Supplementary Material

Iron and nitrogen co-doped carbon quantum dots for sensitive and selective detection of hematin and ferric ions and cell imaging

Yuqing Wu [a,1], Lei Cao [a,b,1], Minghui Zan [c], Zheng Hou [a], Mingfeng Ge [a], Wen-Fei Dong [a], Li Li [a,*]

[a] CAS Key Laboratory of Biomedical Diagnostics, Suzhou Institute of Biomedical Engineering and Technology, Chinese Academy of Science (CAS), Suzhou 215163, P. R. China;

[b] School of Biomedical Engineering (Suzhou), Division of Life Sciences and Medicine, University of Science and Technology of China, Hefei 230026, P. R. China;

[c] State Key Laboratory of Pathogen and Biosecurity, Beijing Institute of Microbiology and Epidemiology, Beijing, 100071, P. R. China;

 Corresponding authors.

E-mail addresses: lil@sibet.ac.cn (L. Li)

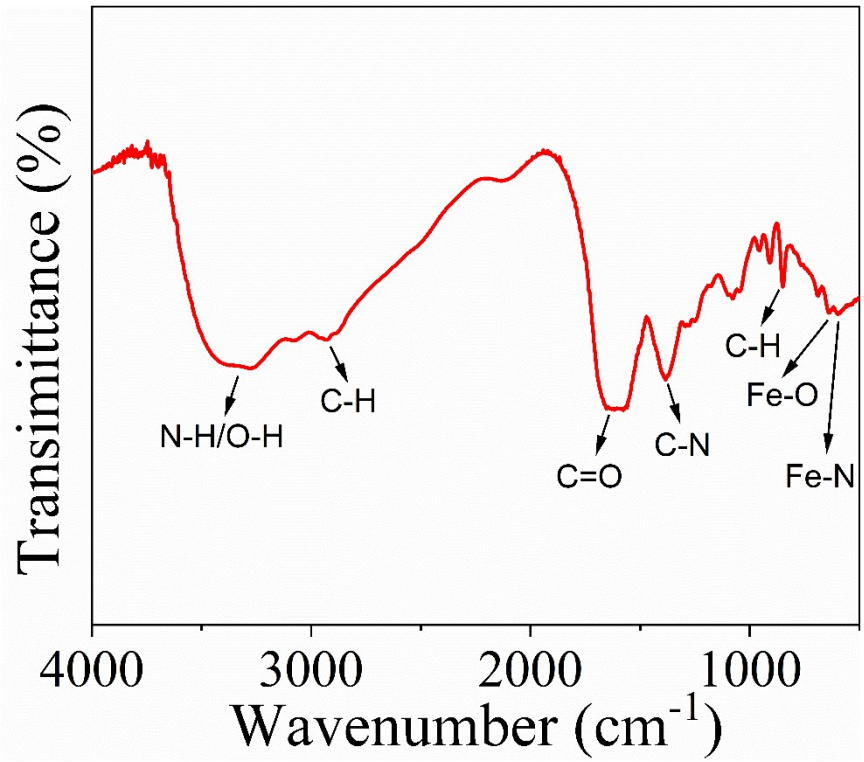


Fig. S1. FTIR spectrum of Fe, N-CDs.

