Supporting Information

Modular Design of Bi-specific Nanoplatform Engaged in Malignant Lymphoma Immunotherapy

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Table S1. The coupling rate and coupling quantity of SA and the hydrodynamic sizes and zeta potential of SA@Fe$_3$O$_4$ with the different reactant mass.

The quantity of iron (μg)	The quantity of SA (μg)	Hydrodynamic size (nm)	Zeta potential (mV)	The quantity of coupled SA (μg)	The number of coupled SA for each nanoparticle	The coupling rate of SA (%)
200	0	12.93±1.39	-15.6±0.87	---	---	
200	50	13.35±0.59	-15±2.72	10.8	0.12	21.6
200	100	15.01±0.04	-8.53±0.13	57.71	0.6	57.71
200	200	15.62±1.46	-5.31±0.44	162.66	1.75	81.33
200	300	14.62±0.63	-6.13±0.59	232.69	2.5	77.56
200	400	14.73±0.33	-6.56±1.84	232.17	2.5	58.04

The number of SA coupled on the surface of PEG@Fe$_3$O$_4$ nanoparticles was measured and calculated as follows:

$$M_{Fe_3O_4} = \frac{4}{3}\pi r^3 \rho_{Fe_3O_4}$$

$$N_{Fe_3O_4} = \frac{m_{Fe_3O_4}}{M_{Fe_3O_4}}$$

$$N_{SA} = \frac{m_{SA}}{M_{SA}}$$

$$R_{SA/Fe_3O_4} = \frac{N_{SA}}{N_{Fe_3O_4}}$$

Where $M_{Fe_3O_4}$ represents the relative molecular mass of one Fe$_3$O$_4$ nanoparticle. r is the radius size of nanoparticles. $\rho_{Fe_3O_4}$ is the density of the Fe$_3$O$_4$. $m_{Fe_3O_4}$ and m_{SA} are the quantity of iron oxide and SA respectively. M_{SA} is the relative molecular mass of SA which is 66 KDa. N_{SA} and

$N_{Fe_3O_4}$ are the number of SA and Fe_3O_4 nanoparticle. R_{SA/Fe_3O_4} is the number of SA for each Fe_3O_4 nanoparticle.

Table S2. The number of antibody coupled on the Fe_3O_4 nanoparticles.

	Fe_3O_4 nanoparticle (μg) (in terms of Fe)	CD20 anitbody (μg)	CD3 antibody (μg)	Coupled antibody (μg)	The number of antibody for each nanoparticle
CD20@Fe_3O_4	500	1500	0	1250	~2.64
CD20&CD3@Fe_3O_4	500	750	750	1200	~2.55

The number of antibody coupled on the surface of SA@Fe_3O_4 nanoparticles was measured and calculated as follows:

$$M_{Fe_3O_4} = \frac{4}{3}\pi r^3 \rho_{Fe_3O_4}$$

$$N_{Fe_3O_4} = \frac{m_{Fe_3O_4}}{M_{Fe_3O_4}}$$

$$N_{antibody} = \frac{m_{antibody}}{M_{antibody}}$$

$$R_{antibody/Fe_3O_4} = \frac{N_{antibody}}{N_{Fe_3O_4}}$$

Where $M_{Fe_3O_4}$ represents the relative molecular mass of one Fe_3O_4 nanoparticle. r is the radius size of nanoparticles. $\rho_{Fe_3O_4}$ is the density of the Fe_3O_4. $m_{Fe_3O_4}$ and m_{SA} are the quantity of iron oxide and SA respectively. $M_{antibody}$ is the average molecular mass of CD20 and CD3 antibody which is 140 KDa. $N_{antibody}$ and $N_{Fe_3O_4}$ are the number of antibody and Fe_3O_4 nanoparticle. $R_{antibody/Fe_3O_4}$ is the number of antibody for each Fe_3O_4 nanoparticle.

Table S3. The relaxation properties of different test samples.

