Electronic Supplementary Material (ESI) for Journal of Materials Chemistry B.

Supporting Information:

Preventing biofilm formation and eradicating pathogenic bacteria by Zn doped histidine derived carbon quantum dots

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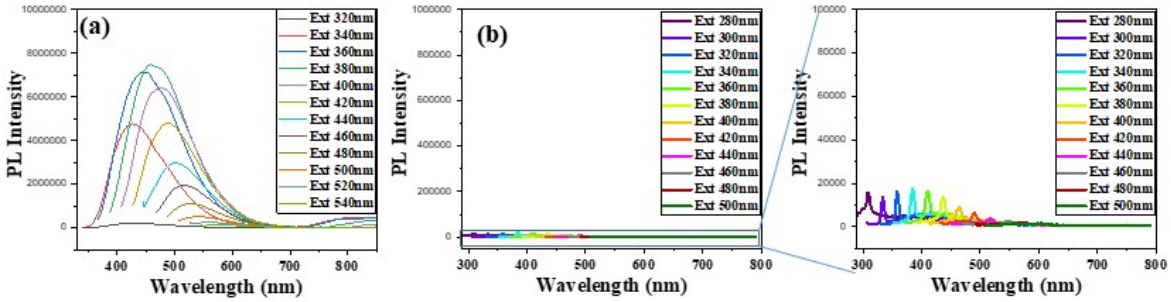

Figure S1: Fluorescence spectra of (a) NCDs and (b) aqueous solution of histidine molecules at various excitation wavelengths (λex = 320, 340, 360, 380, 400, 420, 440, 460, 480, 500, 520, and 540 nm).

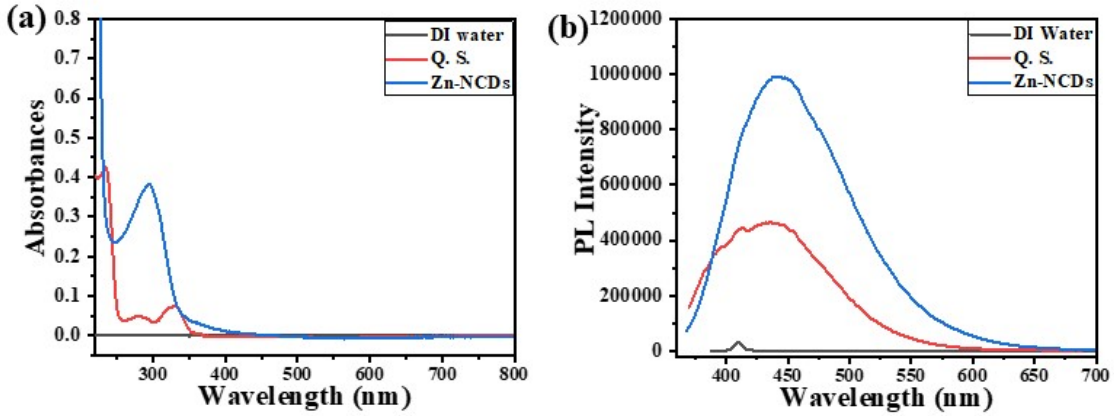

Figure S2: Quantum yield calculations of Zn-NCDs with respect to quinine sulphate (Q.S.). (a) Absorbance common peak at 350 nm and (b) fluorescence of Zn-NCDs and quinine sulphate at λex = 350 nm.

