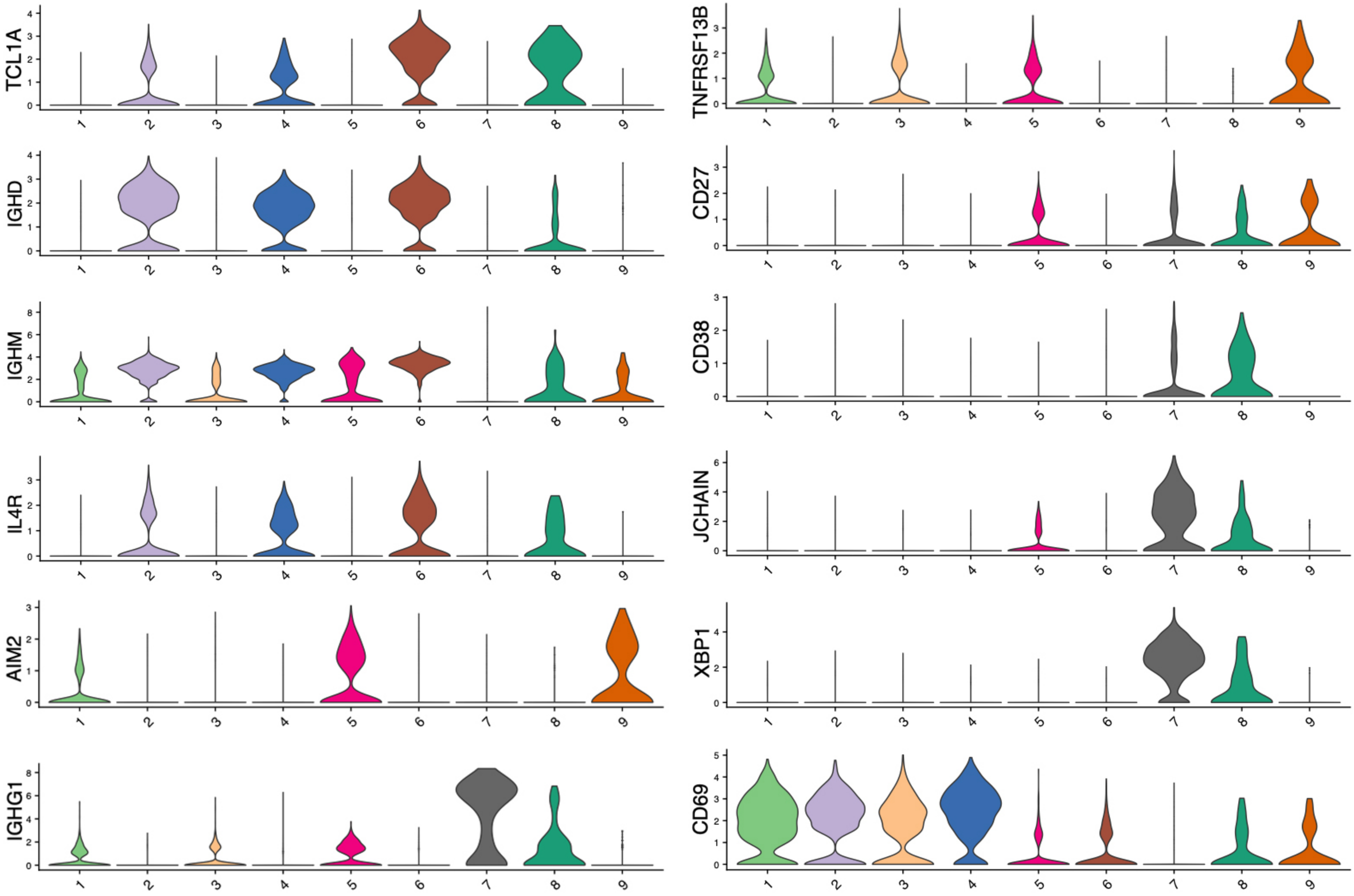
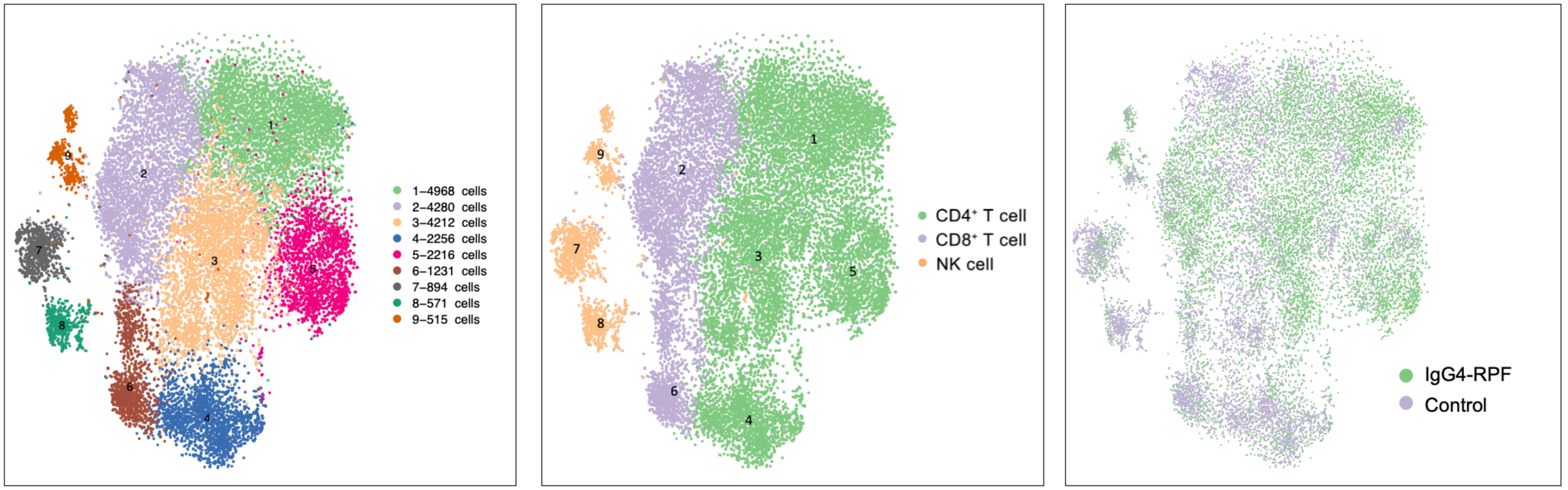
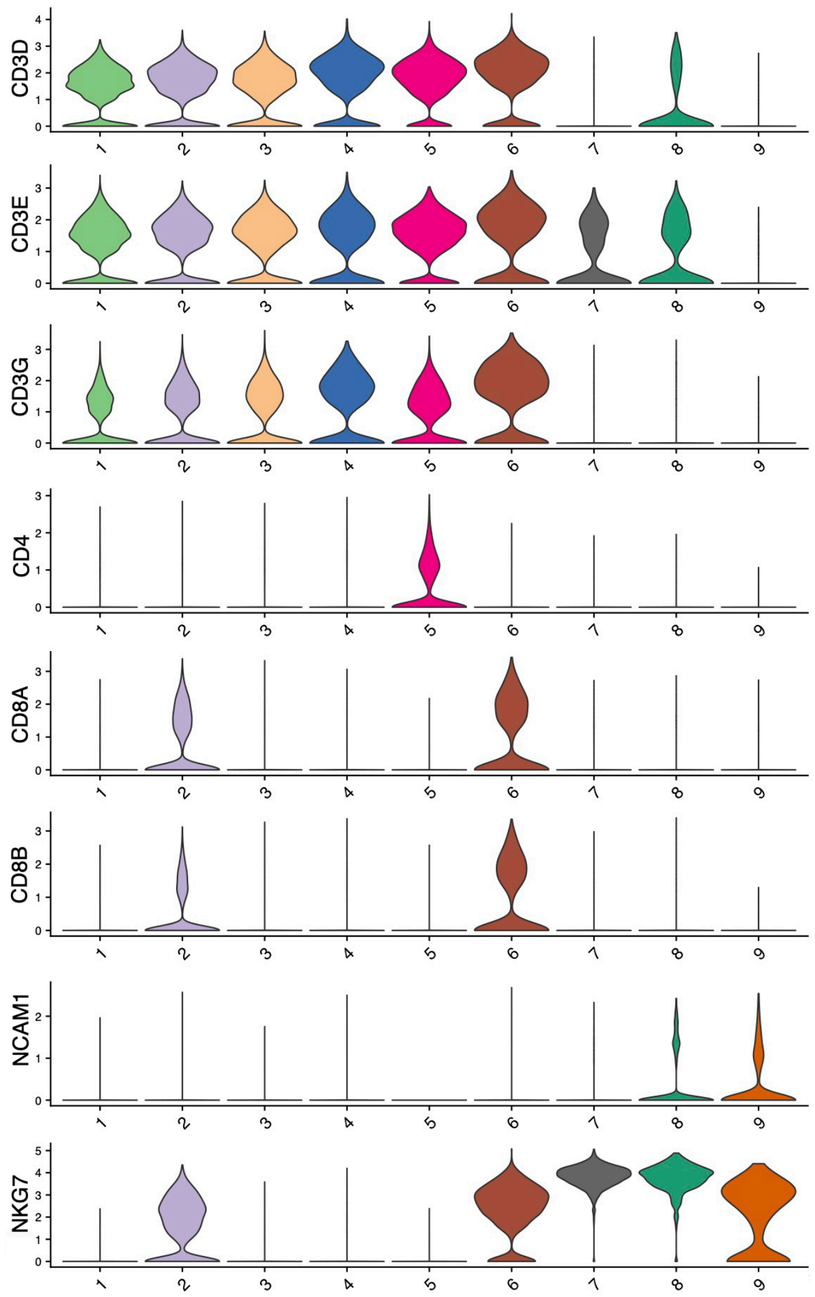


