In one aspect, a kit for performing methods of determining a concentration of bacterial target cells in a sample, comprising a cartridge configured to be removably coupled to an instrument configured to rotate the cartridge about a rotation axis and detect a plurality of bacterial target cells within the sample, the cartridge comprising an inlet portion defining an inlet reservoir configured to contain the sample; a separation portion including a first surface and a second surface defining a separation chamber, the separation chamber being configured to be fluidically coupled to the inlet reservoir such that at least a portion of the sample can pass from the inlet reservoir to the separation chamber when the cartridge is rotated; and a detection portion defining a detection chamber, the detection portion including a detection surface that forms a boundary of the detection chamber, the detection chamber being fluidically coupled to the separation chamber such that at least the plurality of bacterial target cells can pass through the separation chamber and into the detection chamber, the detection surface and the first surface of the separation portion forming a non-zero detection angle, said non-zero detection angle between the detection surface and the first surface of the separation portion being between 1 degree and 8 degrees, the detection surface including a surface modification including a coating comprising a charged polymer to enhance adhesion of the plurality of bacterial target cells and thereby being configured to capture the plurality of bacterial target cells; a density medium formulated to separate the bacterial target cells from contaminants having a density of between 1.01 g/cm^3 and 1.13 g/cm^3; and a staining reagent formulated to bind to and enhance detection of the plurality of bacterial target cells. Such a kit may be used for detecting a concentration of a plurality of target cells within a sample. In some embodiments, the kit further comprises a dilution reagent. In some embodiments, the detection angle between the detection surface and the first surface of the separation portion is between about 1 degree and about 8 degrees; and the detection surface includes a surface modification to enhance adhesion of the plurality of target cells. In some embodiments, the first surface of the separation portion and the detection surface are monolithically constructed; and the detection angle is about 2 degrees. In some embodiments, the detection surface includes a chemical modification to enhance adhesion of the plurality of target cells. In certain embodiments, the surface modification includes a coating comprising a charged polymer. In some embodiments, the density medium is stored within a prefilled, sealed container that is separate from the cartridge and has a volume of less than fifty percent of a volume of the cartridge. In some embodiments, the density medium comprises any of an antifoaming agent, a wetting agent, a dispersant, or an emulsifier. In some embodiments, the dilution reagent is stored with a prefilled container that is separate from the cartridge, the dilution reagent comprising any of an antifoaming agent, a wetting agent, a dispersant, or an emulsifier.

There is disclosed a method of detecting a concentration of a plurality of target cells within a sample. The method comprises conveying the sample into an inlet reservoir of a cartridge, the cartridge further comprising a separation portion and a detection portion, the separation portion including a first surface and a second surface defining a separation chamber, the separation chamber being configured to be fluidically coupled to the inlet reservoir, the

detection portion defining a detection chamber and including a detection surface that forms a boundary of the detection chamber, the detection chamber being fluidically coupled to the separation chamber, the detection surface and the first surface of the separation portion forming a non-zero detection angle, the detection surface being configured to capture the plurality of target cells; coupling the cartridge to a rotation element of an instrument; and actuating the instrument to cause the instrument to rotate the cartridge at a rotation speed sufficient to cause a) at least a portion of the sample to be conveyed from the inlet reservoir through the separation chamber and into the detection chamber; and b) the plurality of target cells to be captured on the detection surface; receive, via a detector of the instrument, a signal indicating a quantity of the plurality of target cells captured on the detection surface; and determine, based on the signal, the concentration of the plurality of target cells in the sample within a lower limit of 10^3 colony forming units (CFU) per milliliter (mL) and an upper limit of 10^9 CFU per mL.

There is disclosed a method of detecting a concentration of a plurality of target cells within a sample including conveying the sample into an inlet reservoir of a cartridge. The cartridge includes a separation portion and a detection portion. The separation portion includes a first surface and a second surface defining a separation chamber that can be fluidically coupled to the inlet reservoir. The detection portion includes a detection surface that forms a boundary of a detection chamber. The detection chamber is fluidically coupled to the separation chamber, and the detection surface and the first surface of the separation portion form a non-zero detection angle. The detection surface is configured to capture the plurality of target cells. The cartridge is coupled to a rotation element of an instrument. The instrument is then actuated to cause the instrument to: (1) rotate the cartridge at a rotation speed sufficient to cause at least a portion of the sample to be conveyed from the inlet reservoir through the separation chamber and pass into the detection chamber, and the target cells to be captured on the detection surface; (2) receive, via a detector of the instrument, a signal indicating a quantity of the target cells captured on the detection surface; and (3) determine, based on the signal, the concentration of the plurality of target cells in the sample.

