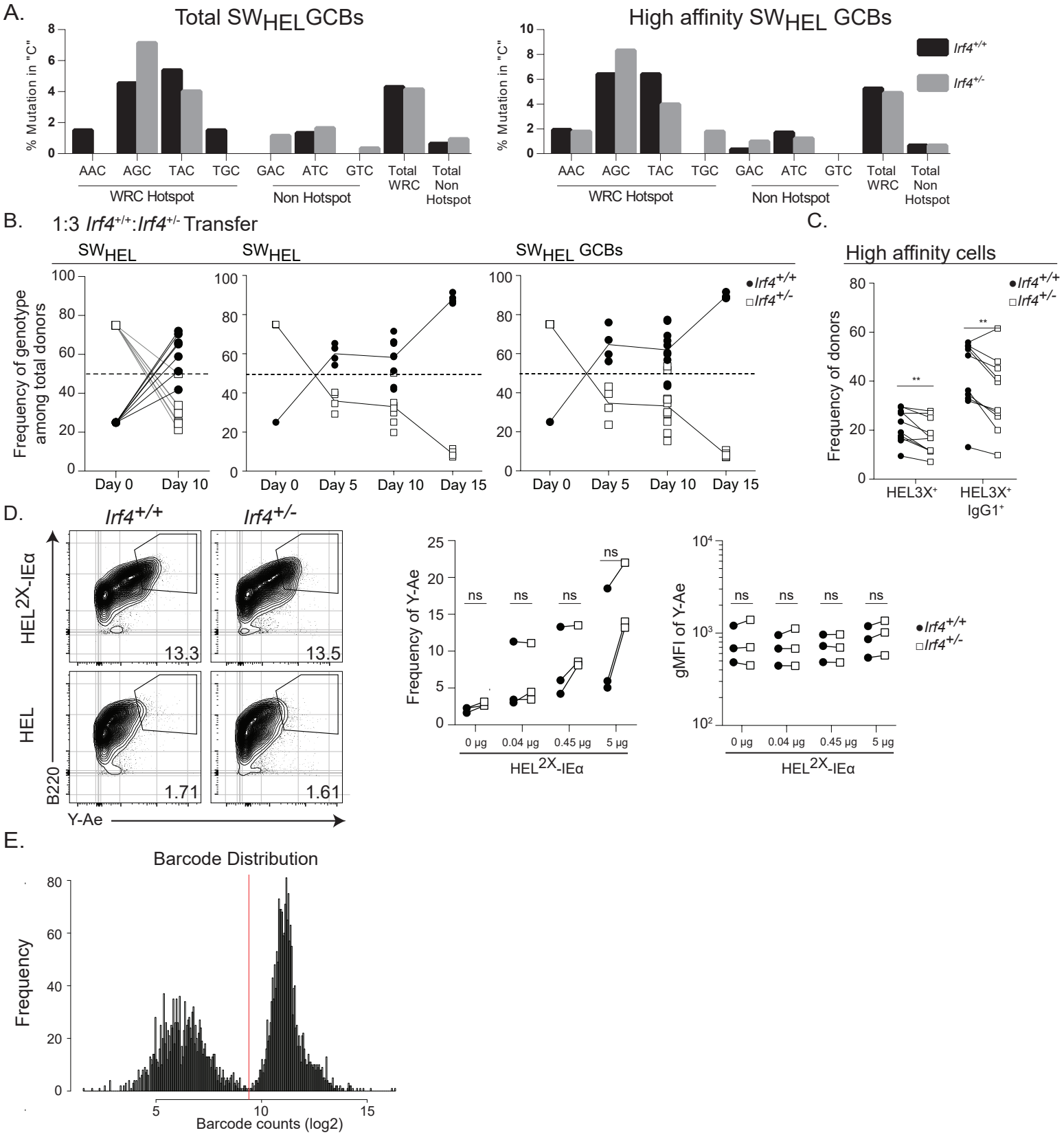



**Supplementary Figure 1**

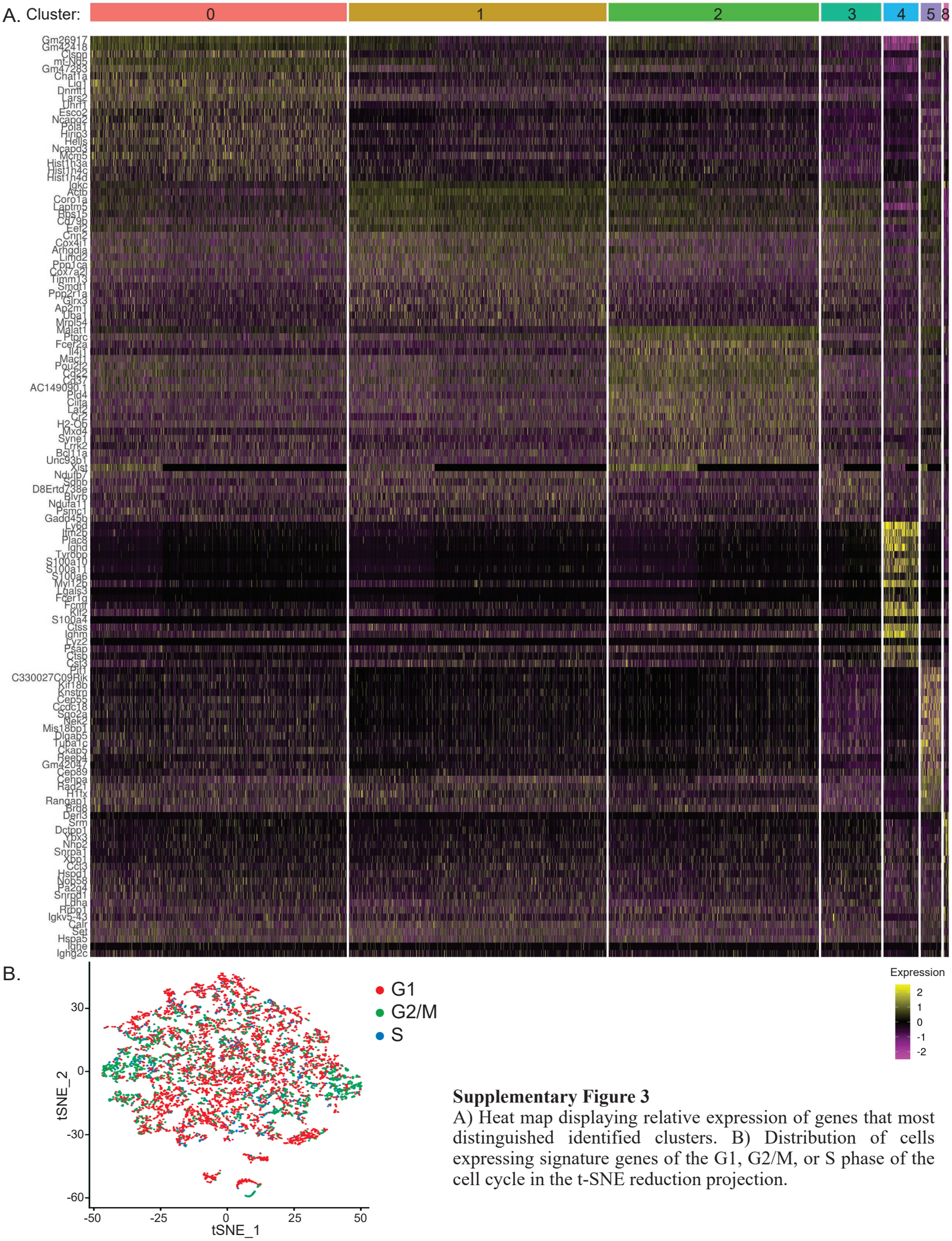
A) Representative flow cytometry plots and frequency of B220$^{lo}$ SW$_{HEL}$ cells identified as CD45.2$^+$CD45.1$^-$CD3$^-$B220$^+$HEL$^{WT+}$ day 5 after immunization. B) Representative flow cytometry plots, frequency, and absolute cell counts of GL7$^+$Fas$^+$ GCBs at the indicated time points after immunization identified as CD45.2$^+$CD45.1$^-$CD3$^-$B220$^+$HEL$^{WT+}$. C) gMFIs of relevant receptors on donor-specific GCBs, identified as CD45.2$^+$CD45.1$^-$CD3$^-$B220$^+$HEL$^{WT+}$CD38$^{lo}$Fas$^+$. D) In vitro analysis of IRF4 expression levels between *Irf4*$^{+/+}$ and *Irf4*$^{+/-}$ B cells. Equivalent numbers of CD45.2$^+$CD45.1$^+$ *Irf4*$^{+/+}$ or CD45.2$^+$CD45.1$^-$ *Irf4*$^{+/-}$ B cells were stimulated in cocultures with αIgD-Dextran and analyzed at 72 or 96 hours for expression of the CD45 allotypic markers and IRF4 by flow cytometry. E) BCR expression; HEL$^{WT+}$ gMFI on total SW$_{HEL}$, IgG1$^+$ SW$_{HEL}$, or SW$_{HEL}$ GCBs. Panel on right is IgG1 gMFI on total SW$_{HEL}$ on day 10 and 15. We note that, in some panels, dots that cluster together represent mice from separate experiments.

