Supplementary Information

Chiral Ultrasmall Nickel Hydroxide Nanoparticles Enable Enantioselective Magnetic Resonance Imaging of Hepatocellular Carcinoma and Lung Metastases

Yu Li[a], Zefan Zhang[b], Meimei Gao[c], Jinwei Bai[b], Xuan Zhang[b], Wenyuan Cheng[b], Baodui Wang[b], Junqiang Lei[a]

[a] The First Clinical Medical College, Lanzhou University, Lanzhou 730000, China.

[b] State Key Laboratory of Applied Organic Chemistry and Key Laboratory of Nonferrous Metal Chemistry and Resources Utilization of Gansu Province, College of Chemistry and Chemical Engineering, Lanzhou University, Lanzhou, Gansu, 730000, China.

[c] Department of Pharmacy, the First Affiliated Hospital of Zhengzhou University, Zhengzhou 450052, China.

Experimental Section

Chemicals

Sodium hydroxide (NaOH, AR,96%), nickel chloride hexahydrate ($NiCl_2 \cdot 6H_2O$,AR), D-ASP (99%), L-ASP (99%) and DL-ASP (99%) were all purchased from Sigma-Aldrich (St. Louis, Missouri, USA). All aqueous solutions in the experiment were prepared using ultrapure water (≥18.25 MΩ, Milli-Q, Millipore).

Instruments

Transmission electron microscopy (TEM) was performed with a JEOL JEM-2100 (Hitachi, Tokyo, Japan) microscope operating at 200kV. The CD signals were characterized by a CHIRASCAN CD spectrometer from Applied Photophysics (Surrey, UK) with an optical path length of 1 cm. X-ray photoelectron spectra (XPS) were acquired with a Kratos Analytical Axis Ultra system (Manchester, UK). Powder X-ray powder diffraction (XRD) patterns were acquired by a Bruker D8 (Germany) equipped with a Cu Kα radiation source (40 kV, 40 mA) at a rate of 6º/min. UV-visible (UV-vis) absorption spectra were determined with a Shimadzu UV-vis 3101 spectroscope. A Magnetom skyra 3.0T(SIEMENS,Lanzhou,China) was used to obtain T1 values and T1-weighted images. Magnetic resonance imaging (MRI) processing software (SIEMENS, Lanzhou, China) was used to process the contrast ratio of the original T1-weighted images. Size distributions were determined using a Malvern Zetasizer (Malvern, UK). Confocal images were obtained using an Olympus FV1000 laser scanning confocal microscope (Tokyo, Japan).