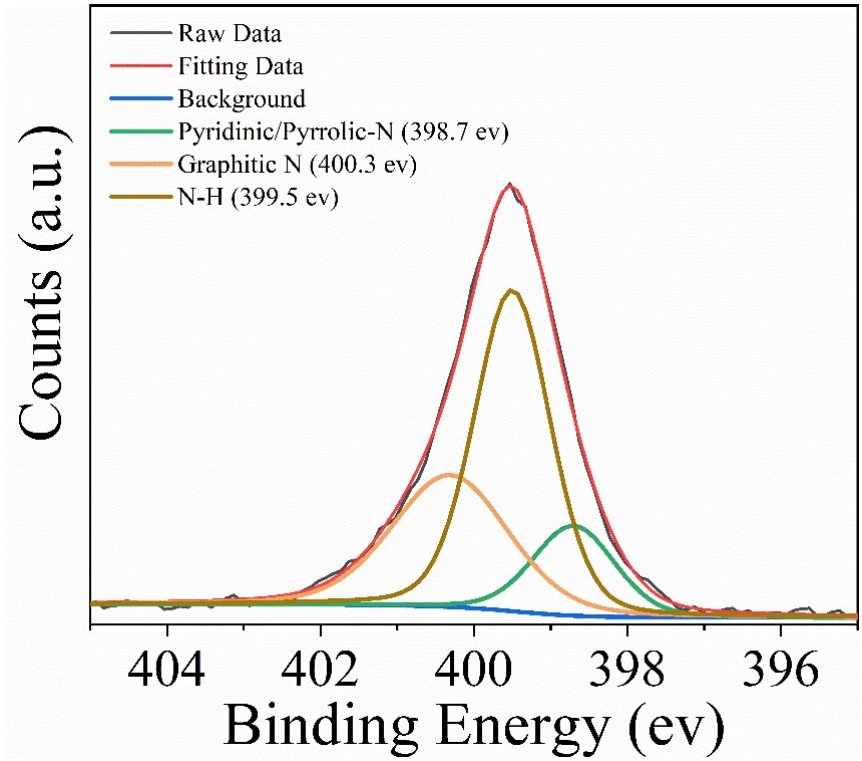
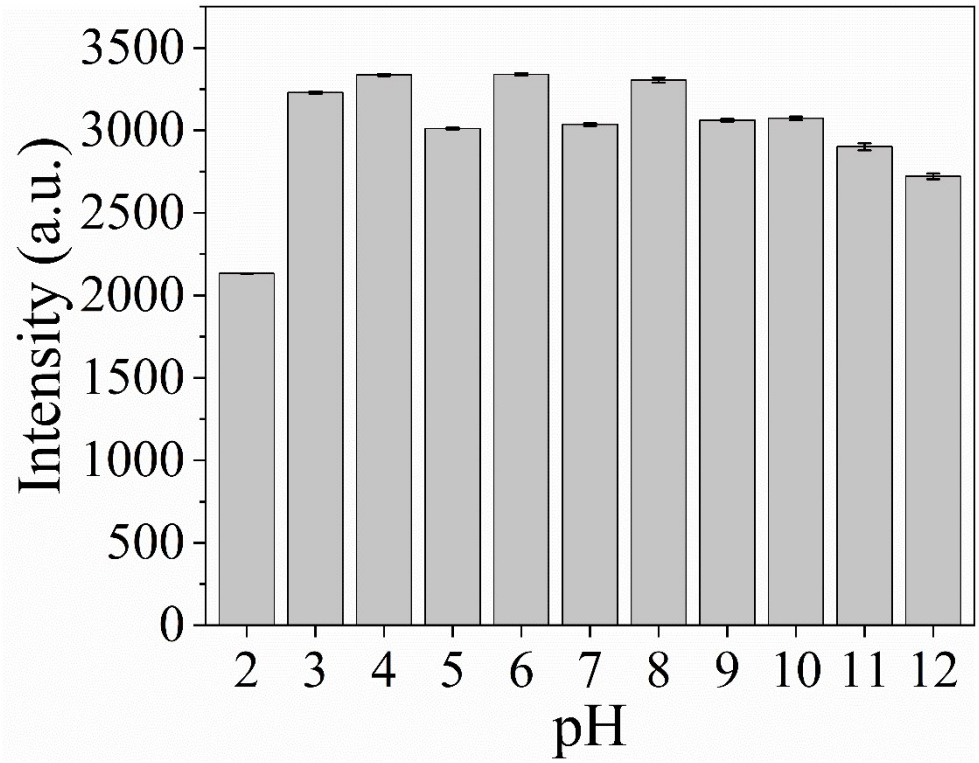
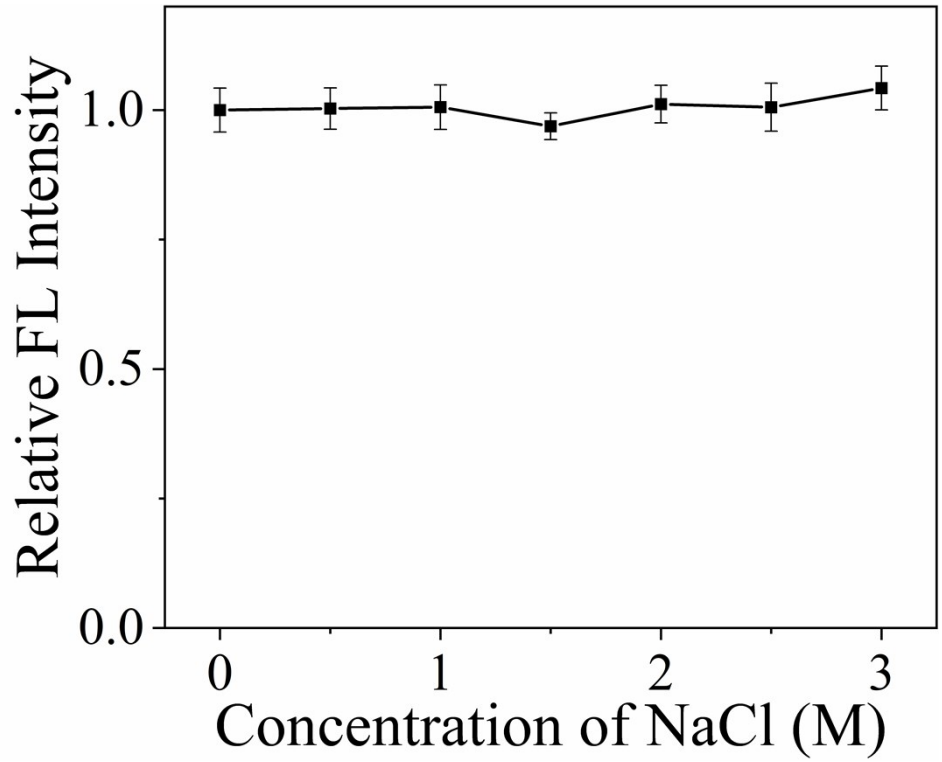


