## SUPPORTING INFORMATION

## One-step Nucleotide-programmed Growth of Porous Upconversion Nanoparticles: Application to Cell Labeling and Drug Delivery\*\*

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Figure S1 The SEM (a) and TEM (b) images of the UCNPs prepared without the nucleotide.



**Figure S2** The photographs of the UCNPs dispersed in aqueous solution (a); HEPES buffer (pH 7.4) (b); HEPES buffer (pH 5.0) (c); the media for cell culture (d).



Figure S3 Dynamic light scattering (DLS) curve of UCNPs dispersed in different media.



**Figure S4** SEM images of the products obtained with different molar ratio of GMP/lanthanide ions (a) 1/10, (b) 1/4, (c) 1/2, and (d) 1/1.



**Figure S5** FT-IR spectra of GMP (a), GMP with the addition of lanthanide ions (b), GMP with the addition of lanthanide ions and NaF before the hydrothermal treatment (c). Transitions marked with stars are assigned in Table S1. Changes in wavenumbers of phosphate, C-N stretching vibrations of 5'-GMP were observed after complexation with lanthanide ions and NaYF<sub>4</sub>:20%Yb, 2%Er nanoparticles. They indicate that both of phosphate and nucleobase moieties in 5'-GMP are involved in the coordination bonds.



Figure S6 Low (a) and high magnification (b) TEM micrographs of UCNPs prepared with  $HPO_4^{2^2}$ .



Figure S7 SEM images of UCNPs synthesized with G nucleoside.



**Figure S8** SEM images of the UCNPs obtained at different reaction times: before adding NaF (a), adding NaF for 1 min (b), 3 min (c), 6 min (d), 10 min (e) and 140 °C for 24 h (f).



Figure S9 UV-Vis spectra of the supernatant of solution at different stage of the reaction.



**Figure S10** Low (a) and high magnification TEM micrographs of UCNPs prepared with GMP before the hydrothermal treatment.



**Figure S11** High-resolution XPS (a) C 1s, (b) N 1s, (c) O 1s, (d) P 2p from UCNPs prepared with GMP before the hydrothermal treatment. Shifts of the binding energies in the N 1s (397 eV) and O 1s (537 eV) spectrum indicated that these nucleotides interactions with the nanoparticle surface may occur through the nitrogen atoms in the bases and oxygen atoms in the phosphate.



**Figure S12** TGA analysis of product synthesized without nucleotide (a) and with GMP (b) before the hydrothermal process.



Figure S13 FT-IR spectra of NaYF<sub>4</sub>: Yb/Er nanoparticles after the hydrothermal treatment.



**Figure S14** Representative TEM images of UCNPs prepared by using (a) AMP, (b) CMP and (c) UMP as additive.



**Figure S15** The emission spectrum (a) and wide-angle XRD pattern (b) of UCNP obtained with AMP, CMP, GMP and UMP.

lected materials	
Pore volume	Average pore size
(cm <sup>3</sup> g <sup>-1</sup> )	(nm)
	Pore volume (cm <sup>3</sup> g <sup>-1</sup> )

		(cm g)	
UCNP-PO <sub>4</sub> <sup>3-</sup>	19.91	0.109	7.1
UCNP-GMP	15.76	0.107	6.1
UCNP-AMP	14.81	0.101	6.2

UCNP-CMP	16.1	0.112	7.3
UCNP-UMP	16.1	0.126	8.2

## Table S2 Changes in wavenumbers of stretching vibrations in Figure S5

	Wavenumber (cm <sup>-1</sup> )		
	v(N7-	$v_a(PO_3)$	$v_{s}(PO_{3})$
	C8)		
5'-GMP disodium salt	1490	1066	975
5'-GMP disodium salt/Lanthanide	1483	1080	988
5'-GMP disodium salt/UCNP (before hydrothermal	1483	1103	990
treatment)			