Type	r_1 (mM^{-1}s^{-1})	r_2 /r_1
PEG@Fe_3O_4	8.15	3.58
SA@Fe_3O_4	7.06	4.21
CD20&CD3@Fe_3O_4	5.27	4.36
Magnevist	4.52	—

Table S4. The median survival time of mice with different treatment groups.

Type	PBS	T cell	CD20&CD3@Fe$_3$O$_4$	T cell+ CD20&CD3@Fe$_3$O$_4$
Median survival (day)	39	40	56	69
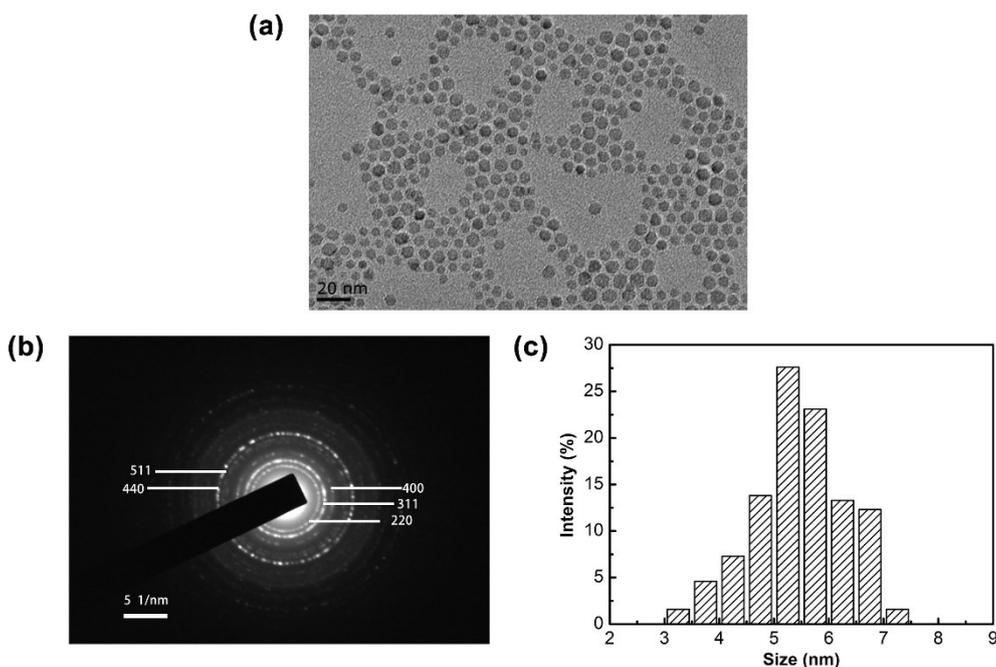
Figure S1. (a)TEM image and (b) electron diffraction pattern of OAm@Fe$_3$O$_4$, (c) a size distribution