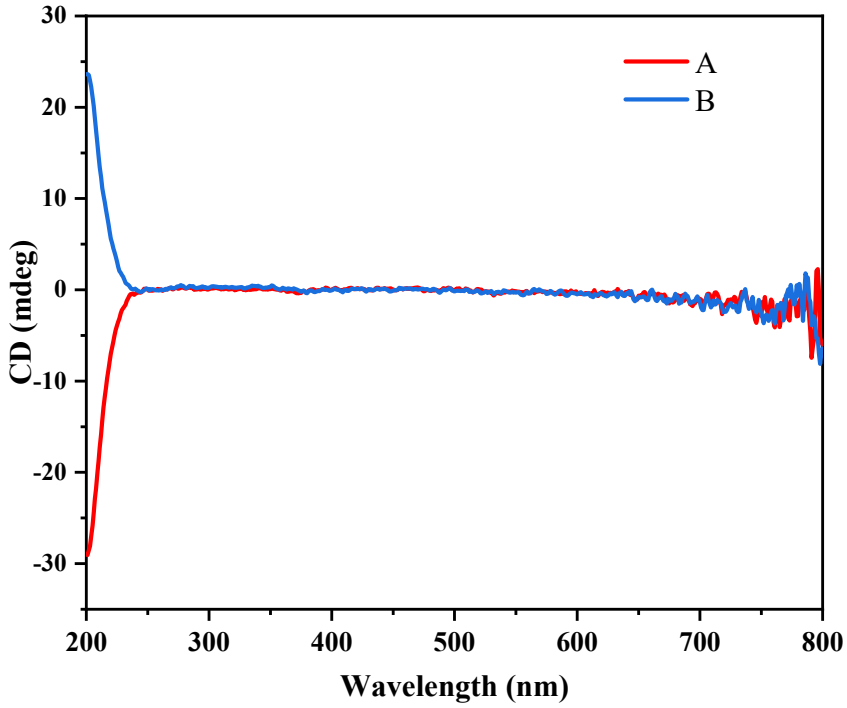

Figure S1. CD spectrum of the precursor solution. A is the precursor solution of D-Aspartic acid and nickel chloride without added NaOH, while B is the precursor solution of L-Aspartic acid and nickel chloride without added NaOH.

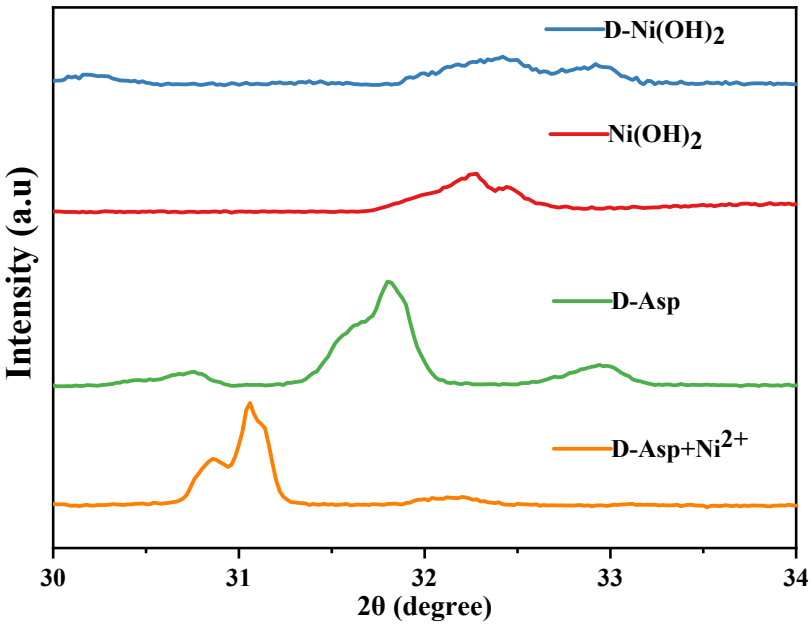

Figure S2. The XRD spectrum of chiral $Ni(OH)_2$ NPs, $Ni(OH)_2$ without chiral ligands, D-Aspartic acid and D-Aspartic acid-Ni^{2+} complexes with 2θ ranging from 30 degree to 34 degree.

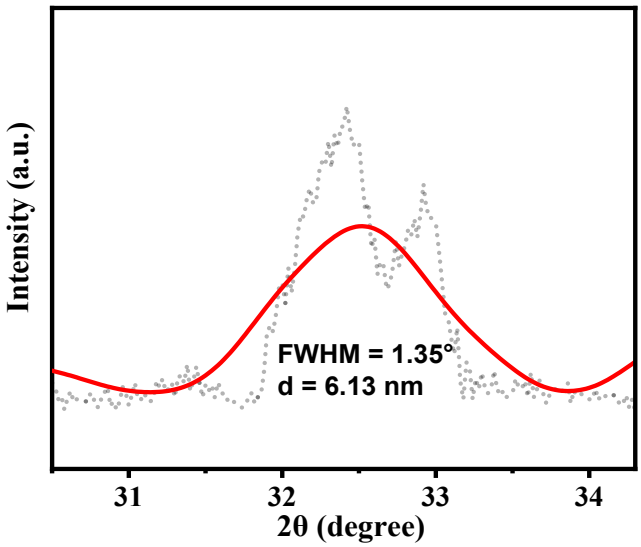

Figure S3. Grain size of D-$Ni(OH)_2$ NPs calculated using the Scherrer formula from the XRD spectrum.

