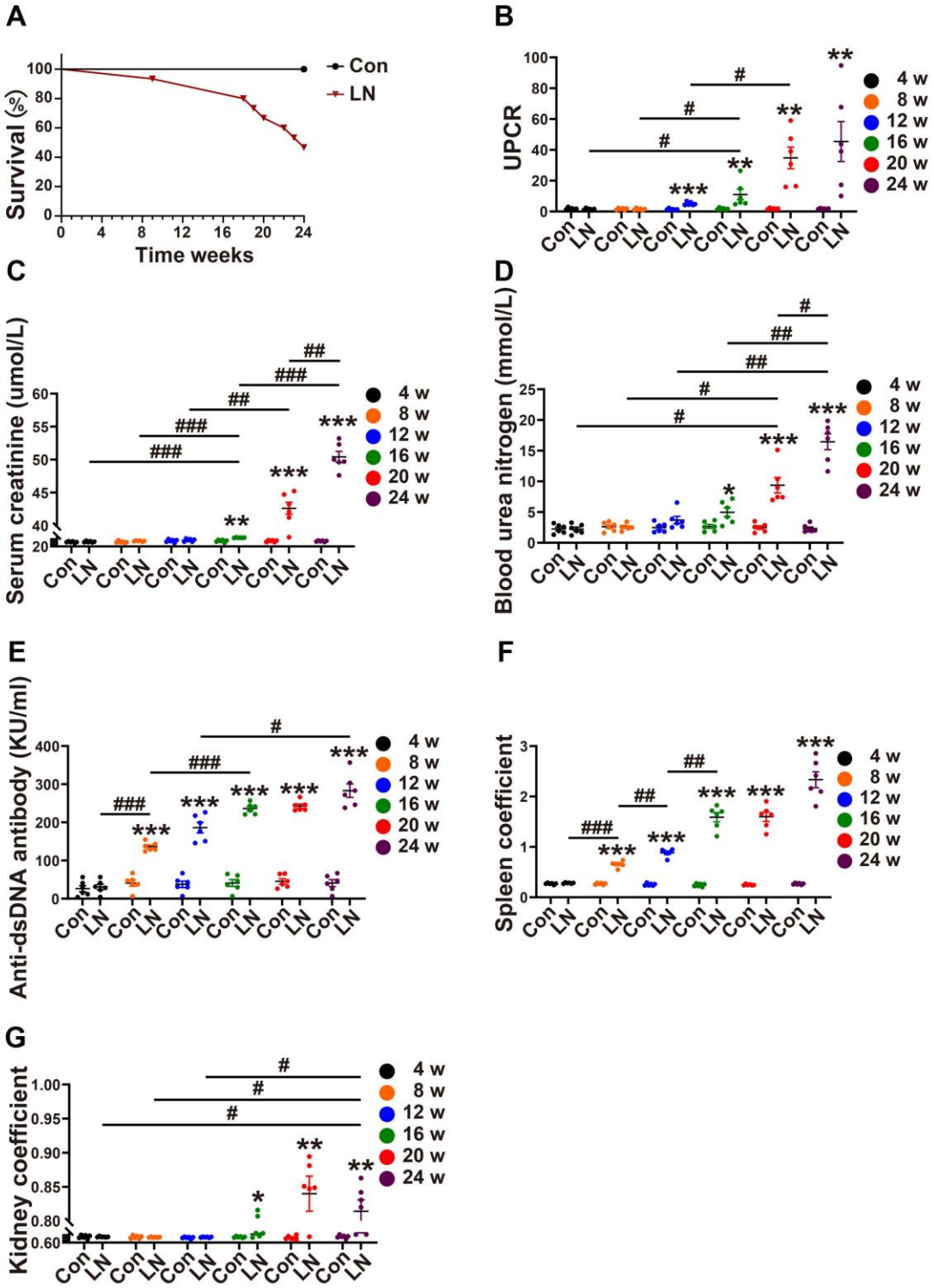