histogram of OAm@Fe$_3$O$_4$ in TEM imaging. (D$_{TEM}$ = 5.5±0.6 nm).
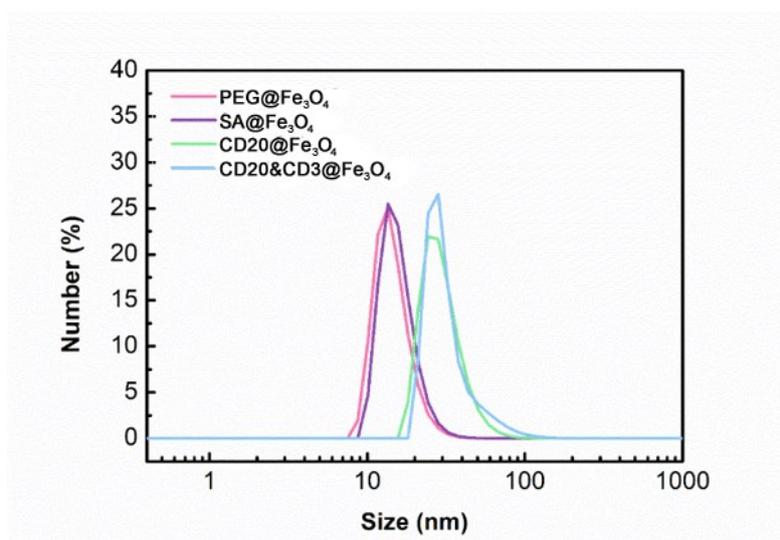
Figure S2. The hydrodynamic size of Fe$_3$O$_4$ nanoparticles with different surface modification.
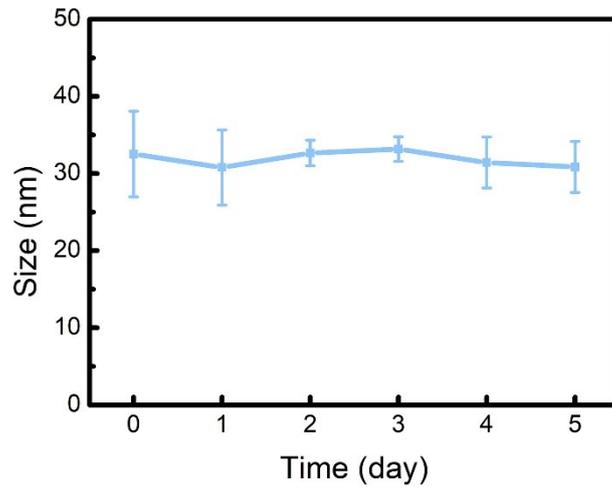
Figure S3. The stability of BSNP
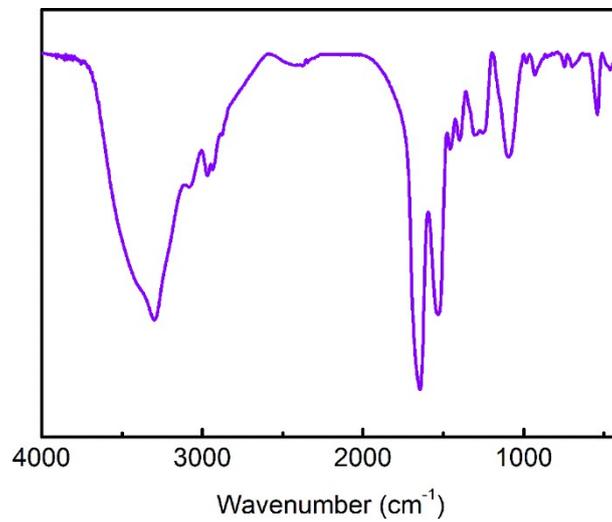
Figure S4. The IR spectra of SA.
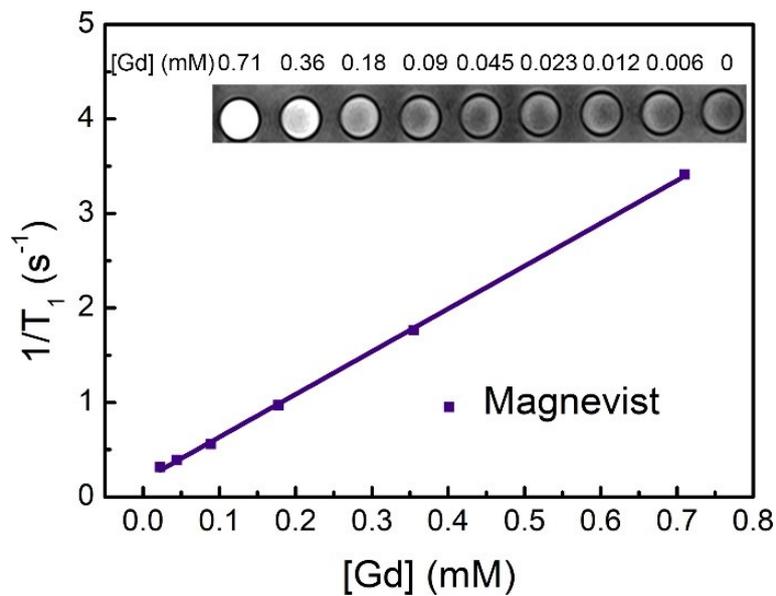
