A new field of biomedical research, biomechanics of hemostasis and thrombosis, has been quickly developing over the past few years. The mechanical properties of fibrin are essential in vivo for the ability of clots to stop bleeding in flowing blood but also determine the likelihood of obstructive thrombi that cause heart attacks and strokes. Despite such critical importance, the molecular structural basis of clot mechanics is not well understood. This seminar will focus on recent biophysical research on both platelet aggregation/adhesion and blood clots. An optical trap system has been developed to study protein-protein binding/unbinding at the single molecule level, and used to characterize fibrinogen-integrin interactions that are responsible for platelet aggregation. The results of this research are relevant to the behavior of platelets in flowing blood. Through studies of the structure and mechanical behavior of fibrin clots at the macroscopic, network, fiber and molecular levels, we show that they can only be understood by integration of their materials properties at all these levels and propose a molecular basis for their remarkable extensibility and compressibility. Studies of the forced elongation of fibrin provide important qualitative and quantitative characteristics of the molecular mechanisms underlying fibrin mechanical properties at the microscopic and macroscopic scales. The long-term goal is to relate these basic science discoveries to thrombotic disorders, bleeding, and embolization in coronary artery disease, stroke and cancer, as well as angioplasty and methods of clot ablation and removal, and application of fibrin sealants.