## A single-cell based mass cytometry study on heterogeneous interactions between upconversion nanoparticles and human immune cells

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Figure S1. The manual gating strategy.

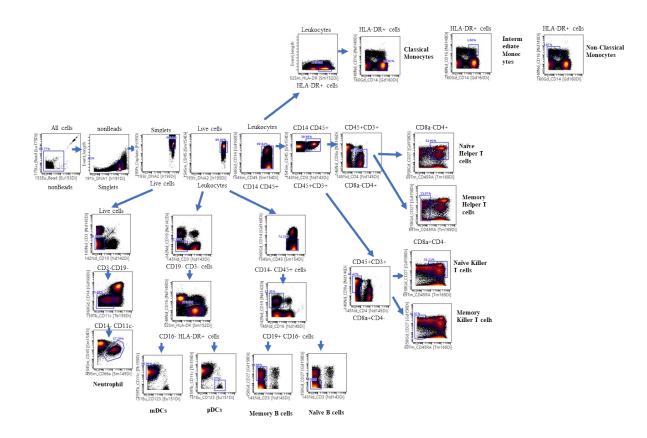


Figure S2. Zeta potential analysis of UCNP@Polymer

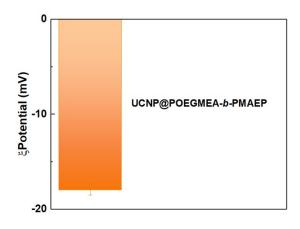


Table S1. Statistic of cell type identification in untreated, 0.5, 1, and 2 ppm of UCNP@Polymer. data was presented in mean and standard deviation.

	Untreated		0.5	ppm	1 p	pm	2ppm	
	Value	Error	Value	Error	Value	Error	Value	Error
mDCs	25.67	1.28	24.84	1.24	45.06	2.25	39.50	1.97
Classical monocytes	23.84	1.19	22.01	1.10	12.83	0.64	12.25	0.61
Naive B cells	5.76	0.29	4.93	0.25	2.93	0.15	3.13	0.16
Memory killer T cells	4.10	0.21	4.47	0.22	3.29	0.16	3.37	0.17
Naive killer T cells	3.91	0.20	3.43	0.17	2.81	0.14	3.14	0.16
Memory B cells	3.21	0.16	3.13	0.16	3.23	0.16	3.62	0.18
Naive helper T cells	3.01	0.15	1.40	0.07	0.73	0.04	1.09	0.05
Memory helper T cells	2.80	0.14	2.67	0.13	1.66	0.08	1.87	0.09
Non-classical monocytes	1.14	0.06	1.53	0.08	1.98	0.10	2.13	0.11
Intermediate monocytes	0.38	0.02	0.22	0.01	0.21	0.01	0.16	0.01
Neutrophils	0.28	0.01	0.18	0.01	0.11	0.01	0.11	0.01
pDCs	0.27	0.01	0.43	0.02	0.47	0.02	0.48	0.02