Supplementary Figure S1. Violin plots of selected marker genes in the different B cell clusters

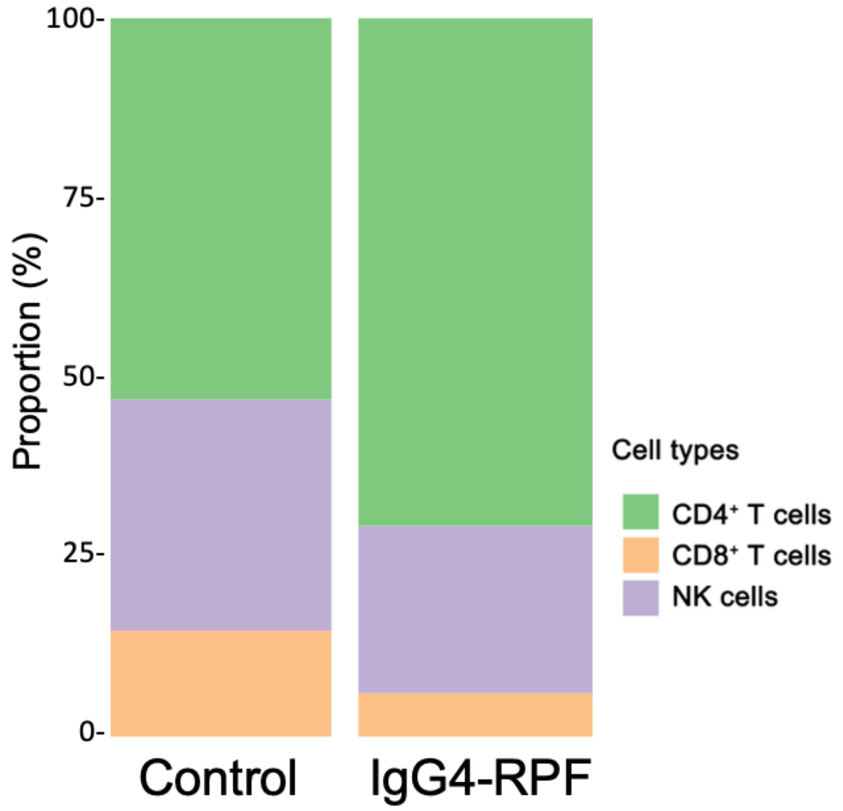