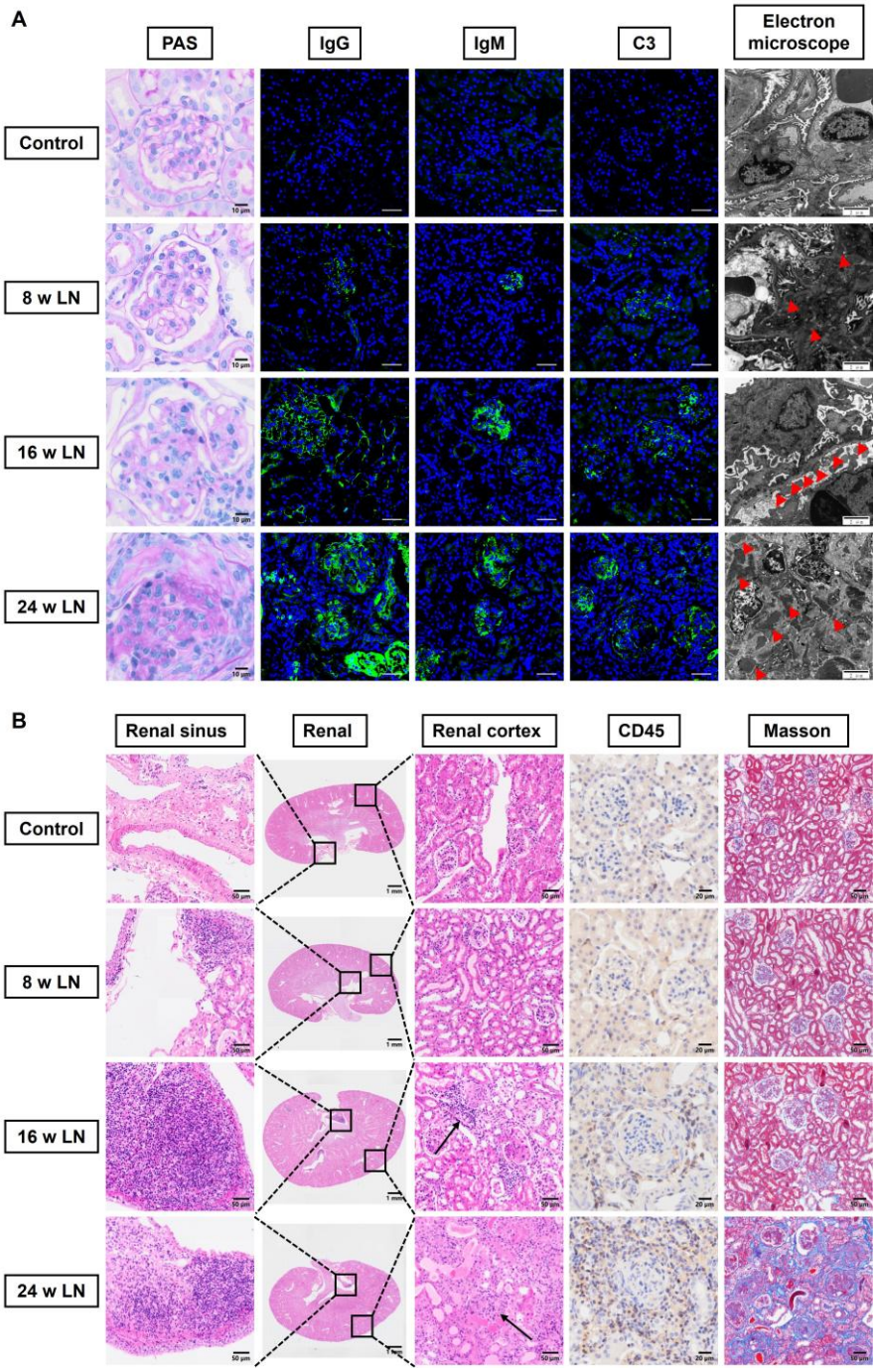