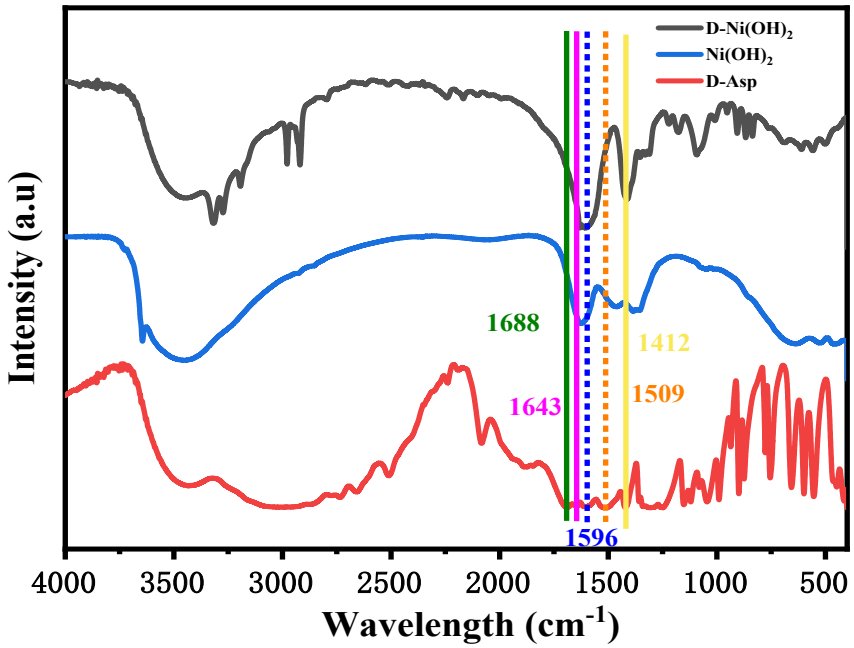

Figure S4. The infrared spectrum of chiral $Ni(OH)_2$ NPs, $Ni(OH)_2$ and D-Aspartic acid.