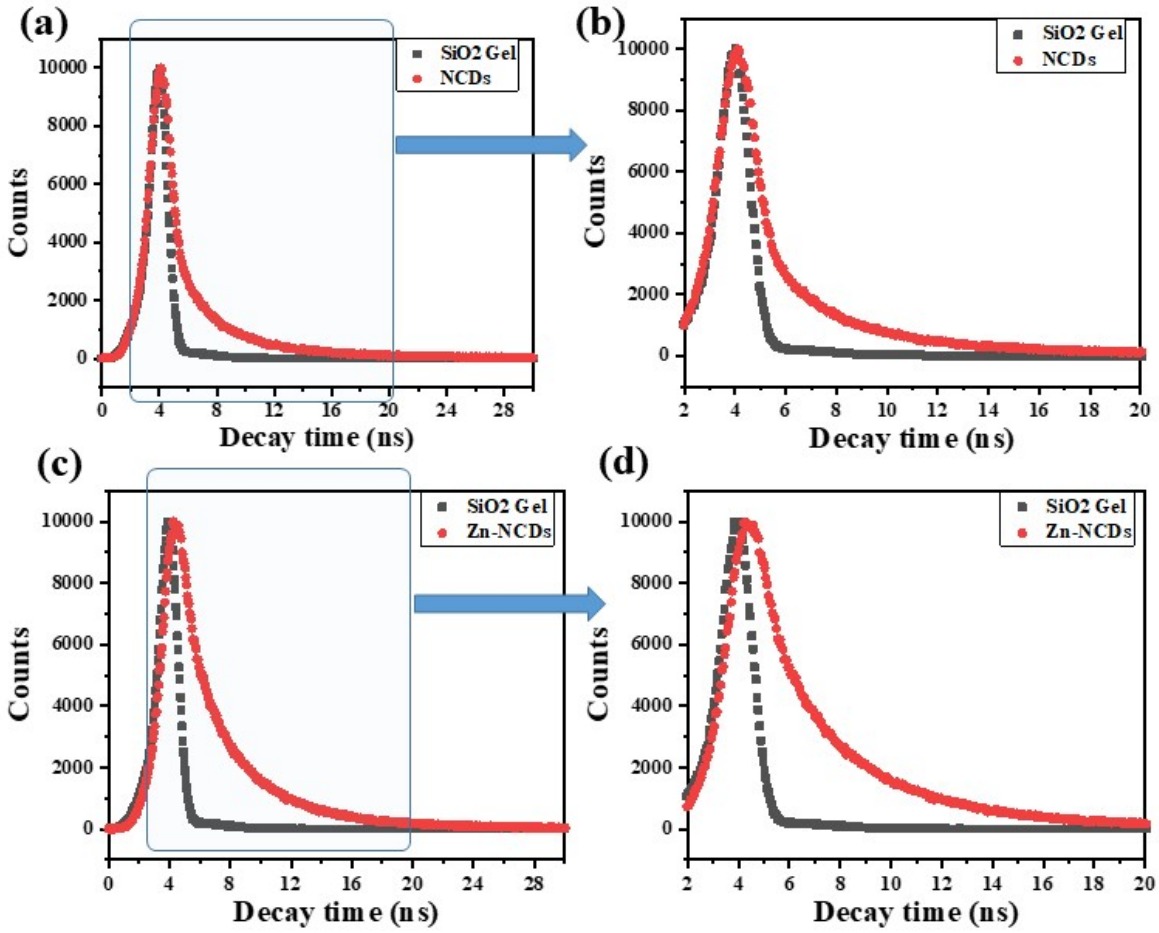

Figure S3: (a, b) NCDs and (c, d) Zn-NCDs fluorescence lifetimes were measured using time-correlated single photon counting (TCSPC) compering with SiO_2-gel. Decay times were found to be 4.01 ns and 4.47 ns, respectively.

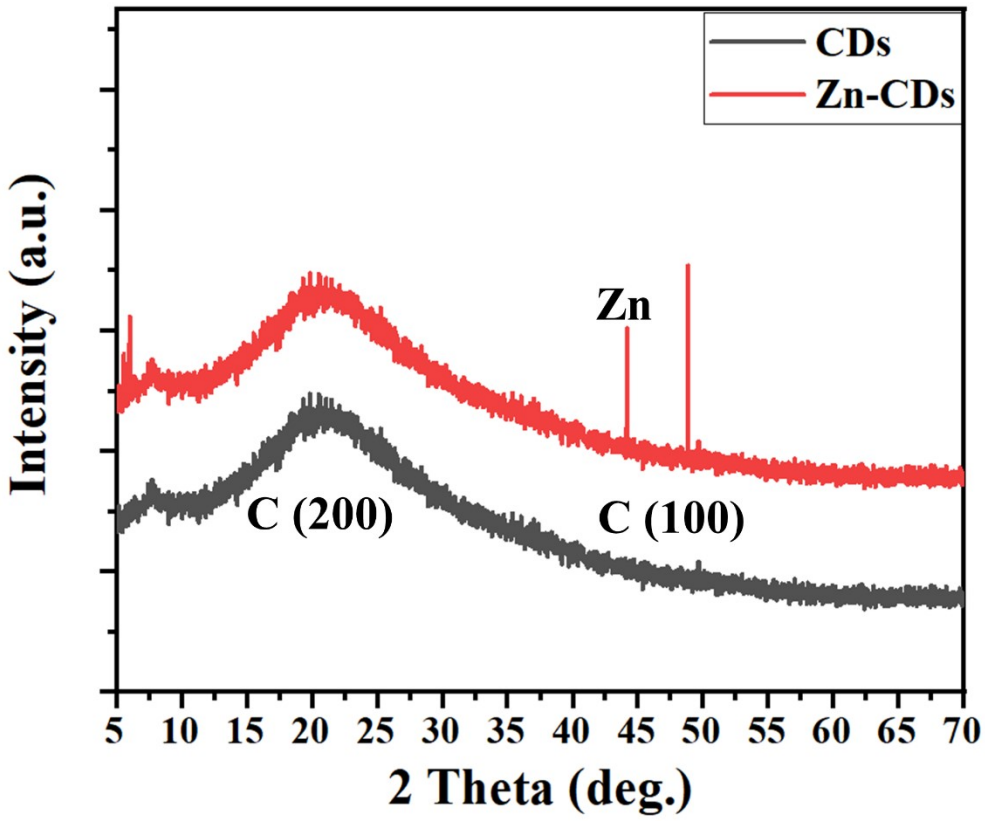

Figure S4: F XRD plots of NCDs and Zn-NCDs.

