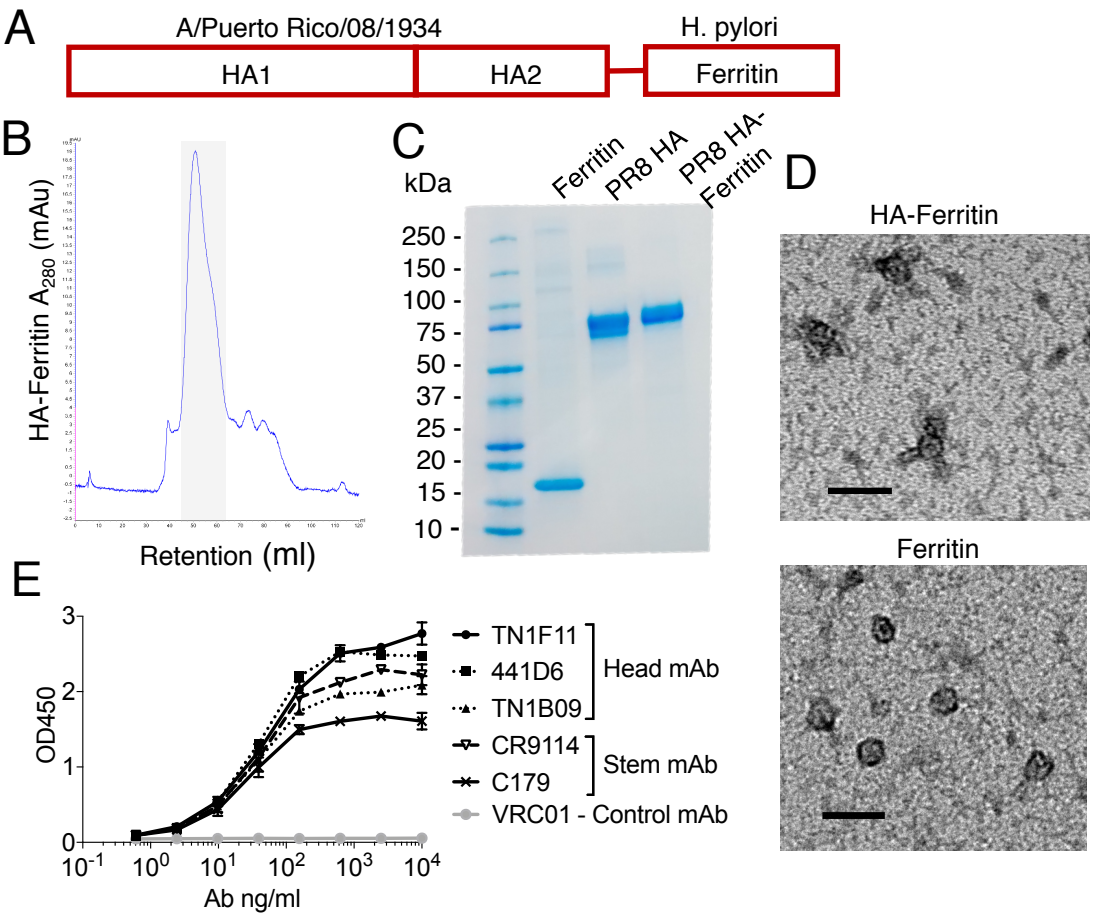
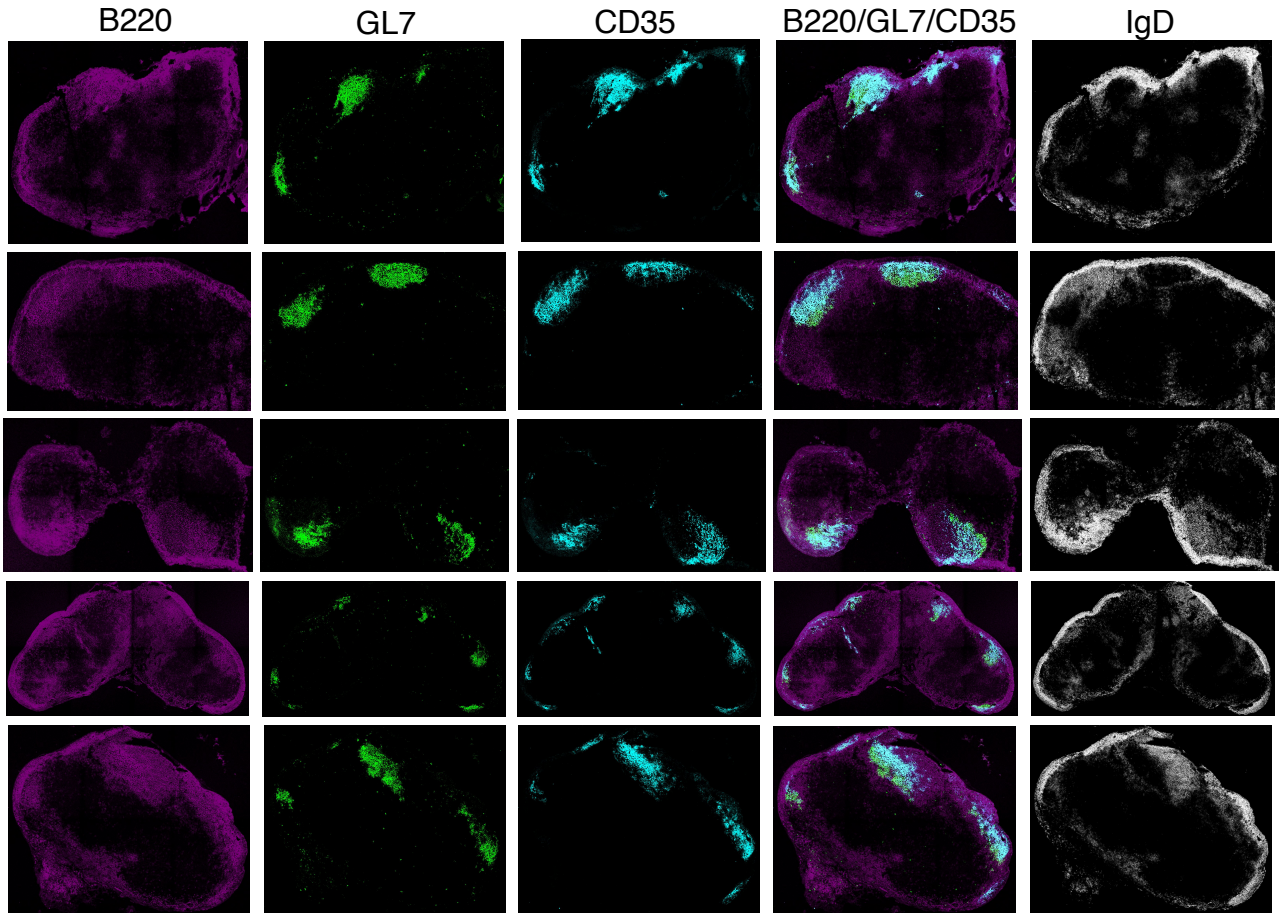
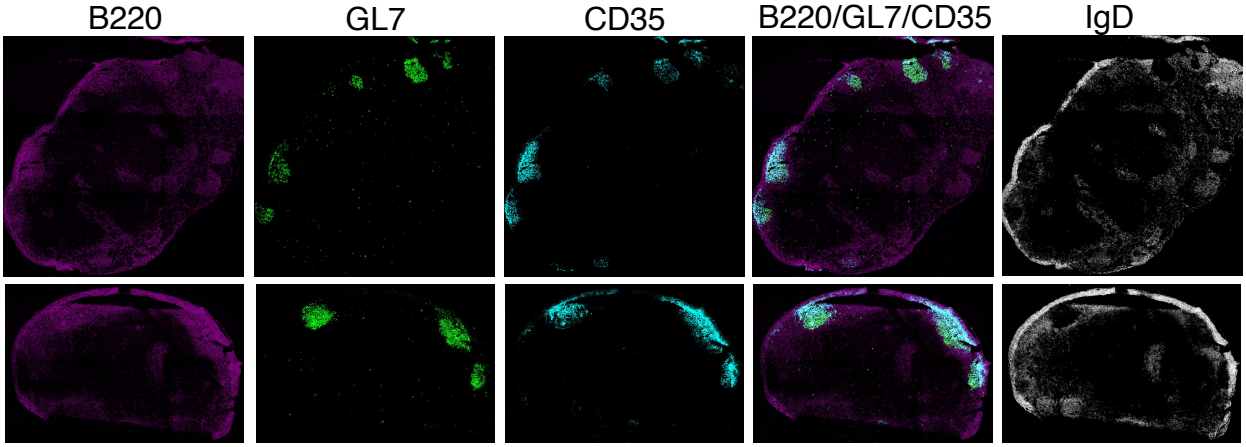



