

## Supporting Information

Biomimetic polysaccharide-cloaked lipidic  
nanovesicles/microassemblies improve the enzymatic activity  
and prolong the action time for hyperuricemia treatment

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### **Supplementary Table S1-S10**

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**Table S1.** Entrapment efficiency, size, polydispersity index and zeta potential of UHLN and UHLNM.

Formulation	Entrapment efficiency (%)	Size	Polydispersity index	Zeta potential (mV)
UHLN	57.27 ± 3.93	322.60 ± 8.2 nm	0.24 ± 0.027	-19.37 ± 1.80
UHLNM	62.48 ± 3.87	27.00 ± 1.12 μm	-	-23.50 ± 8.57

Notes: data were presented as mean ± standard deviation (n=3).

**Table S2.** Fluorescence changes of Uase and BHLN and BHLNM.

Formulation	$\lambda_{\max}^a$	$F_1^b$	$F_1^c$	$F_1^b - F_1^c$
Uase	330 nm	872.195	-	-
BHLN	325 nm	-	107.533	764.662
Uase+BHLN	327 nm	-	979.728	-107.533
Uase	330 nm	872.195	-	-
BHLNM	365 nm	-	100.730	771.465
Uase+BHLNM	330 nm	-	972.925	-100.73

<sup>a</sup>Fluorescence maximum wavelength of Uase, BHLN, BHLNM and their mixture

<sup>b</sup>Fluorescence intensity of Uase at maximum wavelength

<sup>c</sup>Fluorescence intensity of BHLN, BHLNM and their mixture (Uase+BHLN or Uase+BHLNM) at maximum wavelength

**Table S3.** FITC fluorescence changes of Uase, UHLN and UHLNM were induced by heat treatment at 25°C and 55°C.

Formulation	25°C		55°C			$F_1^b - F_1^c$
	$\lambda_{\max}^a$	$F_1^b$	Formulation	$\lambda_{\max}^a$	$F_1^c$	
Uase	519 nm	717.767	Uase	520 nm	531.295	186.472
UHLN	522 nm	783.496	UHLN	520 nm	731.444	52.052
UHLNM	521 nm	790.895	UHLNM	520 nm	778.141	12.754

<sup>a</sup>Fluorescence maximum wavelength of Uase, UHLNX

<sup>b</sup>Fluorescence intensity of Uase and UHLNX at maximum wavelength when treated at 25°C

<sup>c</sup>Fluorescence intensity of Uase and UHLNX at maximum wavelength when treated at 55°C

**Table S4.** Fluorescence intensity at maximum wavelength when the mixture of Uase and BSA was set at different ratios.

Uase			Mixture of Uase and BSA			F <sub>3</sub> <sup>e</sup>
Concentration	$\lambda_{\max}$ <sup>a</sup>	F <sub>1</sub> <sup>b</sup>	Ratio (BSA:Uase)	$\lambda_{\max}$ <sup>c</sup>	F <sub>2</sub> <sup>d</sup>	
-	-	-	1:0 (BSA 1.0 $\mu$ M)	340 nm	129.540	-
0.5 $\mu$ M	332 nm	143.263	1:0.5	335 nm	255.077	272.803
1.0 $\mu$ M	329 nm	299.790	1:1.0	333 nm	395.433	429.330
1.5 $\mu$ M	332 nm	421.945	1:1.5	334 nm	533.739	551.485
2.0 $\mu$ M	331 nm	555.033	1:2.0	334 nm	637.283	684.573
2.5 $\mu$ M	330 nm	702.846	1:2.5	331 nm	772.700	832.386
3.0 $\mu$ M	330 nm	771.515	1:3.0	333 nm	863.311	901.055
3.5 $\mu$ M	330 nm	872.195	1:3.5	333 nm	934.539	1001.735

<sup>a</sup>Fluorescence maximum wavelength of Uase

<sup>b</sup>Fluorescence intensity of Uase at maximum wavelength

<sup>c</sup>Fluorescence maximum wavelength of BSA or the mixture of Uase and BSA

<sup>d</sup>Fluorescence intensity of mixture of Uase and BSA at maximum wavelength

<sup>e</sup>Fluorescence intensity of Uase plus fluorescence intensity of BSA at maximum wavelength

