Supporting Information

for

Fabrication of multi-functional carbon dots based on "one stone, three birds" strategy and its applications for dual mode Fe^{3+} detection, effective promotion on cell proliferation and treatment on ferric toxicosis *in vitro*

Huijuan Cai,[a] Huilin Xu,[a] Hetao Chu,[a] Jianshu Li*[a,b] and Dongyue Zhang*[a,b]

[a]College of Polymer Science and Engineering, Sichuan University, Chengdu 610065, P. R. China.

[b]State Key Laboratory of Polymer Materials Engineering, Sichuan University, Chengdu 610065, P. R. China.

Figures and Tables

Fig. S1 Fluorescence spectra of the synthesized CDs under different carbonization temperatures (a), times (b) and initial feed ratios (c) of Asp/DABSA.

Fig. S2 High-resolution X-ray photoelectron spectroscopy (XPS) of (a) C1s, (b) N1s, (c) O1s and (d) S2p of the synthesized CDs.

Fig. S3 Fluorescence spectra of the synthesized CDs solution in the presence of different (a) cations, (b) anions and (c) amino acids.

Fig. S4 (a) Fluorescence quenching ratio F_0/F_q of CDs solution in the presence of different concentrations of Fe^{3+}, (b, c, d) interferent experiments and (e) fluorescence response of CDs towards different cations in a mixture.

Fig. S5 Zeta potentials of CDs (0.2 mg/mL) and CDs-Fe^{3+} (0.25 mM) in aqueous solution.

Fig. S6 UV-*vis* spectra of CDs with various concentrations of Fe^{3+}.

Fig. S7 Fluorescence decay curves of CDs, CDs-Fe^{3+}-1 (CDs: *conc.*=0.2mg/mL, Fe^{3+}: *conc.*=0.3 mM) and CDs-Fe^{3+}-2 (CDs: *conc.*=0.2mg/mL, Fe^{3+}: *conc.*=0.5 mM).

Fig. S8 Confocal images of MC3T3 cells cultured with CDs (*conc.*=200 μg/mL) for 12 h (cell nucleus was stained with DAPI).

Fig. S9 Cell viability and proliferation of L929 cells/MSCs cultured with CDs at different concentration for 24 and 72 h, respectively.

Fig. S10 Cell viability and proliferation of MC3T3 cells cultured with DABSA-180 °C at different concentrations for 24 and 72 h, respectively.

Fig. S11 Intracellular ROS generation of MC3T3 cells cultured with CDs for 72 h, using DCFH-DA as a fluorescence probe and cells cultured without CDs as control.

Fig. S12 Cell viability of MC3T3 cells cultured with different concentration of Fe^{3+} for 24 h.

Fig. S13 Optical images of MC3T3 cells cultured with (a) Fe^{3+} (500 μM) and (b) Fe^{3+}-CDs (Fe^{3+}: 500 μM, CDs: 0.1 mg/mL), scale bar=200 μm.

Fig. S14 Cell viability and proliferation of MC3T3 cells cultivated in various culture media for 24 and 72 h respectively.

Fig. S15 (a) ALP activity and (b) collage I (Col I) expression during the osteogenic differentiation of MC3T3 cells cultivated in OIM, OIM+CDs, OIM+Fe^{3+} and OIM+Fe^{3+}+CDs for 1, 3, 7 and 14 days.

Fig. S16 (a) ALP and (b) ARS staining during the osteogenic differentiation of MC3T3 cells cultivated in OIM, OIM+CDs, OIM+Fe^{3+} and OIM+Fe^{3+}+CDs for 7 and 14 days.

Table S1. Average fluorescence lifetimes of CDs and CDs-Fe^{3+}.

Table S2. Fluorescent detection of Fe^{3+} in real samples.