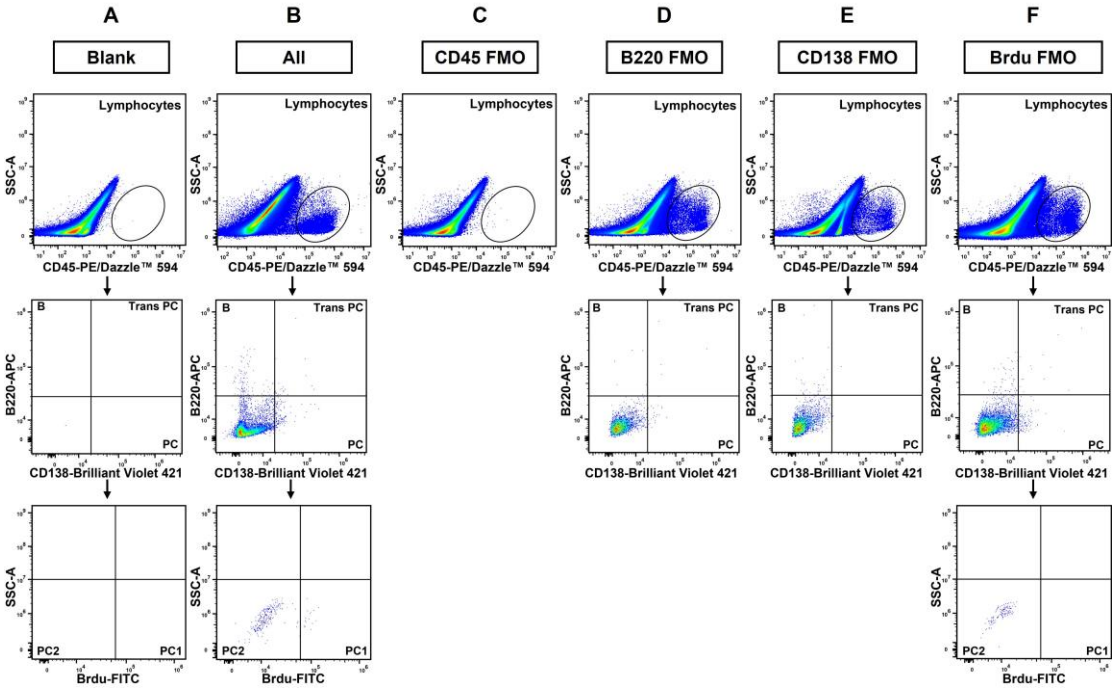
Supplementary Figure 1 The changes of serum, urine and immune-related indicators in LN mice of different ages. (A) Survival rates of six groups of mice from week 0 to week 24 (n = 15). (B) Urinary protein/creatinine ratio (UPCR) in the six groups of mice. (C, D) Serum creatinine and urea nitrogen levels in mice. (E) Serum anti-dsDNA antibody levels in mice. (F, G) kidney coefficient and spleen coefficient in mice. Data are presented as mean ± SD. (B-G: n = 6), *p<0.05, **p<0.01, ***p<0.001; #p<0.05, ##p<0.01, ###p<0.001; *represents the significant degree of difference