**Table S5.** Fluorescence intensity at maximum wavelength when the mixture of UHLN and BSA was set at different ratios.

UHLN			Mixture of UHLN and BSA			F <sub>3</sub> <sup>e</sup>
Concentration	$\lambda_{\max}$ <sup>a</sup>	F <sub>1</sub> <sup>b</sup>	Ratio (BSA:UHLN)	$\lambda_{\max}$ <sup>c</sup>	F <sub>2</sub> <sup>d</sup>	
-	-	-	1:0 (BSA 1.0 $\mu$ M)	340 nm	129.540	-
0.5 $\mu$ M	332 nm	203.566	1:0.5	331 nm	234.444	333.106
1.0 $\mu$ M	332 nm	312.642	1:1.0	330 nm	338.334	442.482
1.5 $\mu$ M	330 nm	411.609	1:1.5	331 nm	433.256	541.149
2.0 $\mu$ M	332 nm	479.060	1:2.0	330 nm	480.278	608.600
2.5 $\mu$ M	331 nm	513.922	1:2.5	332 nm	516.274	643.462
3.0 $\mu$ M	329 nm	527.409	1:3.0	328 nm	549.269	656.949
3.5 $\mu$ M	329 nm	556.486	1:3.5	331 nm	588.517	686.060

<sup>a</sup>Fluorescence maximum wavelength of UHLN

<sup>b</sup>Fluorescence intensity of UHLN at maximum wavelength

<sup>c</sup>Fluorescence maximum wavelength of BSA or the mixture of UHLN and BSA

<sup>d</sup>Fluorescence intensity of mixture of UHLN and BSA at maximum wavelength

<sup>e</sup>Fluorescence intensity of UHLN plus fluorescence intensity of BSA at maximum wavelength

**Table S6.** Fluorescence intensity at maximum wavelength when the mixture of UHLNM and BSA was set at different ratios.

UHLNM			Mixture of UHLNM and BSA			F <sub>3</sub> <sup>e</sup>
Concentration	$\lambda_{\max}$ <sup>a</sup>	F <sub>1</sub> <sup>b</sup>	Ratio(BSA:UHLNM)	$\lambda_{\max}$ <sup>c</sup>	F <sub>2</sub> <sup>d</sup>	
-	-	-	1:0 (BSA 1.0 $\mu$ M)	340 nm	129.540	-
0.5 $\mu$ M	331 nm	167.514	1:0.5	331 nm	250.267	297.054
1.0 $\mu$ M	330 nm	265.625	1:1.0	333 nm	311.586	395.165
1.5 $\mu$ M	331 nm	320.58	1:1.5	331 nm	361.899	450.12
2.0 $\mu$ M	331 nm	367.362	1:2.0	329 nm	381.593	496.902
2.5 $\mu$ M	328 nm	381.879	1:2.5	329 nm	416.263	511.419
3.0 $\mu$ M	329 nm	399.533	1:3.0	330 nm	421.516	529.073
3.5 $\mu$ M	328 nm	412.663	1:3.5	328 nm	427.745	542.203

<sup>a</sup>Fluorescence maximum wavelength of UHLNM

<sup>b</sup>Fluorescence intensity of UHLNM at maximum wavelength

<sup>c</sup>Fluorescence maximum wavelength of BSA or the mixture of UHLNM and BSA

<sup>d</sup>Fluorescence intensity of mixture of UHLNM and BSA at maximum wavelength

<sup>e</sup>Fluorescence intensity of UHLNM plus fluorescence intensity of BSA at maximum wavelength

**Table S7.** Fluorescence intensity at maximum wavelength when the mixture of BHLN and BSA was set at different ratios.

BHLN			Mixture of BHLN and BSA			F <sub>3</sub> <sup>e</sup>
Concentration	$\lambda_{\max}$ <sup>a</sup>	F <sub>1</sub> <sup>b</sup>	Ratio (BSA:BHLN)	$\lambda_{\max}$ <sup>c</sup>	F <sub>2</sub> <sup>d</sup>	
-	-	-	1:0 (BSA 1.0 $\mu$ M)	340 nm	129.540	-
0.5 $\mu$ M	325 nm	36.828	1:0.5	334 nm	113.328	166.368
1.0 $\mu$ M	322 nm	60.717	1:1.0	336 nm	119.813	190.257
1.5 $\mu$ M	328 nm	71.429	1:1.5	332 nm	123.716	200.969
2.0 $\mu$ M	326 nm	81.786	1:2.0	327 nm	126.436	211.326
2.5 $\mu$ M	328 nm	91.928	1:2.5	327 nm	131.391	221.468
3.0 $\mu$ M	329 nm	97.161	1:3.0	329 nm	131.429	226.701
3.5 $\mu$ M	325 nm	107.533	1:3.5	327 nm	135.443	237.073