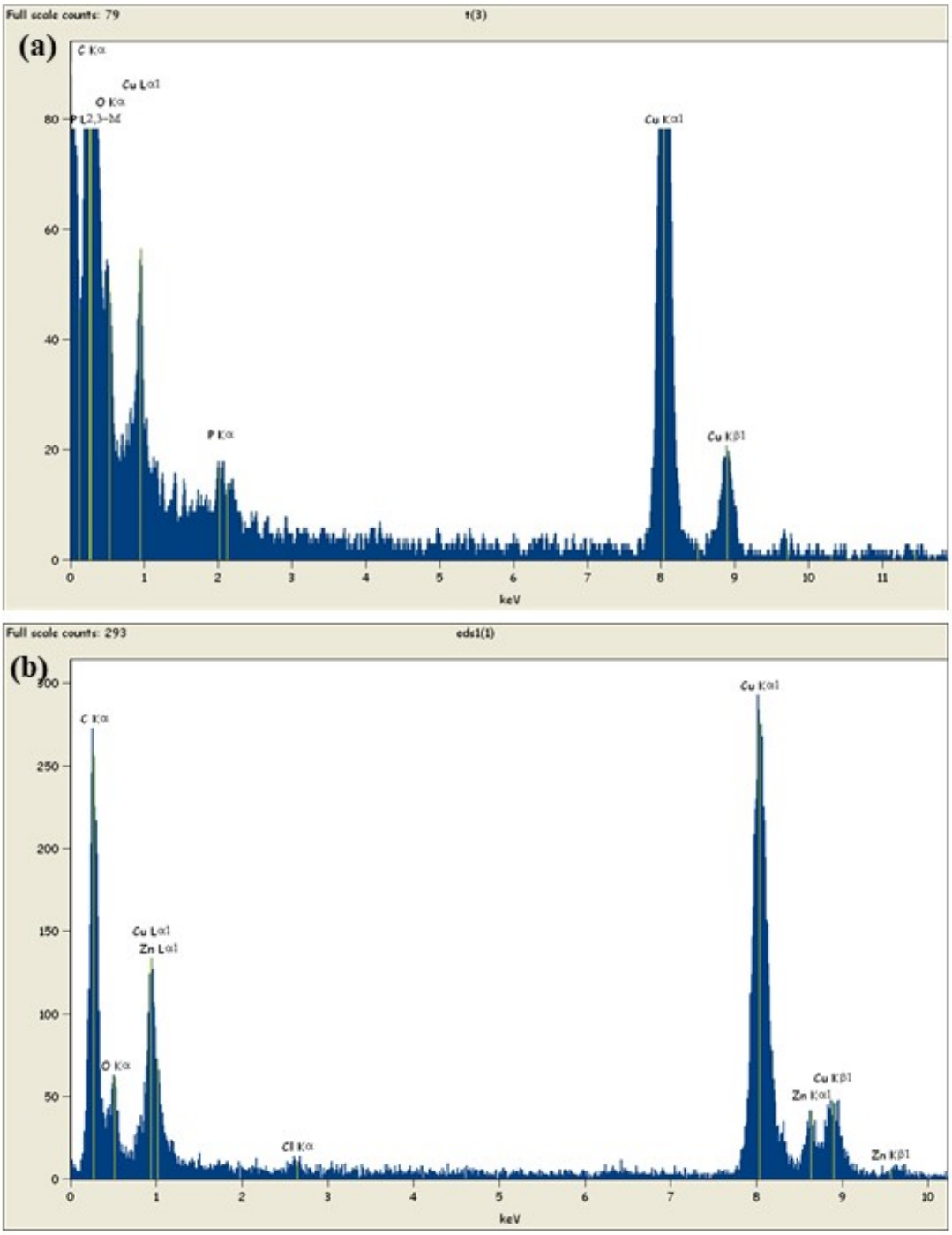

Figure S5: EDS analysis of (a) NCDs, and (b) Zn-NCDs.

