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Mechanochemical Processes. In: General Biophysics v. 1, Chapt. 5, Pages 218-298
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Transliteration of the Last name: Des**hch**erevsky

The cited work of V.I.Descherevsky in the list of references of the quoting article:

(It should be noted that of the 144 references of the review, three refer to the publications of Descherevsky. But the peculiarity of this review is that under one number there are given links to several publications at once! So, in fact, the review provides links to six publications of Descherevsky).

Page 296 References

[116] – **Three** Publications:

- 1) V.I. Des**hch**erevsky, Biofizika 13, 928 (1968).
[Descherevsky V.I. Dve modeli myshechnogo sokrashcheniya (Two models of muscular contraction). Biofizika **13**, № 5, 928—935 (1968. In Russian)]
- 2) V.I. Des**hch**erevsky, Biorheology 7, 147 (1971)
[Descherevsky V. I. A kinetic theory of striated muscle contraction.—«Biorheology», 1971, 7, 147—170].
- 3) V.I. Des**hch**erevsky, Stud. Biophys. 33 (3), 157 (1972).
[Descherevsky V. I. A theoretical approach to muscle contraction.—«Studia biophysica», 1972, 33, H. 3, 157-165].

[117] V.I. Des**hch**erevsky. «Matematicheskie modeli myshechnogo sokrashcheniya (Mathematical Models of Muscular Contraction)». Nauka, Moscow. 1977.

[124] – **Two** Publications:

- 1) V.I. Des**hch**erevsky, Biofizika 15, 53 (1970) (in Russian)
[Descherevsky V. I. Teoriya sokrashcheniya asinchronnykh myshz (Theory of Contraction of Asynchronous Muscles). Biofizika **15**, No 1, p. 53—61, 1970].
- 2) V.I. Des**hch**erevsky, J. Theor. Biol. 64, 517 (1977).
[Descherevsky V. I. Kinetic model of regulation of muscle protein activity. «J. Theoret. Biol.», 1977, 64, 517—534].

Quotes

Pages 252-253.

It was A. Huxley [114] who made the very first attempt to elaborate a quantitative physical theory based on the sliding model.

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A. Huxley's theory was simplified and improved by Des**hch**erevsky [116, 117] who investigated three states of the cross-bridges: closed cross-bridges developing a pull; closed cross-bridges impeding the sliding of the threads; and disconnected cross-bridges. The cross-bridges contact each other independently and pull the threads, thus causing active contraction; then the same cross-bridges brake the movement, since the threads have shifted; and finally, the cross-bridges are disconnected. Denoting as n_0 the total number of active HMM projections in half the thick filament, as n the number of the pulling cross-bridges, and as m the number of hindering ones, we get the following kinetic equations:

$$n = k_1 (n_0 - n - m) - (v/L) n, \quad (5.34)$$

$$m = (v/L) n - k_2 m. \quad (5.35)$$

Here, v/L is the rate constant of the transformation of pulling bridges into hindering ones, which is equal to the velocity of the relative movement of the filaments v divided by the distance L between the two neighboring active sites of actin on which a bridge can be closed. An expression of Newton's second law is added to these equations:

$$M v = f_0 (n - m) - f n_0, \quad (5.36)$$

(Further the main provisions of V.I. Deshcherevsky's kinetic theory are stated - without mentioning his surname).

Page 254.

Consequently, there should be another cycle setting into motion Deshcherevsky's cycle. This second cycle is a closed chain of the chemical transformations when ATP is split. Deshcherevsky's theory provides a correct stationary solution for the isotonic contraction. However, it gives no explanation of the development of the stress during the isometric contractions.

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Deshcherevsky was the first to obtain Hill's equation theoretically. We see that Deshcherevsky's cycle includes no reverse processes.

Later Hill gave up this theory, mainly because the force P_0 is not constant but rather depends on the length of the sarcomere (see p. 239) [120]. It is evident that the theory of muscle contraction cannot be elaborated within the framework of equilibrium thermodynamics. This theory requires the consideration of kinetic processes.

Further works by Hill and co-workers are devoted to an improvement of Huxley's theory [121, 122]. However, it proved impossible to examine the problems in these works in such a simple and clearcut form as in the work by Deshcherevsky. A paper by Hill *et al.* [106] contains a review of a number of alternative sliding models.

The theory of the non-stationary kinetic behavior of the muscle was also dealt with in numerous publications [108, 113, 116, 117, 123 —125a]. We shall examine these problems in Section 5.10.

Pages 259-260.

It is quite natural that this theory yields results that are equivalent to Huxley-Deshcherevsky theory (see p. 253). Now let us compare the formulas.

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In the aforementioned theory, friction occurs as a result of the opening and closing of the cross-bridges, inasmuch as these processes require an energy of activation. It is only natural that the friction coefficient proves to be exponentially dependent on temperature. In the macroscopic theory, the molecular model is replaced with the Huxley-Deshcherevsky formal model (the bridge either pulls or hampers), although in reality these phenomena are supposed to occur simultaneously. The advantage of this theory is that it is in accordance with the principle of microscopic reversibility and directly expresses the kinetic constants in terms of the molecular parameters L , $\cos \theta$, G , and f_0 . This explains the temperature dependence of b and, as we shall see, of f_0 .

According to the aforementioned theory, the cross-bridges are closed independently of one another. Is this supposition well grounded? Or can we assume that there is cooperativity in the sense that the closing of one cross-bridge exerts an influence on the closing of others? This is not the first time that the concept of cooperative allosteric properties of actin has been suggested.

Page 267.

Measurements of isometric stress at a fixed potential are reported by Deshcherevsky [134]. The development of stress in time is described by a sum of two exponentials. The temperature dependence of the rate of the process corresponds to the barriers $G_1 \sim 19-20$ and $G_2 \sim 15-16$ kcal mol⁻¹. At the same time, the height of the barrier for the diffusion of Ca²⁺ from the reticulum, which is determined by the speed of the saturation of the reticulum with Ca²⁺ [135], amounts to 18-20 kcal mol⁻¹.

[*Note.* Here the figure at link [134] is erroneous - it must be, apparently, [124] - where two publications of V.I. Deshcherevsky are given].

Pages 273-274.

The time to establish the stationary state can be found with the help of the equations of Deshcherevsky, (5.34) and (5.35), assuming that $m = 0$.

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