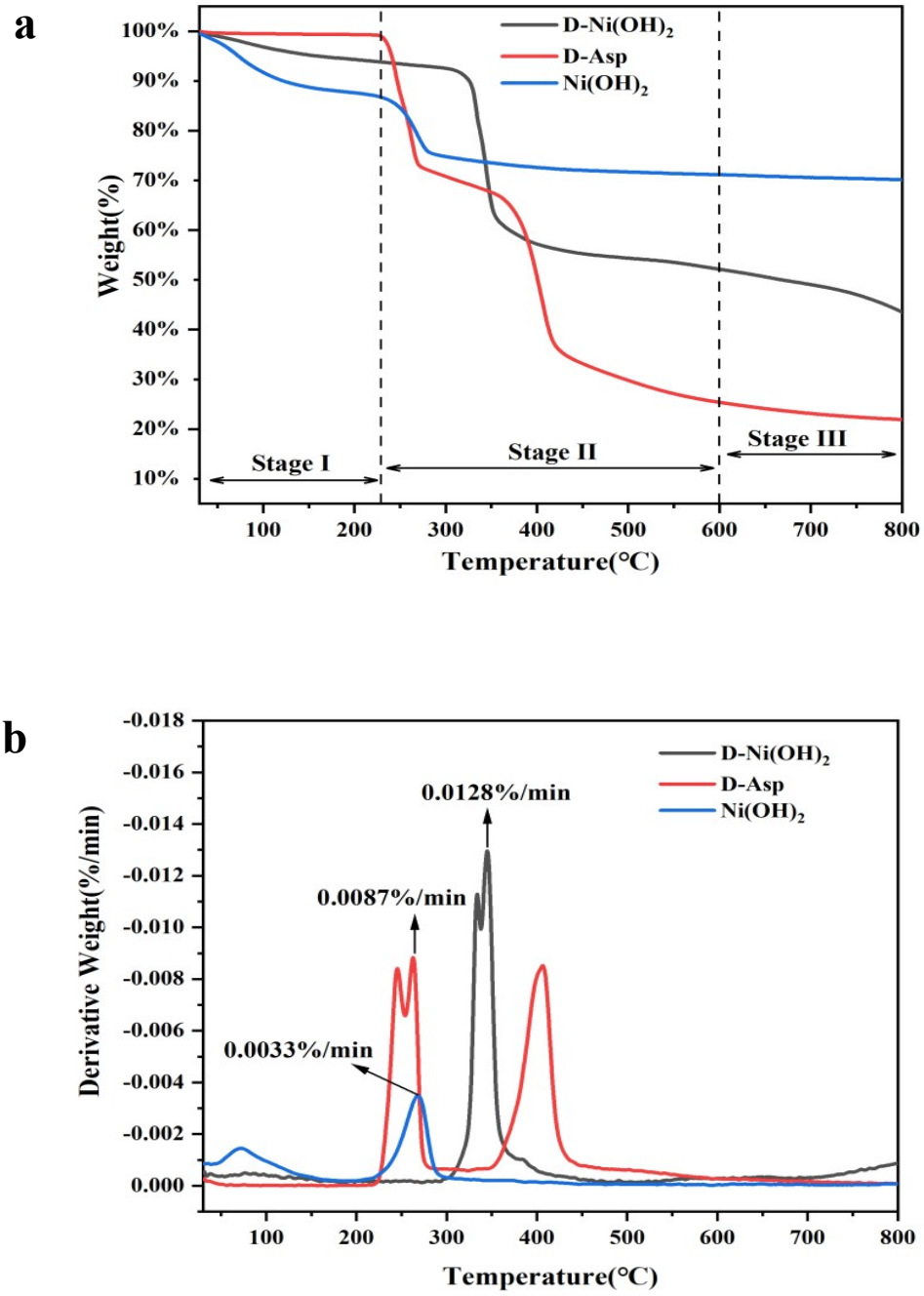

Figure S5. (a)Thermogravimetric curves of D-$Ni(OH)_2$ NPs, D-Aspartic acid and $Ni(OH)_2$. (b) Differential thermogravimetric (DTG) curves of D-$Ni(OH)_2$ NPs, D-Aspartic acid and $Ni(OH)_2$.

