

John Tarbell, PhD

CUNY and Wallace Coulter Distinguished Professor
Department of Biomedical Engineering
The City College of New York
New York, NY 10031



Fluid mechanics in vascular disease and cancer: the role of the glycocalyx

Abstract: The relationship between arterial fluid mechanics and vascular disease has been studied extensively for nearly 50 years. Several fluid mechanical characteristics have been identified that are associated with the localization of disease including: low wall shear stress, reversing oscillatory wall shear stress and others. For the development of therapeutics, endothelial cell biomolecular, genetic and epigenetic responses have been compared between atherogenic and atheroprotective fluid mechanical environments in order to identify unique cell signaling pathways that might be targeted by drugs to suppress vascular disease.

Another avenue for the development of therapeutics has come into focus in recent years associated with the endothelial surface “glycocalyx” – a layer of proteoglycans, glycoproteins, bound proteins and other components. It is now known from animal studies that the glycocalyx is degraded focally in regions of vascular disease development allowing elevated LDL permeability, elevated leukocyte adhesion, reduced nitric oxide production and other mechanisms that propagate vascular disease. These observations have led recently to searches for potential therapeutics that might stimulate new synthesis of the glycocalyx. This is an area of ongoing activity that is in its infancy.

Most recently it has been observed that the surface glycocalyx on cancer cells senses interstitial flow forces that are enhanced in tumors and promote cancer cell migration that may contribute to metastasis. Thus the cancer cell glycocalyx may be a target for cancer therapeutics as well.

In this lecture I will review the above with emphasis on the role of fluid mechanics and the glycocalyx in vascular disease and cancer.