**Supplemental Figure 1. Design and characterization of PR8 HA-ferritin nanoparticles. (A)** Schematic of PR8 HA gene fused to ferritin from Helicobacter pylori. **(B)** Size exclusion chromatography (greyed area signifies retained fractions) of HA-ferritin. **(C)** SDS PAGE showing HA-ferritin with expected molecular weight of 85 kDa. **(D)** Negatively stained TEM images of purified HA-ferritin and ferritin nanoparticles confirming expected particle size of 37nm and 14nm, respectively. Scale bar 30nm. **(E)** Antigenicity of HA-ferritin was confirmed by binding of mAbs specific to the head (TN1F11, 446D1 and TN1B09) and stem (C179, CR9114) of influenza PR8 HA in an ELISA.

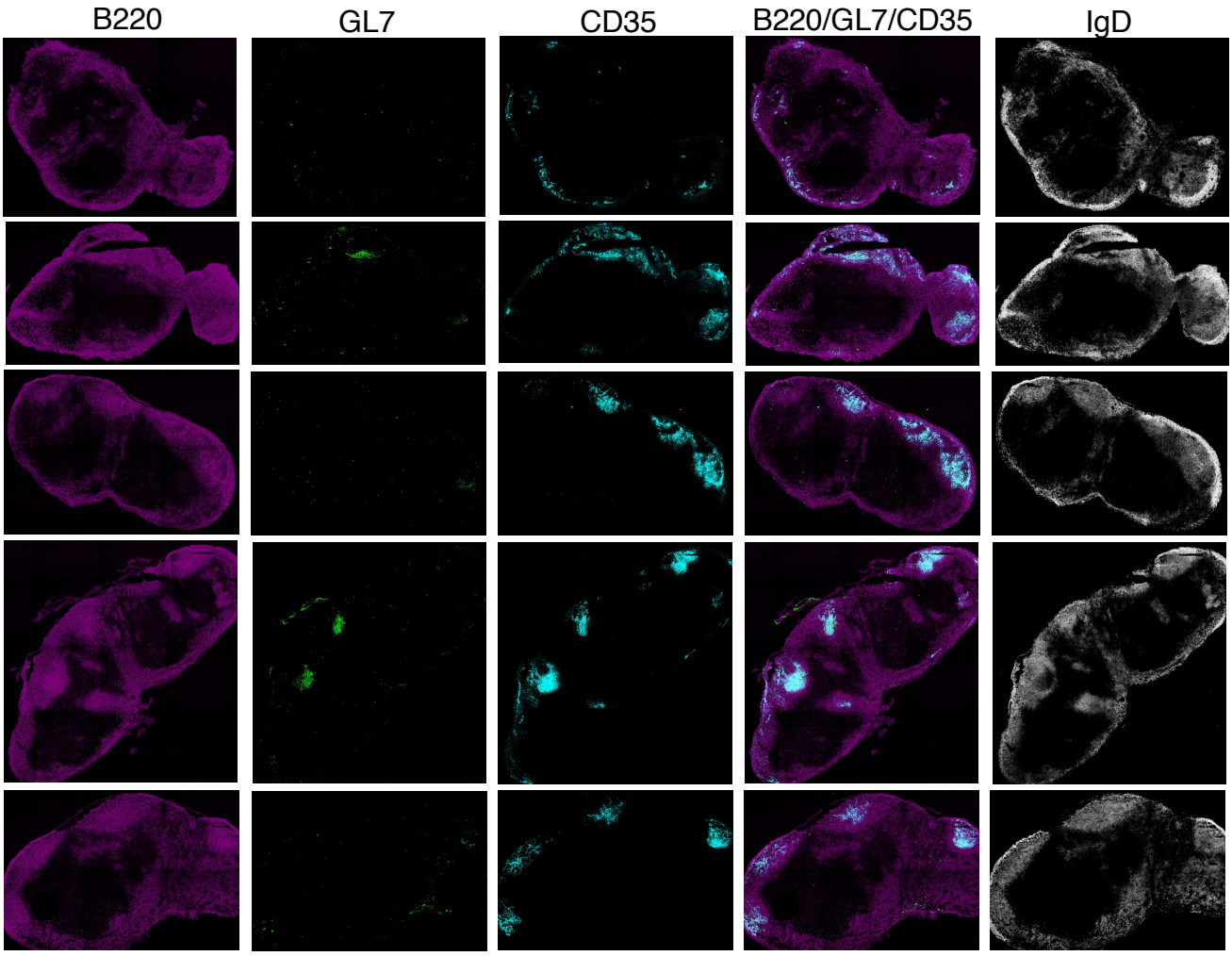
A HA-ferritin 3.8 $\mu$g



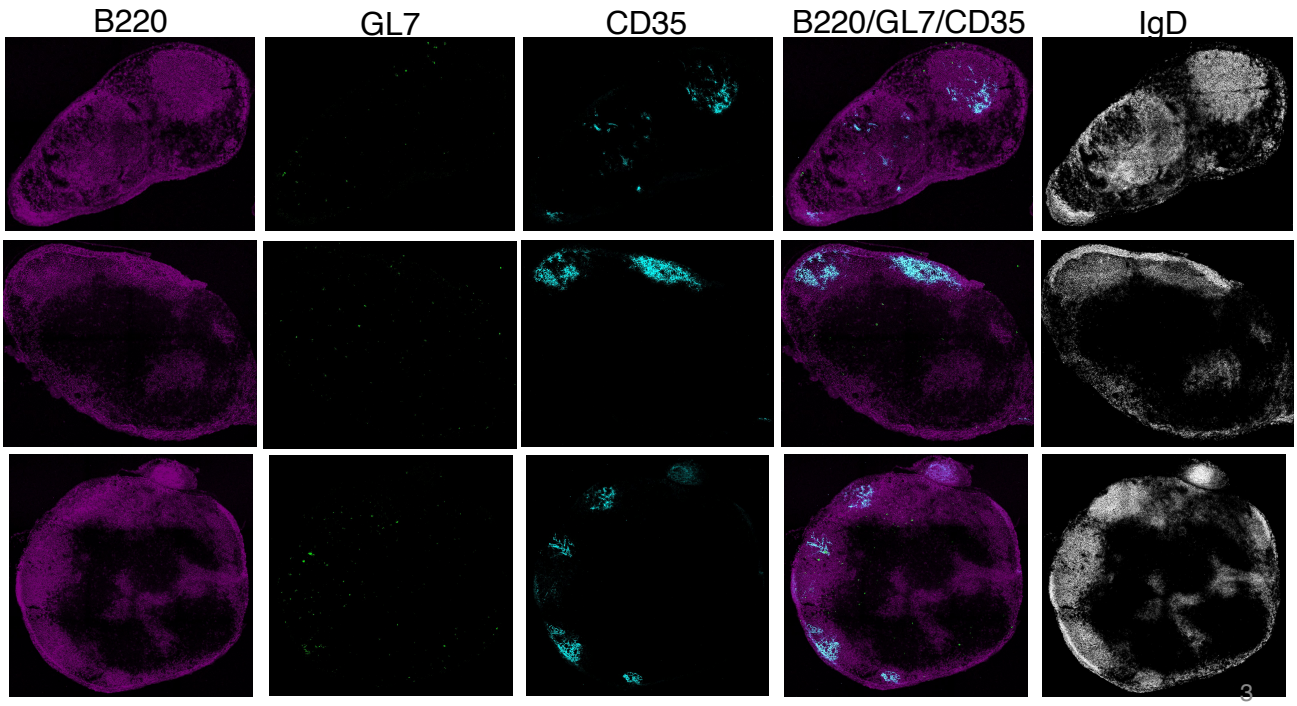

B HA-ferritin 0.38 $\mu$g



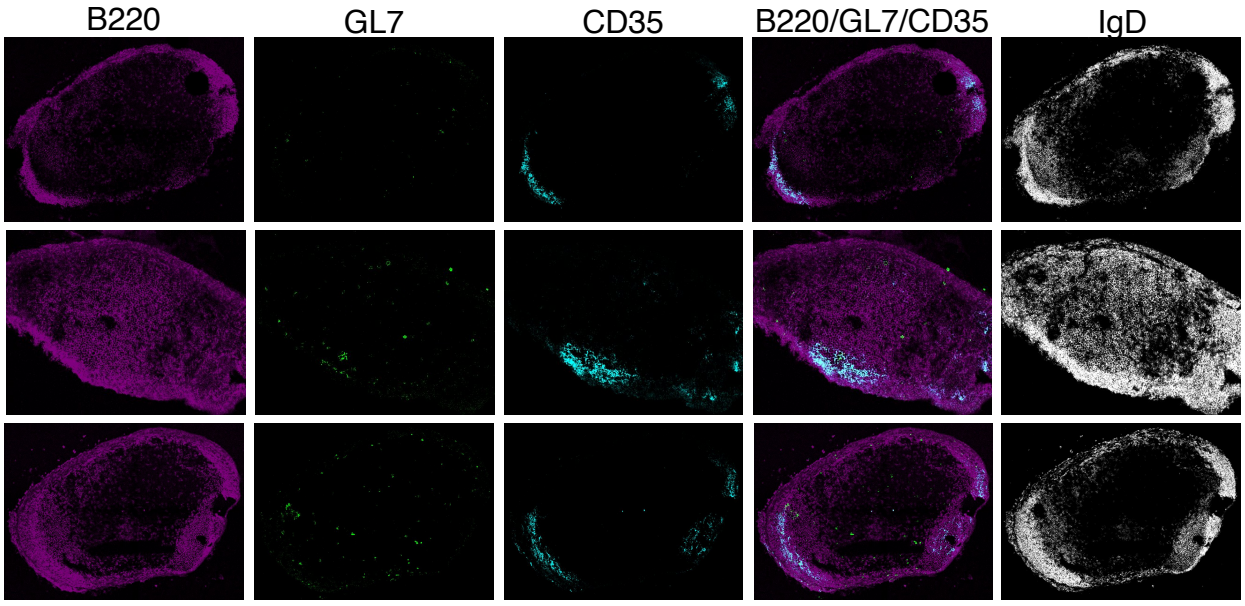