Fig. S2. N 1s XPS spectrum of Fe, N-CDs.

Fig. S3. Effect of ionic strengths on the fluorescence intensity of the Fe, N-CDs with the excitation wavelength at 365 nm.

Fig. S4. Effect of different pH values on the fluorescence intensity of the Fe, N-CDs.




Relative FL Intensity
1.0
0.5
0.0
0
1
2
3
Concentration of NaCl (M)

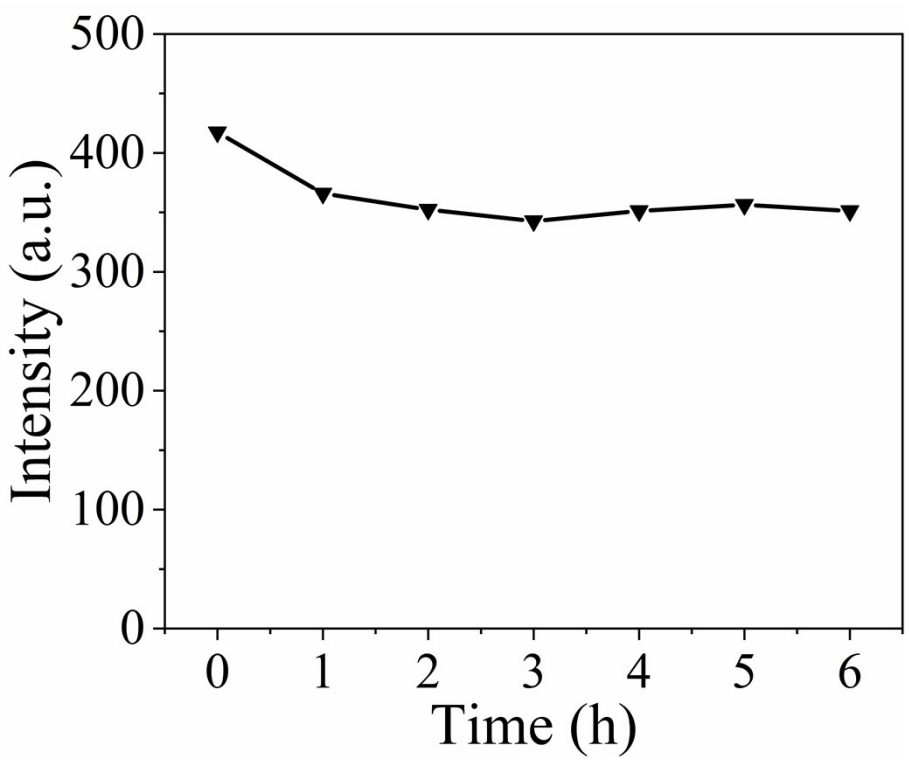


Fig. S5. Fluorescence intensity of Fe, N-CDs under irradiation of 365 nm UV light.

