Electronic Supplementary Material (ESI) for Analytical Methods.
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Supplementary Materials for:

Smartphone sensing of Mn(VII) and in vivo and in vitro imaging based on nitrogen-doped red fluorescent carbon dots

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Materials

Passion fruit was purchased from a local supermarket (Shanxi, China). Neutral red was gained from Shanghai Aladdin Reagent Co., Ltd. (Shanghai, China). $PbCl_2$, $CdCl_2$, $MnCl_2$, $NiCl_2$, $CuCl_2$, $CaCl_2$, $CrCl_3$, $CoCl_2$, $AlCl_3$, $MgCl_2$, $FeCl_3$, $BaCl_2$, $BiCl_3$, $ZnCl_2$, $AgNO_3$, KI, KF, $KMnO_4$, Na_2CrO_4, Na_3PO_4, $Na_2S_2O_3$, Na_2S, KSCN, Na_2SO_4, NaCl, Na_2CO_3, $NaNO_3$, NaBr, Na_2SO_3, $NaNO_2$, alanine, arginine, aspartic acid, cysteine, glutamic acid, leucine, lysine, methionine, phenylalanine, proline, threonine, tyrosine and valine were purchased from Beijing Chemical Corp (Beijing, China).

Apparatus

Transmission electron microscopy (TEM) study was carried out in a JEOL JEM-2100 instrument operating at an accelerating voltage of 200 KV. Samples for TEM measurements were obtained by placing a drop of colloidal solution on a carbon-coated copper grid and then drying at room temperature. Atomic force microscope (AFM) images were obtained by using an AFM Bruker MultiMode 8 in the contact mode. UV-vis absorption spectra were recorded through HITACHI U-2910 UV. Fluorescent (FL) spectra were operated with a Hitachi F-4500 fluorescence spectrophotometer (Tokyo, Japan). Fourier transform infrared (FTIR) spectrum was recorded on a Bruker tensor 2 spectrometer using a resolution of 4 cm^{-1}. The sample with 1 mg diluted with KBr (ratio 1:200) was pressed into the discs. X-ray photoelectron spectrometer (XPS) data were obtained with an AXIS ULTRA DLD electron spectrometer from Shimadzu Company using 300W Al Kα radiation The FL lifetime was measured by using an Edinburgh FLS920. Nanosecond FL lifetime experiments were performed using a FLS 920 time-correlated single-photon counting (TCSPC) system under right-angle sample geometry. The FL lifetime was measured using an Edinburgh FLS 920. All FL images were collected with Zeiss LSM880 confocal laser-scanning microscope.

Fluorescence QY measurements

The relative fluorescence quantum yield (Φ) of R-CDs was calculated using the equation of $\Phi_x = \Phi_{std} I_x A_{std} \eta_x^2 / (I_{std} A_x \eta_{std}^2)$. In the equation, I_x and I_{std} are FL intensities of R-CDs and the reference, respectively. A_x and A_{std} denote the optical densities of R-

CDs and the reference, respectively. η_x and η_{std} represent the refractive indices of R-CDs and reference, respectively. The absorbances of all samples in a 1.0 cm cuvette were kept under 0.050 at excitation wavelength to minimize re-absorption effects.

Cell viability assay

For cell cytotoxicity text, HeLa cells were first plated on a Costar 96-well tissue-culture cluster and cultured at 37°C with 5% CO_2 in air for 3 h to adhere cells onto the surface. The well without cells and treatment with R-CDs was taken as a zero set. The medium was then changed with 100 μL of fresh DMEM supplemented with 10% FBS containing R-CDs, and cells were allowed to grow for another 24 h. At least five parallel samples were performed in each group. Cells without treatment with R-CDs were taken as a control. After adding 20 μL of 5.0 mg mL^{-1} MTT reagent into individual well, the cells were further incubated for 4 h, followed by removing the culture medium with MTT, and then 150 μL of DMSO was added. The resulting mixture was shaken for 10 min at room temperature. The OD of the mixture was measured at 490 nm with a SunRisemicroplate reader (Tecan Austria GmbH, Grödig, Austria). The cell viability was estimated using the equation of Cell Viability (%) = $(OD_{Treated}/OD_{Control})\times100\%$, where $OD_{Control}$ and $OD_{Treated}$ were obtained in absence and presence of R-CDs, respectively.

