Christina Hamlet
e-mail: chamlet@email.unc.edu
Laura A. Miller
e-mail: lam9@email.unc.edu
Austin Baird
e-mail: abaird@email.unc.edu
Terry Rodriguez
e-mail: tjrodrig@email.unc.edu

Excitable tissues in fluids

A wide range of numerical, analytical, and experimental work in recent years has focused on understanding the interaction between fluids and elastic structures in the context of cardiovascular flows, animal swimming and flying, cellular flows, and other biological problems. While great progress has been made in understanding such systems, less is known about how these excitable tissues modulate their mechanical properties in response to fluid forces and other environmental cues. The broad goal of this work is to develop a framework to integrate the conduction of action potentials with the contraction of muscles, to the movement of organs and organisms, to the motion of the fluid, and back to the nervous system through environmental cues. Such coupled models can then be used to understand how small changes in tissue physics can result in large changes in performance at the organ and organism level. Two examples will be discussed in this presentation. The first example considers how active contractions generated by the cardiac conduction system can enhance flows in tubular hearts, particularly at low Reynolds numbers. The second example considers how the interactions between pacemakers in the upside down jellyfish can alter feeding currents generated by the bell pulsations. In both cases, the ultimate goal is to simulate the electropotentials in the nervous system that trigger mechanical changes in 1D fibers representing the muscular bands. The muscular contractions then apply forces to the boundaries that interacts with the fluid modeled by the Navier-Stokes equations. The computational framework used to solve these problems is the immersed boundary method originally developed by Charles Peskin.