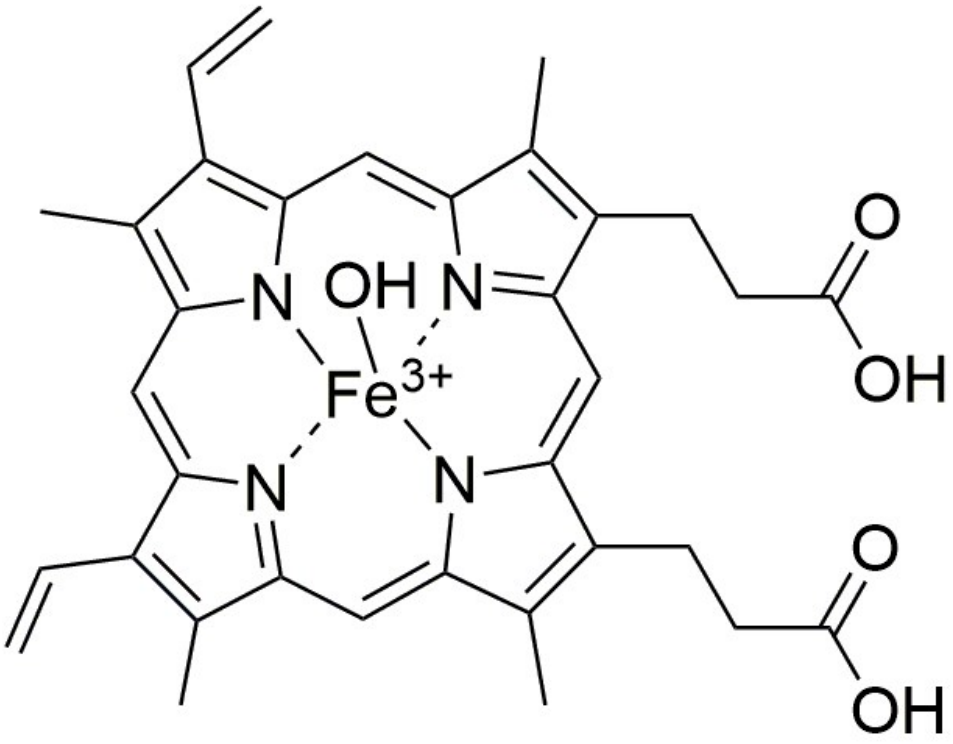


Fig. S6. The sturcture formula of hematin.

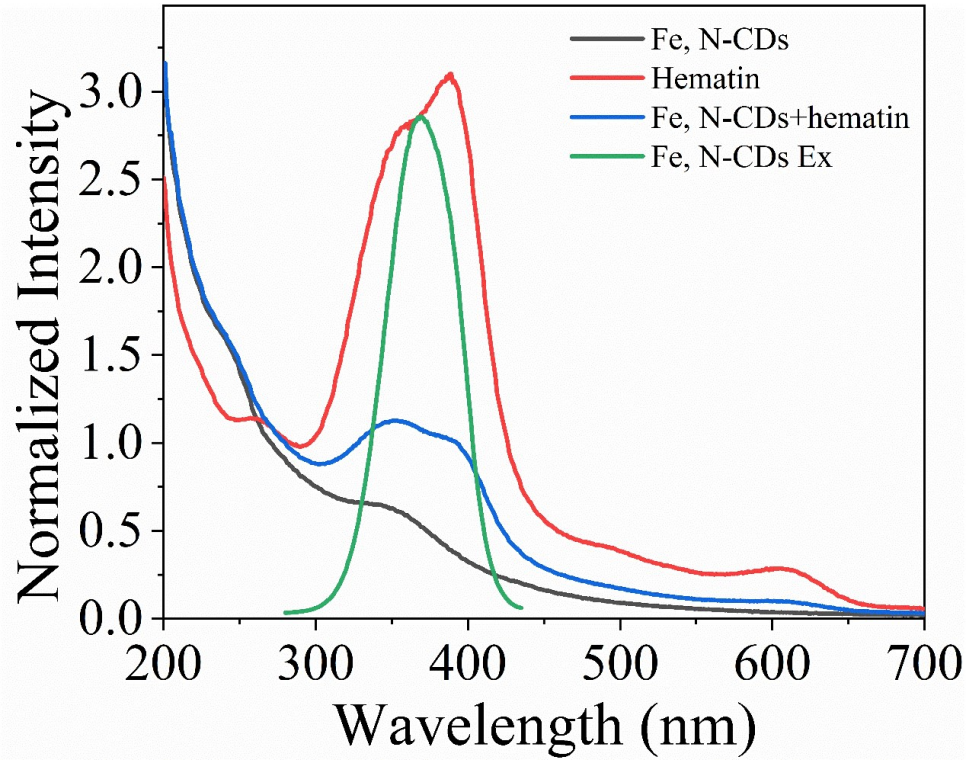


Fig. S7. UV-vis absorption of Fe, N-CDs in the absence and presence of hematin.