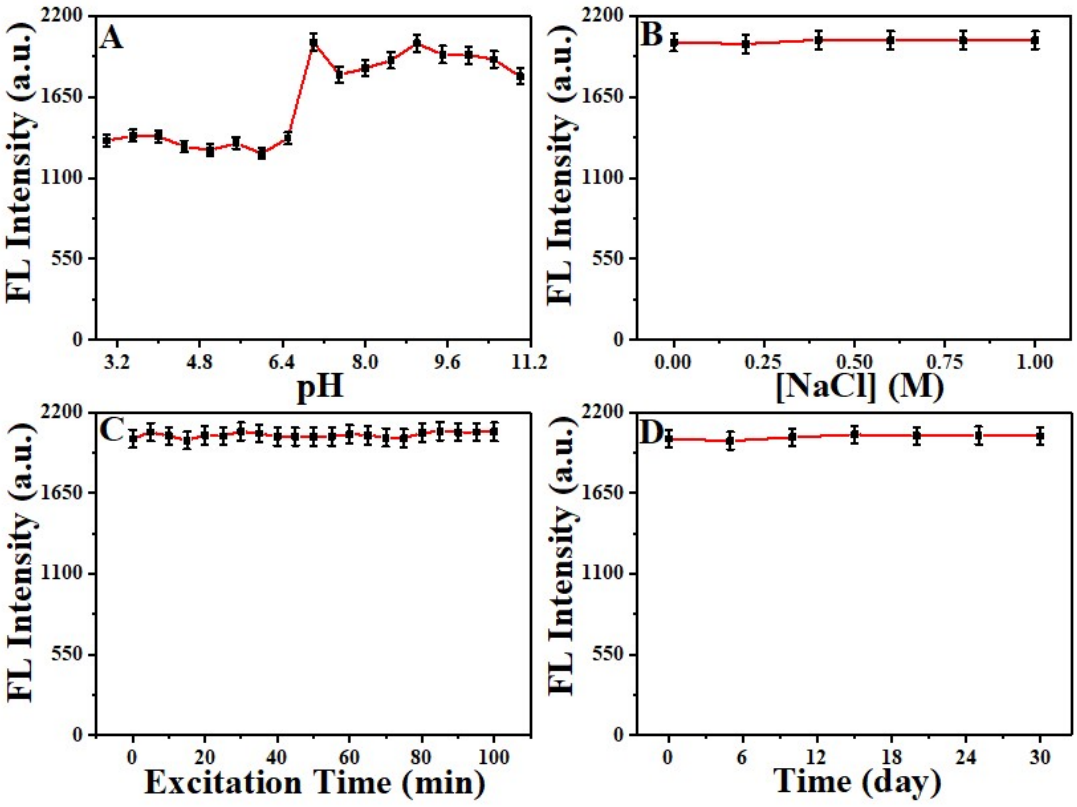

Figure S1 (A) Effect of pH on FL intensity of R-CDs. (B) Effect of NaCl concentration on FL intensity of R-CDs. (C) Effect of excitation time on FL intensity of R-CDs. (D) Effect of storage time on the FL intensity of R-CDs.

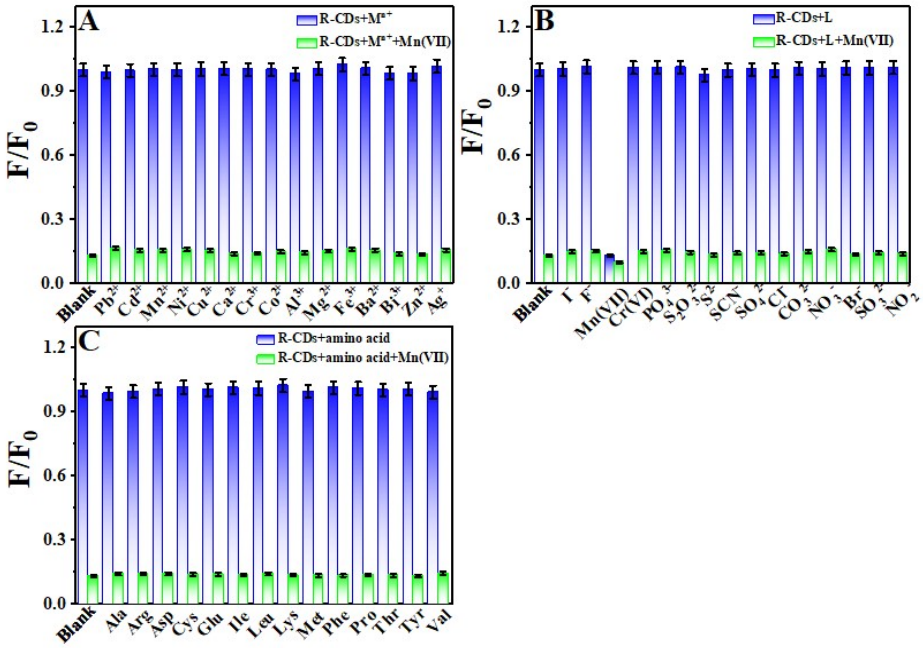

Figure S2 Selectivity of R-CDs for Mn(VII) against different metal ions, anions and

amino acids (500 μM) under pH 7.0.