<sup>a</sup>Fluorescence maximum wavelength of BHLN

<sup>b</sup>Fluorescence intensity of BHLN at maximum wavelength

<sup>c</sup>Fluorescence maximum wavelength of BSA or the mixture of BHLN and BSA

<sup>d</sup>Fluorescence intensity of mixture of BHLN and BSA at maximum wavelength

<sup>e</sup>Fluorescence intensity of BHLN plus fluorescence intensity of BSA at maximum wavelength

**Table S8.** Fluorescence intensity at maximum wavelength when the mixture of BHLNM and BSA was set at different ratios.

BHLNM			Mixture of BHLNM and BSA			F <sub>3</sub> <sup>e</sup>
Concentration	$\lambda_{\max}$ <sup>a</sup>	F <sub>1</sub> <sup>b</sup>	Ratio(BSA:UHLNM)	$\lambda_{\max}$ <sup>c</sup>	F <sub>2</sub> <sup>d</sup>	
-	-	-	1:0 (BSA 1.0 $\mu$ M)	340 nm	129.540	-
0.5 $\mu$ M	330 nm	46.184	1:0.5	333 nm	95.902	175.724
1.0 $\mu$ M	359 nm	53.127	1:1.0	332 nm	103.229	182.667
1.5 $\mu$ M	290 nm	63.155	1:1.5	335 nm	109.762	192.695
2.0 $\mu$ M	290 nm	73.192	1:2.0	332 nm	113.652	202.732
2.5 $\mu$ M	365 nm	84.659	1:2.5	332 nm	114.085	214.199
3.0 $\mu$ M	367 nm	93.589	1:3.0	328 nm	117.809	223.129
3.5 $\mu$ M	365 nm	100.73	1:3.5	365 nm	120.829	230.270

<sup>a</sup>Fluorescence maximum wavelength of BHLNM

<sup>b</sup>Fluorescence intensity of BHLNM at maximum wavelength

<sup>c</sup>Fluorescence maximum wavelength of BSA or the mixture of BHLNM and BSA

<sup>d</sup>Fluorescence intensity of mixture of BHLNM and BSA at maximum wavelength

<sup>e</sup>Fluorescence intensity of BHLNM plus fluorescence intensity of BSA at maximum wavelength

**Table S9.** Fluorescence intensity at maximum wavelength when the mixture of Uase, BHLN and BSA was set at different ratios.

BHLN+Uase			Mixture of BHLN, Uase and BSA			F <sub>3</sub> <sup>e</sup>
Concentration	$\lambda_{\max}$ <sup>a</sup>	F <sub>1</sub> <sup>b</sup>	Ratio (BSA:BHLN:Uase)	$\lambda_{\max}$ <sup>c</sup>	F <sub>2</sub> <sup>d</sup>	
-	-	-	1:0 (BSA 1.0 $\mu$ M)	340 nm	129.540	-
0.5 $\mu$ M	332 nm	180.091	1:0.5:0.5	332 nm	234.270	498.368
1.0 $\mu$ M	329 nm	360.507	1:1.0:1.0	330 nm	305.048	490.047
1.5 $\mu$ M	332 nm	493.374	1:1.5:1.5	330 nm	337.505	622.914
2.0 $\mu$ M	331 nm	636.819	1:2.0:2.0	330 nm	371.111	766.359
2.5 $\mu$ M	330 nm	794.774	1:2.5:2.5	331 nm	400.263	924.314
3.0 $\mu$ M	330 nm	868.676	1:3.0:3.0	330 nm	410.817	998.216
3.5 $\mu$ M	330 nm	979.728	1:3.5:3.5	327 nm	433.156	1109.270

<sup>a</sup>Fluorescence maximum wavelength of BHLN and Uase

<sup>b</sup>Fluorescence intensity of BHLN and Uase at maximum wavelength

<sup>c</sup>Fluorescence maximum wavelength of BSA or the mixture of BHLN, Uase and BSA

<sup>d</sup>Fluorescence intensity of mixture of BHLN, Uase and BSA at maximum wavelength

<sup>e</sup>Fluorescence intensity of BHLN and Uase plus fluorescence intensity of BSA at maximum wavelength

**Table S10.** Fluorescence intensity at maximum wavelength when the mixture of Uase, BHLNM and BSA was set at different ratios.