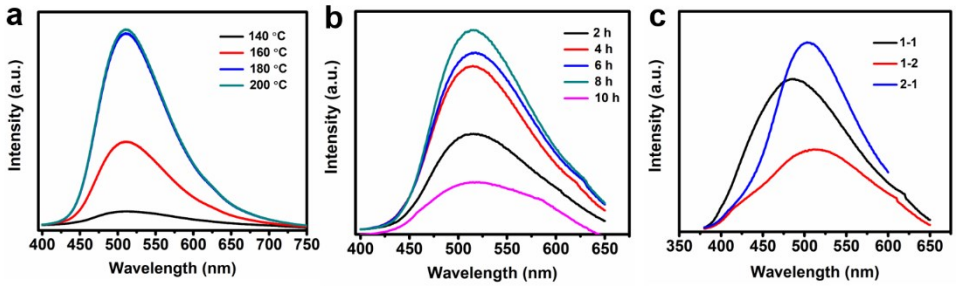

Fig. S1 Fluorescence spectra of the synthesized CDs under different carbonization (a) temperatures, (b) times and (c) initial feed ratios of Asp/DABSA (*conc.*=0.25 mg/mL).

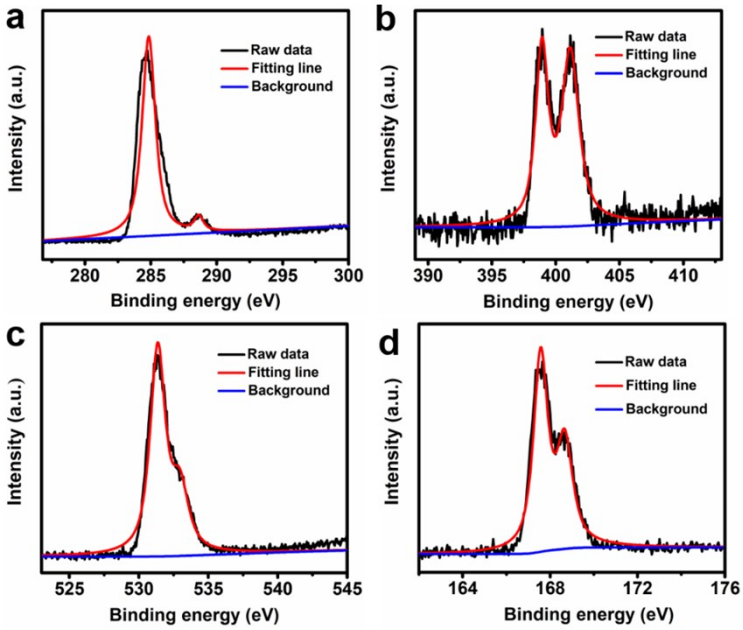

Fig. S2 High-resolution (a) C1s, (b) N1s, (c) O1s and (d) S2p *X*-ray photoelectron spectra (XPS) of the synthesized CDs.

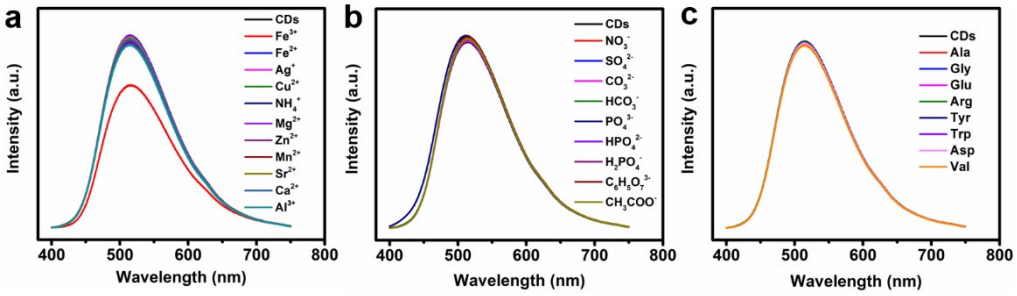

Fig. S3 Fluorescence spectra of the synthesized CDs solution (*conc.*=0.2 mg/mL) in the presence of different (a) cations (final concentration, Fe^{3+}: 50 μM, other cations: 500 μM), (b) anions and (c) amino acids (500 μM).