In another aspect, a method of detecting a concentration of a plurality of bacterial target cells within a sample is provided. The method comprises transferring a density medium formulated to separate bacterial target cells from contaminants having a density of between 1.01 g/cm^3 and 1.13 g/cm^3 from a container into a cartridge, the cartridge comprising an inlet portion, a separation portion and a detection portion, the inlet portion defining an inlet reservoir, the separation portion including a first surface and a second surface defining a separation chamber, the separation chamber being fluidically coupled to the inlet reservoir, the detection portion

including a detection surface that forms a boundary of a detection chamber, the detection chamber being fluidically coupled to the separation chamber,

the detection surface and the first surface of the separation portion forming a non-zero detection angle, said non-zero detection angle between the detection surface and the first surface of the separation portion being between 1 degree and 8 degrees, the detection surface including a surface modification including a coating comprising a charged polymer to enhance adhesion of the plurality of bacterial target cells and thereby being configured to capture the plurality of bacterial target cells; and the transferring being performed such that the density medium is contained within the separation chamber, the density medium having a density greater than a density of a first portion of the sample and less than a density of a second portion of the sample, the second portion of the sample containing the plurality of bacterial target cells; conveying the sample into the inlet reservoir; rotating the cartridge within an instrument at a rotation speed and for a rotation duration sufficient to cause a) the second portion of the sample to pass from the inlet reservoir through the density medium in the separation chamber and into the detection chamber and b) the plurality of bacterial target cells to be captured on the detection surface; receiving, via a detector of the instrument, a signal indicating a quantity of the plurality of bacterial target cells captured on the detection surface; and determining, based on the signal, the concentration of the plurality of bacterial target cells in the sample.

In another aspect, a method of determining susceptibility of a plurality of bacterial target cells to a treatment protocol is provided. The method comprises conveying a first portion of a sample containing the plurality of bacterial target cells into a cartridge, the cartridge comprising a separation portion and a detection portion, the separation portion including a first surface and a second surface defining a separation chamber, said separation chamber comprising a density medium formulated to separate bacterial target cells from contaminants having a density of between 1.01 g/cm^3 and 1.13 g/cm^3, the detection portion including a detection surface that forms a boundary defining a detection chamber, the detection chamber being fluidically coupled to the separation chamber, the detection surface and the first surface of the separation portion forming a non-zero detection angle, said non-zero detection angle between the detection surface and the first surface of the separation portion being between 1 degree and 8 degrees, the detection surface including a surface modification including a coating comprising a charged polymer to enhance adhesion of the plurality of bacterial target cells and thereby being configured to capture the plurality of bacterial target cells; actuating a first instrument to cause the first instrument to rotate the cartridge at a rotation speed sufficient to cause a) the first portion of the sample to be conveyed through the separation chamber and into the detection chamber and b) the plurality of bacterial target cells to be captured on the detection surface; receive, via a detector of the first instrument, a signal indicating a quantity of the plurality of bacterial target cells captured on the

detection surface; and determine, based on the signal, the concentration of the plurality of bacterial target cells in the first portion of the sample; processing, based on the concentration of the plurality of bacterial target cells within the first portion of the sample, a second portion of the sample; conveying, after the processing, the second portion of the sample into a reaction chamber; and actuating a second instrument to perform a susceptibility assay on the second portion of the sample to determine susceptibility of the plurality of bacterial target cells to the treatment protocol. In some embodiments, the method processing includes diluting the second portion of the sample until a concentration of the plurality of target cells within the second portion of the sample is within a predetermined range.

plurality of target cells. In certain embodiments, the staining reagent is a fluorescent staining reagent formulated to stain the plurality of target cells. In some embodiments, the instrument rotates the cartridge at the rotation speed of between about 3000 rpm and 15,000 rpm for a time period of at least 1 minute. In certain embodiments, the rotation speed is between about 6000 rpm and 7000 rpm. In some embodiments, the container and the cartridge are packaged together within a kit.