between the LN and Con groups. # represents the significance of the differences among the six groups of LN mice.

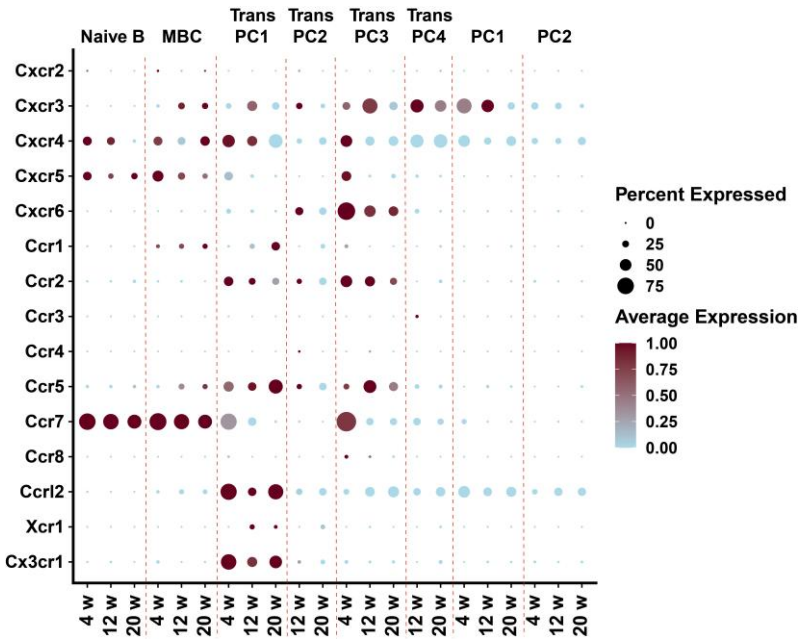


Supplementary Figure 2 Pathological changes of kidneys in LN mice of different ages. (A) Results of PAS staining, immunofluorescence staining (IgG, IgM, C3), and electron microscopic staining in glomeruli of Control, 8w LN, 16w LN, and 24w LN mice, with red arrows indicating immune complexes deposited in different parts of the glomerulus. (B) Control, 8w LN, 16w LN, and 24w LN mice kidneys were stained with H&E, immunohistochemical CD45 staining, and Masson's trichrome staining to reveal the infiltration of interstitial immune cells in different parts of the renal cortex and medulla and the degree of fibrosis in the renal cortex, with black arrows indicating immune cells infiltrated in different parts of the kidneys. PAS scale bar: 10 μm, immunofluorescence

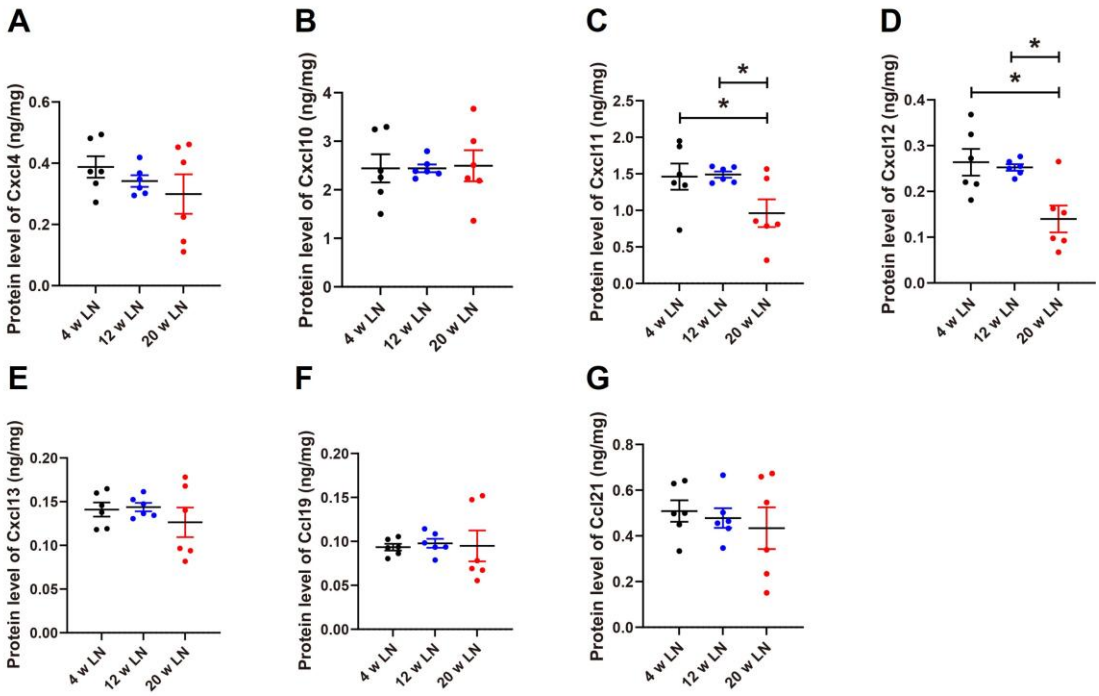
scale bar: 50 μm, transmission electron microscopy scale bar: 2 μm, H&E scale bar: 50 μm, CD45 scale bar: 20 μm, Masson scale bar: 50 μm.