C Soluble HA 3.8 $\mu$g



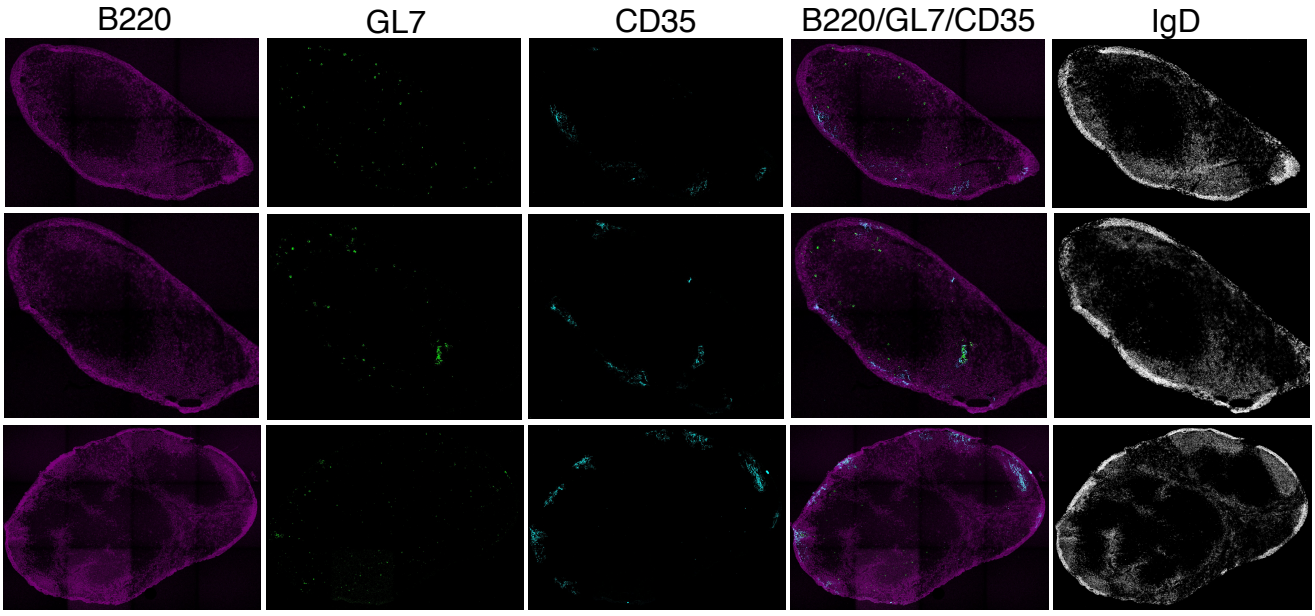

D Soluble HA 0.38 $\mu$g



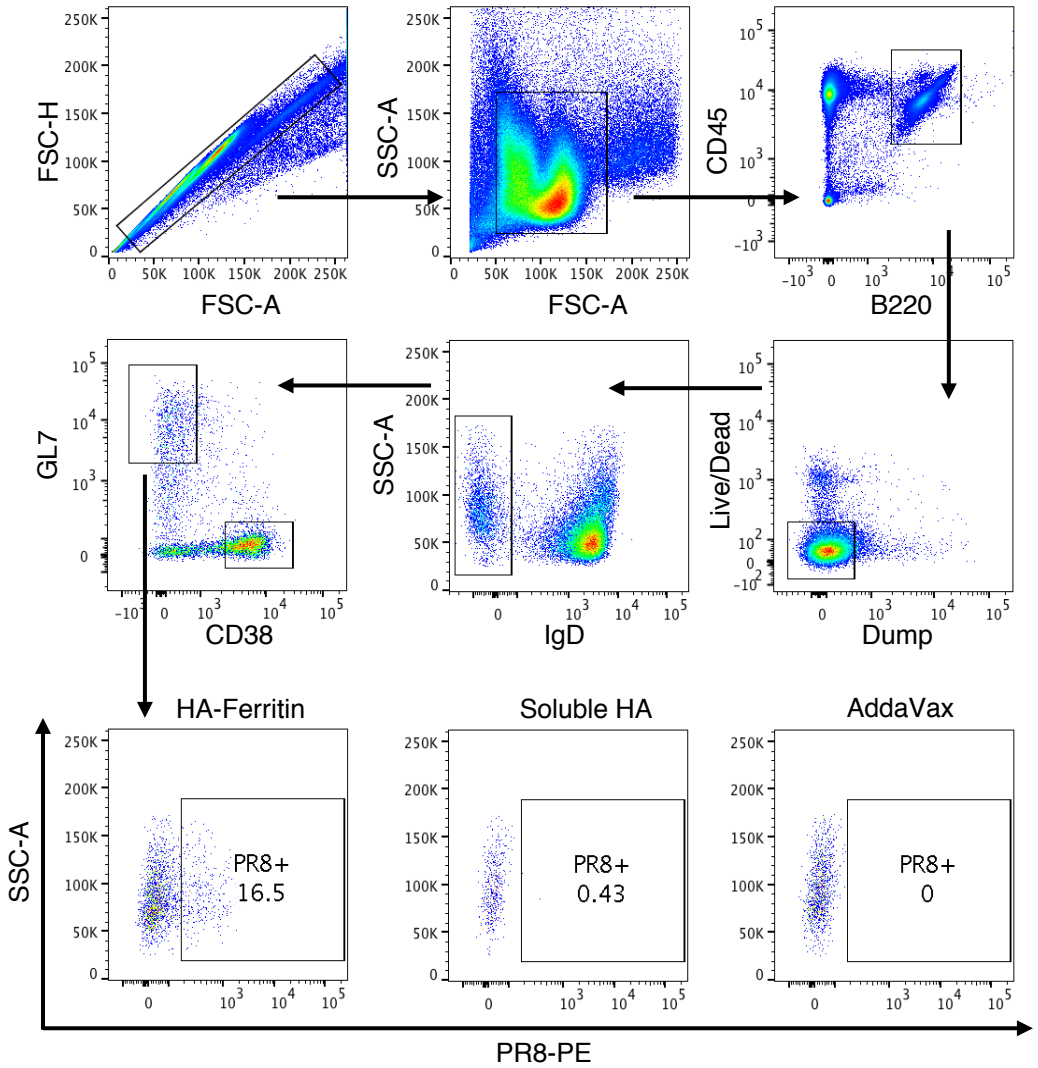
E Ferritin 1.2 μg



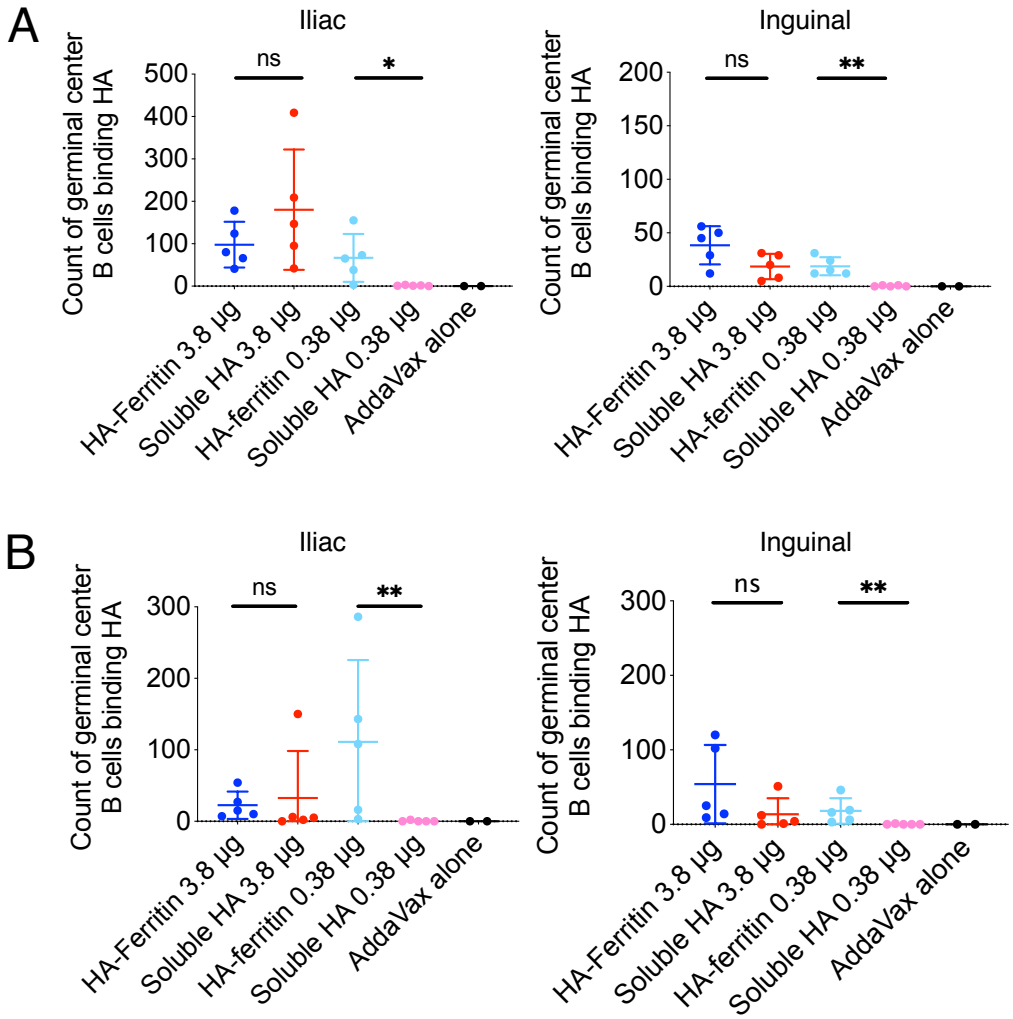

F PBS



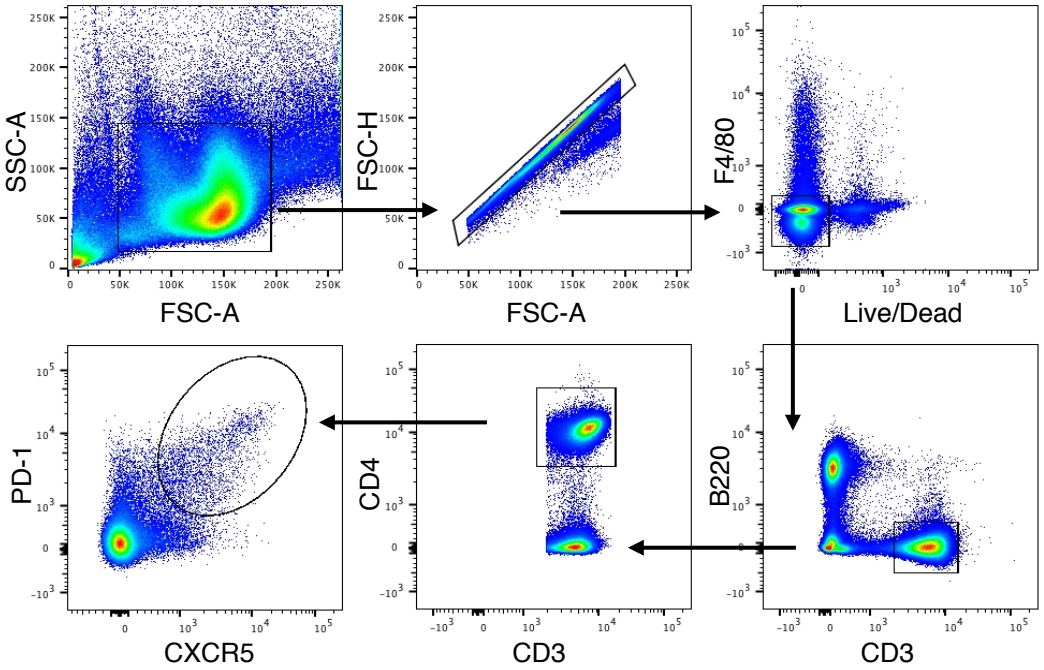

**Supplemental Figure 2. Confocal microscopy evaluation of germinal centers in lymph nodes.** C57Bl/6 (*n* = 5 mice per group) mice were immunized with **(A)** high dose HA-ferritin (5 μg), **(B)** low dose HA-ferritin (0.5 μg), **(C)** molar equivalent of high dose soluble HA (3.8 μg), **(D)** low dose soluble HA (0.38 μg), **(E)** 1.2 μg ferritin, all adjuvanted with AddaVax or **(F)** PBS alone. Draining inguinal lymph nodes were excised, sectioned and stained with antibodies to identify B cells (B220; magenta), germinal centers (GL7; green), follicular dendritic cells (CD35; blue), and class switching (IgD; white).



