Electronic Supplementary Material (ESI) for Analytical Methods.

Electronic Supporting Information

Nanoarchitectonics of Neomycin-derived fluorescent carbon dots for selective detection of Fe^{3+} ion

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HRTEM Images:

The HRTEM samples were deposited on Ultrathin Carbon Film on Lacey Carbon Support Film, 400 mesh, Copper TEM grd. The samples were dried overnight in vacuum before imaging on a JEOL 2010 LAB6 TEM.

UV-Vis Spectra:

The UV-vis absorption spectra for Neo-CQD were collected in a quartz cuvette using a UV−Vis 1800 Shimadzu spectrophotometer

Fluorescence Spectra:

The fluorescence emission spectra measured on an Agilent, Carry Eclipse spectrofluorophotometer at 340 nm excitation wavelength.

Quantum Yield Calculations:

The quantum yield of Neo-CDs has been calculated in different solvents using quinine sulfate as a reference, which are reported in **Table S1**. In DDW the Neo-CDs showed highest quantum yield of 55%, whereas lowest in the acetonitrile.

Table 1: Quantum yield of Neo-CDs in different solvents.

Sr. No.	Solvent	λ_{max}	Quantum yield
1	Double distilled water	0.182	0.55
2	acetone	0.137	0.40
3	acetonitrile	0.415	0.19
4	DMF	0.255	0.38
5	ethanol	0.253	0.34
6	DMSO	0.33	0.37
7	THF	0.331	0.20

Photobleaching study

The Neo-CDs have been irradiated under 365 nm UV light and measured the fluorescence emission at time interval, **Figure S1a**. We found that the Neo-CDs were stable upon irradiation of 365 nm UV light for 100 minutes. Further we extended our study, the Neo-CDs then irradiated with 254 nm UV light (higher energy) and subjected to fluorescence spectroscopy. We found that at fluorescence intensity goes on decreasing with increase in irradiation time. The fluorescence intensity decreased from 661 to 415 after irradiation of 254 nm UV light for 100 min, **Figure S1b**. These results indicates that the as prepared Neo-CDs are much more stable under 365 nm UV light compared to 254 nm UV light.

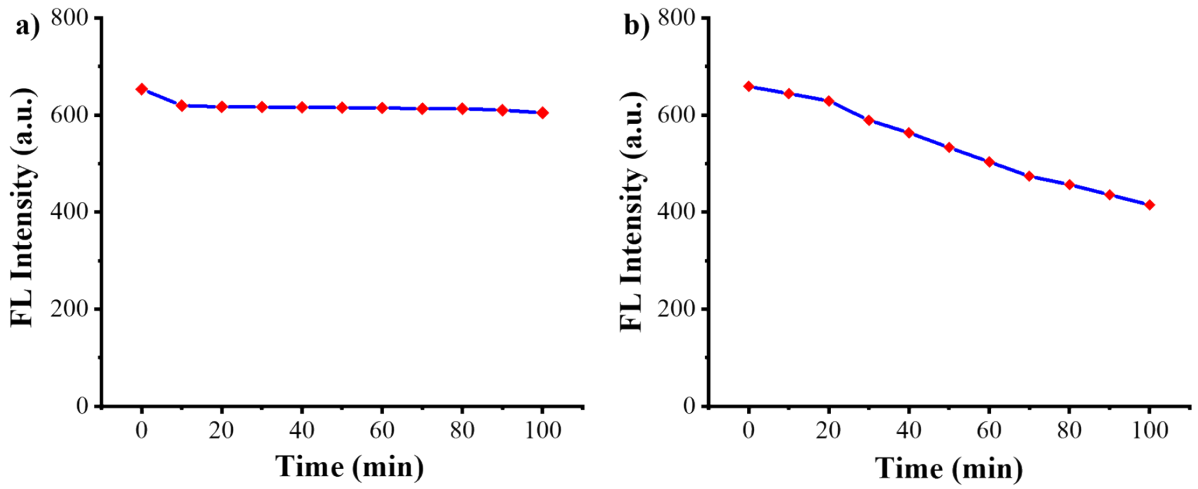

Figure S1. The fluorescence intensity of the Neo-CDs under a) 365 nm and b) 254 nm UV light at different time.