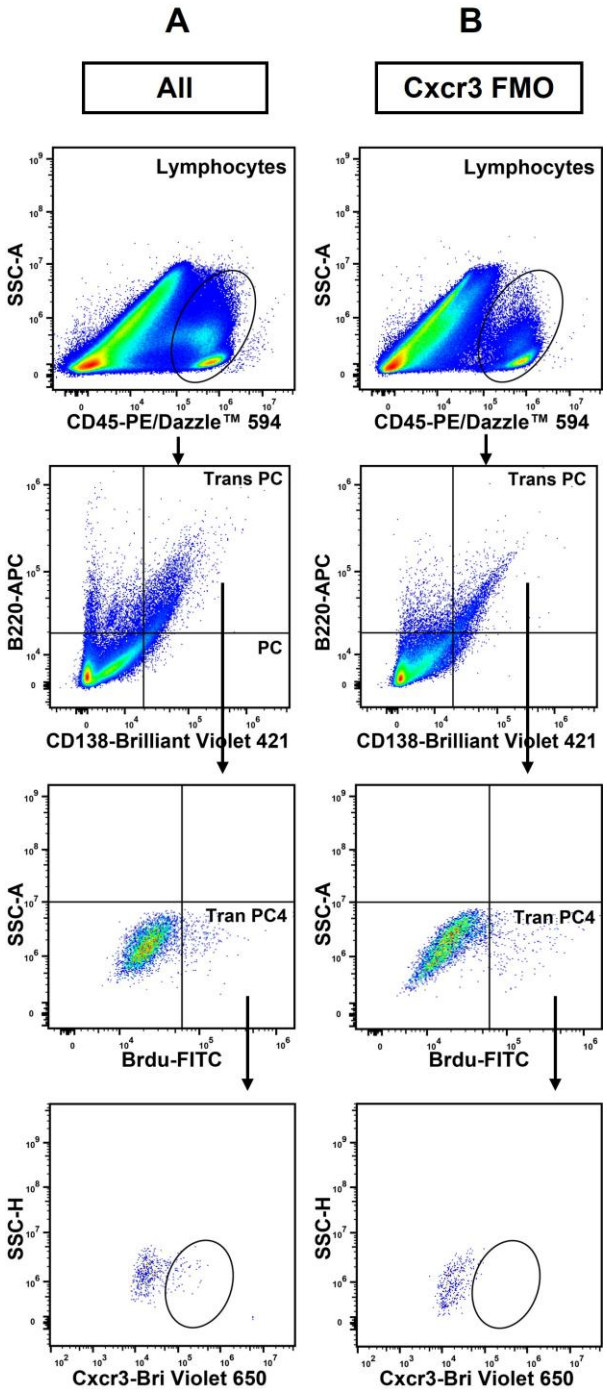
Supplementary Figure 3 Flow Cytometry gating strategy for kidney of LN mice. (A) The single-cell suspension of kidneys without added antibodies. (B) The single-cell suspension of kidneys was added with the following antibodies: PE/Dazzle™ 594 anti-mouse CD45 Antibody, Brilliant Violet 421™ anti-mouse CD138 (Syndecan-1) Antibody, APC anti-mouse/human CD45R/B220 Antibody, FITC anti-BrdU Antibody. (C) The single-cell suspension of kidneys was added with the following antibodies: Brilliant Violet 421™ anti-mouse CD138 (Syndecan-1) Antibody, APC anti-mouse/human CD45R/B220 Antibody, FITC anti-BrdU Antibody. (D) The single-cell suspension of kidneys was added with the following antibodies: PE/Dazzle™ 594 anti-mouse CD45 Antibody, Brilliant Violet 421™ anti-mouse CD138 (Syndecan-1) Antibody, FITC anti-BrdU Antibody. (E) The single-cell suspension of kidneys was added with the following antibodies: PE/Dazzle™ 594 anti-mouse CD45 Antibody, APC anti-mouse/human CD45R/B220 Antibody, FITC anti-BrdU Antibody. (F) The single-cell suspension of kidneys was added with the following antibodies: PE/Dazzle™ 594 anti-mouse CD45 Antibody, Brilliant Violet 421™ anti-mouse CD138 (Syndecan-1) Antibody, APC anti-mouse/human CD45R/B220 Antibody. FMO: fluorescence-minus-one.