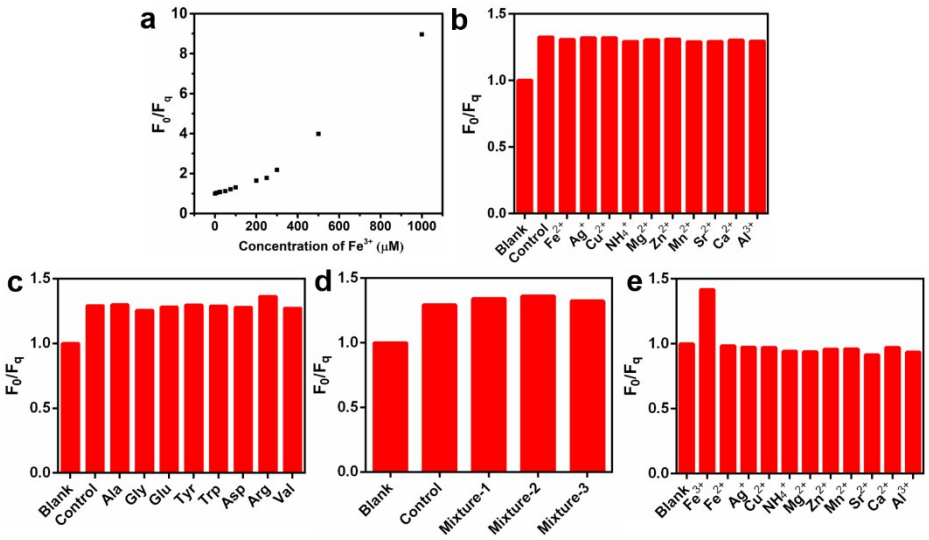

Fig. S4 (a) Fluorescence quenching ratio F_0/F_q of CDs solution (0.2 mg/mL) in the presence of different concentrations of Fe^{3+}; interferent experiment of other (b) cations (0.5 mM), (c) amino acids (Arg: 0.25 mM, other amino acids:0.5 mM) and (d) different mixtures solution (total concentration: 0.5 mM; mixture-1: Ala, Gly, Glu, Tyr, Trp, Asp, Arg, Val; mixture-2: Fe^{2+}, Cu^{2+}, NH_4^+, Mg^{2+},Sr^{2+}, Ca^{2+}, K^+, Al^{3+}; mixture-3: Zn^{2+}, Mn^{2+}) towards the detection of Fe^{3+}, where F_0 and F_q were the intensities of CDs in the absence and presence of Fe^{3+}, respectively, (e) the fluorescence response of CDs towards different cations in a mixture (total concentration: 0.25 mM), where F_0 and F_q were the intensities of CDs in the absence and presence of different cations, respectively.

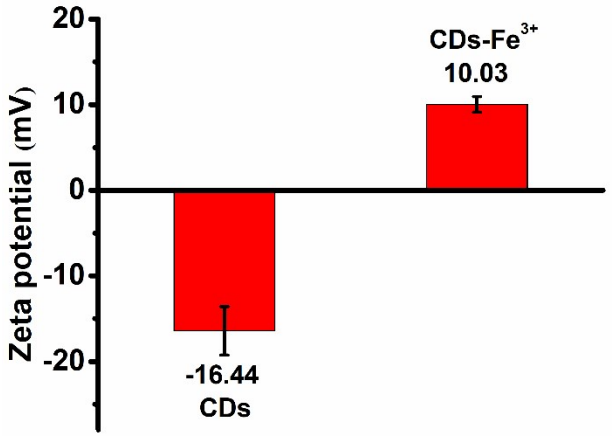

Fig. S5 Zeta potentials of CDs (0.2 mg/mL in upwater) and CDs-Fe^{3+} (CDs:0.2 mg/mL, Fe^{3+}: 0.25mM) solution.