BHLNM+Uase			Mixture of BHLNM, Uase and BSA			
Concentration	$\lambda_{\max}^a$	$F_1^b$	Ratio (BSA:BHLN:Uase)	$\lambda_{\max}^c$	$F_2^d$	$F_3^e$
-	-	-	1:0 (BSA 1.0 $\mu\text{M}$ )	340 nm	129.540	-
0.5 $\mu\text{M}$	336 nm	189.447	1:0.5:0.5	336 nm	217.134	318.987
1.0 $\mu\text{M}$	329 nm	352.917	1:1.0:1.0	329 nm	288.718	482.457
1.5 $\mu\text{M}$	333 nm	485.100	1:1.5:1.5	333 nm	342.155	614.64
2.0 $\mu\text{M}$	330 nm	628.225	1:2.0:2.0	330 nm	374.712	757.765
2.5 $\mu\text{M}$	328 nm	787.505	1:2.5:2.5	328 nm	407.303	917.045
3.0 $\mu\text{M}$	329nm	865.104	1:3.0:3.0	329 nm	412.373	994.644
3.5 $\mu\text{M}$	330 nm	972.925	1:3.5:3.5	330 nm	423.418	1102.470

<sup>a</sup>Fluorescence maximum wavelength of BHLNM and Uase

<sup>b</sup>Fluorescence intensity of BHLNM and Uase at maximum wavelength

<sup>c</sup>Fluorescence maximum wavelength of BSA or the mixture of BHLNM, Uase and BSA

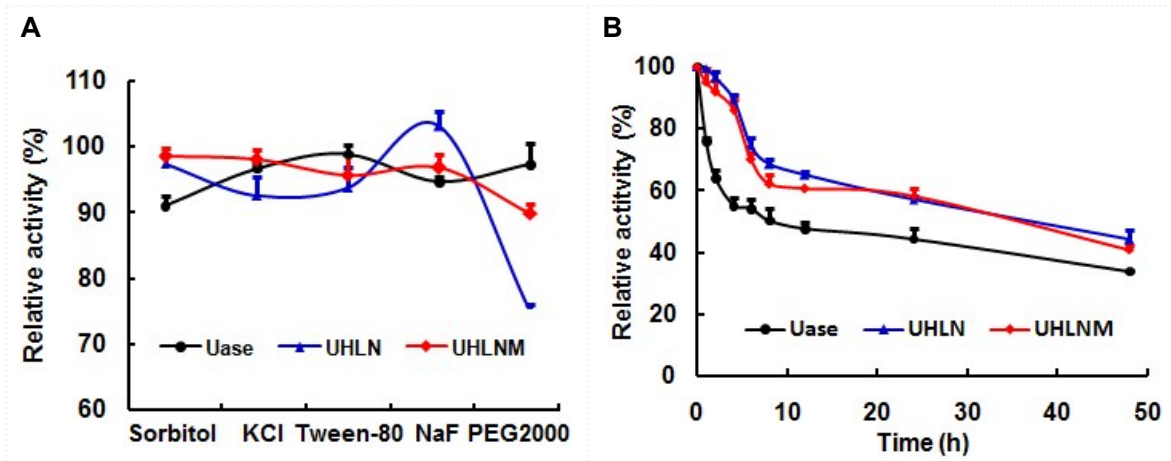
<sup>d</sup>Fluorescence intensity of mixture of BHLNM, Uase and BSA at maximum wavelength

<sup>e</sup>Fluorescence intensity of BHLNM and Uase plus fluorescence intensity of BSA at maximum wavelength

## **Supplementary Figure S1**

**Figure S1. Effects of exterior factors on the catalytic activities of Uase, UHLN and UHLNM.**





**Figure S1. Effects of exterior factors on the catalytic activities of Uase, UHLN and UHLNM.** The effects of (A) chemical agents (chemical stabilities) and (B) plasma (physiological stabilities) of Uase, UHLN and UHLNM. The original activity of Uase, UHLN and UHLNM was taken as 100%. The data were presented as mean  $\pm$  standard deviation, n = 3.