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CRYOPRESERVATION PERFUSION FLOW SIMULATION USING NAVIER-STOKES EQUATIONS

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During perfusion of tissues with cooling liquids, flow pattern inside the flow passages influences convective heat transfer process. We have developed a computer software package capable of accurately predicting detailed temperature or heat flux distribution on the walls of twodimensional and threedimensional flow passages of varying cross section shapes and sizes. The analytic model consists of complete Navier-Stokes equations for incompressible, steady, laminar flow of Newtonian fluids. Computational grids used to discretize realistic flow passage configurations were developed on the basis of our previous work on boundary-conforming grids using efficient optimization. Our flow analysis iterative algorithm is computationally efficient since it incorporates our new method for acceleration of iterative algorithms.

We have obtained detailed computational prediction of flowfield velocity vectors, pressures, local stresses, wall friction and convective heat transfer coefficients in small passages having varying cross sections including strongly stenosed blood vessels. Results were obtained for cooling fluids at different bulk temperatures and for the passage walls at different temperatures. Various perfusion speeds and cooling liquid viscosity and density variation were studied by computing flows at different Reynolds numbers with the capability of numericaly predicting strong recirculation regions.

In the future we plan to include turbulence modelling so that we can simulate perfusion in large vesels at higher Reynolds numbers. We also plan to couple our heat conduction prediction computer code with this software package in order to get a time-accurate prediction capability for the combined convective/conductive heat transfer in a perfused tissue.