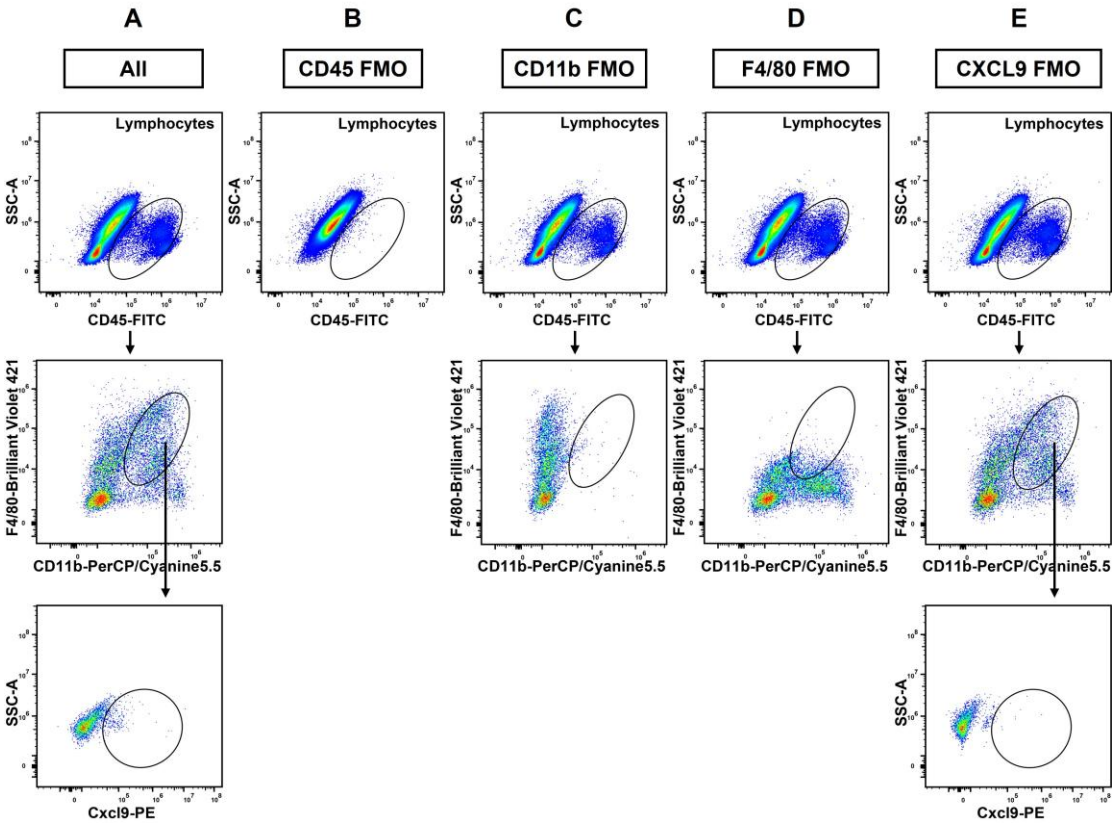
Supplementary Figure 4 Dot plot shows the expression level of chemokine receptor genes for Naive B cells, MBC, TransPC1, TransPC2, TransPC3, TransPC4, PC1, and PC2 in the kidneys of 4w LN, 12w LN, and 20w LN.



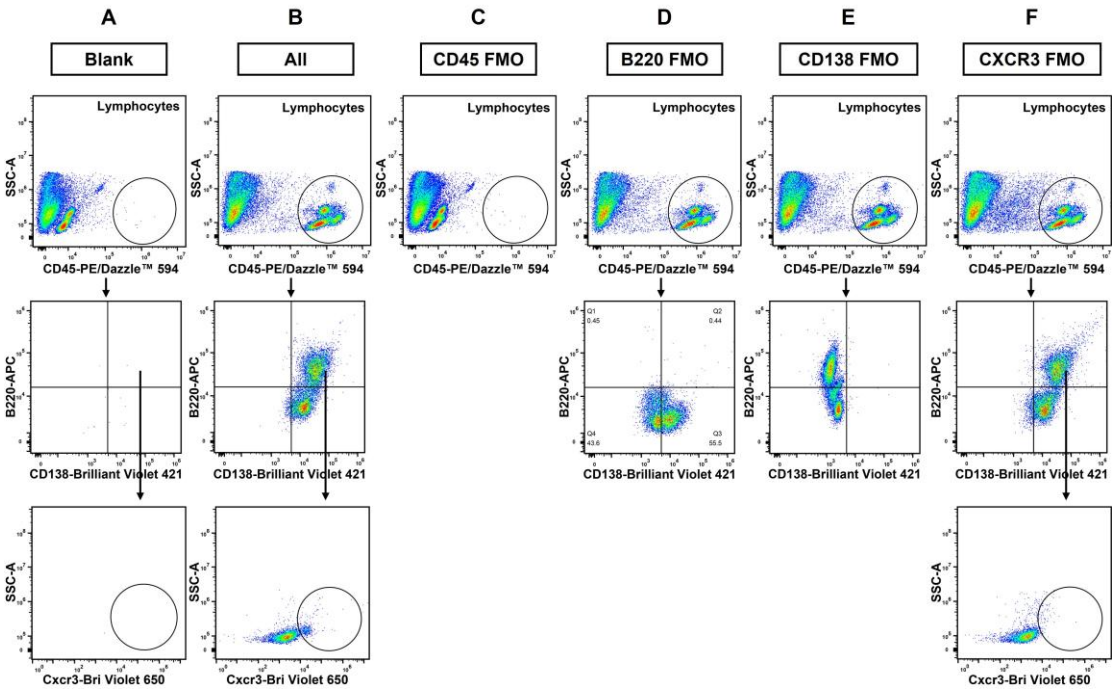
Supplementary Figure 5 The protein expression levels of Cxcl4, Cxcl10, Cxcl11, Cxcl12, Cxcl13, Ccl19 and Ccl21 in the kidneys of 4w LN, 12w LN and 20w LN were detected by ELISA. (n = 6).



