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Homework #3
Micro-Scale Engineering
Due: February 11, 2014

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We have reviewed the paper on "Inertial Focusing for Tumor Antigen–Dependent and –Independent Sorting of Rare Circulating Tumor Cells" in the class. Based on the results presented in slide #18, an array with 32-µm gaps has an extended operating range for cells between 8 and 30 µm. But, it retains only 60% of WBCs. Is such a low retention rate a concern? You can find the answer from the paper.

This retention rate is not a concern because the WBCs that are lost are smaller in size than the reported CTCs, which are the cells this device is interested in isolating and identifying.

For the 32-µm gap, the center-to-center distance between the posts is 56 µm. Estimate the diameter of the post. Assume it is the diameter of a sphere and calculate the corresponding Reynolds number w.r.t. a flow velocity of 0.5 mm/sec. Is this a laminar flow or a turbulent flow surrounding the sphere? Identify one condition that the flow is no longer laminar.

Estimate the diameter of the post:

56 - 32 µm = 24 µm diameter posts

Calculate the corresponding Reynolds Number:

$Re = \rho u_m D/\mu$
$\rho = 1000.00\ kg/m^3$
$u_m = 0.50\ mm/sec = 0.0005\ m/sec$
$\mu = 0.001002\ (N \bullet s)/m^2$
D = 2.4E-5
Re = (1000 * 0.0005 * 2.4E-5)/0.001002

Re = 1.198 E-2

Is this a laminar flow or a turbulent flow surrounding the sphere? Identify one condition that the flow is no longer laminar.

There is laminar flow surrounding the sphere, due to the Reynolds Number being less than 1. To make the flow no longer laminar you would have to increase the velocity to 0.05 m/sec, which would increase the Reynolds Number to 1.198 leading to a transitional flow rather than singularly laminar.