	CDI	ഹം	^		•	•			•	b .09	oba HL	.DR D	ile Ob	RA	
	Ó	13 M	<sup>1</sup> 0	1A OB	a co	19 CD3	0	* (D <sup>8</sup>	<sup>58</sup> (D)	° 0	ob NA		1 0	р <sup>г</sup> М	arker
	.0										Ŵ			ex	pression
PG #1-	0	0	0	0	0	0	0	0	5.5	1.2	374.0	234.0	8.7		Â
PG #2-	0	0	0	0 0	0	0	0	ŏ	2.4	1.0	262.0	276.0	11.6		
PG #3-		0.3	4.7	8.9	0.6	1.5	6.3	1.1	2.2	0.8	152.0	114.0	3.3		
	2.3	1.0	157.0	66.6	0.7	2.2	3.4	1.5	3.7	0.9	229.0	172.0	4.3		
PG #5-	0.3	0.5	1.2	1.7	1.1	2.1	0.5	3.6	212.0	0.9	7.4	11.3	448.0		4500
PG #6-	0.3	0.5	1.4	1.9	1.4	2.5	0.8	96.4	233.0	0.9	7.5	57.3	371.0	-	- 1500
PG #6	0.3	164.0	1.9	1.4	2.3	192.0	1.5	470.0	4.8	1.1	25.3	4.2	75.1		
PG #8		0.9	1.3	1.6	2.2	164.0	1.4	439.0	5.2	1.0	21.2	4.7	316.0		
PG #9-		0.5	1.4	1.8	1.3	2.4	0.6	4.5	239.0	1.0	7.7	70.2	359.0		
PG #10-		3.0	1.2	2.1	147.0	2.5	0.4	1.2	3.9	3.3	904.0	0.9	663.0		
PG #11		0.4	1.2	1.5	1.2	2.3	0.7	65.7	206.0	0.9	6.3	6.5	443.0		
PG #12-		1.0	1.7	1.8	2.4	306.0	0.9	53.7	8.5	1.2	27.4	11.6	1584.0		
PG #13-		97.1	1.6	2.0	180.0	2.6	0.4	1.5	3.8	4.5	608.0	14.2	1250.0		
PG #14-		103.0	1.7	1.3	3.5	490.0	1.1	3.2	5.4	1.2	28.7	6.5	67.4		
PG #15-		0.7	1.4	1.6	2.2	232.0	97.8	24.3	4.1	1.1	20.2	3.2	313.0		
PG #16-		4.3	1.3	15.6	3.0	382.0	1.0	2.7	35.8	1.1	18.9	18.7	53.2		
PG #17-	0.3	161.0	2.0	1.6	2.4	243.0	1.2	255.0	6.4	1.1	25.2	7.5	1139.0	-	- 1000
PG #18-	6.1	1.4	184.0	111.0	1.5	3.9	3.4	1.9	4.5	1.2	335.0	188.0	72.1		
PG #19-		0.6	6.0	31.9	0.9	2.9	10.4	2.1	4.3	2.4	1724.0	541.0	24.8		
PG #20		0.6	32.2 1.9	144.0	1.3 2.2	2.8 239.0	5.6	2.8 21.7	202.0 4.4	7.7	598.0 15.3	475.0 3.3	155.0		
		$\frac{110.0}{1.1}$	1.9	$\frac{1.6}{2.4}$	2.2	239.0	$\frac{110.0}{1.1}$	21.7	4.4	$\frac{1.6}{1.1}$	15.5 36.7	5.5 60.1	150.0 631.0		
PG #22	0.4	63.3	1.5	2.4	3.5	456.0	1.1	60.4	10.1	1.1	20.8	8.2	69.3		
PG #23 -		1.4	1.3	1.6	1.9	197.0	105.0	5.7	3.7	1.1	37.0	8.2 2.8	4.1		
PG #25		125.0	1.5	2.0	0.8	2.3	0.5	34.9	75.3	0.9	11.9	40.2	405.0		
PG #26-		326.0	3.1	1.3	2.9	337.0	89.9	5.0	4.9	2.2	7.7	4.6	625.0		
PG #27		0.4	4.6	561.0	0.6	2.1	10.4	1.4	2.6	1.2	249.0	200.0	8.5		
PG #28-		86.5	17.8	282.0	2.7	228.0	32.3	224.0	8.5	1.7	65.2	35.8	453.0		
PG #29-	0.2	277.0	2.4	1.6	1.6	178.0	0.8	5.0	3.9	1.2	27.8	5.6	787.0	-	- 500
PG #30-		2.5	1.9	2.7	1.1	2.8	0.3	8.4	5.8	0.8	11.5	32.7	267.0		
PG #31-		0.4	1.1	27.8	0.7	2.2	18.3	2.1	3.9	0.9	518.0	5.6	375.0		
PG #32-		2.4	2.2	325.0	1.6	4.2	1.0	36.0	190.0	1.2	10.0	29.5	394.0		
PG #33 -	1.2	69.7	3.1	4.6	4.7	279.0	22.6	228.0	223.0	3.3	37.7	46.6	788.0		
PG #34	0.9	0.7	5.6	12.2	4.1	6.6	1.6	2.9	127.0	243.0	8.1	22.1	142.0		
PG #35-		12.1	3.7	9.7	435.0	4.9	1.8	1.7	4.2	2.1	1339.0	321.0	297.0		
PG #36-		0.4	4.1	45.0	2.1	4.5	0.3	1.3	4.8	4.0	5.3	10.5	22.3		
PG #37 -		60.8	2.1	369.0	161.0	5.3	0.4	1.5	5.7	4.3	764.0	10.2	993.0		
PG #38-	1.5	100.0	2.3	5.4	163.0	270.0	18.6	197.0	12.5	6.3	769.0	11.7	1172.0		
PG #39-		38.0	2.6	3.7	172.0	5.2	1.5	44.4	271.0	5.7	766.0	45.5	1222.0		
PG #40-	4.3	2.0	156.0	134.0	2.4	6.2	5.3	55.2	190.0	2.5	262.0	187.0	433.0		0

Figure S3. Heatmap showing marker expression in PhenoGraph clusters of total live cells.