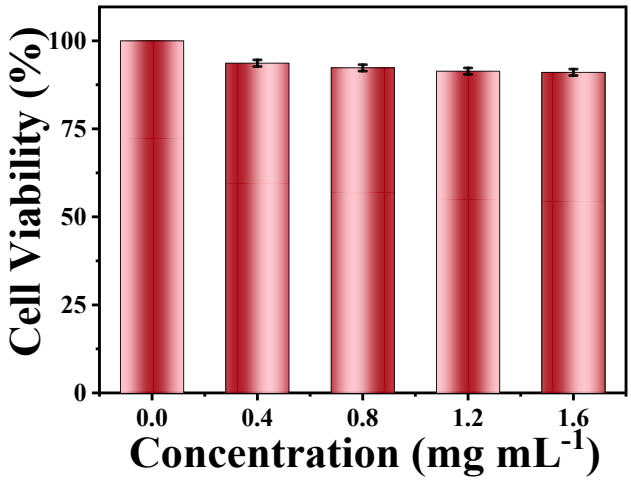

Figure S3 Cytotoxicity test of R-CDs on HeLa cells.

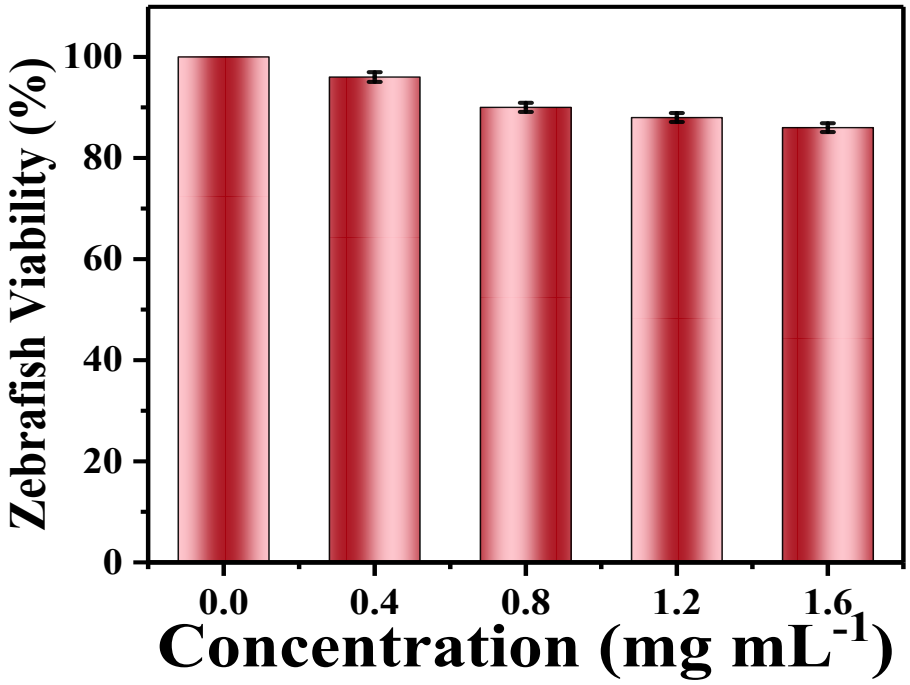

Figure S4 Cytotoxicity test of R-CDs on zebrafish larvae.

Table S1. Comparison of different FL probes for Mn(VII) detection.

Fluorescence probes	Precursor	Linear range (μM)	LOD (nM)	Ref.
NCDs	Threonine and guanidine hydrochloride	5–35	660	[1]
NCDs	Citric acid, p-hydroxybenzoic acid and ammonia	0.51–2	170	[2]
N,S,P-CQDs	Saccharomyces cerevisiae	0.05–20	50	[3]
N,P- CDs	Phthalic acid, 1,2-ethylenediamine, and concentrated phosphoric acid	10−200	48.3	[4]
N,Al-CDs	Durian shell, urea and aluminum nitrate	0–100	46.8	[5]
S,Cl,N-CQDs	1,2-ethylenediamine, glucose and sulfuric acid	0.05−110	12.8	[6]
R-CDs	Passion fruit and neutral red	20−500	10.42	This work

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