CLAIMS

1. A microfluidic device (200) comprising:

at least one inlet (212) for receiving a sample comprising target cells and non-target cells;

a first spiral channel portion (220) having an upstream end (222) in a central region and a downstream end (224) in a peripheral region, the upstream end (222) being coupled to the inlet (212), the first spiral channel portion (220) being configured such that the target cells and the non-target cells occupy different streams at the downstream end;

a first waste outlet (232) arranged to couple with streams of non-target cells at the downstream end (224) of the first spiral channel portion (220);

a link channel portion (240) arranged to couple with streams of target cells at the downstream end (224) of the first spiral channel portion (220);

a second spiral channel portion (260) having an upstream end (262) in a peripheral region and a downstream end (264) in a central region, the upstream end (262) of the second spiral channel portion (260) being coupled to the link channel portion (240), the second spiral channel portion (260) being configured such that the target cells and the non-target cells occupy different streams at the downstream end (264);

a second waste outlet (272) arranged to couple with streams of non-target cells at the downstream end (264) of the second spiral channel portion (260);

a sample outlet (270) arranged to couple with streams of target cells at the downstream end (264) of the second spiral channel portion (260);

a first waste outlet portion (230) and a pressure compensator path (234) forming part of the first waste outlet portion (230) and coupling the downstream end (224) of the first spiral channel portion (220) to the first waste outlet (232);

a sample outlet coupling path (266) coupling the second spiral channel portion (260) to the sample outlet (270);

a second waste outlet coupling path (268) coupling the second spiral channel portion (260) to the second waste outlet (272);

a first buffer inlet (214) coupled to the upstream end (222) of the first spiral channel portion (220), the first buffer inlet (214) configured to receive a sheath buffer; and

a second buffer inlet (252) coupled to the upstream end (262) of the second spiral channel portion (260), the second buffer inlet (252) configured to receive a sheath buffer,

characterised in that the first waste outlet portion (230) is configured to have a flow resistance R_{W1} according to the equation:

$$r_O' = (R_{W1} - r_{O1}R_{R1+S2})/R_{C2+R2//W2}$$

wherein r_{O1} is a flow rate ratio of recovery equal to a ratio of a flow rate Q_{SI2} through the link channel portion (240) and a flow rate Q_{WO1} at the first waste outlet (232), r_O' is equal to the sum of r_{O1} and a ratio of an input flow rate Q_{BI2} of sheath buffer into the second buffer inlet (252) and the flow rate Q_{WO1} at the first waste outlet (232), R_{R1+S2} is the flow resistance of the link channel portion (240), and $R_{C2+R2//W2}$ is the flow resistance of the second spiral channel portion (260) and the parallel combination of the sample outlet coupling path (266) and the second waste outlet coupling path (268).

2. A microfluidic device according to claim 1, wherein the first buffer inlet (214) is arranged to introduce the sheath buffer to the first spiral channel portion (220) adjacent to an inner wall of the first spiral channel portion and the at least one inlet (212) is arranged to introduce the sample to the first spiral channel portion (220) adjacent to an outer wall of the first spiral channel portion.

3. A microfluidic device according to any preceding claim wherein the sample is a blood sample or blood constituents.

4. A microfluidic device according to any preceding claim wherein the target cells are circulating tumor cells or circulating rare cells.

5. A microfluidic device according to any preceding claim, wherein the first and second spiral channel portions (220, 260) are configured such that the target cells undergo inertial focusing and the non-target cells migrate in lateral position under the influence of Dean forces.

6. A microfluidic device according to any preceding claim, wherein the target cells have a cell diameter greater than a cell diameter threshold and the non-target cells have a diameter less than the cell diameter threshold.

7. A microfluidic device according to any preceding claim wherein flow resistances associated with the first waste outlet (232) and the link channel portion (240) are configured according to the flow rate ratio.

8. A microfluidic device according to claim 7 wherein channel widths associated with the first waste outlet (232) and the link channel portion (240) are configured according to the flow rate ratio.

9. A microfluidic device according to claim 7 or 8 wherein flow resistances associated with the second waste outlet (272) and the sample outlet (270) are configured according to the flow rate ratio.

10. A microfluidic device according to claim 9 wherein channel widths associated with the second waste outlet (272) and the sample outlet (270) are configured according to the flow rate ratio.

11. A microfluidic device according to any one of claims 7 to 10 wherein the flow rate ratio is in the range of 0.1 to 10.