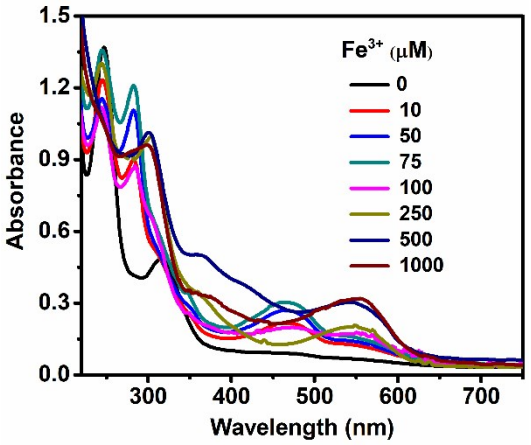

Fig. S6 UV-vis spectra of CDs (*conc.*=0.2 mg/mL) with various concentrations of Fe^{3+}.

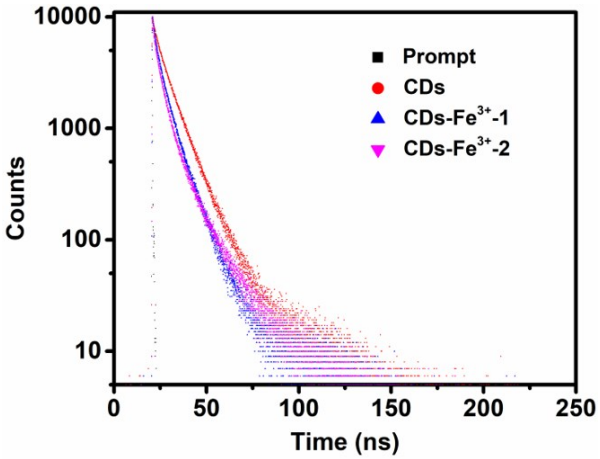

Fig. S7 Fluorescence decay curves of CDs, CDs-Fe^{3+}-1 (CDs: *conc.*=0.2mg/mL, Fe^{3+}: *conc.*=0.3 mM) and CDs-Fe^{3+}-2 (CDs: *conc.*=0.2 mg/mL, Fe^{3+}: *conc.*=0.5 mM).

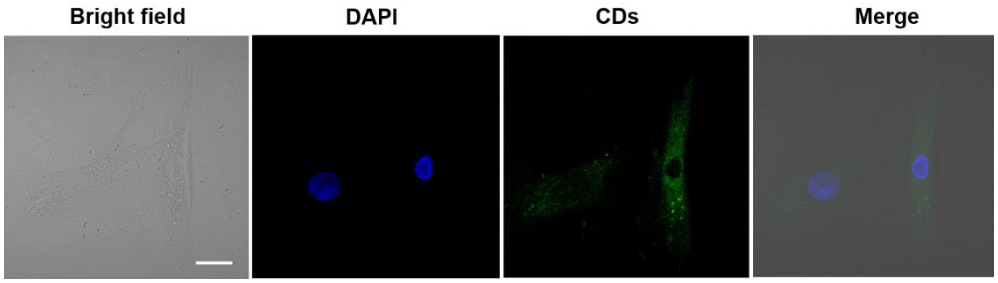

Fig. S8 Confocal images of MC3T3 cells cultured with CDs (*conc.*=200 μg/mL) for 12 h (cell nucleus was stained with DAPI).

