Table S1. Statistic data of fitting by different mathematical models for SEM, zeta potential and hydrodynamic size data

Sample	SEM		Zeta potential		Hydrodynamic size					
	Lognormal functions		Boltzmann functions		Lognormal functions		Extreme functions		Boltzmann functions	
	R^2	χ^2	R^2	χ^2	R^2	χ^2	R^2	χ^2	R^2	χ^2
Fe_3O_4	0.76	2.19	0.99	3.83	0.98	398.5	-	-	-	-
Fe_3O_4/APTES	0.80	0.86	0.99	3.52	-	-	0.85	607.9	-	-
Fe_3O_4/HA	0.73	3.16	0.92	6.80	-	-	-	-	0.97	172.5

Table S2. Statistics of relative enzyme bioluminescence intensity (Figure 7)

Samples	p
	Concentrations
Fe_3O_4	>0.05
Fe_3O_4/APTES	0.001
Fe_3O_4/HA	0.0001
	Comparison by sample pairs
Fe_3O_4/APTES- Fe_3O_4	0.001
Fe_3O_4/HA- Fe_3O_4	0.0001
Fe_3O_4/HA- Fe_3O_4/APTES	>0.05

Bioactivity in relation to control:

Samples	Concentrations, mg/L												
Fe_3O_4-control	2.1E-13	2.1E-12	2.1E-11	2.1E-10	2.1E-7	2.1E-6	2.1E-5	2.1E-4	2.1E-3	2.1E-2	2.1E-1	2.1E+0
	0.001	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0001											
Fe_3O_4/APTES-control	6.8E-14	6.8E-13	6.8E-12	6.8E-11	6.8E-10	6.8E-8	6.8E-7	6.8E-6	6.8E-5	6.8E-4	6.8E-3	6.8E-2	6.8E-1
	>0.05	0.0001	0.0001	0.0001	0.0001	0.001	>0.05	0.0001	0.0001	>0.05	0.0001	0.001	0.0001
	0.01												
Fe_3O_4/HA-control	8.5E-14	8.5E-13	8.5E-12	8.5E-11	8.5E-10	8.5E-9	8.5E-8	8.5E-7	8.5E-6	8.5E-5	8.5E-4	8.5E-3	8.5E-2	8.5E-1
	>0.05	>0.05	0.01	>0.05	>0.05	>0.05	>0.05	0.01	0.01	0.01	0.01	>0.05	>0.05	0.001
	>0.05												

Table S3. Statistics of relative bioluminescence intensity of enzyme system in 1,4-benzoquinone solution (Figure 9)

Samples	p	
	Concentrations	
Fe_3O_4	0.0001	
Fe_3O_4/APTES	0.0001	
Fe_3O_4/HA	0.001	
	Comparison by sample pairs	
	Concentration≤5E-06	Concentration>5E-06
Fe_3O_4/APTES- Fe_3O_4	0.01	>0.05
Fe_3O_4/HA- Fe_3O_4	>0.05	0.001
Fe_3O_4/HA- Fe_3O_4/APTES	0.01	0.001

Bioactivity in relation to control:

Samples	Concentraions, mg/L												
Fe_3O_4-control	4.7E-12	4.7E-11	4.7E-10	4.7E-9	4.7E-8	4.7E-7	4.7E-6	4.7E-5	4.7E-4	4.7E-3	4.7E-2	4.7E-1	4.7E+0
	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	0.0001	0.0001
	>0.05												
Fe_3O_4/APTES-control	1.1E-12	1.1E-11	1.1E-10	1.1E-9	1.1E-8	1.1E-7	1.1E-6	1.1E-5	1.1E-4	1.1E-3	1.1E-2	1.1E-1	1.1E+0
	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	0.01	0.01	>0.05	0.0001
	>0.05												
Fe_3O_4/HA-control	4.9E-13	4.9E-12	4.9E-11	4.9E-10	4.9E-9	4.9E-8	4.9E-7	4.9E-6	4.9E-5	4.9E-3	4.9E-2	4.9E-1	
	>0.05	>0.05	>0.05	>0.05	0.01	>0.05	>0.05	0.01	0.01	0.001	0.0001	0.0001	
	0.01												

Table S4. Statistics of relative bacterial bioluminescence intensity (Figure 6)

Samples	p
	Concentrations
Fe_3O_4	>0.05
Fe_3O_4/APTES	>0.05
Fe_3O_4/HA	0.01
	Comparison by sample pairs
Fe_3O_4/APTES- Fe_3O_4	0.01
Fe_3O_4/HA- Fe_3O_4	>0.05
Fe_3O_4/HA- Fe_3O_4/APTES	0.01

Bioactivity in relation to control:

Samples	Concentrations, mg/L										
Fe_3O_4-control	7.5E-3			7.5E-2			7.5E-1			1.9E+0	
	>0.05			0.01			0.01			0.0001	
						0.01					
Fe_3O_4/APTES-control	1E-3			1E-2		1E-1			5E-1		1E+0	
	>0.05			>0.05		>0.05			>0.05		>0.05	
						>0.05						
Fe_3O_4/HA-control	1E-5	4.6E-5	9.3E-5	4.6E-4	9.3E-4	4.6E-3	9.3E-3	4.6E-2	9.3E-2	4E-1	9E-1
	>0.05	>0.05	>0.05	>0.05	0.01	0.01	0.01	0.001	0.001	0.001	0.001
						0.001					

Table S5. Statistics of relative bioluminescence induction period in 1,4-benzoquinone solution (Figure 8)

Samples	p
	Concentrations
Fe_3O_4	>0.05
Fe_3O_4/APTES	0.01
Fe_3O_4/HA	0.0001
	Comparison by sample pairs
Fe_3O_4/APTES- Fe_3O_4	0.01
Fe_3O_4/HA- Fe_3O_4	0.01
Fe_3O_4/HA- Fe_3O_4/APTES	>0.05

Bioactivity in relation to control:

Samples	Concentrations, mg/L												
Fe_3O_4-control	4.7E-12	4.7E-11	4.E-10	4.7E-9	4.E-8	4.E-7	4.E-6	4.E-5	4.E-4	4.7E-3	4.7E-2	4.7E-1	4.7E+0
	0.01	0.01	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05
	>0.05												
Fe_3O_4/APTES-control	1.1E-12	1.1E-11	1E-10	1E-9	1E-8	1E-7	1E-6	1E-5	1E-4	1.1E-3	1.1E-2	1.1E-1	1.1E+0
	>0.05	>0.05	0.01	0.01	>0.05	0.01	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	0.01
	0.01												
Fe_3O_4/HA-control	4.9E-13	4.9E-12	4.9E-11	4.9E-10	4.9E-9	4.9E-8	4.9E-7	4.9E-6	4.9E-5	4.9E-4	4.9E-3	4.9E-2	4.9E-1
	>0.05	>0.05	>0.05	>0.05	0.01	0.01	0.01	0.01	0.001	0.01	0.01	0.01	0.0001
	0.01												

Table S6. Microstructure of MNPs

Sample	**Fe_3O_4**			**Fe_3O_4/APTES**			**Fe_3O_4/HA**		
hkl [1]	**2Q**, ° [2]	**d,** Å [3]	**FWHM**, ° [4]	**2Q**, °	**d,** Å	**FWHM**, °	**2Q**, °	**d,** Å	**FWHM**, °
220	45.60	2.971	3.877(5)	45.61	2.959	1.790(1)	45.67	2.966	1.591(2)
311	53.98	2.535	1.445(2)	54.01	2.525	1.870(1)	54.01	2.535	1.344(7)
400	66.28	2.094	2.558(2)	66.41	2.095	2.980(2)	66.36	2.094	1.401(2)
422	84.25	1.714	5.912(6)	84.37	1.711	1.870(5)	84.25	1.714	1.483(2)
511	90.77	1.610	1.541(2)	90.68	1.609	2.749(5)	90.71	1.612	1.792(3)
440	101.52	1.476	2.248(7)	101.6	1.479	0.860(4)	101.4	1.476	1.591(2)
a, Å [5]		8.383(2)			8.372(1)			8.382(6)	
X [6]		0.387(7)			0.290(3)			0.382(1)	
δ [7]		0.059(4)			0.117(2)			0.062(7)	
Structure		$Fe_{2,94}O_4$			$Fe_{2,88}O_4$			$Fe_{2,93}O_4$	
D XRD, nm [8]		6.9±2.4			9.6±1.4			10.3±1.3	
CV, % [9]		34			14.5			12.6	
D SEM, nm [10]		32.1±4.3			24.18±2.8			34.75±4.3	
CV, %		13.5			11.6			12.45	

[1] hkl – Miller indexes.
[2] Q – angle at which the reflex was measured.
[3] d – interplanar distance.
[4] FWHM – full width at half maximum of XRD reflex.
[5] a – interplanar distance.
[6] X – the Fe^{2+}/Fe^{3+} ratio.
[7] δ – calculated value, which range from zero (stoichiometric magnetite) to 1/3 (completely oxidized).
[8] D XRD – average particle size calculated by the Scherrer equation ± standard deviation.
[9] CV – coefficient of variation characterizing the polydispersity of the system.
[10] D SEM – average particle size calculated by the SEM ± standard deviation.

Table S7. Statistic data of fitting by different mathematical models

			Fe_3O_4		
	Lorenz function	**Gauss function**	**Voigt function**	**Pseudo-Voigt function**	**PearsonVII function**
R^2	0.90868	0.90211	0.90956	0.90989	0.90965
χ^2	11.54172	12.37203	11.43064	11.38935	11.41964
			Fe_3O_4/APTES		
R^2	0.90834	0.91022	0.91136	0.91105	0.9116
χ^2	51.12376	50.77037	50.12376	50.3012	49.99087
			Fe_3O_4/HA		
R^2	0.93461	0.93082	0.93592	0.93612	0.93606
χ^2	10.46463	11.07169	10.25538	10.22408	10.2392