In another aspect, an apparatus is provided comprising a cartridge configured to be removably coupled to a rotation element configured to rotate the cartridge about a rotation axis to capture a plurality of bacterial target cells within a sample, the cartridge comprising an inlet portion defining an inlet reservoir configured to contain the sample; a separation portion including a first surface and a second surface defining a separation chamber, the separation portion containing a density medium formulated to separate bacterial target cells from contaminants and having a density of between 1.01 g/cm^3 and 1.13 g/cm^3 which is a density greater than a density of a first portion of the sample and less than a density of a second portion of the sample, the second portion including the plurality of bacterial target cells, the separation chamber configured to be fluidically coupled to the inlet reservoir such that at least the second portion of the sample can pass from the inlet reservoir to the separation chamber when the cartridge is rotated; and a detection portion including a detection surface that forms a boundary of a detection chamber, the detection chamber fluidically coupled to the separation chamber such that at least the plurality of bacterial target cells can pass through the density medium and into the detection chamber, the detection surface and the first surface of the separation portion forming a non-zero detection angle, said non-zero detection angle between the detection surface and the first surface of the separation portion being between 1 degree to 8 degrees such that the plurality of bacterial target cells impinge on the detection surface when passing into the detection chamber, the detection surface including a surface modification including a coating comprising a charged polymer to enhance adhesion of the plurality of bacterial target cells and thereby being configured to capture the plurality of bacterial target cells; and a dilution reagent, wherein at least one of the dilution reagent or the density medium comprise any of an antifoaming agent, a wetting agent, a dispersant, or an emulsifier.

There is disclosed an apparatus is provided comprising a cartridge configured to be removably coupled to a rotation element configured to rotate the cartridge about a rotation axis to capture a plurality of target cells within a sample, the cartridge comprising an inlet portion defining an inlet reservoir configured to contain the sample; a separation portion including a first

surface and a second surface defining a separation chamber, the separation chamber configured to be fluidically coupled to the inlet reservoir such that at least a portion of the sample can be conveyed from the inlet reservoir to the separation chamber when the cartridge is rotated; and a detection portion defining a detection chamber, the detection portion including a detection surface that forms a boundary of the detection chamber, the detection chamber fluidically coupled to the separation chamber such that at least the plurality of target cells can be conveyed through the

separation chamber and into the detection chamber, the detection surface and the first surface of the separation portion forming a non-zero detection angle, the detection surface including a surface modification to enhance adhesion of the plurality of target cells, a ratio of a volume of the separation chamber and a volume of the detection chamber being at least about 2.0.

There is disclosed an apparatus is provided comprising a cartridge configured to be removably coupled to a rotation element configured to rotate the cartridge about a rotation axis to capture a plurality of target cells within a sample, the cartridge comprising an inlet portion defining an inlet reservoir configured to contain the sample; a separation portion including a first surface and a second surface defining a separation chamber, the separation portion configured to contain a density medium having a density greater than a density of a first portion of the sample and less than a density of a second portion of the sample, the second portion including the plurality of target cells, the separation chamber configured to be fluidically coupled to the inlet reservoir such that at least the second portion of the sample can pass from the inlet reservoir to the separation chamber when the cartridge is rotated; and a detection portion includes a detection surface that forms a boundary of a detection chamber, the detection chamber fluidically coupled to the separation chamber such that at least the plurality of target cells can pass through the density medium and into the detection chamber, the detection surface being nonparallel to at least one of the first surface or the second surface such that the plurality of target cells impinge on the detection surface when passing into the detection chamber, the detection surface configured to capture the plurality of target cells.

There is disclosed an apparatus is provided comprising a cartridge configured to be removably coupled to a rotation element configured to rotate the cartridge about a rotation axis to capture a plurality of target cells within a sample, the cartridge comprising an inlet portion defining an inlet reservoir configured to contain the sample; a separation portion including a first surface and a second surface defining a separation chamber, the separation chamber configured to be fluidically coupled to the inlet reservoir such that at least a portion of the sample can be conveyed from the inlet reservoir to the separation chamber when the cartridge is rotated; and a detection portion defining a detection chamber, the detection portion including a detection surface that forms a boundary of the detection chamber, the detection chamber fluidically coupled to the separation chamber such that at least the plurality of target cells can be conveyed through the separation chamber and into the detection chamber, the detection surface and the first surface of the separation portion forming a non-zero detection angle, the detection surface configured to capture the plurality of target cells, a ratio of a volume of the separation chamber and a volume of the detection chamber being at least about 2.0.