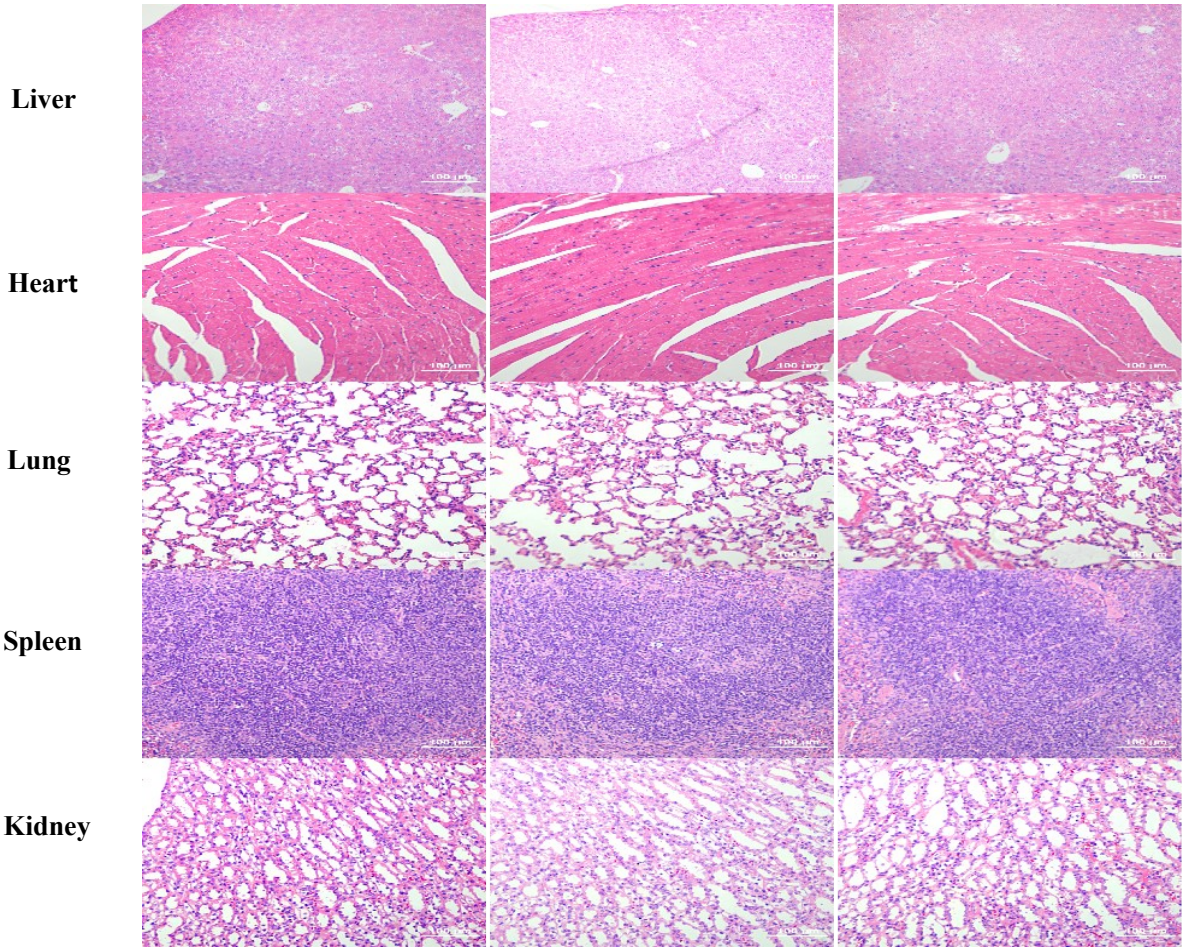

Figure S6. After 72 hours of injecting healthy mice with PBS, D-$Ni(OH)_2$ NPs, and L-$Ni(OH)_2$ NPs (20 mg/kg), HE images of different organs (liver, heart, lung, spleen, and kidney).