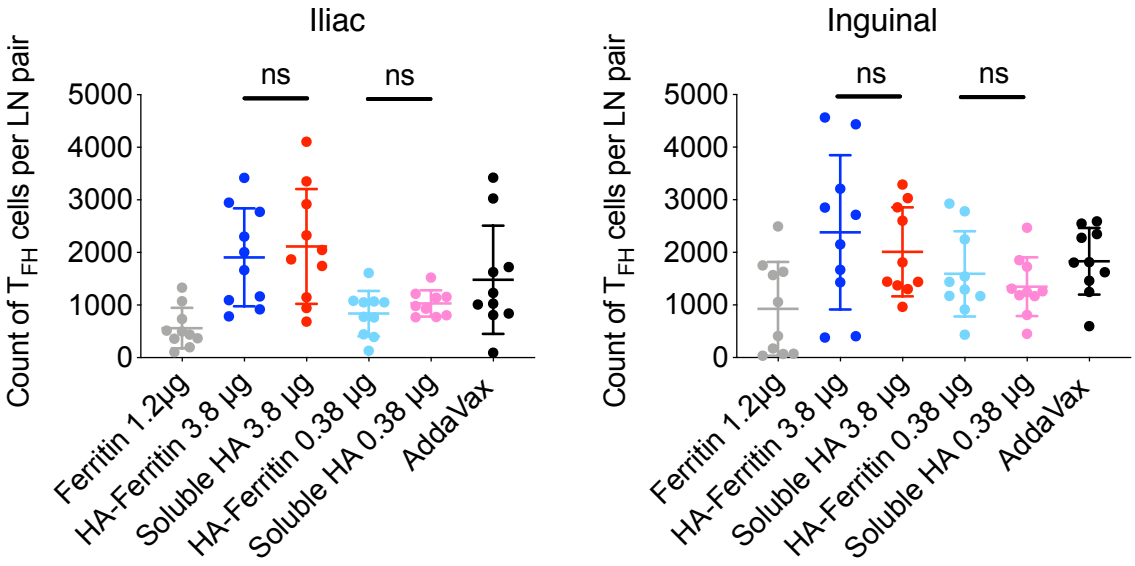

**Supplemental Figure 3. Identification of HA-specific germinal center B cells in mouse lymph nodes.** Germinal center cells in lymph node suspensions were gated as singlets, lymphocytes, $CD45^{+}B220^{+}$, live, $IgD^{-}$, $GL7^{+}$ using flow cytometry. PR8 HA-Biotin labelled with Streptavidin-PE was used to probe for HA-specific B cells. Representative examples of probe staining in lymph node cells from mice vaccinated with ferritin, soluble HA and HA-ferritin are shown.



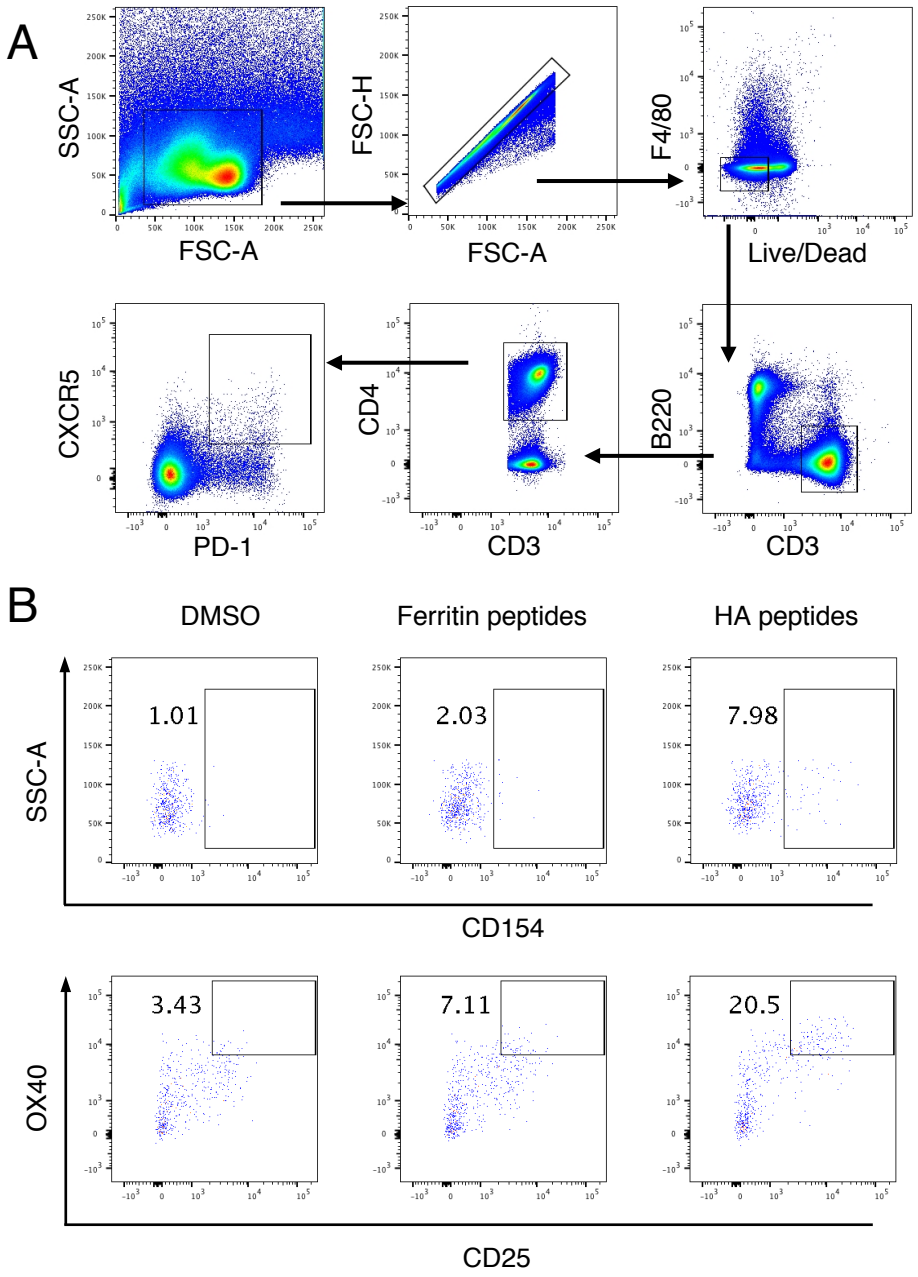

**Supplemental Figure 4. Frequencies of HA-specific germinal center B cells at early timepoints following vaccination**. C57Bl/6 ($n$ = 5 mice per group) mice were immunized with HA-ferritin (5 or 0.5 $\mu$g) or a molar equivalent of soluble HA (3.8 or 0.38 $\mu$g), adjuvanted with AddaVax. At 14 days post vaccination, the absolute count of HA-specific germinal center B cells in draining iliac (left) and inguinal (right) lymph nodes at 7 **(A)** and 14 **(B)** days post vaccination was determined using a probe of biotinylated PR8 HA labelled with streptavidin-PE. Data represent mean ± SD and are representative of one experiment. *p <0.05, **p<0.01, determined by a Mann-Whitney test.



