“**Computational modeling and simulation of cell transport, deformation, adhesion, and rolling in flowing blood**”

Prosenjit Bagchi
Department of Mechanical and Aerospace Engineering
Rutgers University
Piscataway, New Jersey

Abstract:
Computational modeling and simulation of blood flow in small vessels of diameter 10--300 microns remain a major challenge. It is because blood in such vessels behaves as a suspension of deformable particles. Individuality of blood cells must be recognized in small vessels. At the same time, a large number of cells must be considered to realistically simulate the blood flow in such vessels. The red blood cells (or, erythrocytes), a major constituent of blood, are highly deformable particles. Deformability of the red blood cells, and cell-to-cell interaction give rise to many hydrodynamic phenomena that have immense biological significance. White blood cells (or, leukocytes), which are responsible for body's immune response, may also deform significantly during their interaction with the wall of a blood vessel and with other cells. The problem of cell-cell or cell-wall interaction is multiscale in nature which occurs under a balance of the hydrodynamic force, and the adhesive force due to stochastically forming and breaking molecular bonds.

In this talk, I will present computational modeling and simulations based on the immersed boundary method to study the hydrodynamics of deformable cells. The rheological models of individual blood cell will be incorporated within the computational framework. Molecular interaction between adjacent cells, and between a cell and the vessel wall will also be considered. In the first part of the talk, the focus will be on the deformation and lateral migration of cells in wall-bounded flows, binary interaction of cells, and simulation of multiple [O(100)] deformable cells (primarily, red blood cells). In the second part, I will focus on the hydrodynamics of rolling motion of leukocytes over an adhesive surface, and elucidate how rheological properties of the leukocytes and the biophysical parameters underlying the cell/surface adhesion are coupled to the hydrodynamics to promote cell adhesion under flowing conditions.