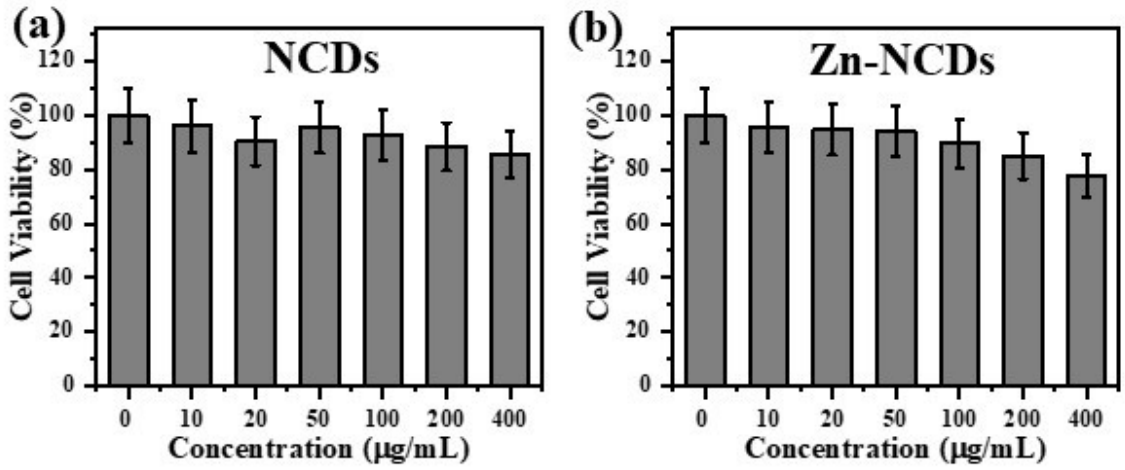

Figure S6: MTT assay. As described in the experimental section, Hela cells were incubated with various concentrations of (a) NCDs and (b) Zn-NCDs nanomaterials for 24 hours, and cell viability was measured. The data are expressed as percentages of the control, and the results are presented as the mean standard deviation of four different experiments.

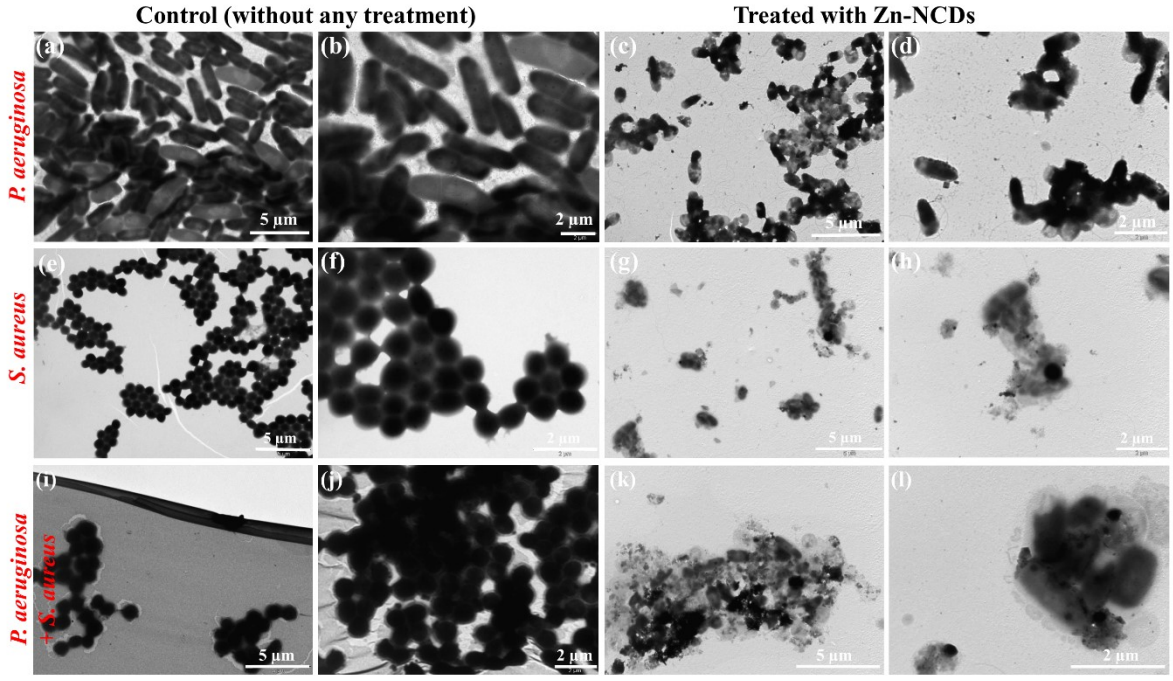

Figure S7: TEM imaging of bacterial cells. (a-d) *P. aeruginosa*, (e-k) *S. aureus*, and (il) a mixture of *S. aureus* and *P. aeruginosa*. (a, b, e, f, i, j) Untreated samples. (c, d, g, h, k, l) Following Zn-NCDs treatment for 24 hours.