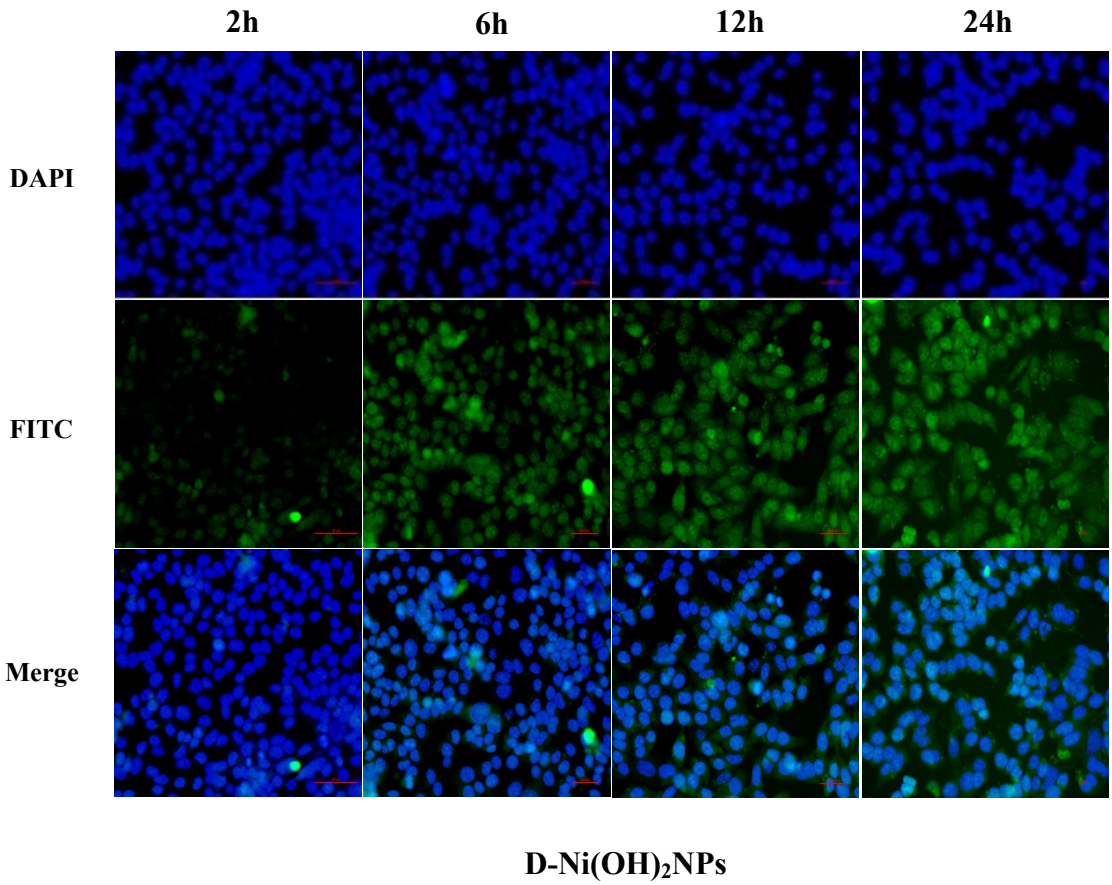

Figure S7. TPL images of Huh7 cells incubated with D-$Ni(OH)_2$ NPs at a concentration of 0.1 mg/mL for 2, 6, 12, and 24 hours.