CLAIMS

1. A kit for performing methods of determining concentration of bacterial target cells in a sample, comprising:
    - a cartridge configured to be removably coupled to an instrument configured to rotate the cartridge about a rotation axis and detect a plurality of bacterial target cells within the sample, the cartridge comprising:
        - an inlet portion defining an inlet reservoir configured to contain the sample;
        - a separation portion including a first surface and a second surface defining a separation chamber, the separation chamber being configured to be fluidically coupled to the inlet reservoir such that at least a portion of the sample can pass from the inlet reservoir to the separation chamber when the cartridge is rotated; and
        - a detection portion defining a detection chamber, the detection portion including a detection surface that forms a boundary of the detection chamber, the detection chamber being fluidically coupled to the separation chamber such that at least the plurality of bacterial target cells can pass through the separation chamber and into the detection chamber, the detection surface and the first surface of the separation portion forming a non-zero detection angle, said non-zero detection angle between the detection surface and the first surface of the separation portion being between 1 degree and 8 degrees, the detection surface including a surface modification including a coating comprising a charged polymer to enhance adhesion of the plurality of bacterial target cells and thereby being configured to capture the plurality of bacterial target cells;
    - a density medium formulated to separate the bacterial target cells from contaminants having a density of between 1.01 g/cm^3 and 1.13 g/cm^3; and
    - a staining reagent formulated to bind to and enhance detection of the plurality of bacterial target cells.
2. The kit of claim 1, further comprising a dilution reagent.
3. The kit of claim 1 or 2, wherein the first surface of the separation portion and the detection surface are monolithically constructed; and the detection angle is 2 degrees.
4. The kit of any one of claims 1 to 3, wherein the density medium is stored within a prefilled, sealed container that is separate from the cartridge and has a volume of less than fifty percent of a volume of the cartridge and/or wherein the density medium comprises any of an antifoaming agent, a wetting agent, a dispersant, or an emulsifier.

5. The kit of any one of claims 2 to 4, wherein the dilution reagent is stored with a prefilled container that is separate from the cartridge, the dilution reagent comprising any of an antifoaming agent, a wetting agent, a dispersant, or an emulsifier.

6. A method of detecting a concentration of a plurality of bacterial target cells within a sample, the method comprising:

- transferring a density medium formulated to separate bacterial target cells from contaminants having a density of between 1.01 g/cm^3 and 1.13 g/cm^3 from a container into a cartridge, the cartridge comprising an inlet portion, a separation portion and a detection portion, the inlet portion defining an inlet reservoir, the separation portion including a first surface and a second surface defining a separation chamber, the separation chamber being fluidically coupled to the inlet reservoir, the detection portion including a detection surface that forms a boundary of a detection chamber, the detection chamber being fluidically coupled to the separation chamber, the detection surface and the first surface of the separation portion forming a non-zero detection angle, said non-zero detection angle between the detection surface and the first surface of the separation portion being between 1 degree and 8 degrees, the detection surface including a surface modification including a coating comprising a charged polymer to enhance adhesion of the plurality of bacterial target cells and thereby being configured to capture the plurality of bacterial target cells; and the transferring being performed such that the density medium is contained within the separation chamber, the density medium having a density greater than a density of a first portion of the sample and less than a density of a second portion of the sample, the second portion of the sample containing the plurality of bacterial target cells;
- conveying the sample into the inlet reservoir;
- rotating the cartridge within an instrument at a rotation speed and for a rotation duration sufficient to cause a) the second portion of the sample to pass from the inlet reservoir through the density medium in the separation chamber and into the detection chamber and b) the plurality of bacterial target cells to be captured on the detection surface;
- receiving, via a detector of the instrument, a signal indicating a quantity of the plurality of bacterial target cells captured on the detection surface; and
- determining, based on the signal, the concentration of the plurality of bacterial target cells in the sample.

7. The method of claim 6, wherein the instrument determines the concentration of the plurality of bacterial target cells within a lower limit of 10^3 colony forming units (CFU) per milliliter (mL) and an upper limit of 10^9 CFU per mL.

8. The method of claim 6 or 7, further comprising:

- conveying a dilution reagent into the cartridge, at least one of the dilution reagent or the density medium comprising any of an antifoaming agent, a wetting agent, a dispersant, or an emulsifier.

9. The method of claim 8, wherein at least one of the dilution reagent or the density medium comprises a poloxamer.

10. The method of claim 8 or 9, wherein the conveying the dilution reagent includes mixing the dilution reagent with the sample and conveying the dilution reagent and the sample into the inlet reservoir of the cartridge in the same operation.

11. The method of any one of claims 6 to 10, wherein the density medium has a density of between 1.05 grams per cubic centimeter and 1.09 grams per cubic centimeter.