					L				
	Untreated		0.5 p		1 pp		2ppm		
7.0111	Value	Error	Value	Error	Value	Error	Value	Error	
PG#1	17.116	0.8558	11.122	0.5561	6.9	0.345	6.63	0.3315	
PG#2	0.05	0.0025	0.122	0.0061	14.26	0.713	13.026	0.6513	
PG#3	0.15	0.0075	0.48	0.024	13.544	0.6772	12.16	0.608	
PG#4	4.994	0.2497	9.61	0.4805	4.71	0.2355	3.734	0.1867	
PG#5	6.41	0.3205	8.132	0.4066	3.686	0.1843	4.08	0.204	
PG#6	6.164	0.3082	5.484	0.2742	4.934	0.2467	5.094	0.2547	
PG#7	5.058	0.2529	5.41	0.2705	4.316	0.2158	4.544	0.2272	
PG#8	3.98	0.199	5.08	0.254	4.268	0.2134	4.676	0.2338	
PG#9	4.77	0.2385	4.614	0.2307	3.458	0.1729	3.504	0.1752	
PG#10	5.378	0.2689	4.418	0.2209	2.518	0.1259	2.648	0.1324	
PG#11	4.524	0.2262	4.972	0.2486	2.588	0.1294	2.76	0.138	
PG#12	4.174	0.2087	4.478	0.2239	2.72	0.136	3.014	0.1507	
PG#13	3.554	0.1777	3.374	0.1687	3.532	0.1766	3.818	0.1909	
PG#14	3.702	0.1851	4.142	0.2071	3.014	0.1507	2.974	0.1487	
PG#15	4.024	0.2012	3.826	0.1913	2.796	0.1398	2.952	0.1476	
PG#16	3.626	0.1813	4.08	0.204	2.654	0.1327	2.628	0.1314	
PG#17	3.588	0.1794	3.342	0.1671	2.304	0.1152	2.66	0.133	
PG#18	2.82	0.141	2.804	0.1402	2.048	0.1024	2.282	0.1141	
PG#19	1.446	0.0723	1.792	0.0896	3.09	0.1545	3.23	0.1615	
PG#20	1.846	0.0923	2.17	0.1085	2.302	0.1151	2.432	0.1216	
PG#21	2.948	0.1474	2.256	0.1128	1.348	0.0674	1.542	0.0771	
PG#22	1.144	0.0572	1.19	0.0595	1.226	0.0613	1.18	0.059	
PG#23	1.042	0.0521	1.188	0.0594	0.982	0.0491	1.01	0.0505	
PG#24	1.084	0.0542	1.252	0.0626	0.858	0.0429	0.936	0.0468	
PG#25	0.826	0.0413	0.952	0.0476	0.858	0.0429	0.92	0.046	
PG#26	1.806	0.0903	0.626	0.0313	0.214	0.0107	0.47	0.0235	
PG#27	0.016	0.001	0.028	0.0014	1.384	0.0692	1.072	0.0536	
PG#28	0.696	0.0348	0.42	0.021	0.53	0.0265	0.742	0.0371	
PG#29	0.634	0.0317	0.592	0.0296	0.486	0.0243	0.44	0.022	
PG#30	0.392	0.0196	0.554	0.0277	0.514	0.0257	0.6	0.03	
PG#31	0.33	0.0165	0.51	0.0255	0.476	0.0238	0.51	0.0255	
PG#32	0.63	0.0315	0.392	0.0196	0.266	0.0133	0.488	0.0244	
PG#33	0.104	0.0052	0.03	0.0015	0.41	0.0205	0.38	0.019	
PG#34	0.28	0.014	0.18	0.009	0.156	0.0078	0.172	0.0086	
PG#35	0.102	0.0051	0.126	0.0063	0.156	0.0078	0.192	0.0096	
PG#36	0.308	0.0154	0.102	0.0051	0.084	0.0042	0.062	0.0031	
PG#37	0.184	0.0092	0.122	0.0061	0.092	0.0046	0.12	0.006	
PG#38	0.064	0.0032	0.016	0.001	0.15	0.0075	0.184	0.0092	
PG#39	0.028	0.0014	0.012	0.001	0.098	0.0049	0.096	0.0048	
PG#40	0.008	0.001	0	0	0.07	0.0035	0.038	0.0019	

Table S2. Population abundance of Phenograph clustering. Summarized statistic data was presented in mean and standard deviation.