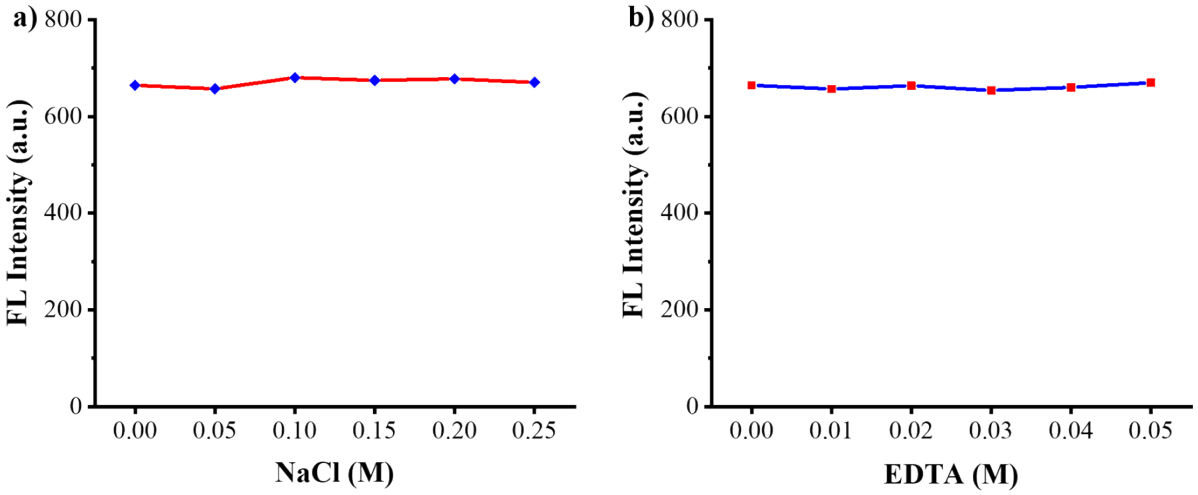

Figure S2. (a) Effect of concentration of NaCl as an ionic strength at λ_{ex} = 340 nm (b) Effect of concentration of EDTA as a masking agent λ_{ex} = 340 nm.

Effect of pH:

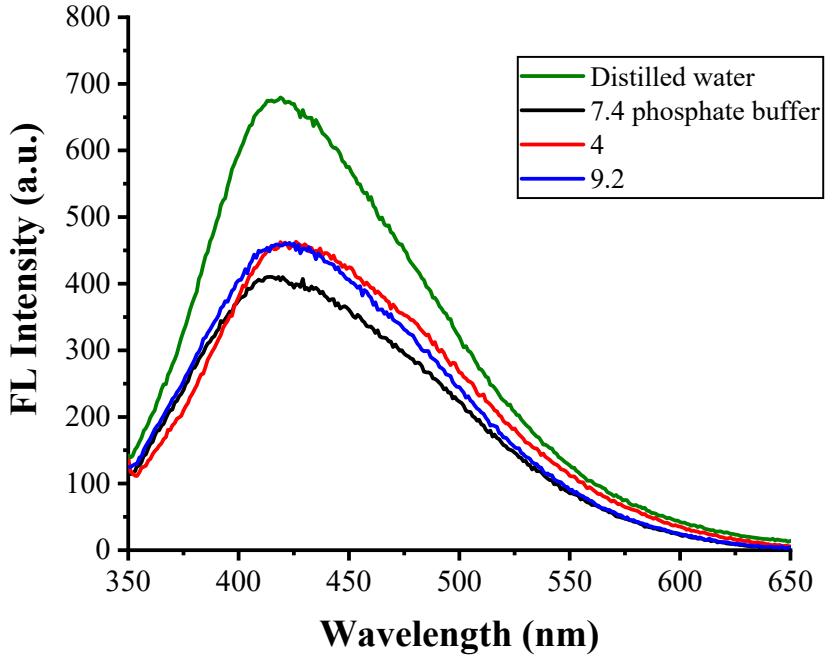

Figure S3: The effect of pH on the fluorescence intensity of the as-prepared Neo-CDs (λ_{ex} = 340 nm).