Supplementary Figure 6 Flow Cytometry gating strategy kidney of LN mice. (A) The single-cell suspension of kidneys was added with the following antibodies: PE/Dazzle™ 594 anti-mouse CD45 Antibody, Brilliant Violet 421™ anti-mouse CD138 (Syndecan-1) Antibody, APC anti-mouse/human CD45R/B220 Antibody, FITC anti-BrdU Antibody, Brilliant Violet 650™ anti-mouse CD183 (Cxcr3) Antibody. (B) The single-cell suspension of kidneys was added with the following antibodies: PE/Dazzle™ 594 anti-mouse CD45 Antibody, Brilliant Violet 421™ anti-mouse CD138 (Syndecan-1) Antibody, APC anti-mouse/human CD45R/B220 Antibody, FITC anti-BrdU Antibody. FMO: fluorescence-minus-one.



Supplementary Figure 7 Flow Cytometry gating strategy for kidney of LN mice. (A) The single-cell suspension of kidneys was added with the following antibodies: FITC anti-mouse CD45 Antibody, PerCP/Cyanine5.5 anti-mouse/human CD11b Antibody, Brilliant Violet 421™ anti-mouse F4/80 Antibody, PE anti-mouse Cxcl9 (MIG) Antibody. (B) The single-cell suspension of kidneys was added with the following antibodies: PerCP/Cyanine5.5 anti-mouse/human CD11b Antibody, Brilliant Violet 421™ anti-mouse F4/80 Antibody, PE anti-mouse Cxcl9 (MIG) Antibody. (C) The single-cell suspension of kidneys was added with the following antibodies: FITC anti-mouse CD45 Antibody, Brilliant Violet 421™ anti-mouse F4/80 Antibody, PE anti-mouse Cxcl9 (MIG) Antibody. (D) The single-cell suspension of kidneys was added with the following antibodies: FITC anti-mouse CD45 Antibody, PerCP/Cyanine5.5 anti-mouse/human CD11b Antibody, PE anti-mouse Cxcl9 (MIG) Antibody. (E) The single-cell suspension of kidneys was added with the following antibodies: FITC anti-mouse CD45 Antibody, PerCP/Cyanine5.5 anti-mouse/human CD11b Antibody, Brilliant Violet 421™ anti-mouse F4/80 Antibody. FMO: fluorescence-minus-one.



Supplementary Figure 8 Flow Cytometry gating strategy for peripheral blood. (A) The single-cell suspension of kidneys was added with the following antibodies: PE/Dazzle™ 594 anti-mouse CD45 Antibody, Brilliant Violet 421™ anti-mouse CD138 (Syndecan-1) Antibody, APC anti-mouse/human CD45R/B220 Antibody, FITC anti-BrdU Antibody, Brilliant Violet 650™ anti-mouse CD183 (Cxcr3) Antibody. (B) The single-cell suspension of kidneys was added with the following antibodies: PE/Dazzle™ 594 anti-mouse CD45 Antibody, Brilliant Violet 421™ anti-mouse CD138 (Syndecan-1) Antibody, APC anti-mouse/human CD45R/B220 Antibody, FITC anti-BrdU Antibody. FMO: fluorescence-minus-one.

