Computational Modeling of Lung Organogenesis

Cadet Kimberly Jung
Department of Civil & Mechanical Engineering
United States Military Academy
West Point, New York

Advisor: Dr. Andrew Johnson
Senior Scientist, Army High Performance Computer Center
Minneapolis, MN

ABSTRACT:

Computational Modeling of Lung Organogenesis. Computational fluid dynamics simulations of a fluid mechanical model of the contractions of a developing embryonic rat lung in a single section of tube were generated with the CrayX1 at the Army High Performance Computing Center in Minneapolis. The purpose of this project is to better understand the mechanics behind in utero germ-line therapy for curing cystic fibrosis. Reynolds' number was determined to be 0.005 using fluid properties and dimensions of a rat embryonic bronchial tube, classifying the flow as creep flow. The shape and velocity of the annulus were varied, as well as the elasticity of the lung cavity, which was modeled as an expanding bulb at the end of the bronchial tube based on a percentage of the volume displaced by the annulus. Once the geometric movements were determined, the simulations were run, and velocity and pressure cross-sections were generated. Since it is creep flow, the flows solved were relatively smooth; almost no backflow or recirculation was observed.

KEYWORDS: computational fluid dynamics, lung organogenesis, creep flow

CONTACT: Andrew Johnson, Ph.D, Senior Scientist, Army High Performance Computer Center. Minneapolis, MN. Email: ajohn@ahpcrc.org

Cadet Kimberly Jung, United States Military Academy, West Point, NY, Tel: (845) 515-5211, Email: kimberly.jung@usma.edu