Supporting Information

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

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**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$^{3+}$.

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**Fig. S8** Confocal images of MC3T3 cells cultured with CDs (conc.=$200\ \mu\text{g/mL}$) 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. = 0.2 mg/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.
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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).

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<th>Average fluorescence lifetime (ns)</th>
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<td>CDs</td>
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Table S2  Fluorescence detection of Fe$^{3+}$ in real samples.

<table>
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<tr>
<th>Real samples</th>
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<th>Calculated conc. of Fe$^{3+}$ in real samples (μM)</th>
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