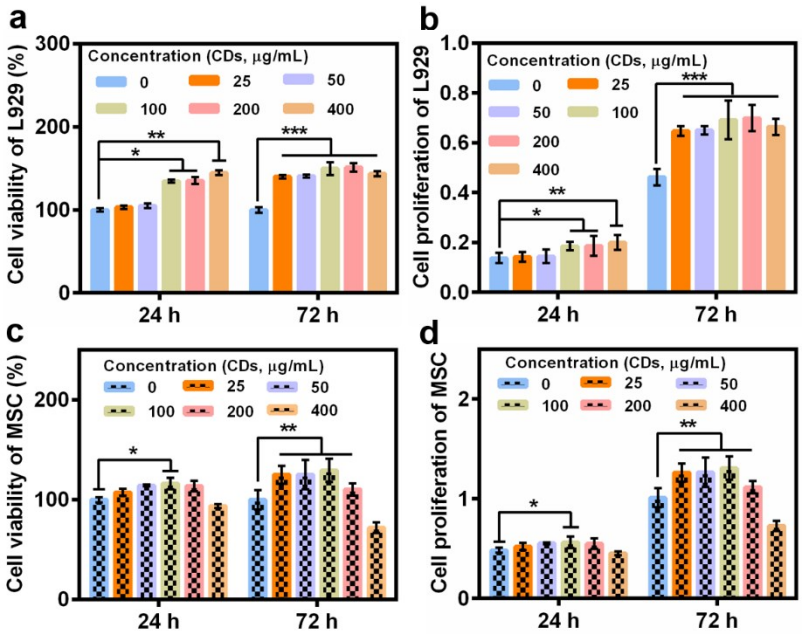

Fig. S9 Cell viability and proliferation of L929 cells (a and b) and BMSCs (c and d) cultured with CDs at different concentration for 24 and 72 h, respectively.

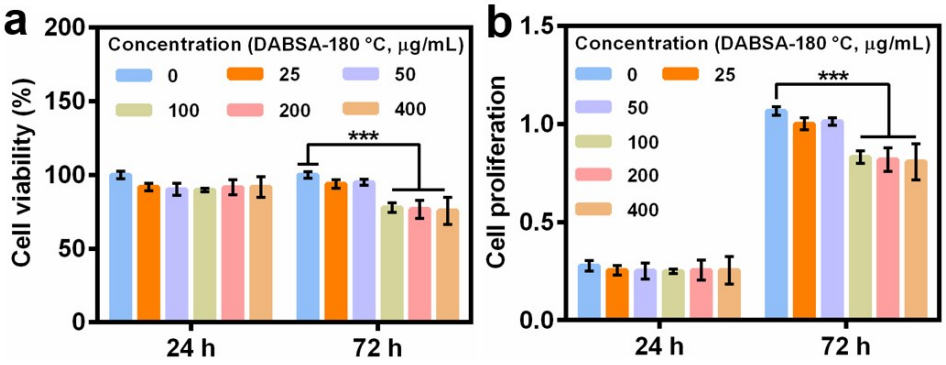

Fig. S10 Cell viability of MC3T3 cells cultured with DABSA-180 °C at different concentration for 24 and 72 h, respectively.

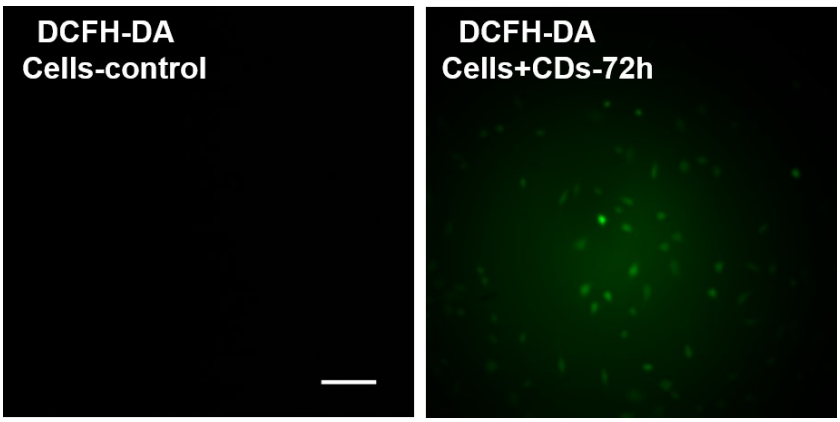

Fig. S11 Intracellular ROS generation of MC3T3 cells after cultured with CDs for 72 h, using DCFH-DA as a probe and cells cultured without CDs as control, scale bar=100 μm.