A



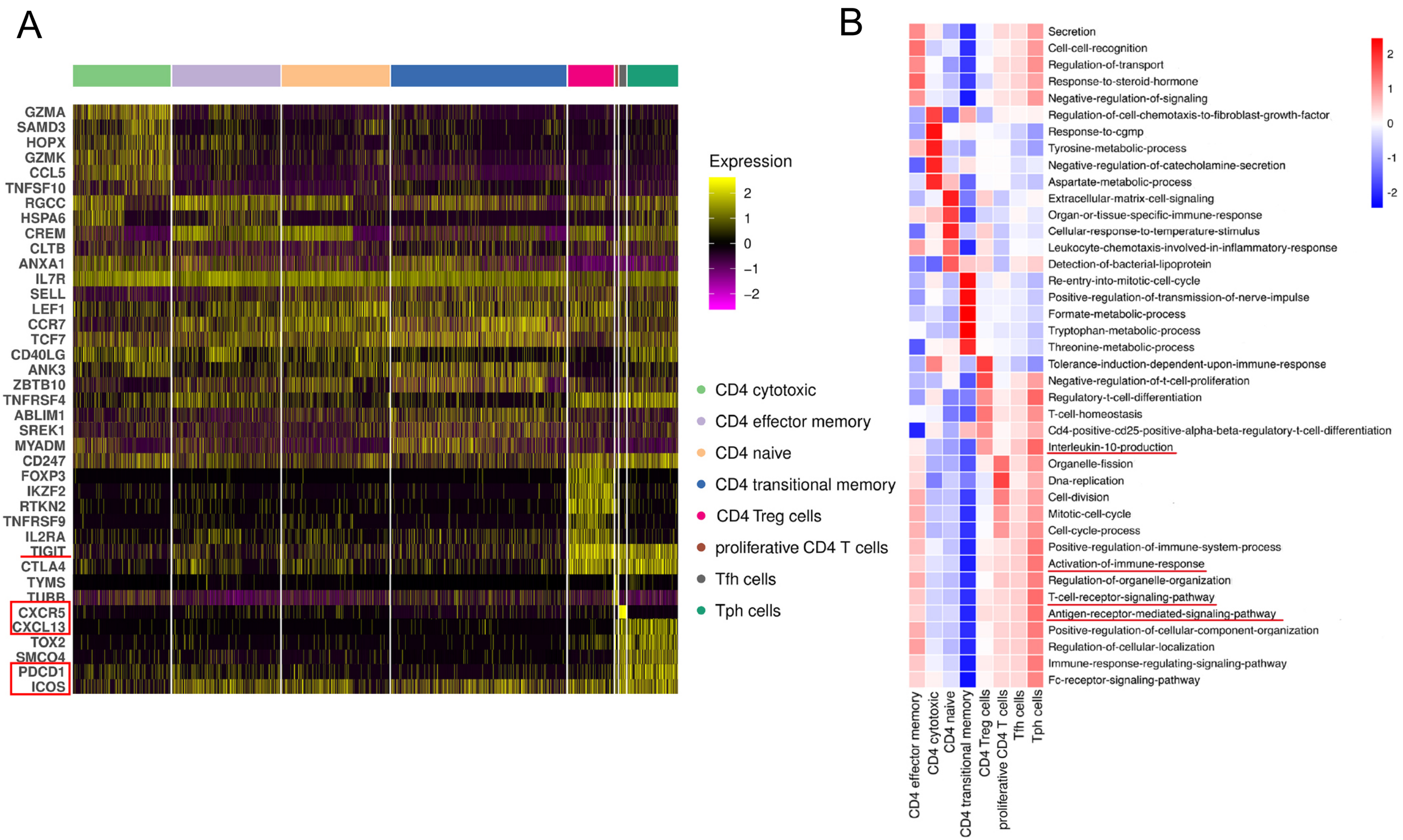
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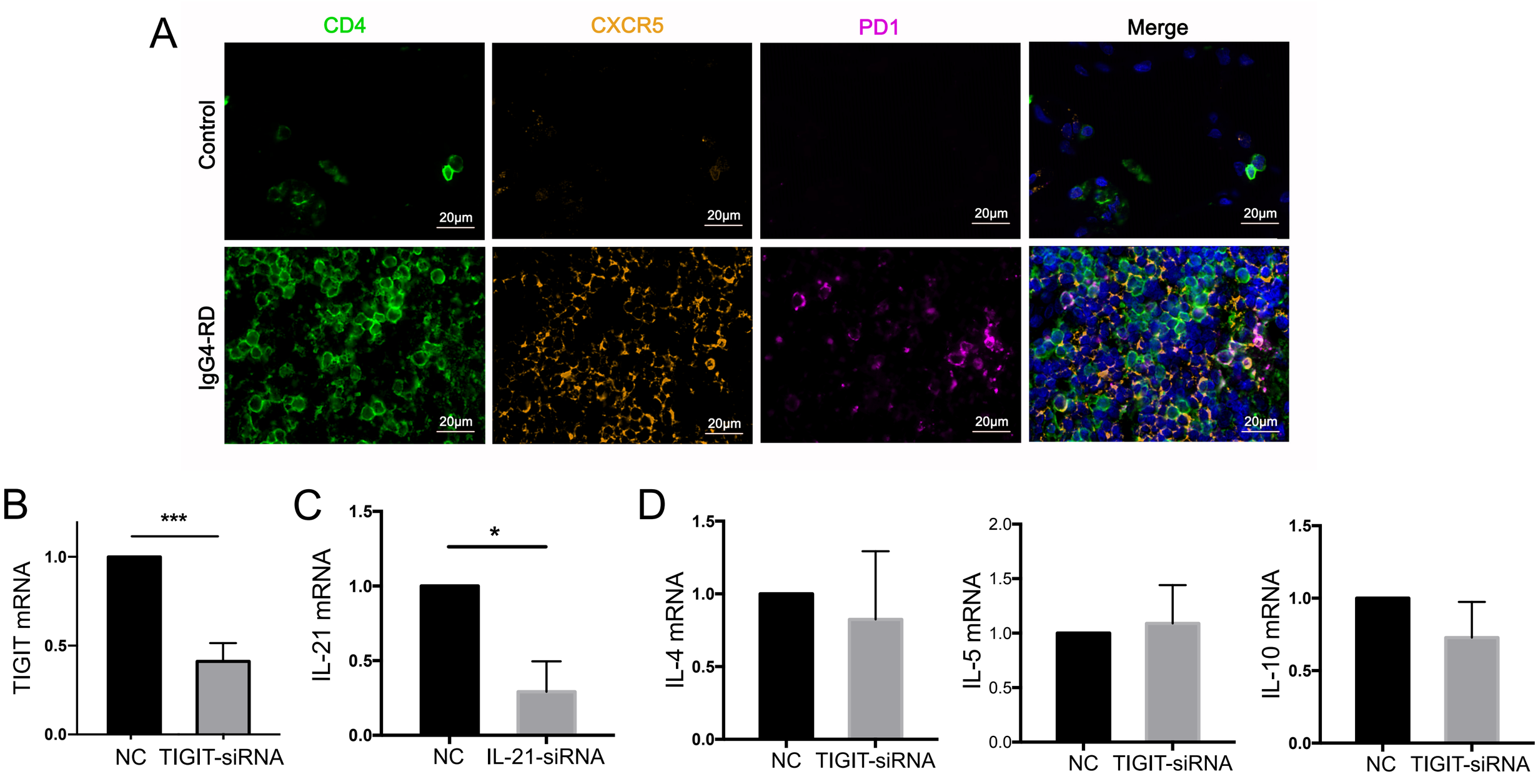