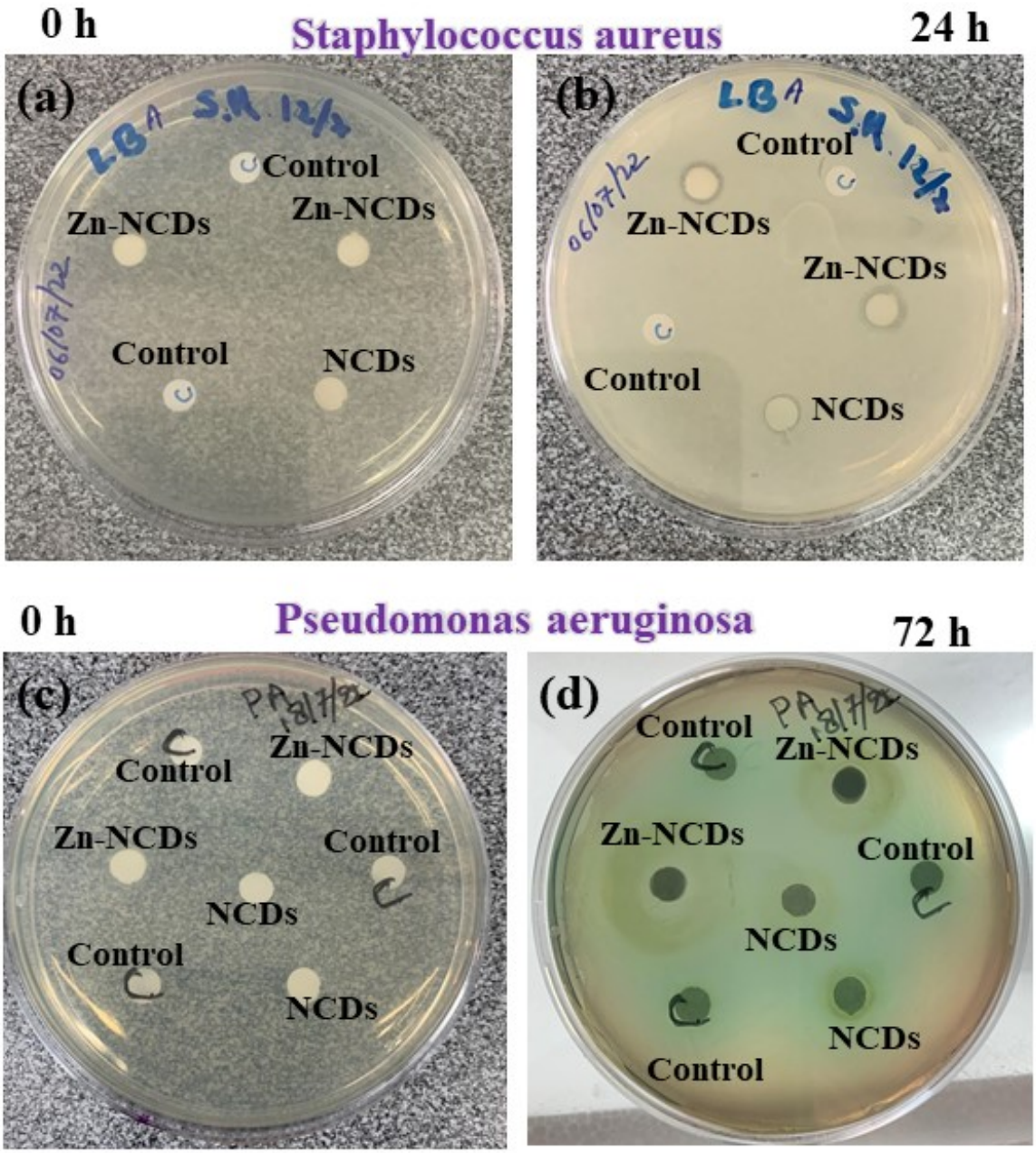

Figure S8: The effects of NCDs and Zn-NCDs on the growth of (a, b) *S. aureus* and (c, d) *P. aeruginosa*.