Cyclic Voltammetry:

Cyclic voltammogram (CV) were recorded on electrochemical workstation –CH instrument, Inc. CHI6107. CV was recorded to determine the redox property of the Neo-CDs. From the CV it was observed that is shows supercapacitance (reference) behaviour. A three-electrode cell with a platinum working electrode, a silver reference (Ag/AgCl) electrode and a platinum wire as counter electrode in water containing 2M potassium chloride as the supporting electrolyte and 1 mL H_2O containing 0.3 mg CNDs as the sample at a scan rate of 100 mV/s under room temperature

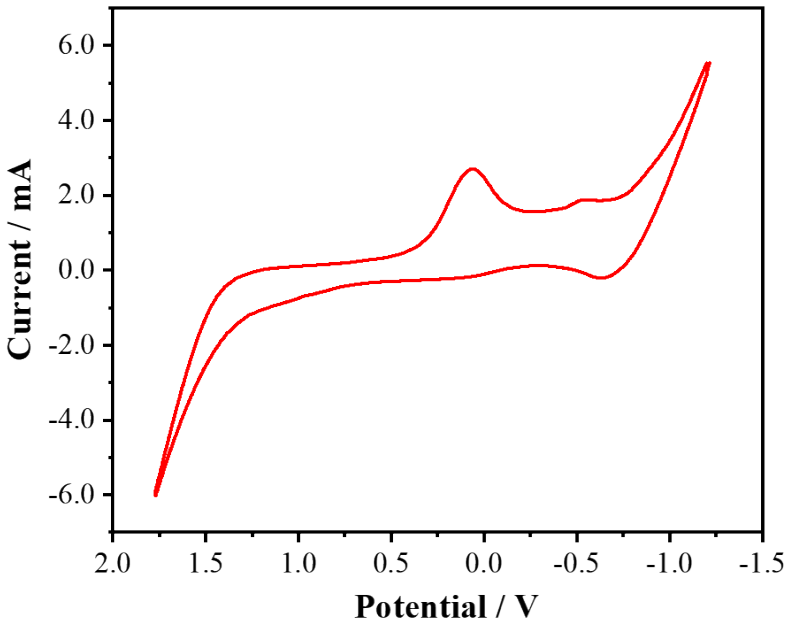

Figure S4: Cyclic voltammogram of Neo-CDs

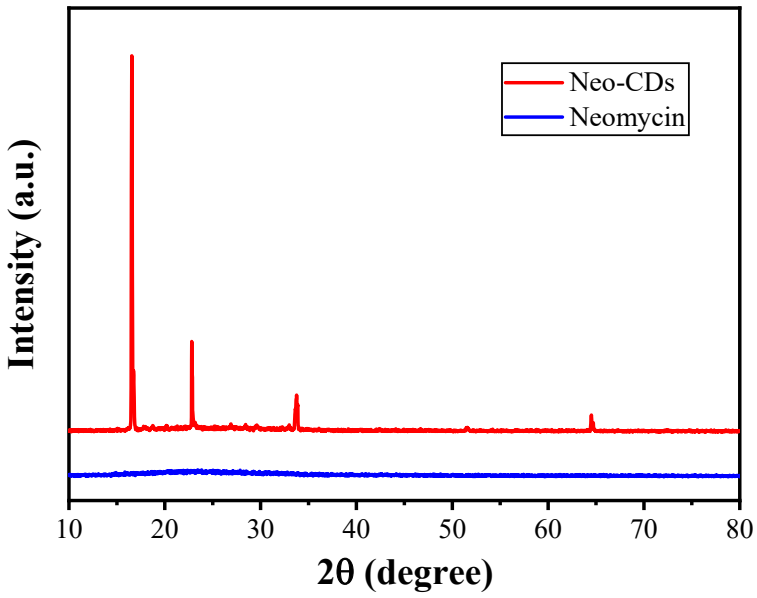

Figure S4: Thin film XRD of Neo-CDs

XPS:

X-ray photoelectron spectroscopy (XPS) recorded using PHI 5000 Versa Probe II (FEI Inc.) spectrometer. Binding energy calibration was based on C1s at 284.6 eV.