C



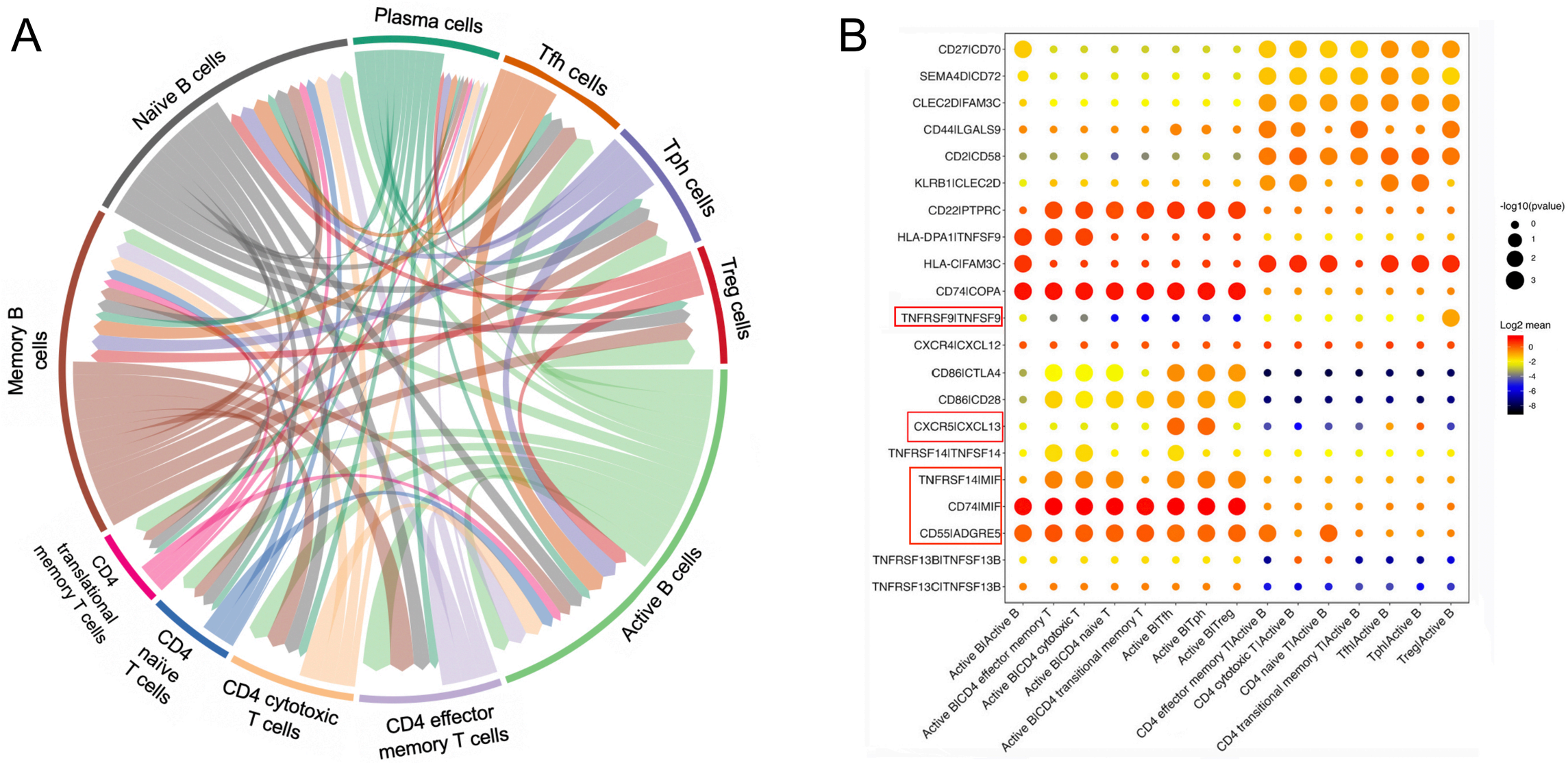
Supplementary Figure S2. T and NK cell analysis by scRNA-seq. **(A)** tSNE plots of T/NK cell clusters, with cell types, and cells colored according to disease status in the two different groups. **(B)** Marker gene expressions in the different T/NK cell clusters. **(C)** The proportion of different T/NK cell types in the two groups.



