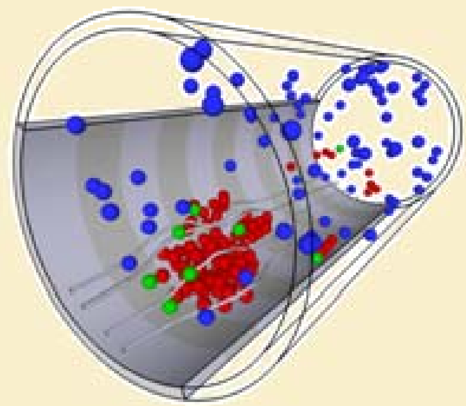
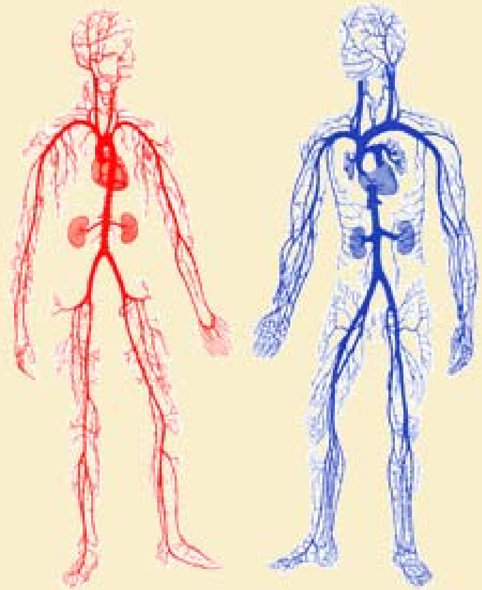
Multiscale Simulation of Arterial Blood Flow

Crunch Group

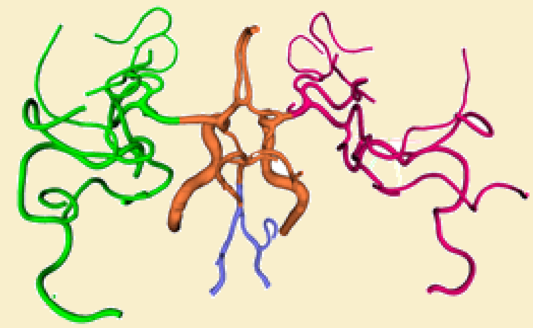
BROWN





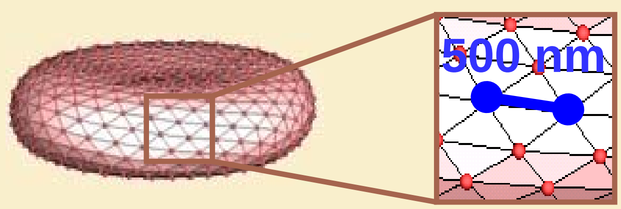
The CRUNCH Group

The CRUNCH group is a research group in the Division of Applied Mathematics at Brown University. The thrust of its research is the development of numerical algorithms, visualization methods and parallel software for continuum and atomistic simulations in fluid mechanics and related applications. The main approach to numerical discretization is based on spectral/*hp* element methods, multi-element polynomial chaos, and stochastic molecular dynamics (DPD). The group is directed by Prof. George Em Karniadakis.



Human Arterial Tree Project

The ultimate goal of the arterial tree project is to model blood flow interactions in different regions of the cardiovascular system. We aim to establish a biomechanics gateway on the TeraGrid and make the arterial tree a platform and a simulation framework for further developments and systematic studies in hemodynamics, disease modeling, and drug delivery.



A Stochastic Molecular Dynamics Method for Multiscale Modeling of Blood Platelet Phenomena

Our integrated approach couples multiscale representations of blood flow, which include 1D quasi-transient flow in compliant vessels at the largest scale and unsteady 3D flows in curved vessels at the millimeter scale, with thrombus formations at fissures in the lumen of atherosclerotic vessels, which consist of interactions between micron-sized platelets and nano-scale proteins. These flow models will also be coupled in time with a developing thrombus-wall interaction, which depends on changes in the behavior of platelet receptors, bonds, and structures. To this end, we will develop a coarse-grained molecular dynamics approach based on recent formulations of dissipative particle dynamics (DPD) to seamlessly connect length scales ranging from 10 nm to several mm.

TeraGrid

TeraGrid integrates the most powerful open computing resources in the USA. We are working closely with computer scientists at the Argonne National Labs to develop middleware that can facilitate the transition from a single supercomputer to the TeraGrid. In particular, we have focused on the use and further development of MPICH-G2/MPIg, which relieves the computational scientist from low-level details of communication handling, network topology, resource allocation and management on the grid.

For more information, please visit: http://www.cfm.brown.edu/crunch/index2.shtml