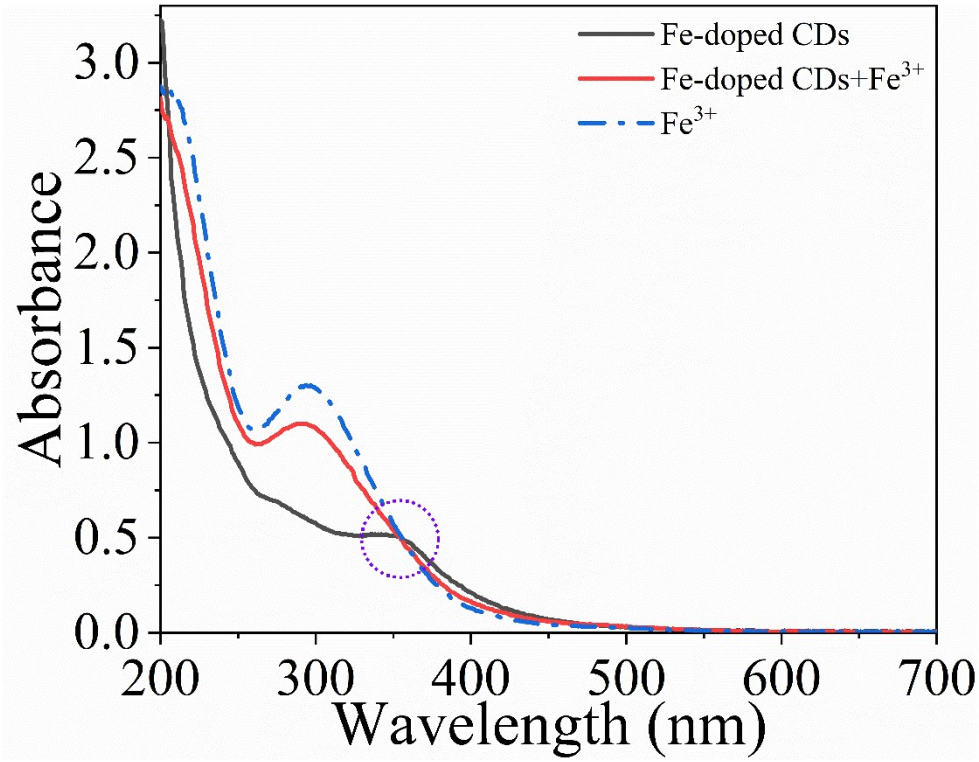


Fig. S8. UV-vis absorption of Fe, N-CDs in the absence and presence of Fe^{3+}.

