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

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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 model predicts an ATP level (C) downstream of the capillary region in the micromolar range, and C is shown to increase with increasing consumption rate and with decreasing flow. C values in this range have been observed in human knee-extensor exercise and have been shown to cause diameter increases in upstream vessels via conducted responses. The results support the concept that an oxygen-dependent ATP release mechanism contributes to the metabolic regulation of blood flow.