Figure S5. Plot of $1/T_1$ against Gd concentration of Magnevist in water under 3.0 T MR scanner (The slope of the corresponding linear fit was the relaxivity). The inner image is T_1-weighted MR images of Magnevist with different Gd concentrations in water.
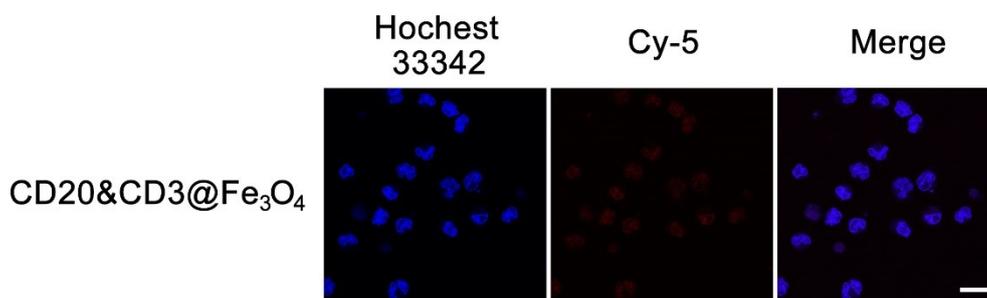
Figure S6. The laser confocal image of living Raji cells co-cultured with BSNP(The scale bar is 50 μm).
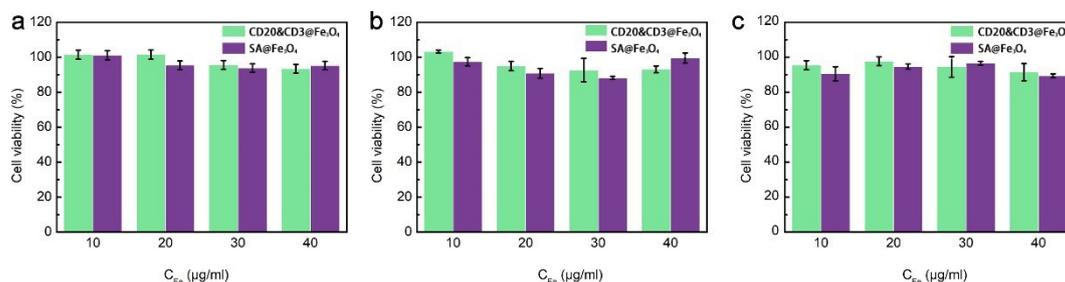