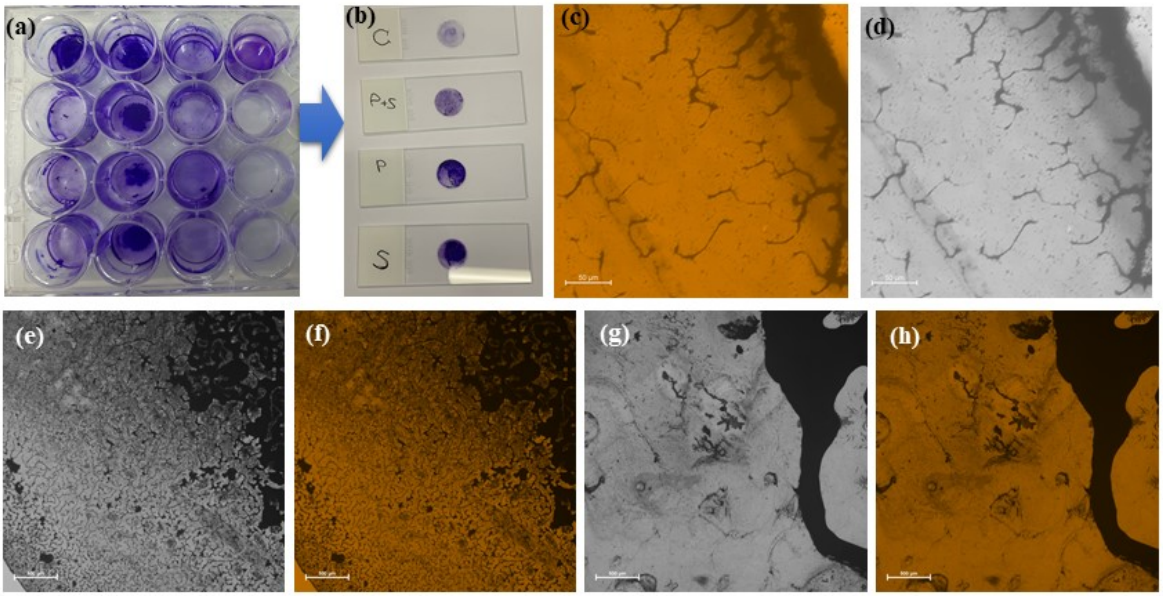

Figure S9: The formation of biofilms on an autoclaved glass cover slides placed at the bottom of 24-well plates. (a) 24-well plates stained with crystal violet dye after biofilm formation. (b) The formed biofilm transferred to a glass slide for fluorescence microscopy. (c-h) Microscopy images of (c, d) *P. aeruginosa*, (e, f) *S. aureus*, and (g, h) a mixture of both strains. (c, f, h) Fluorescence images (excitation = 590 nm; emission = 670 nm). (d, e, g) Bright field images.