Supplementary Table 1 Activity and chronicity items included in LN kidney biopsy report. National Institutes of Health (NIH)

Items	Con	4 w	8 w	12 w	16 w	20 w	24 w
Components of the activity index							
Endocapillary hypercellularity	0	0	0	1-2	3	3	3
Neutrophils and/or karyorrhexis	0	0	0	0	1	2	3
Fibrinoid necrosis	0	0	0	0	0	1×2	2×2
Hyaline deposits	0	0	0	0	0	1	2
Cellular/fibrocellular crescents	0	0	0	0	1×2	2×2	3×2
Interstitial inflammation (interstitial leukocytes)	0	0	1	2	2	3	3
Total	0	0	1	3-4	8	15	21
Items included in the NIH chronicity score							
Total glomerulosclerosis (global+ segmental)	0	0	0	0	0	1	2
Fibrous crescents	0	0	0	0	0	1	2
Interstitial fibrosis	0	0	0	0	0	1	2
Tubular atrophy	0	0	0	0	0	1	3
Total	0	0	0	0	0	4	9

Supplementary Table 2 The top 10 DEGs across 11 cell subgroups

Cell subgroups	T cells	B cells	PC	DC	NK	Mφ	ILC	NEUT	TEC	EC	PEC
Top10 genes											
	Ccl5	*Ly6d*	*Igkc*	*Naaa*	*Gzma*	*C1qa*	*Gata3*	*Ccl3*	*Kap*	*Fabp4*	*Mgp*
	Cd3g	*Cd79a*	*Jchain*	*Irf8*	*Ncr1*	*Apoe*	*Gm20186*	*Plac8*	*Gpx3*	*Igfbp5*	*Ren1*
	Ms4a4b	*Ebf1*	*Ighg3*	*Siglech*	*Xcl1*	*C1qb*	*Hs3st1*	*Ccl4*	*Fxyd2*	*Ly6c1*	*Igfbp7*
	Trbc2	*Ms4a1*	*Ighg1*	*Xcr1*	*Prf1*	*Lyz2*	*Calca*	*Trp53inp1*	*Aldob*	*Flt1*	*Dcn*
	Nkg7	*Iglc2*	*Igha*	*Rnase6*	*Gzmb*	*C1qc*	*Il1rl1*	*Cd63*	*Miox*	*Plvap*	*Tagln*
	Cd3d	*Cd79b*	*Ighg2c*	*Cst3*	*Klrd1*	*H2-Eb1*	*Lmo4*	*Gk*	*Spp1*	*Plpp3*	*Cald1*
	Cd3e	*Ighd*	*Ighg2b*	*Wdfy4*	*Cd7*	*Cd74*	*Il7r*	*Hcst*	*Napsa*	*Emcn*	*Acta2*
	Trac	*Ighm*	*Iglc1*	*Ppt1*	*Il2rb*	*H2-Aa*	*Areg*	*Socs3*	*Rida*	*Plpp1*	*Bgn*
	Trbc1	*Bank1*	*Iglc2*	*Cox6a2*	*Txk*	*Ctss*	*Lztfl1*	*Cdkn1a*	*Umod*	*Igfbp3*	*Nphs2*
	Cd28	*Fcmr*	*Slpi*	*Clec9a*	*Klrk1*	*Mafb*	*Il2ra*	*Rflnb*	*Spink1*	*Sparc*	*Cdkn1c*

Supplementary Table 3 The proportion (%) of different immune cell subgroups between the three groups

Cell subgroups	Group		
	4 w LN	12 w LN	20 w LN
T cells	13.49	51.77	31.95
B cells	1.23	0.82	0.81
plasmacyte	0.11	1.46	2.42
dendritic cells	4.48	2.00	2.90
natural killer cells	3.57	1.54	0.65
Macrophages	56.67	22.02	44.36
innate lymphoid cells	4.33	1.70	0.77
neutrophile granulocyte	1.55	0.80	1.24
tubular epithelial cells	4.61	7.69	6.91
endothelial cells	9.59	9.58	7.42
pericytes	0.37	0.64	0.58