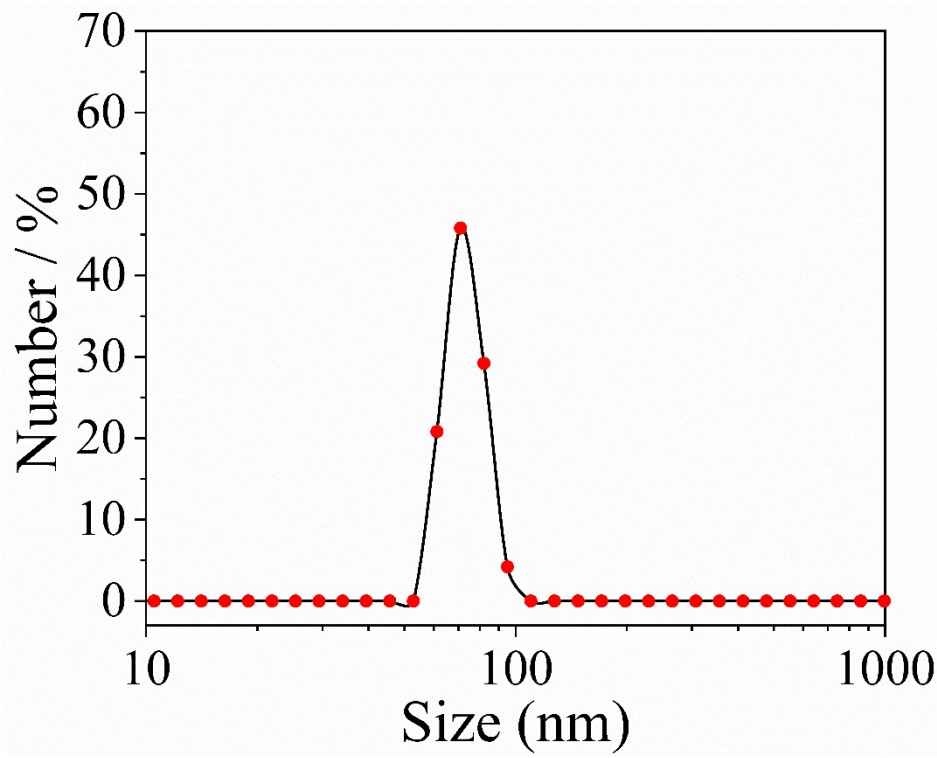


Fig. S9. Number-average particle diameter from dynamic light scattering of Fe, N-CDs with Fe^{3+} which dispersed in ultrapure water.

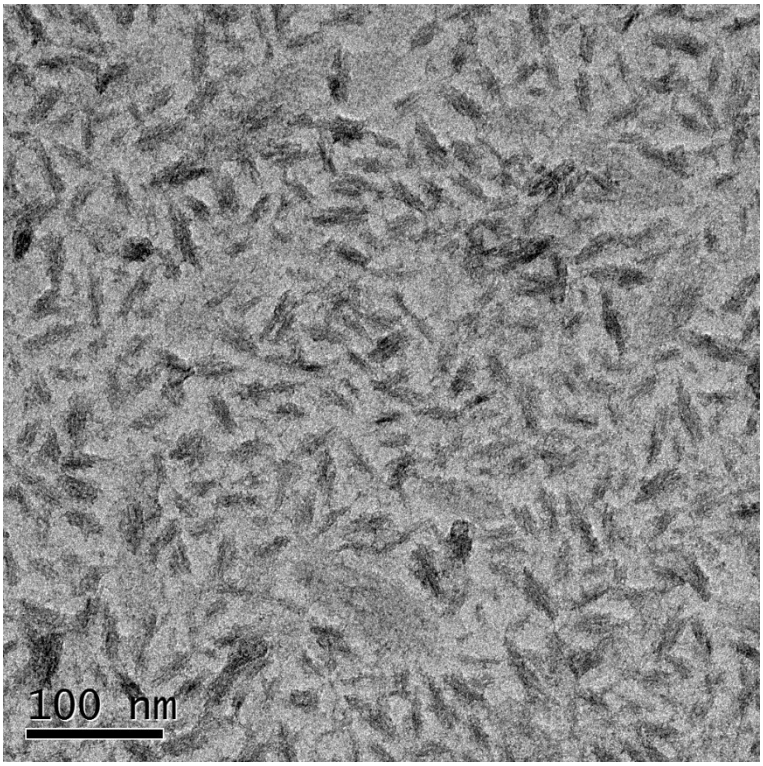


Fig. S10. The TEM image of Fe, N-CDs after adding Fe^{3+}.