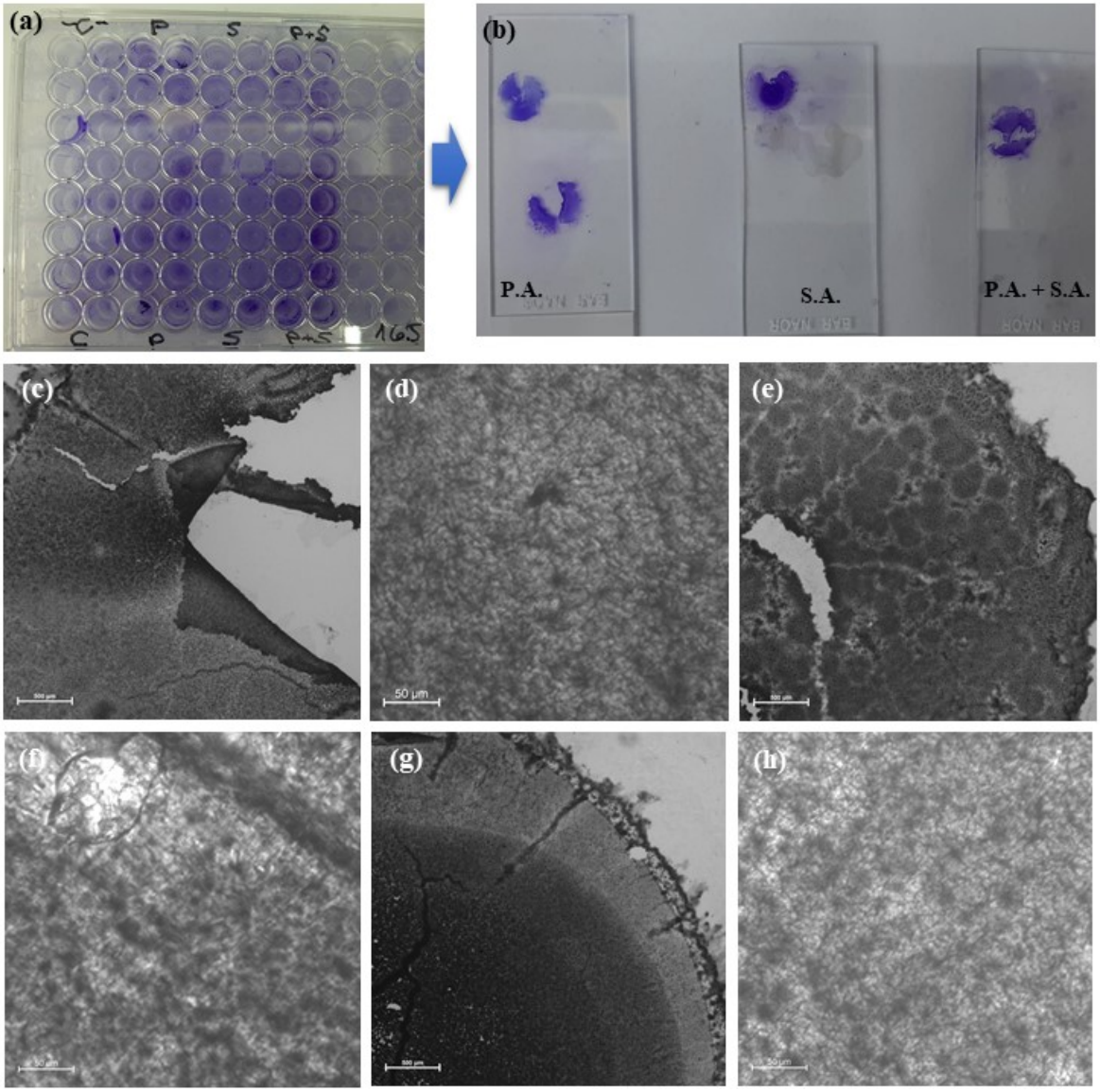

Figure S10: (a) The formation of biofilms at the bottom surfaces of 96-well plates. The photograph shows biofilm stained with crystal violet dye after biofilm formation. (b) The formed biofilm transferred to a glass slide for microscopy. (e-h) Bright field images of (c, d) *P. aeruginosa*, (e, f) *S. aureus*, and (g, h) a mixture of both *S. aureus* and *P. aeruginosa*.

