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Image-based modeling of blood flow and oxygen transfer in feto-placental capillaries PHILIP PEARCE, Massachusetts Institute of Technology, OLIVER JENSEN, University of Manchester — During pregnancy, oxygen diffuses from maternal to fetal blood through the placenta. At the smallest scale of the feto-placental vasculature are the terminal villi, bulbous structures that are thought to be the main sites for oxygen transfer in the final trimester of pregnancy. The objective of this study is to investigate blood flow and oxygen transfer in the terminal villi of the placenta. Three-dimensional representations of villous and capillary surfaces, obtained from confocal laser scanning microscopy, are converted to finite-element meshes. Simulations of blood flow and oxygen transfer are performed to calculate the vascular flow resistance of the capillaries and the total oxygen transfer rate from the maternal blood. Scaling arguments, which predict the oxygen transfer across a range of Peclet numbers, are shown to be an efficient tool for quantifying the effect of statistical variability and experimental uncertainty. The effect of commonly observed localised dilations in the fetal vasculature on oxygen transfer is quantified using an idealised model in a simplified geometry. The model predicts how, for a fixed pressure drop through a capillary, oxygen transfer is maximised by an optimal shape of the dilation, leading to an increase in oxygen transfer of up to 15

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