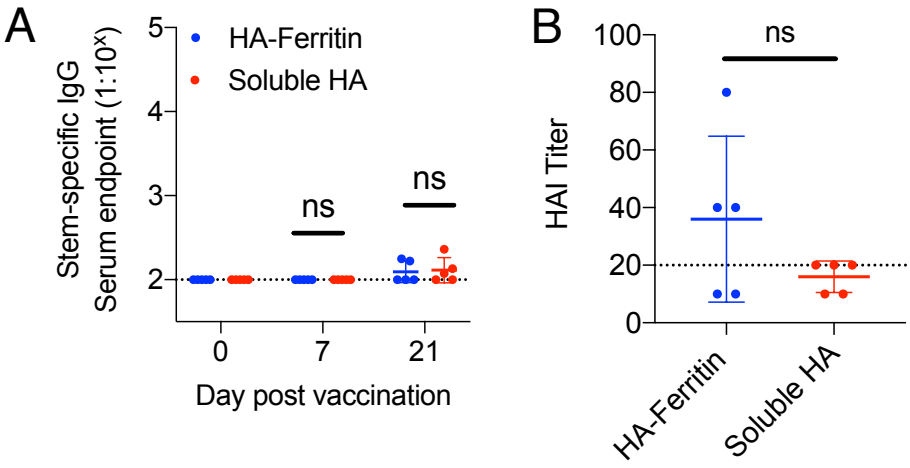

**Supplemental Figure 5. Identification of T follicular helper ($T_{FH}$) cells in mouse lymph nodes ex vivo.** $T_{FH}$ cells in lymph node suspensions were gated as lymphocytes, singlets, live F4/80$^{-}$, CD3$^{+}$B220$^{-}$, CD4$^{+}$, CXCR5$^{+}$PD-1$^{+}$ using flow cytometry.



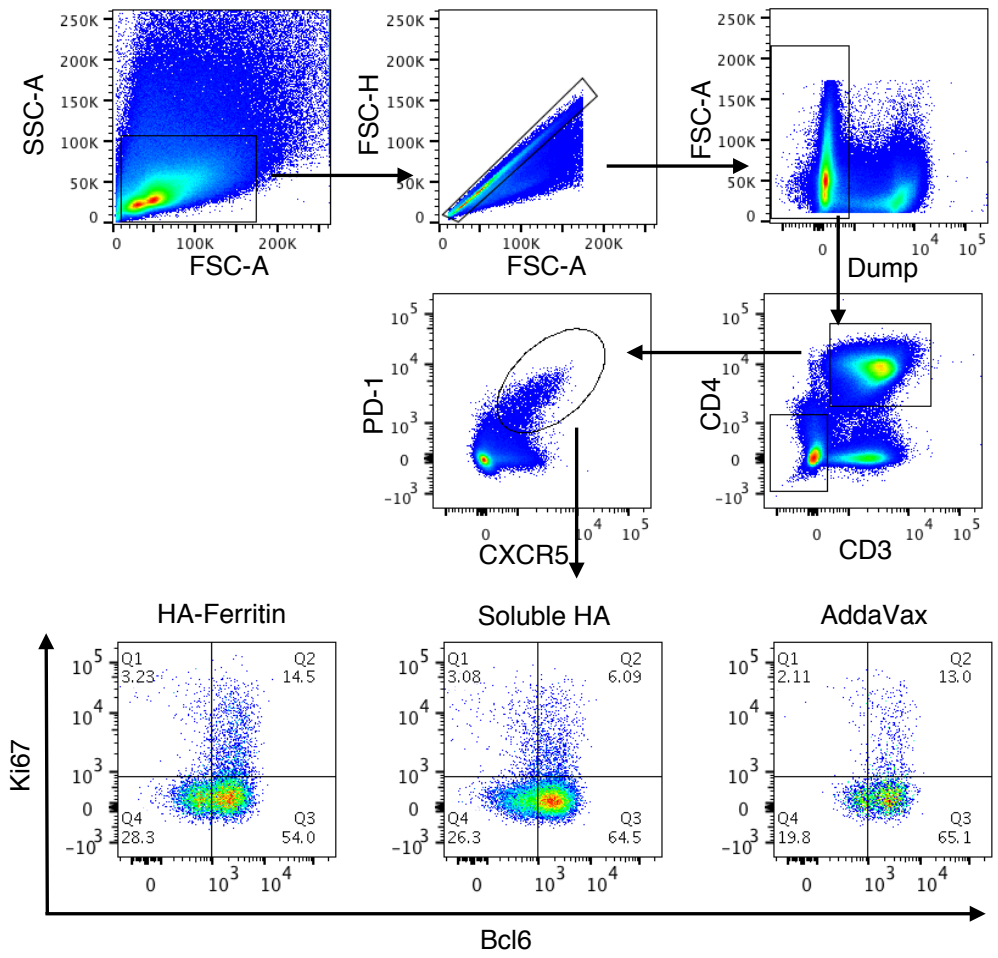

**Supplemental Figure 6. Absolute counts of T follicular helper ($T_{FH}$) cells in lymph nodes after vaccination.** C57Bl/6 (*n* = 10 mice per group) mice were immunized with HA-ferritin (5 or 0.5 *µ*g) or a molar equivalent of soluble HA (3.8 or 0.38 *µ*g), or 1.2 *µ*g ferritin alone, adjuvanted with AddaVax. 14 days following vaccination, draining iliac (left) and inguinal (right) lymph nodes were harvested. The count of $T_{FH}$ cells (identified as $CD4^+CXCR5^+PD\text{-}1^+$) per lymph node pair was determined by flow cytometry. Data shown are combined from two independent experiments. Data represent mean ± SD. Significance determined by a Mann-Whitney test.



