Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Numerical modeling of the fetal blood flow in the placental circulatory system ALEXANDER SHANNON, SERGIO GALLUCCI, PARISA MIRBOD, Clarkson University — The placenta is a unique organ of exchange between the growing fetus and the mother. It incorporates almost all functions of the adult body, acting as the fetal lung, digestive and immune systems, to mention a few. The exchange of oxygen and nutrients takes place at the surface of the villous tree. Using an idealized geometry of the fetal villous trees in the mouse placenta, in this study we performed 3D computational analysis of the unsteady fetal blood flow, gas, and nutrient transport over the chorionic plate. The fetal blood was treated as an incompressible Newtonian fluid, and the oxygen and nutrient were treated as a passive scalar dissolved in blood plasma. The flow was laminar, and a commercial CFD code (COMSOL Multiphysics) has been used for the simulation. COMSOL has been selected because it is multi-physics FEM software that allows for the seamless coupling of different physics represented by partial differential equations. The results clearly illustrate that the specific branching pattern and the in-plane curvature of the fetal villous trees affect the delivery of blood, gas and nutrient transport to the whole placenta.

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Date submitted: 01 Aug 2015 Electronic form version 1.4