Experiment in (A) is from 15 mice in 4 experiments performed. Experiment in (B) is from 16 mice in 4 experiments performed, while (C) is from 5 mice in 1 experiment performed; contour plots are concatenated files from all mice of a given group in a given experiment. Experiments in (E) are from 12 mice in 3 experiments performed. Unpaired t tests were performed to determine significance: all ns, not significant ($p > 0.05$), unless noted. ** $p \leq 0.01$, **** $p \leq 0.0001$.




**Supplementary Figure 2**

A) Frequency of mutated "C" in either *Irf4*$^{+/+}$ or *Irf4*$^{+/-}$ total or high affinity clones within "WRC" AID hotspot motif sequences over the VDJ. B) Frequency of *Irf4*$^{+/+}$ and *Irf4*$^{+/-}$ total $SW_{HEL}$ cells or total $SW_{HEL}$ GCBs at indicated time points, 1:3 initial cotransfer (*Irf4*$^{+/+}$ : *Irf4*$^{+/-}$), transfer and immunization as in **Fig. 2A**. C) Frequency of high affinity $SW_{HEL}$ or IgG1$^{+}$ $SW_{HEL}$ cells, 1:3 initial cotransfer (*Irf4*$^{+/+}$ : *Irf4*$^{+/-}$). Lines linking dots denote measurements from a single mouse. D) Equal numbers of *Irf4*$^{+/+}$ and *Irf4*$^{-/-}$ $SW_{HEL}$ cells were cultured in vitro with indicated amounts of $HEL^{2X}$-IEα or HEL, and MHCII presentation of IEα was measured by Y-Ae frequency and gMFI. *Irf4*$^{+/+}$ cells were distinguished from *Irf4*$^{-/-}$ by CFSE labeling. Flow cytometry plots shown are representative of 3 separate co-culture experiments and lines linking dots denote measurements from a single well. Paired t tests were performed to determine significance: ** $p \leq 0.01$, ns, not significant ($p > 0.05$). E) Frequency of cells in the scRNA-seq experiment having a given number of sequences encoded by the anti-CD45.1 CITE-seq approach; line represents gating for genotype calling of single cells.




**Supplementary Figure 3**

A) Heat map displaying relative expression of genes that most distinguished identified clusters. B) Distribution of cells expressing signature genes of the G1, G2/M, or S phase of the cell cycle in the t-SNE reduction projection.