

THE PHYSIOLOGICAL PRINCIPLE OF MINIMUM WORK

A REPLY

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P. S. Bauer¹ has recently questioned the validity of the Physiological Principle of Minimum Work as formulated and applied by me² to certain problems concerning the efficiency of operation of the oxygen transport system in man.

In contrast to his opinions or the implications which he makes in respect to my work, I reply that this principle should not, and does not rest upon any principle of physics which applies, like the Principle of Least Action (no mention of which was made in my papers), exclusively to ideal conservative systems. Poiseuille's law of flow was used as the simplest approximation to conditions obtaining in capillaries, and the gravitational factor (especially for a man in the basal state and lying down) was neglected as one of secondary magnitude compared to those dealt with in the general problem. Some elementary procedures in calculus, mechanics, and graphical analysis were used in solving the purely mathematical portions of certain problems, but these were simply the ordinary working tools of applied mathematics. Although supported by many analogies and general experience, the validity or "justification" of the Physiological Principle of Minimum Work rests primarily upon the approximate consistency established between theory and certain facts of observation.

The principle merely states that in many cases and especially in the circulation of the blood the cost of actual operation of living systems tends to be a minimum and that cost is to be measured in units, like the calorie and the erg, which have dimensions equivalent to those of *work*.

¹ Bauer, P. S., *J. Gen. Physiol.*, 1929-30, 13, 617.

² Murray, C. D., *Proc. Nat. Acad. Sc.*, 1926, 12, 207, 299; *J. Gen. Physiol.*, 1926-27, 9, 835.