Sensing Study:

For sensing the Fe^{3+} metal ion, the final Neo-CDs concentration was 1mg/mL and concentration of Fe^{3+} metal ion was 10^{-5} M.

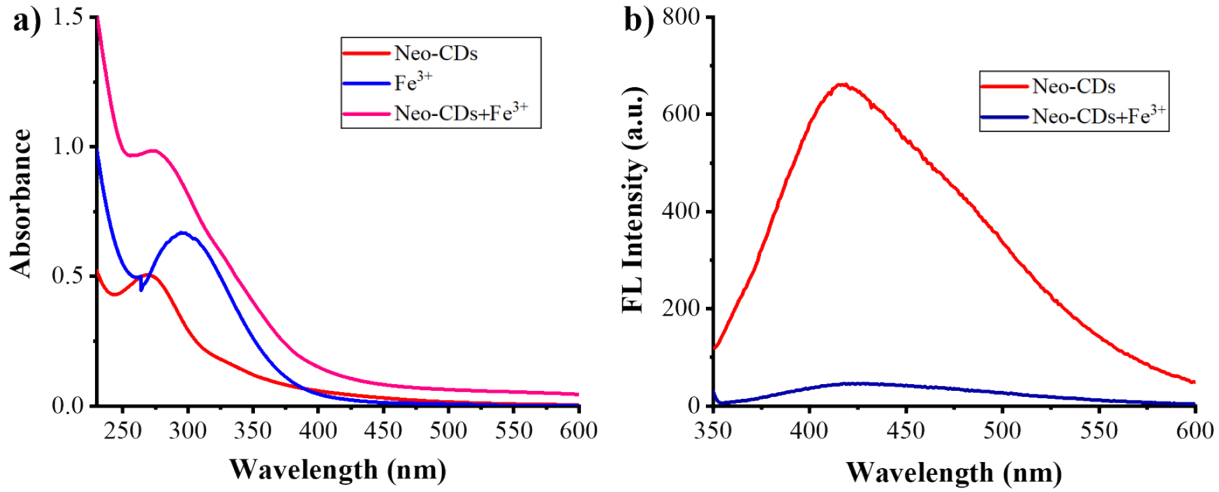

Figure S5. (a) The UV-vis spectra and (b) Fluorescence emission spectra of as-prepared Neo-CDs in presence and absence of Fe^{3+}.

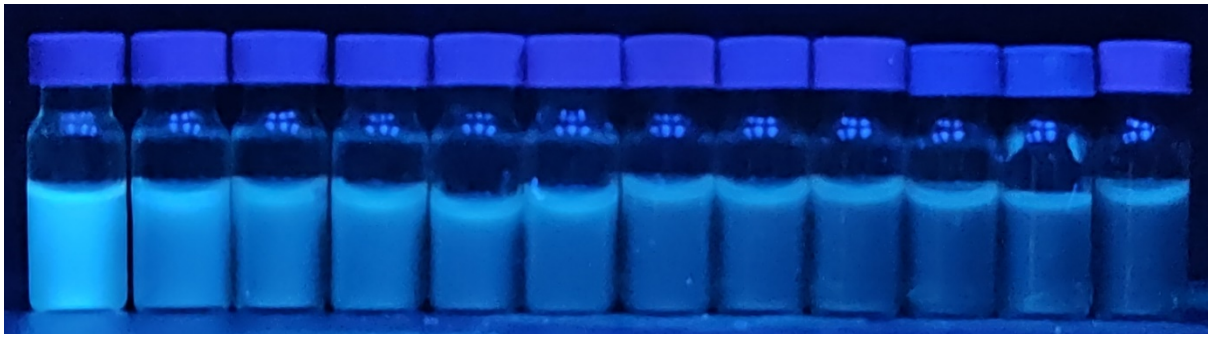

Figure S6. Solutions of Neo-CDs in DDW with addition of increasing concentration of Fe^{3+} ion under 365 nm UV light

Paper Strip Preparation.

