We have developed a microfluidic platform capable of enabling rapid size-based separations of micron-scale species (particles, cells).

- Embedded weir-like barrier separates two lanes with unequal depths, oriented parallel to the flow direction and extending along the entire centerline length.
- Merges high selectivity of a physical membrane barrier with ability to operate at high flow rates (mL/min), making it possible to process large volumes with no clogging.

PC3 cells (20 – 30 µm dia.), spiked into whole blood diluted 1:5 with PBS to equalize viscosities.
- PC3: 1.43 x 10^6 cells/mL
- WBC: 1.45 x 10^6 cells/mL
- RBC: 8.12 x 10^15 cells/mL
- PBS: 8.12 x 10^6 cells/mL

- PC3 spiked blood injected into the inner inlet at 1 mL/min
- PBS co-injected into the outer inlet at the same flow rate (20-35 µm depths)
- PC3 cells separated with > 99% efficiency and enriched by 2.2x
- 6 mL sample processed in 6 min

Separation Performance
Particle-based experiments, 3D simulations (STAR-CCM+)

Curved, equal depth
- Inner and outer lanes: 40 µm
- Centerline barrier gap: 5 µm
- Radius of curvature: 500 µm
- Particle size: 2 µm
- Flow rate: 2 mL/min
- Dean vortices in curved region transport a few small particles across gap to the outer lane
- Straight, unequal depth
- Lane 1: 30 µm
- Lane 2: 20 µm
- Centerline barrier gap: 7 µm
- Flow rate: 2 mL/min
- Pressure difference at entry drives particle migration from shallow lane into deep lane
- Ratio of transverse to lateral pressures governs transport across barrier

Dilution

High separation efficiencies can be maintained across flow rates from 0.1 – 2.0 mL/min, making this approach ideal for high-throughput processing.

Acknowledgments: Cancer Prevention & Research Institute of Texas (CPRIT grant RP150421); Texas A&M High Performance Research Computing