

The Navier-Stokes equations were solved on a staggered rectangular grid by breaking the equations up into substeps. The model is 3D with a single node in the direction normal to the cross-section (Fig. 3) and slip walls on the faces in this plane. Since only one node is used in the z-direction, the model does not account for any velocity gradient in that direction. We compared the model with a more computationally expensive, fully-3D finite-elements model for a range of conditions, and determined these simplifications result in minimal error. No-slip boundaries are prescribed at the walls that appear in the cross-section, and a free surface is prescribed at the air-liquid interface. The saturated oxygen concentration at the air-liquid interface is 203 μM , corresponding to oxygen concentration of culture medium inside a humidified 5% CO_2 incubator. We neglect minor geometrical features including the well tapers, side pockets in the wells for extracting scaffolds, retaining rings and a meniscus in the fluid.