

ROLE OF OXYGEN-DEPENDENT ATP RELEASE BY RED BLOOD CELLS IN METABOLIC REGULATION OF BLOOD FLOW

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Experimental evidence has shown that red blood cells release ATP at a rate dependent on their oxyhemoglobin saturation level and that this oxygen sensing mechanism may play a role in blood flow regulation. A theoretical model is presented to predict the amount of ATP released along a pathway of five representative vessel segments (artery, arteriole, capillary, venule, and vein) as a function of blood flow rate and tissue oxygen demand. Release rate of ATP is expressed as a decreasing linear function of oxyhemoglobin saturation based on experimental data. The venular ATP level (C) is calculated 2 mm downstream of the capillary region. Changes in ATP level at this location may influence arteriolar diameter via upstream conducted responses or countercurrent exchange of metabolites with arterioles, allowing feedback control of perfusion in response to changing metabolic demand. The model predicts that C is in the micromolar range and increases with increasing consumption rate and with decreasing flow. If it is assumed that feedback control of arteriolar diameter regulates C to a fixed level, flow increases with increasing consumption, although the predicted increase in perfusion with consumption is not as large as observed experimentally. The results support the concept that an oxygen-dependent ATP release mechanism contributes to the metabolic regulation of blood flow. Supported by NIH Grant HL070657.