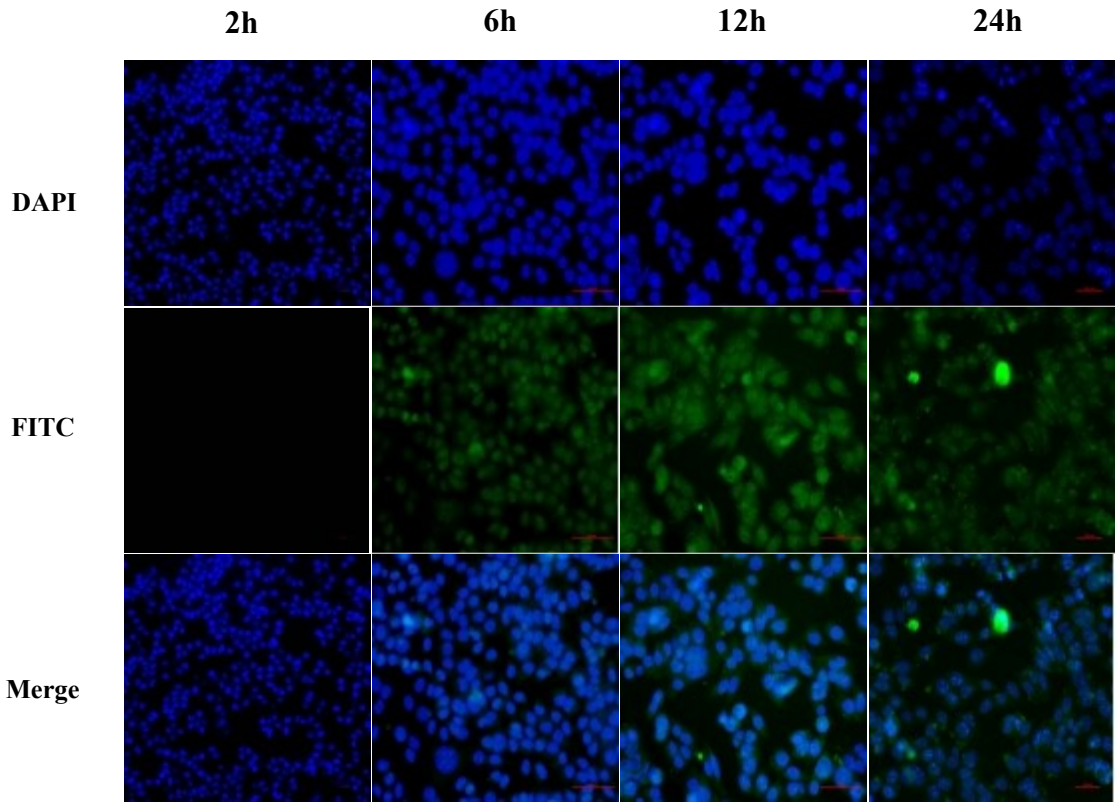

Figure S8. TPL images of Huh7 cells incubated with DL-$Ni(OH)_2$ NPs at a concentration of 0.1 mg/mL for 2, 6, 12, and 24 hours.

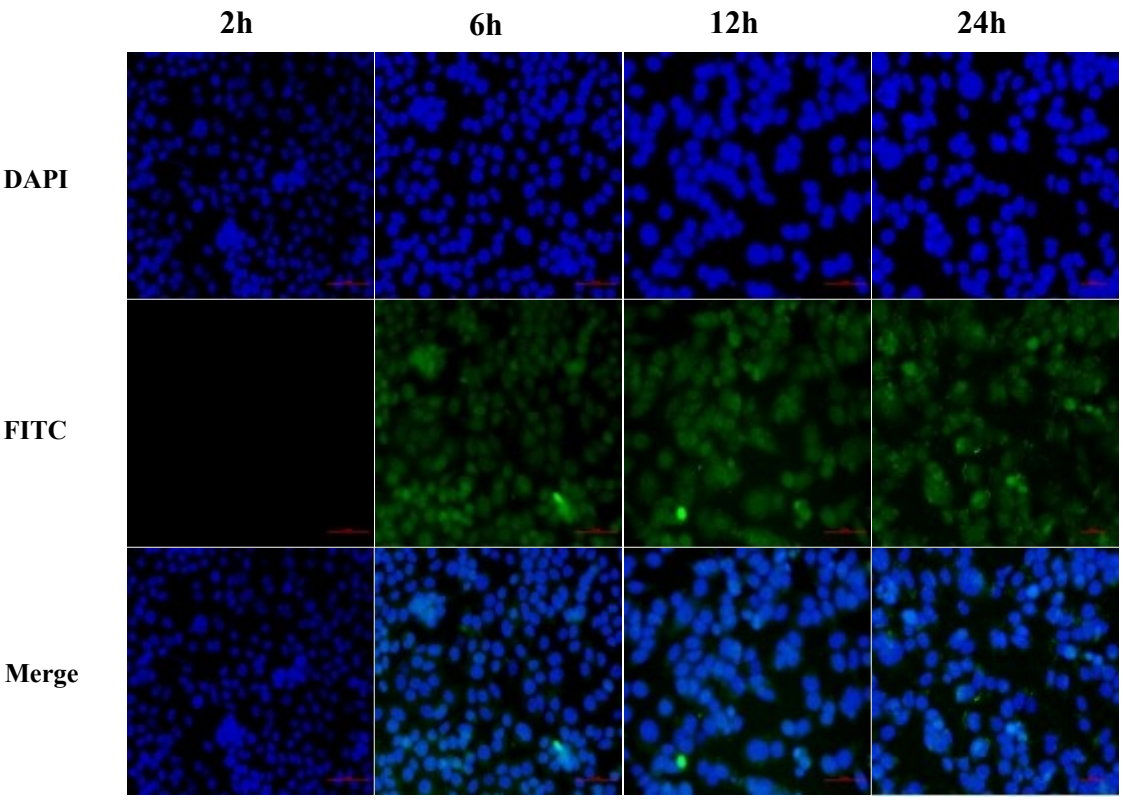

Figure S9. TPL images of Huh7 cells incubated with L-$Ni(OH)_2$ NPs at a concentration of 0.1 mg/mL for 2, 6, 12, and 24 hours.