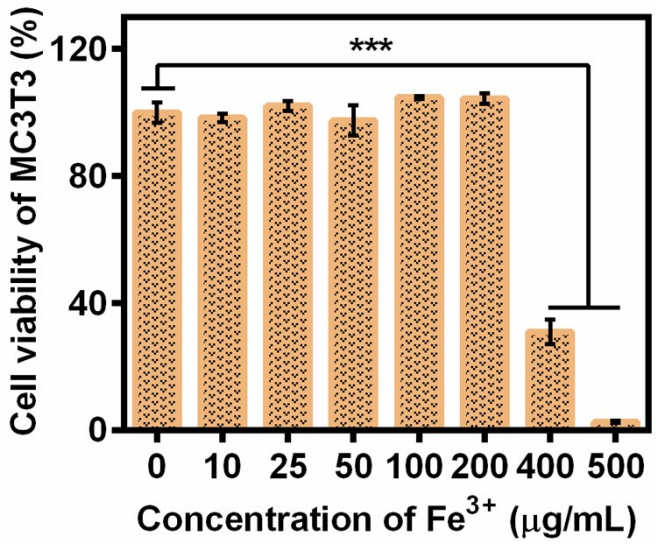

Fig. S12 Cell viability of MC3T3 cells cultured with different concentration of Fe^{3+} for 24 h.

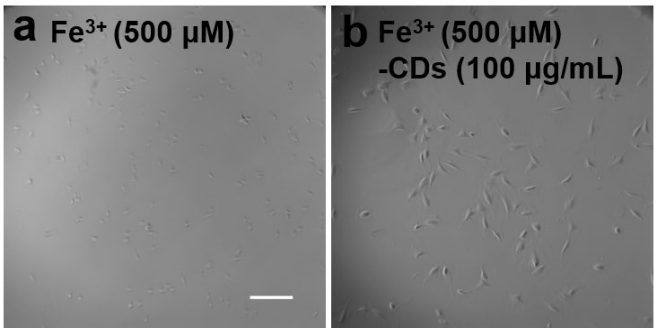

Fig. S13 MC3T3 cell images cultured with (a) Fe^{3+} (500 μM) and (b) Fe^{3+}-CDs (Fe^{3+}: 500 μM, CDs: 0.1 mg/mL), scale bar=200 μm.

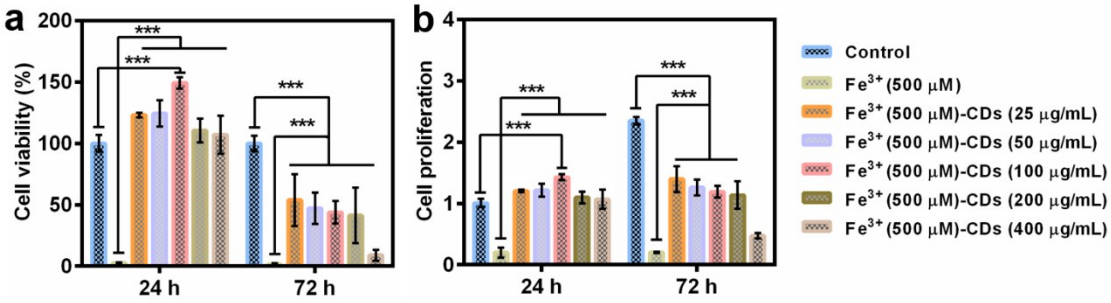

Fig. S14 Cell viability and proliferation of MC3T3 cells cultivated in various culture media for 24 and 72 h respectively. Mean values ± SD, ***p < 0.001, **p < 0.01.