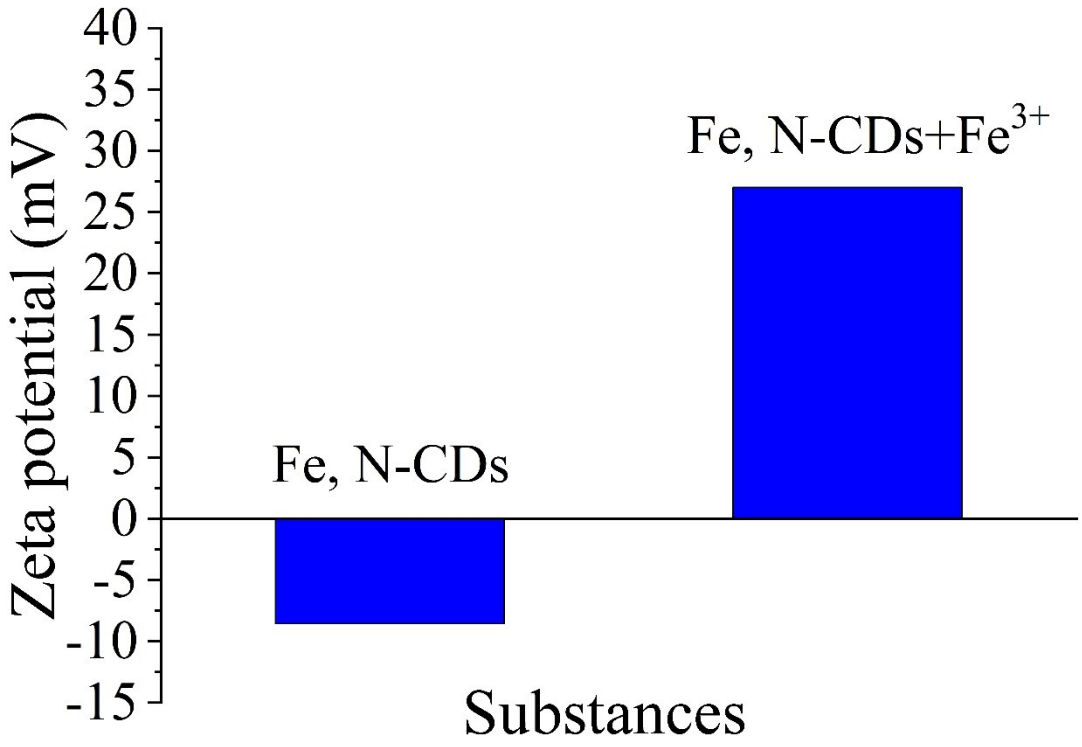


Fig. S11. The zeta potential of Fe, N-CDs before and after Fe^{3+}addition.

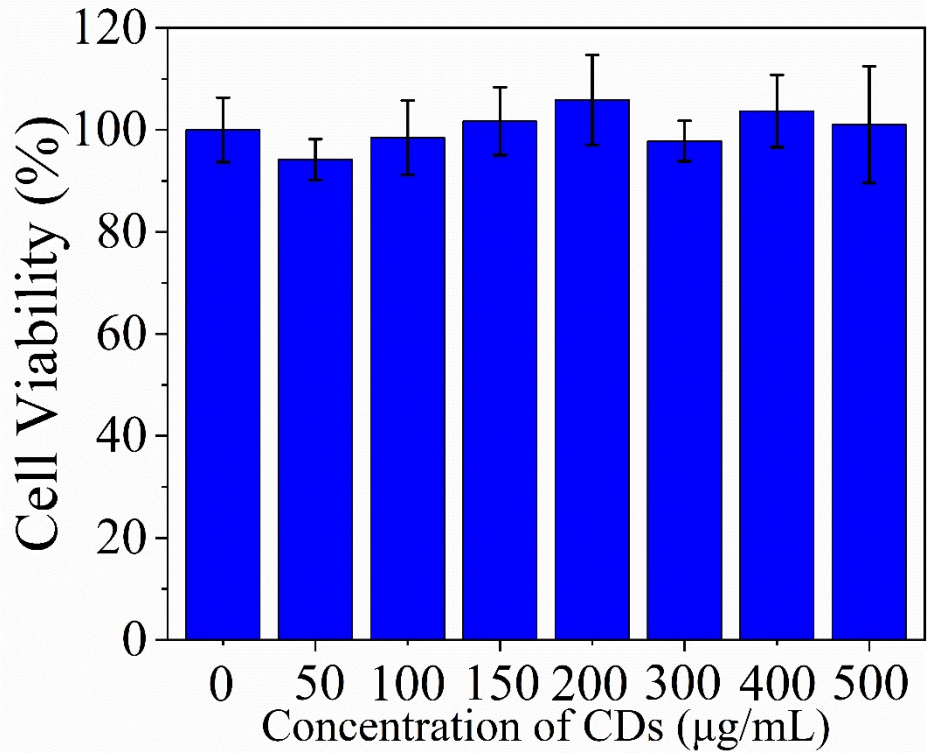


Fig. S12. Cytotoxicity of the Fe, N-CDs against HeLa cells.