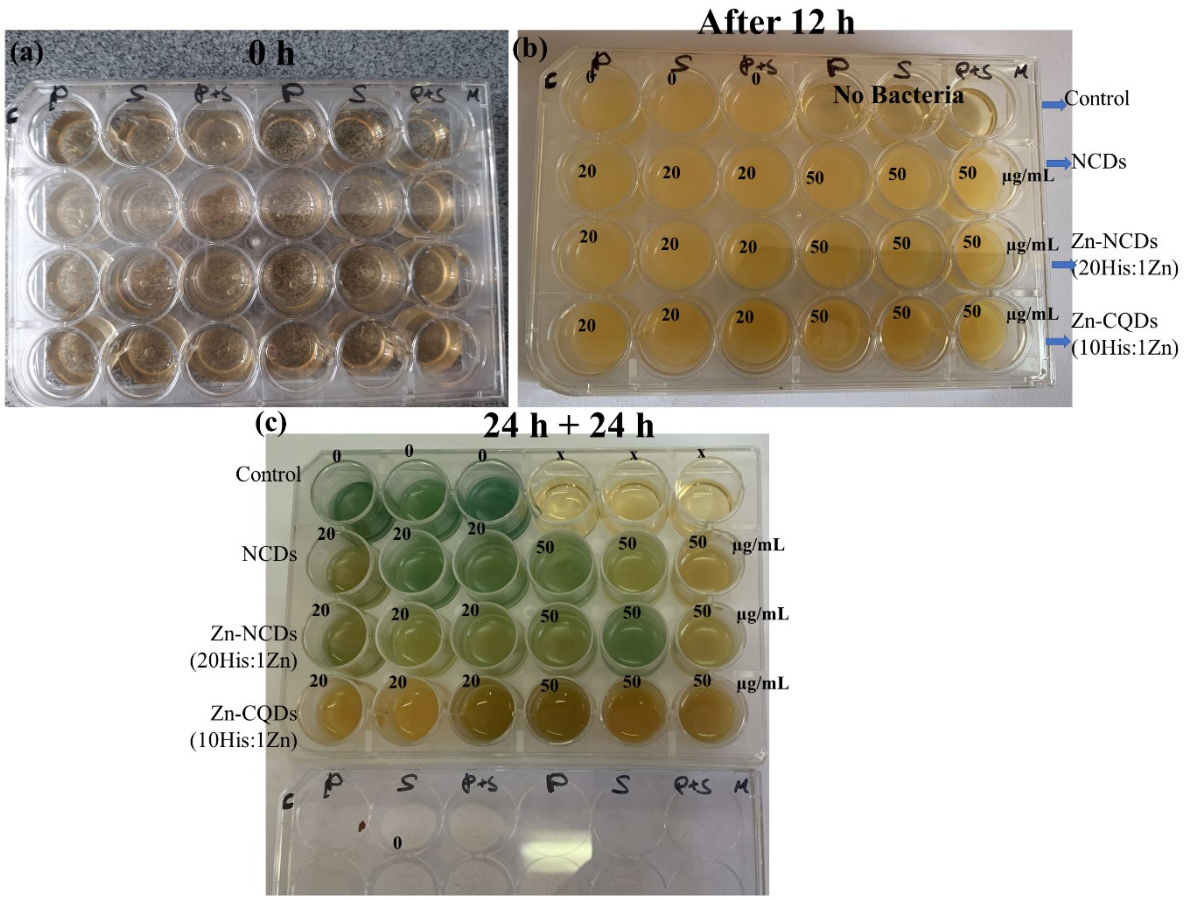

Figure S11: Photographs depicting biofilm formation and treatment with NCDs and Zn-NCDs nanomaterials. Bacteria (*P. aeruginosa*, *S. aureus*, and a mixture of both *S. aureus* and *P. aeruginosa* (P+S)) on a cover glass slide (a) after 0 hours, (b) after 12 hours, and (c) after 48 hours of incubation and 24 hours of treatment with NCDs/Zn-NCDs, as indicated.

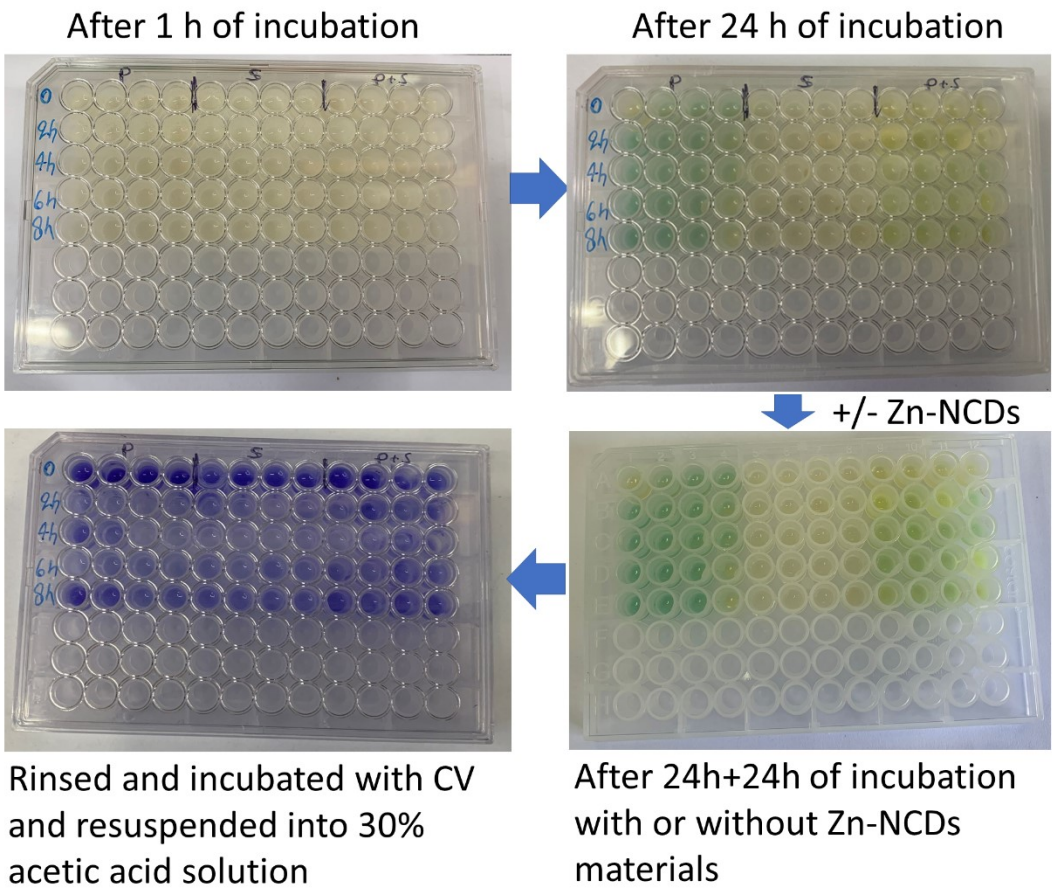

Figure S12: The formation of biofilms on 96-well plates with or without Zn-NCDs nanomaterials by *P. aeruginosa*, *S. aureus*, and a mixture of both *S. aureus* and *P. aeruginosa*.