Figure S7. Cell viabilities of K562 cells incubated with different concentration of SA@Fe$_3$O$_4$ and CD20@Fe$_3$O$_4$ for (a) 24 hours, (b) 48 hours, and (c) 72 hours.
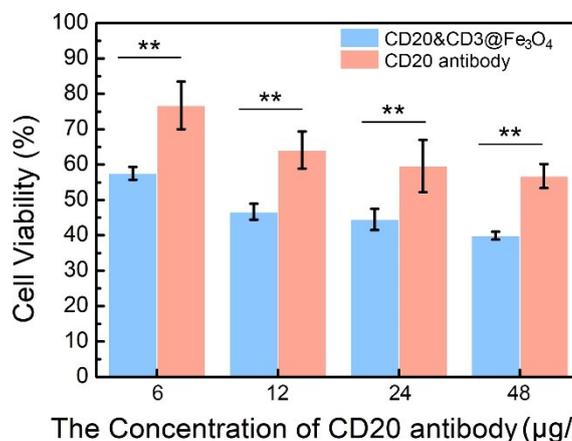
Figure S8. Cell viabilities of Raji cells incubated with different antibody concentration of CD20&CD3@Fe$_3$O$_4$ and CD20 antibody for 24 hours.
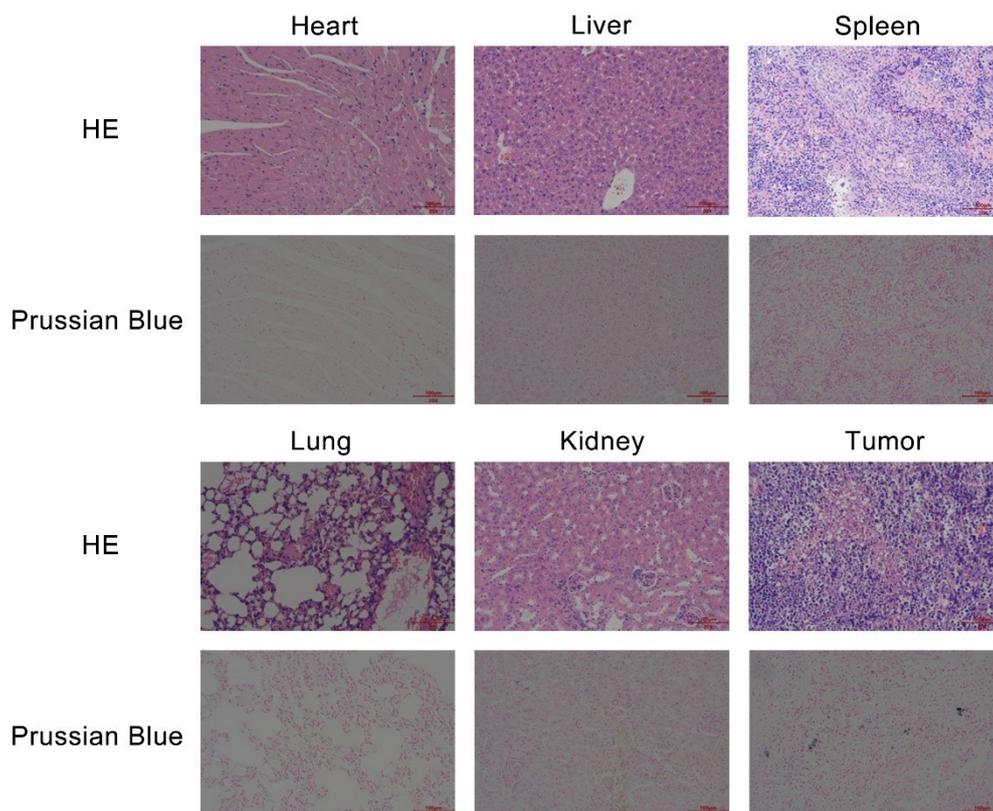
Figure S9. The histochemical staining and Prussian blue staining images of tumor and organs. (The scale bar is 100 μm)
