Claims

1. A method of quantifying bacterial cells in a sample, comprising:

a) passing the sample in a liquid form through a porous substrate, the porous substrate for trapping or retaining bacterial cells on its surface thereof;

b) passing an aqueous nanoparticle solution through the porous substrate, the aqueous nanoparticle solution comprising a plasmonic and/or fluorescent nanoparticle and a first ionic surfactant, the nanoparticle functionalised with an affinity probe for binding to said bacterial cells trapped or retained on the surface of the substrate via affinity binding; and

c) passing a second aqueous solution through the porous substrate, the second aqueous solution for washing the unbound nanoparticle from the porous substrate;

wherein the bacterial cells in the sample is quantifiable by a colorimetric and/or fluorescence output emitted from the nanoparticle bound to the bacterial cells.

2. The method according to claim 1, wherein the first ionic surfactant is selected from cetrimonium bromide (CTAB), cetrimonium chloride (CTAC) or sodium dodecyl sulfate (SDS), and/or wherein the first ionic surfactant in the first solution is at a concentration of at least 2 mg/mL.

3. The method according to claim 1 or 2, wherein the plasmonic and/or fluorescent nanoparticle is selected from metallic nanoparticles, II-VI binary, ternary and quaternary semiconductor nanocrystals, IV-VI semiconductor nanocrystals, III-V semiconductor nanocrystals, I-V semiconductor nanocrystals, I-III-V semiconductor nanocrystals, group IV elemental semiconductor nanocrystals, Cu^{+} and Mn^{2+} doped semiconductor nanocrystals, and their related core/shell structures thereof, or wherein the plasmonic and/or fluorescent nanoparticle is selected from gold nanoparticles, silver nanoparticles or CdSe/CdS core/shell nanorods.

4. The method according to any one of claims 1 to 3, wherein the nanoparticle is functionalised with an affinity probe selected from protein, sugar binding protein, peptide or aptamer, such as Griphonia simplicifolia II (GSII) lectin, BSA, and Antibac2 (AB2) aptamer,

and/or wherein a ratio of affinity probe to nanoparticle is about 1:1 to about 100:1.

5. The method according to any one of claims 1 to 4, wherein the nanoparticle is at a concentration of about 2 nM to about 30 nM.

6. The method according to any one of claims 1 to 5, wherein step (b) further comprises incubating the porous substrate with the first solution for at least 10 min.

7. The method according to any one of claims 1 to 6, wherein the nanoparticle is attachable to the bacterial cells via non-covalent interaction, wherein the non-covalent interaction is selected from electrostatic interaction, ionic bonding, Hydrogen bonding, Van der Waals interaction or a combination thereof.

8. The method according to any one of claims 1 to 7, wherein the second aqueous solution is a protein dissociation buffer such as glycine-HCl buffer at about pH 2.8 to about pH 3.5 or citric acid buffer at about pH 3.

9. The method according to any one of claims 1 to 8, wherein the second aqueous solution comprises a second surfactant selected from Tween-20, CTAB, CTAC, SDS, and/or wherein the second surfactant in the second aqueous solution is at a concentration of about 0.5 wt/wt% to about 1 wt/wt%.

10. The method according to any one of claims 1 to 9, wherein step (c) further comprises incubating the porous substrate with the second aqueous solution for at least 10 min.

11. The method according to any one of claims 1 to 10, wherein the colorimetric and/or fluorescence output emitted from the nanoparticle bound to the bacterial cells is measured or quantified by detecting a colorimetric and/or fluorescence output from the nanoparticles on the porous substrate.

12. The method according to any one of claims 1 to 11, wherein the colorimetric and/or fluorescence output emitted from the nanoparticle bound to the bacterial cells is detectable by eye.

13. The method according to any one of claims 1 to 12, further comprising a step of quantifying the colorimetric and/or fluorescence output emitted from the nanoparticle bound to the bacterial cells via a detector.

14. The method according to any one of claims 1 to 13, for quantifying Gram-positive and/or Gram-negative bacterial cells in the sample.

15. The method according to any one of claims 1 to 14, wherein live bacterial cells in a sample is quantifiable from about 10^2 cfu/mL to about 10^9 cfu/mL, and/or wherein dead bacterial cells in a sample is quantifiable from more than about 10^7 cfu/mL.

16. A device for quantifying bacterial cells in a sample in a liquid form, comprising:

a) a porous substrate for trapping or retaining the bacterial cells on its surface thereof; and

b) an aqueous nanoparticle solution comprising a plasmonic and/or fluorescent nanoparticle and a first ionic surfactant, the nanoparticle functionalised with an affinity probe for binding to said bacterial cells trapped or retained on the surface of the substrate via affinity binding; and

c) a second aqueous solution for washing the unbound nanoparticle from the porous substrate;

wherein the bacterial cells in the sample is quantifiable by a colorimetric and/or fluorescence output emitted from the nanoparticle bound to the bacterial cells.

17. The device according to claim 16, wherein the porous substrate has a pore size of about 0.22 μm.

18. The device according to claim 16 or 17, further comprising a detector for quantifying the colorimetric and/or fluorescence output emitted from the nanoparticle bound to the bacterial cells.

19. The device according to any one of claims 16 to 18, for quantifying Gram-positive and/or Gram-negative bacterial cells in the sample.

20. The device according to any one of claims 16 to 19, wherein the limit of detection for live bacterial cells in a sample is about 10^2 cfu/mL, and/or wherein the limit of detection for dead bacterial cells in a sample about 10^7 cfu/mL.