PHASE ANALYSIS OF DYNAMICS OF TRANSPORT ACTIVITY OF FUNCTIONAL UNITS OF THE RAT SMALL INTESTINE

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The concept of phase portraits is an extremely important one for analysis of the kinetics not only of enzyme reactions [1, 7], but also of complex biological systems [5].

In the investigation described below the possibility of such an analysis of the temporal organization of the small intestine was assessed. The basis for the investigation was provided by data showing that in rats the "behavior" of the intestine revealed that it is constructed in units [2] with a number of oscillatory components [4]. The dynamics of activity of six functional units of the small intestine (0-10-20-30-40-50-60 cm from Treitz' ligament; transport of D-glucose) indicates that coordination may be based on one of these components.

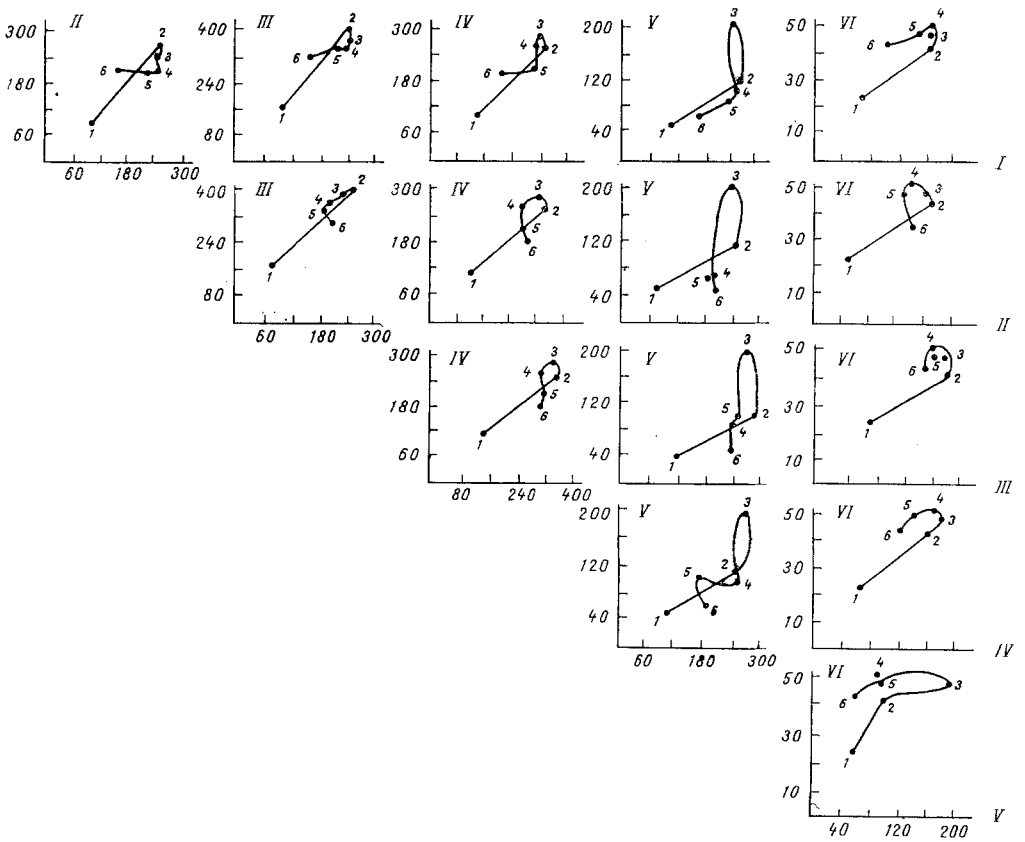

Fig. 1. Phase diagrams of transport activity of segments of small intestine of hungry rats against the background of successive 15-min incubation. Concentration of free hexoses (in mg%): abscissa, for each adjacent higher segment (I-VI); ordinate, for each adjacent lower segment.