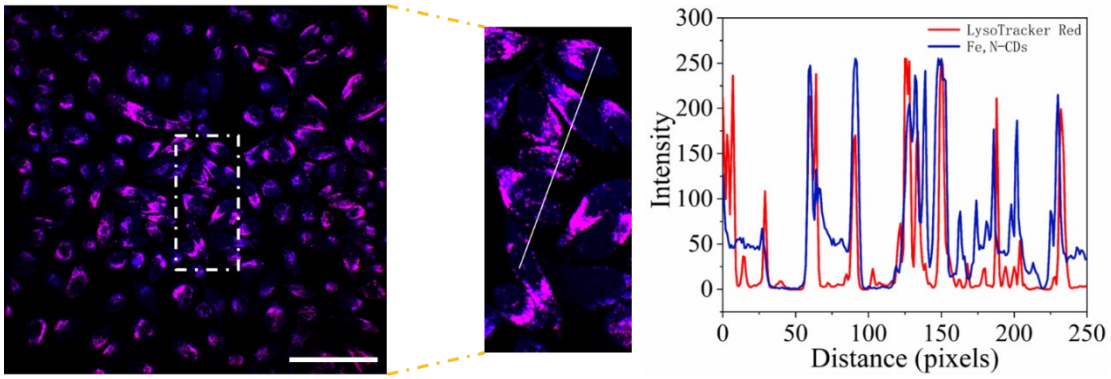


Fig. S13. The results of fluorescent colocalization analysis. The scale bar is 100 μm.

Table S1. Comparison of other reported nanoparticles for the determination of hematin.

Method	Linear range (μmol/L)	Detection limit (μmol/L)	Ref.
N-CDs	0.4~32	0.18	S1
CQDs	0.5~30	0.10	S2
QDs	0.5~15	0.32	S3
CQDs	0.5~10	0.25	S4
N, Cl-CDs	1.53-80	0.46	S5
Fe, N-CDs	0~27	0.024	This work

Table S2. Comparison of other reported nanoparticles for the determination of Fe^{3+}.

Method	Linear range (μmol/L)	Detection limit (μmol/L)	Ref.
S-CDs	1~500	0.10	S6
N, P-CDs	1~150	0.33	S7
GQDs	0~80	7.22	S8
N-CDs	2~25	0.90	S9
MoS_2 QDs	0-50	0.40	S10
Fe, N-CDs	0~200	0.64	This work

Table S3. The detailed data on the average lifetime of Fe, N-CDs, Fe, N-CDs with Fe^{3+} and Fe, N-CDs with hematin.

Samples	τ_1 (ns)	Value	τ_2 (ns)	Value	Average lifetime (ns)
Fe, N-CDs	3.0923	94.011	14.585	255.468	13.75
Fe, N-CDs + Fe^{3+}	2.2594	93.498	13.349	355.167	12.88
Fe, N-CDs + Hematin	4.2735	14.58	12.818	96.914	12.41

References

1. Y. J. Ju, N. Li, S. G. Liu, J. Y. Liang, X. Gao, Y. Z. Fan, H. Q. Luo and N. B. Li, *Analytical and Bioanalytical Chemistry*, 2019, **411**, 1159-1167.
2. J. Y. Liang, L. Han, S. G. Liu, Y. J. Ju, X. Gao, N. B. Li and H. Q. Luo, *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, 2019, **212**, 167-172.
3. F.-Y. Wu, Y.-S. Cheng, D.-M. Wang, M.-L. Li, W.-S. Lu, X.-Y. Xu, X.-H. Zhou and X.-W. Wei, *Materials Science and Engineering: C*, 2020, **112**, 110898.
4. Q. Q. Zhang, B. B. Chen, H. Y. Zou, Y. F. Li and C. Z. Huang, *Biosensors and Bioelectronics*, 2018, **100**, 148-154.
5. W. He, Z. Huo, X. Sun and J. Shen, *Microchemical Journal*, 2020, **153**, 104528
6. Q. Xu, P. Pu, J. Zhao, C. Dong, C. Gao, Y. Chen, J. Chen, Y. Liu and H. Zhou, *Journal of Materials Chemistry A*, 2015, **3**, 542-546.
7. J. Shangguan, J. Huang, D. He, X. He, K. Wang, R. Ye, X. Yang, T. Qing and J. Tang, *Analytical Chemistry*, 2017, **89**, 7477-7484.
8. A. Ananthanarayanan, X. Wang, P. Routh, B. Sana, S. Lim, D.-H. Kim, K.-H. Lim, J. Li and P. Chen, *Advanced Functional Materials*, 2014, **24**, 3021-3026.
9. R. Atchudan, T. N. J. I. Edison, K. R. Aseer, S. Perumal, N. Karthik and Y. R. Lee, *Biosensors and Bioelectronics*, 2018, **99**, 303-311.
10. L. Ruan, Y. Zhao, Z. Chen, W. Zeng, S. Wang, D. Liang and J. Zhao, *Applied Surface Science*, 2020, **528**, 146811