Test strips were prepared and immersed in the solution of the probe in DDW. The strips were air-dried and used for detecting Fe^{3+} in the presence of other metal ions. The test strips were observed under a 365 nm UV light, quenching of fluorescence observed with Fe^{3+}.

Test strip for Fe^{3+} detection using Neo-CDs.

For practical application the Neo-CDs was efficiently applied for detection of Fe3+ ion using a paper strip method. We prepared the test strip using aqueous solution and examined the

detection of Fe^{3+}. The results are displayed in **Figure S5**. It was observed that on the strip test paper, Neo-CDs showed quenching of bright blue fluorescence under 365 nm UV light after addition of Fe^{3+}, whereas other anions did not show any response.

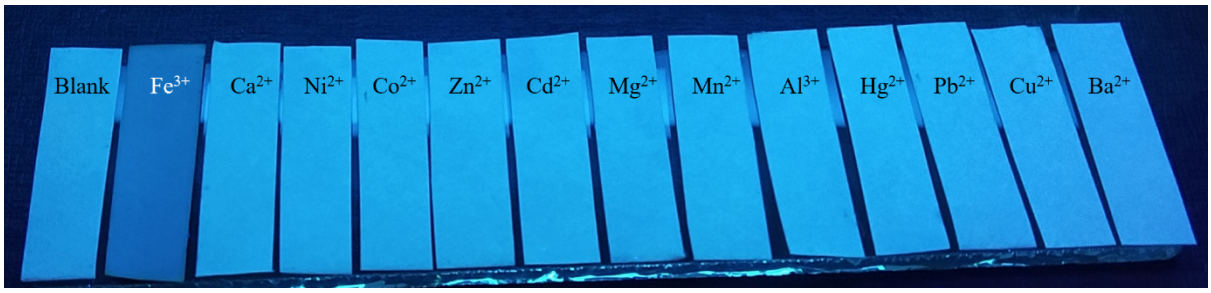

Figure S7. Paper **s**trip (prepared in DDW) based selectively detection of Fe^{3+} with Neo-CDs over other anions by naked eyes under 365 nm UV light.

Table 2. The comparison chart of different fluorescent probes for Fe^{3+} ion detection

Fluorescent probes	*Detection limit (μM)*	*Reference*
Graphene oxide nanosheets	17.9	S1
N and S doped carbon dot	0.8	S2
graphene quantum dots	1.49	S3
Nitrogen/sulphur-doped carbon dots	0.56	S4
Nitrogen-doped carbon quantum dots	9.27	S5
2,2′-dipicolylamin-nitrogen-doped carbon quantum dots	0.92	S6
Graphene quantum dots from biomass waste	2.5	S7
Carbon dots (CD)-embedded cellulose transparent film	2.038	S8
Leftover Kiwi fruit peel-derived carbon dots	0.92	S9
Polyurethane-nitrogen doped carbon dots	1.15	S10
N-doped carbon dots	0.9	S11
CDs from blueberry	9.97	S12
Nitrogen doped CDs derived from *Phyllanthus acidus*	0.9	S13
N/S doped CQDs	2.549	S14

Cranberry Beans Derived Carbon Dots	9.55	S15
Seville orange derived carbon dots	0.53	S16
Dopamine functionalized S, N co-doped CDs	2.86	S17
Carbon dots from Kumquat	0.7	S18
N-doped carbon dots (NCDs)	1.9	S19
Carbon dots from diammonium hydrogen citrate and urea	19	S20
CDs from electrochemical oxidation of graphite	1.8	S21
Carbon dots from dopamine and ethane-diamine	10.8	S22
Carbon dots from α-lipoic acid and ethylenediamine	4	S23
S-doped carbon dots from cellulose fibers	0.96	S24
Carbon dots from alginic acid and ethane-diamine	10.98	S25
N-doped carbon dots from glutamic acid	4.67	S26
Neo-CDs	0.854	This work

References:

S1 D. Wang, L. Wang, X. Dong, Z. Shi and J. Jin, *Carbon N. Y.*, 2012, **50**, 2147–2154.