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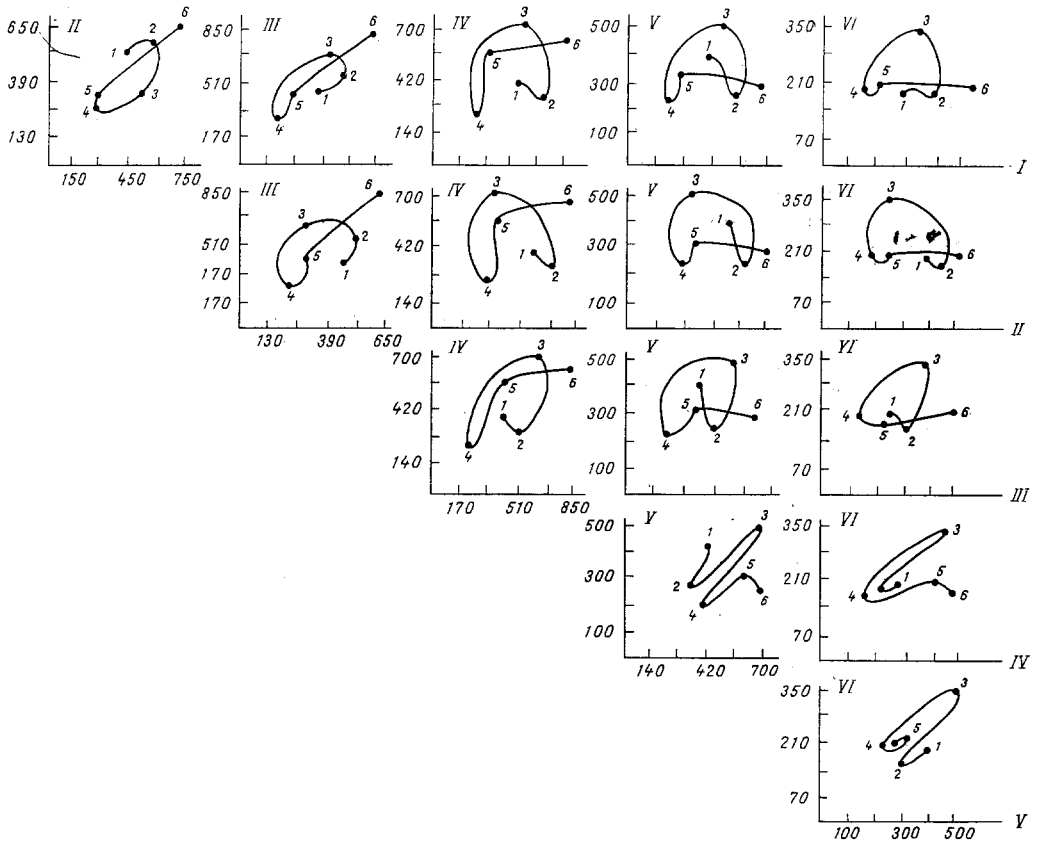

Fig. 2. Phase diagrams of transport activity of segments of small intestine of hungry rats decapitated every 1.5 h between 8 and 16 h after beginning of experiment (incubation 60 min). Legend as to Fig. 1.

The transport activity of units of the intestine was compared in model experiments [4] against the background of successive short periods of incubation (experiment 1) or of a single long period of incubation of intestinal preparations of rats decapitated at intervals of 1.5 h between 8 and 16 h after the beginning of the experiment (experiment 2).

EXPERIMENTAL METHOD

The experimental method was described previously [3]. In hungary rats absorption of glucose (200 mg%, Ringer's solution, 37°C, pH 7.4; oxygenation) was determined by means of a modified "everted pouch" technique. A phase diagram [7] was plotted for each pair of segments of the small intestine, based on the final glucose concentration (in mg%) in the serous fluid (mean data for six rats). Activity of the lower (distal) segment was expressed as a function of activity of the adjacent upper segment. Each point on the diagram corresponded to a particular incubation (experiment 1) or to a particular moment of time (experiment 2).

EXPERIMENTAL RESULTS

It will be clear from Fig. 1 that the dynamics of transport activity (rise, steady state, fall) in isolated populations of enterocytes differs in only a few respects which are more marked in the late period of incubation. Conversely, in an experiment lasting several hours (Fig. 2) the properties of the same populations changed with the typical phase relationship, the character of which depends clearly on the topography of the segments of small intestine compared.

Analysis of the results, in conjunction with data in the literature [1, 5, 6], indicates that in experiment 1 the dynamics reflect the switch to activity of cell populations which differ in certain properties of self-regulation and also in their initial functional state. Evidence in support of the last statement is given, in particular, by the tendency which was noted for phasic relations between the properties of segments II, IV, and VI (Fig. 1). The dynamics found in experiment 2 reflect one particular feature of the temporal organization of the small intestine.

These results of phase analysis may be useful as a means of explaining the topography of physiological and pathological structural changes in the small intestine.

LITERATURE CITED

1. Oscillatory Processes in Biological and Chemical Systems [in Russian], Moscow (1967).
2. G. I. Loginov, Fiziol. Zh. SSSR, 62, 912 (1976).
3. G. I. Loginov, Byull. Éksp. Biol. Med., No. 9, 1043 (1976).
4. G. I. Loginov, Byull. Éksp. Biol. Med., No. 5, 556 (1977).
5. M. I. Setrov, Information Processes in Biological Systems [in Russian], Leningrad (1975).
6. Theoretical and Applied Aspects of Analysis of the Temporal Organization of Biosystems [in Russian], Moscow (1976).
7. C. Walter, Enzyme Kinetics, New York (1966).