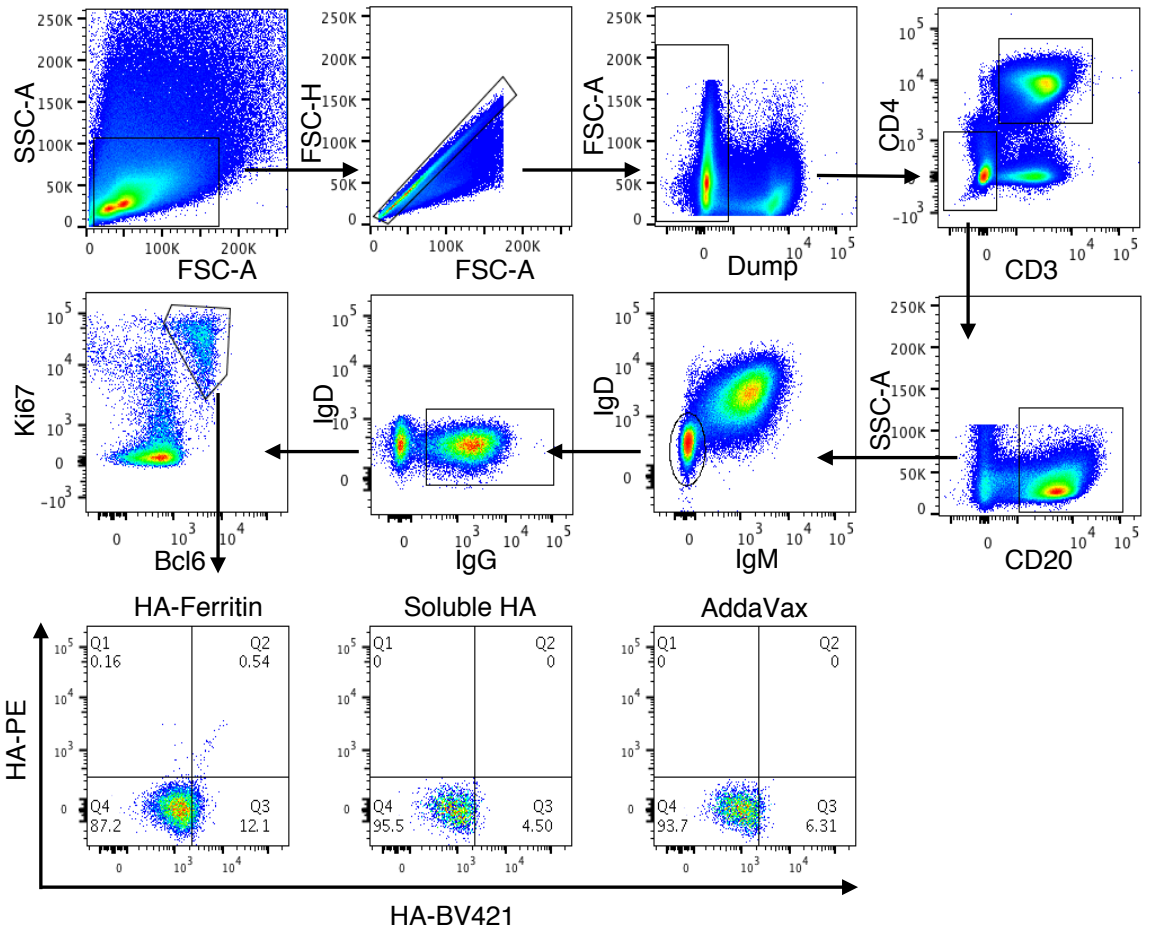

**Supplemental Figure 7. Identification of activated T follicular helper ($T_{FH}$) cells following in vitro stimulation. (A)** Following 18 h stimulation of mouse lymph node suspensions with HA or ferritin peptide pools or DMSO control, $T_{FH}$ cells were gated on as lymphocytes, singlets, live F4/80$^{-}$, CD3$^{+}$B220$^{-}$, CD4$^{+}$, CXCR5$^{+}$PD-1$^{+}$ using flow cytometry. **(B)** Representative examples of TFH activation following DMSO, ferritin or HA peptide stimulation is shown with gates indicating CD154$^{+}$ or CD25$^{++}$OX40$^{++}$ cells.




**Supplemental Figure 8. Stem HA-specific antibody and HAI titers in vaccinated macaques.** Pigtail macaques ($n = 5$) were vaccinated once intramuscularly with HA-ferritin (15 $\mu$g) or a molar equivalent of soluble HA (11.25 $\mu$g), both adjuvanted with AddaVax. A control group received AddaVax alone ($n = 2$). Sera was collected at 0, 7 and 21 days post vaccination. **(A)** Serum IgG titers against HA stem were measured by capture ELISA. **(B)** Serum HAI titers against PR8 virus were measured at 21 days post vaccination. The dashed lines indicate detection cutoff (1:100 dilution for ELISA, 1:20 for HAI assay). Data represent mean ± SD. Significance was determined by a Mann-Whitney test.




**Supplemental Figure 9. Identification of activated T follicular helper ($T_{FH}$) cells in macaque lymph nodes.** Activated $T_{FH}$ cells in lymph node suspensions were gated as lymphocytes, singlets, live, $CD3^{+}CD4^{+}$,$CXCR5^{+}PD\text{-}1^{+}$, $Bcl6^{+}Ki67^{+}$ using flow cytometry. Representative examples of probe staining from macaques vaccinated with HA-ferritin, soluble HA and AddaVax alone are shown.




**Supplemental Figure 10. Identification of germinal center B cells in macaque lymph nodes.** Germinal center B cells in lymph node suspensions were gated as lymphocytes, singlets, live, $CD3^{-}CD4^{-}$,$CD20^{+}$, $IgM^{-}IgD^{-}$, $IgG^{+}$, $Bcl6^{+}Ki67^{+}$ using flow cytometry. PR8 HA-biotin labelled with streptavidin-PE and streptavidin-BV421 was used to probe for HA-specific B cells. Representative examples of probe staining from macaques vaccinated with HA-ferritin, soluble HA and AddaVax alone are shown.

**Supplemental Videos. 3D antigen localization of antigen in the draining lymph nodes.** C57Bl/6 mice ($n = 2$ per group) were immunized with AF647-labelled HA-ferritin (5 $\mu$g) **(Video 1)** or a molar equivalent of AF647-labelled soluble HA (3.8 $\mu$g) **(Video 2)**, both adjuvanted with AddaVax. 14 days later, draining inguinal lymph nodes were fixed, stained (IgD, yellow; CD35, blue), cleared and imaged by lightsheet microscopy. Co-localization of antigen with $CD35^+$ follicular dendritic cells within germinal centers is observed following vaccination with HA-ferritin but not soluble HA.