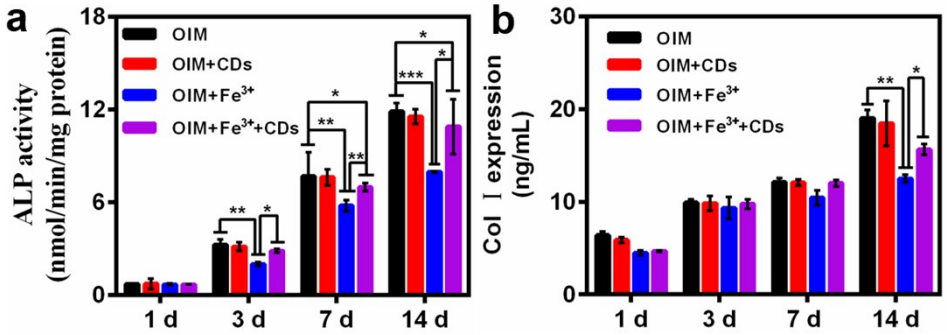

Fig. S15 (a) ALP activity and (b) collage I (Col I) expression during the osteogenic differentiation of MC3T3 cells cultivated in OIM, OIM+CDs, OIM+Fe^{3+} and OIM+Fe^{3+}+CDs for 1, 3, 7 and 14 days. CDs: 25 μg/mL, Fe^{3+}: 200 μM, mean values ± SD, ***p < 0.001, **p < 0.01, *p < 0.05.

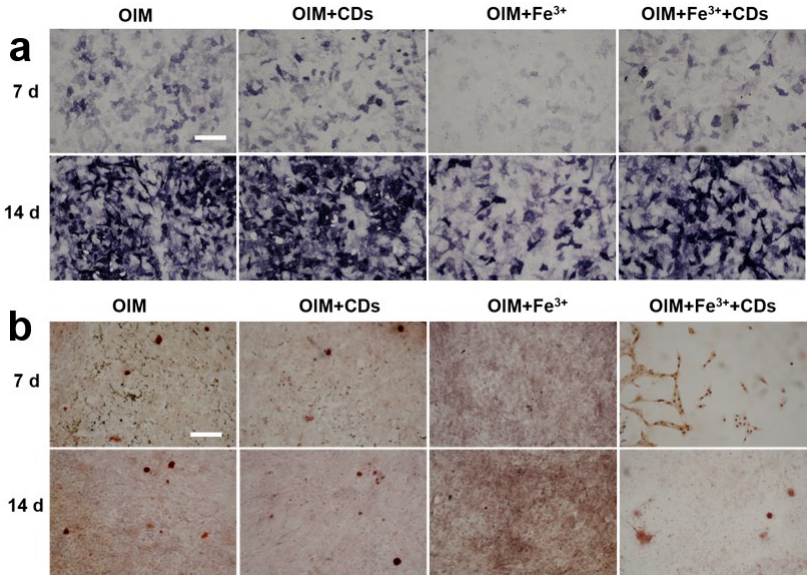

Fig. S16 (a) ALP staining and (b) ARS staining during the osteogenic differentiation of MC3T3 cells cultivated in OIM, OIM+CDs, OIM+Fe^{3+} and OIM+Fe^{3+}+CDs for 7 and 14 d. CDs: 25 μg/mL, Fe^{3+}: 200 μM, mean values ± SD, ***p < 0.001, **p < 0.01, *p < 0.05.

Table S1 Average fluorescence lifetimes of CDs and CDs-Fe^{3+} (*conc.* of Fe^{3+}=0.5 mM).

	Average fluorescence lifetime (ns)
CDs	6.23
CDs-Fe^{3+}	3.98

Table S2 Fluorescence detection of Fe^{3+} in real samples.

Real samples	Theoretical conc. of Fe^{3+} in real samples (μM)	Calculated conc. of Fe^{3+} in real samples (μM)
Tap water	25	25.72
	150	138.46
FBS	25	29.81
	150	142.92