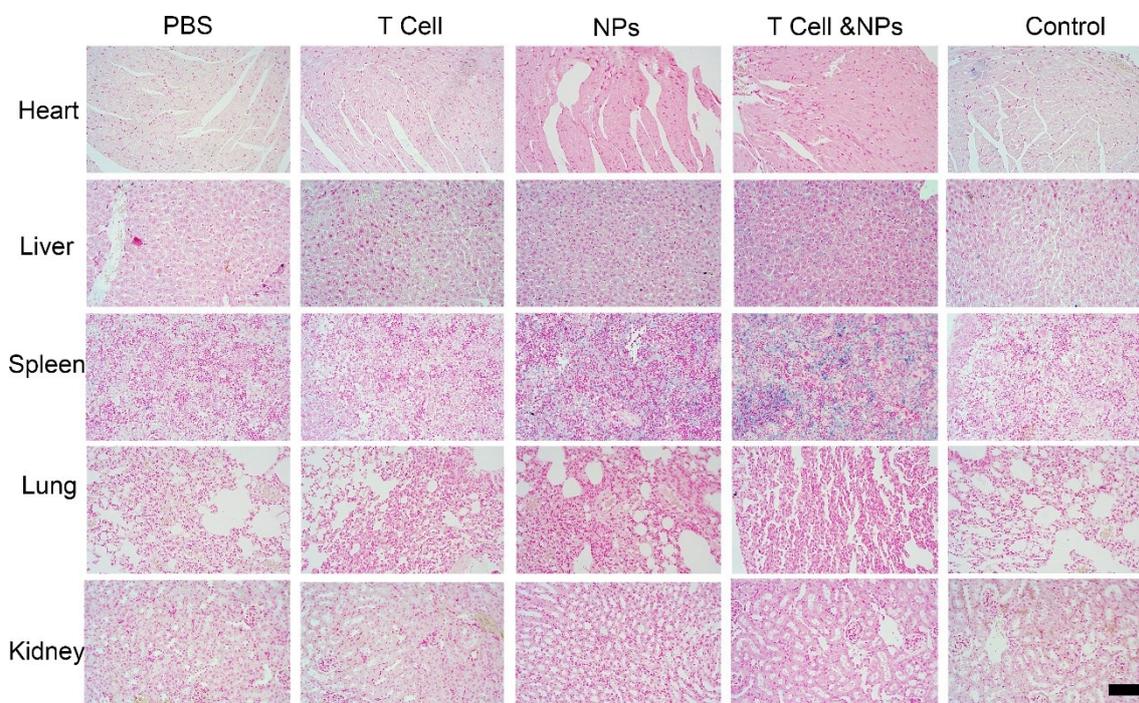
Figure S10. The Prussian blue staining images of organs with different treatment groups. (The scale bar is 100 μm, NPs represents BSNP, Control is the slides of healthy mice)
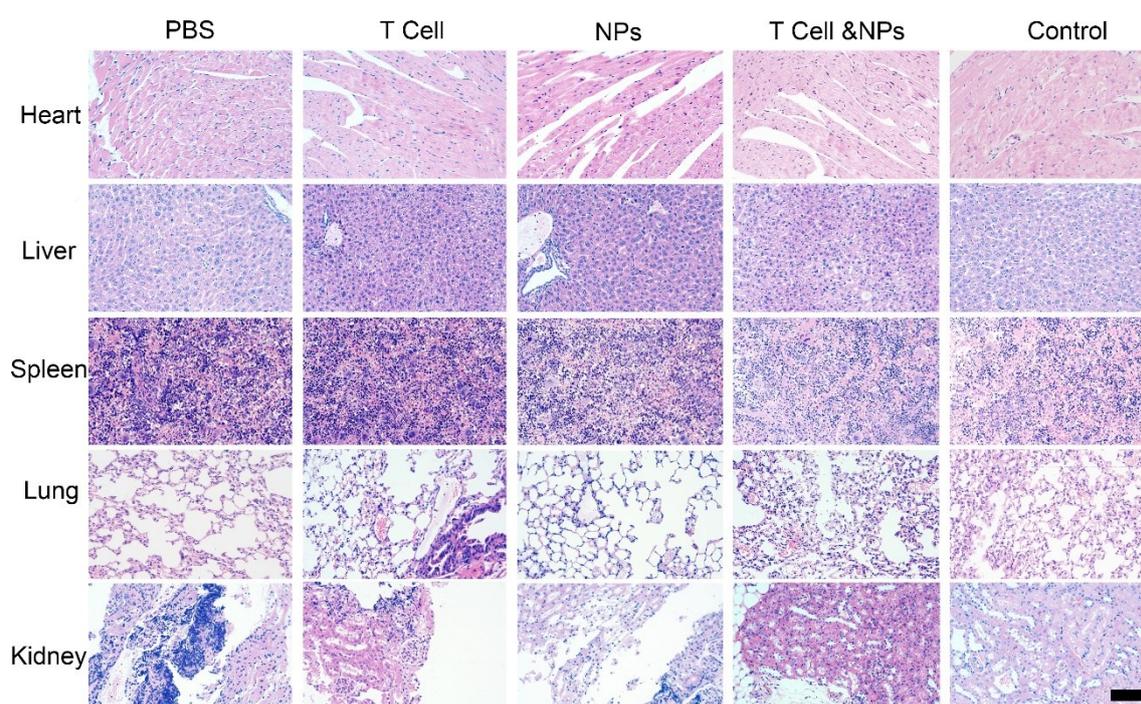
Figure S11. The histochemical staining images of organs with different treatment groups. (The scale bar is 100 μm, NPs represents BSNP, Control is the slides of healthy mice).