S2 W. Lu, X. Gong, M. Nan, Y. Liu, S. Shuang and C. Dong, *Anal. Chim. Acta*, 2015, **898**, 116–127.

S3 L. Zhu, D. Li, H. Lu, S. Zhang and H. Gao, *Int. J. Biol. Macromol.*, 2022, **194**, 254–263.

S4 C. Liang, X. Xie, Q. Shi, J. Feng, D. Zhang and X. Huang, *Appl. Surf. Sci.*, 2022, **572**, 151447.

S5 Y. H. Su, H. H. Huang, C. C. Tseng, H. J. Tsai and W. K. Hsu, *RSC Adv.*, 2021, **11**, 34117–34124.

S6 Q. Li, Z. Guo, X. Zhao, T. Zhang, J. Chen and Y. Wei, *Nanotechnology*, 2020, **31**, 335501.

S7 A. Abbas, T. A. Tabish, S. J. Bull, T. M. Lim and A. N. Phan, *Sci. Rep.*, 2020, **10**, 1–16.

S8 J. Woo, Y. Song, J. Ahn and H. Kim, *Cellulose*, 2020, **27**, 4609–4621.

S9 R. Atchudan, T. N. J. I. Edison, S. Perumal, R. Vinodh, A. K. Sundramoorthy, R. S. Babu and Y. R. Lee, *Chemosensors*, 2021, **9**, 1–15.

S10 S. Nanbedeh and K. Faghihi, *J. Fluoresc.*, 2021, **31**, 517–539.

S11 Z. Liu, R. Jia, F. Chen, G. Yan, W. Tian, J. Zhang and J. Zhang, *J. Colloid Interface Sci.*, 2022, **606**, 567–576.

S12 A. M. Aslandaş, N. Balci, M. Arik, H. Şakiroɨlu, Y. Onganer and K. Meral, *Appl. Surf. Sci.*, 2015, **356**, 747–752.

S13 R. Atchudan, T. N. J. I. Edison, K. R. Aseer, S. Perumal, N. Karthik and Y. R. Lee, *Biosens. Bioelectron.*, 2018, **99**, 303–311.

S14 Y. Deng, J. Qian, Y. Zhou and F. Lu, *ChemistrySelect*, 2020, **5**, 5306–5311.

S15 M. Zulfajri, G. Gedda, C. J. Chang, Y. P. Chang and G. G. Huang, *ACS Omega*, 2019, **4**, 15382–15392.

S16 A. M. Senol and E. Bozkurt, *Microchem. J.*, 2020, **159**, 105357.

S17 S. Lei, N. Chang, J. Zhang and H. Wang, *Anal. Sci.*, 2021, **37**, 851–857.

S18 B. Polatoğlu and E. Bozkurt, *Res. Chem. Intermed.*, 2021, **47**, 1865–1881.

S19 J. Cui, X. Zhu, Y. Liu, L. Liang, Y. Peng, S. Wu and Y. Zhao, , DOI:10.1021/acsanm.2c01170.

S20 W. U. Khan, D. Wang, W. Zhang, Z. Tang, X. Ma, X. Ding, S. Du and Y. Wang, *Sci. Rep.*, 2017, **7**, 1–9.

S21 M. Liu, Y. Xu, F. Niu, J. J. Gooding and J. Liu, *Analyst*, 2016, **141**, 2657–2664.

S22 G. Li, N. Lv, W. Bi, J. Zhang and J. Ni, *New J. Chem.*, 2016, **40**, 10213–10218.

S23 H. Ding, J. S. Wei and H. M. Xiong, *Nanoscale*, 2014, **6**, 13817–13823.

S24 G. Yang, X. Wan, Y. Su, X. Zeng and J. Tang, *J. Mater. Chem. A*, 2016, **4**, 12841–12849.

S25 Y. Liu, Y. Liu, S. J. Park, Y. Zhang, T. Kim, S. Chae, M. Park and H. Y. Kim, *J. Mater. Chem. A*, 2015, **3**, 17747–17754.

S26 J. Yu, C. Xu, Z. Tian, Y. Lin and Z. Shi, *New J. Chem.*, 2016, **40**, 2083–2088.