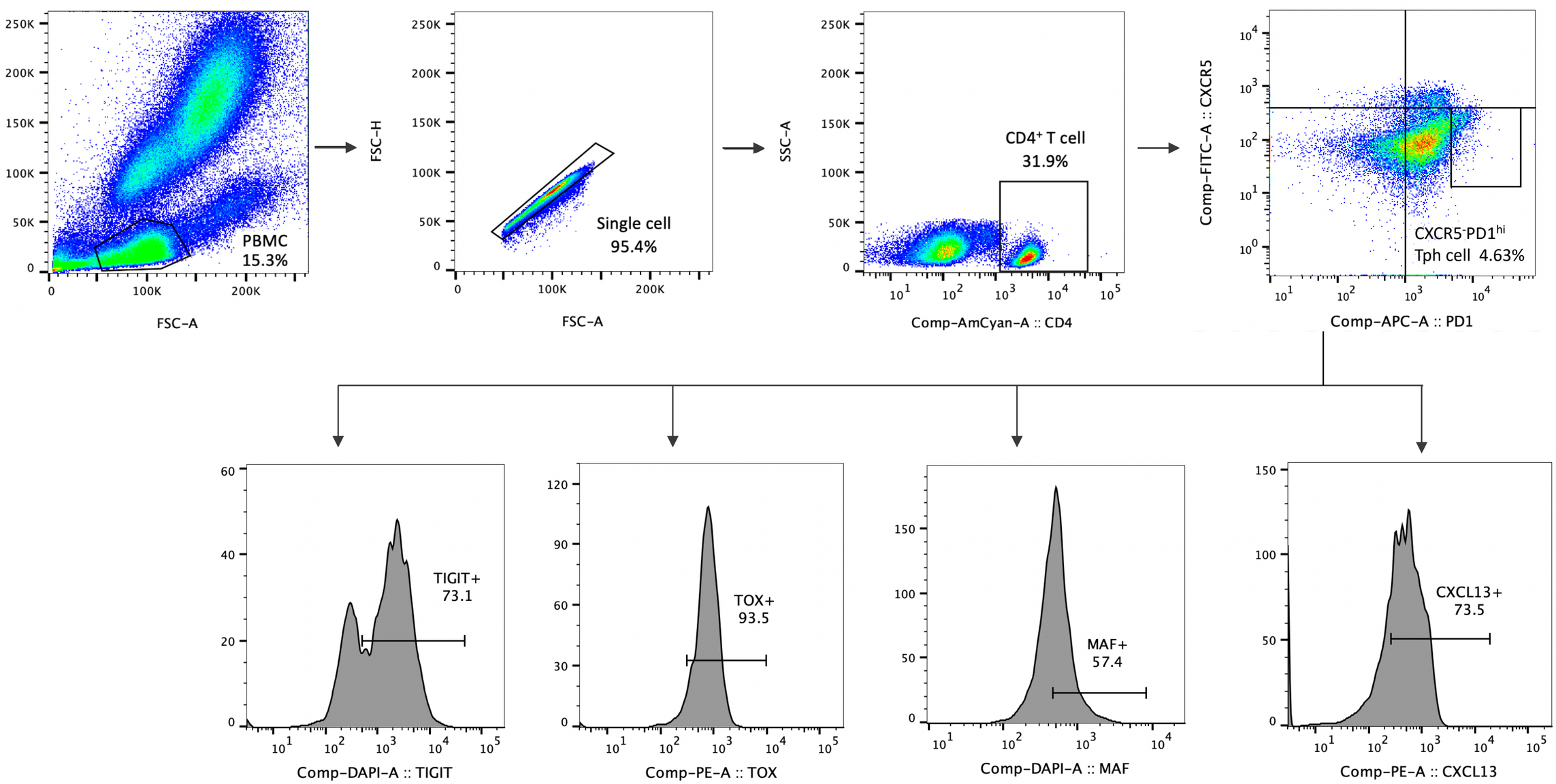
Supplementary Figure S3. (A) Marker genes of different CD4$^+$ T cell subtypes. **(B)** GSVA pathway analysis of CD4$^+$ T cell subtypes.



Supplementary Figure S4. **(A)** Tph cells were increased in retroperitoneum tissue of IgG4-RD patients. **(B)** The expression of TIGIT was significantly decreased in $CD4^+$ T cells with TIGIT knockdown. **(C)** The expression of IL-21 was significantly decreased in $CD4^+$ T cells with IL-21 knockdown. **(D)** The expression of IL-4, IL-5, and IL-10 in $CD4^+$ T cells had no significant changes after TIGIT knockdown. $^{*}\ p < 0.05$, $^{***}\ p < 0.001$.



Supplementary Figure S5. (A) Interaction between B cell subtypes and $CD4^+$ T cell subtypes in the IgG4-RPF group. **(B)** Receptor-ligand pairs between active B cells and $CD4^+$ T cells in the IgG4-RPF group



Supplementary Figure S6. The gating strategies of flow cytometry in our study. First, the lymphocytes were gated and doublets were excluded. Then the $CD4^+$ T cells were gated by CD4. Among the $CD4^+$ T cells, $CXCR5^-PD1^{hi}$ Tph cells were gated by PD1 and CXCR5. Subsequently, the expression of TIGIT, TOX, MAF, and CXCL13 in Tph cells were quantified by histogram.