12. The method of any one of claims 6 to 11, wherein the sample is a blood sample or a urine sample.

13. A method of determining susceptibility of a plurality of bacterial target cells to a treatment protocol, the method comprising:

- conveying a first portion of a sample containing the plurality of bacterial target cells into a cartridge, the cartridge comprising a separation portion and a detection portion, the separation portion including a first surface and a second surface defining a separation chamber, said separation chamber comprising a density medium formulated to separate bacterial target cells from contaminants having a density of between 1.01 g/cm^3 and 1.13 g/cm^3, the detection portion including a detection surface that forms a boundary defining a detection chamber, the detection chamber being fluidically coupled to the separation chamber, the detection surface and the first surface of the separation portion forming a non-zero detection angle, said non-zero detection angle between the detection surface and the first surface of the separation portion being between 1 degree and 8 degrees, the detection surface including a surface modification including a coating comprising a charged polymer to enhance adhesion of the plurality of bacterial target cells and thereby being configured to capture the plurality of bacterial target cells;
- actuating a first instrument to cause the first instrument to:

- rotate the cartridge at a rotation speed sufficient to cause a) the first portion of the sample to be conveyed through the separation chamber and into the detection chamber and b) the plurality of bacterial target cells to be captured on the detection surface;
- receive, via a detector of the first instrument, a signal indicating a quantity of the plurality of bacterial target cells captured on the detection surface; and
- determine, based on the signal, the concentration of the plurality of bacterial target cells in the first portion of the sample;

- processing, based on the concentration of the plurality of bacterial target cells within the first portion of the sample, a second portion of the sample;
- conveying, after the processing, the second portion of the sample into a reaction chamber; and
- actuating a second instrument to perform a susceptibility assay on the second portion of the sample to determine susceptibility of the plurality of bacterial target cells to the treatment protocol.

14. An apparatus, comprising:

- a cartridge configured to be removably coupled to a rotation element configured to rotate the cartridge about a rotation axis to capture a plurality of bacterial target cells within a sample, the cartridge comprising:
  - an inlet portion defining an inlet reservoir configured to contain the sample;
  - a separation portion including a first surface and a second surface defining a separation chamber, the separation portion containing a density medium formulated to separate bacterial target cells from contaminants and having a density of between 1.01 g/cm^3 and 1.13 g/cm^3, which is a density greater than a density of a first portion of the sample and less than a density of a second portion of the sample, the second portion including the plurality of bacterial target cells, the separation chamber configured to be fluidically coupled to the inlet reservoir such that at least the second portion of the sample can pass from the inlet reservoir to the separation chamber when the cartridge is rotated; and
  - a detection portion including a detection surface that forms a boundary of a detection chamber, the detection chamber fluidically coupled to the separation chamber such that at least the plurality of bacterial target cells can pass through the density medium and into the detection chamber, the detection surface and the first surface of the separation portion forming a non-zero detection angle, said non-zero

detection angle between the detection surface and the first surface of the separation portion being between 1 degree and 8 degrees such that the plurality of bacterial target cells impinge on the detection surface when passing into the detection chamber, the detection surface including a surface modification including a coating comprising a charged polymer to enhance adhesion of the plurality of bacterial target cells and thereby being configured to capture the plurality of bacterial target cells; and

- a dilution reagent, wherein at least one of the dilution reagent or the density medium comprise any of an antifoaming agent, a wetting agent, a dispersant, or an emulsifier.

15. The apparatus of claim 14, wherein the first surface of the separation portion and the detection surface are monolithically constructed.

16. The apparatus of claim 14 or 15 wherein the cartridge defines a radial axis that intersects the rotation axis; the first surface of the separation portion and the detection surface are monolithically constructed; and the detection angle is along the radial axis and within a cross-sectional plane defined by the radial axis and the rotation axis.

17. The apparatus of any one of claims 14 to 16, wherein the inlet portion defines an opening through which the sample can be conveyed into the inlet reservoir; and the detection surface is angled in a downward direction with respect to the opening.

18. The apparatus of any one of claims 14 to 17, wherein a ratio of a volume of the separation chamber and a volume of the detection chamber is at least 2.0.

19. The apparatus of any one of claims 14 to 18, wherein a distance between the first surface of the separation portion and the second surface of the separation portion define a thickness of the separation chamber, the thickness being less than 0.6 mm.

20. The apparatus of any one of claims 14 to 19, wherein the separation portion defines a density medium reservoir within which the density medium is contained.

21. The apparatus of any one of claims 14 to 20, wherein at least one of the dilution reagent or the density medium comprises a poloxamer and wherein the poloxamer contains poly(ethylene oxide) (PEO) and poly(propylene oxide) (PPO).

22. The apparatus of any one of claims 14 to 21, further comprising a staining reagent, the staining reagent formulated to bind to and enhance detection of the plurality of bacterial target cells.