**Title:**

## Model for Oxygen Transport in the Human Placenta

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**Abstract:**  (Your abstract must use **Normal style** and must fit in this box.  Your abstract should be no longer than 300 words. The box will 'expand' over 2 pages as you add text/diagrams into it.)

**Goal/Background**: The mature placenta is a complex vascular network extending ultimately to the capillaries of the terminal villi, site of all oxygen and nutrient exchange between the mother and fetus. Respiratory transfer across the placenta to the fetus occurs in three steps: (i) maternal blood bathes the chorionic villi in oxygen, (ii) oxygen permeates the villus surface and diffuses into fetal capillaries, and (iii) oxygen is transported to the fetus via the bloodstream.

**Materials/Methods**: Step (ii) has been modelled by the diffusion of oxygen from the villous membrane and the fetal capillaries.  The stationary concentration $c(\boldsymbol{x},t)$ of oxygen within each of the villi is the solution of the two-dimensional Laplace's equation, $\Delta c = 0$, with a fixed concentration $c_v$ at the villous surface and a Robin boundary condition at the capillary boundary: $D\partial c/\partial n = Kc$, where $\partial/\partial n$ is outward normal derivative, $D$ is the oxygen diffusion constant and $K$ is the permeability of the capillary.  These equations are solved in regions [panels (d,e,f)] determined by the villus and capillary boundaries obtained from digitized images [panels (a,b,c)].

**Results**: The solution for the oxygen concentration determines the diffusive current of oxygen across the capillaries.  Many factors are expected to influence this current, including the numbers and shapes of villi and capillaries.  Our initial analysis findicates that (c) yields the largest flux per unit perimeter length and area of the villi, followed by (b) and (a).

**Conclusions**: The geometrical shapes and spatial distributions of the villi and capillaries are important placental characteristics for the transport of oxygen to the fetus.  Once the main factors that determine oxygen transport have been identified, this approach, applied to digitized placental slides that allow analysis of many hundreds of villi per slide (and multiple slides per placenta) should provide a quantitative basis for measuring placental oxygen fluxes.
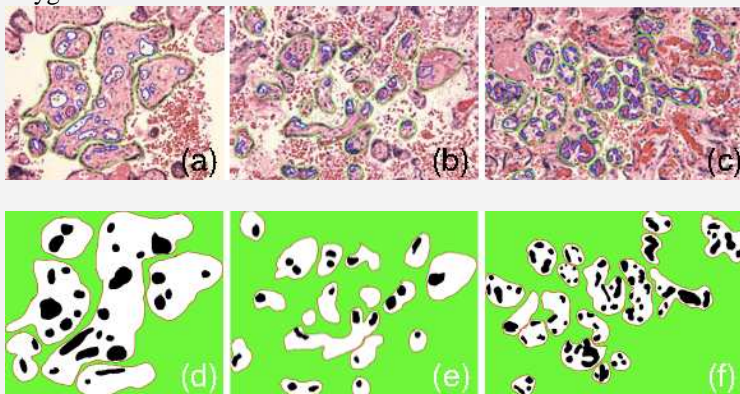
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