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CHANGES IN MITOGENETIC RADIATION IN STRUCTURAL-ENERGETIC STATES OF THE LIVER AFTER INJECTION OF GLUCOSE AND AN INCREASE IN VAGAL TONE

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It is shown previously [1] that the unbalanced molecular orderliness which is a feature of the normal liver is intensified during weak nerve stimulation, and it was suggested that this phenomenon is connected with intensification of cell fields [1].

There is no doubt that an increase in molecular orderliness of a substrate facilitates regulation of metabolism. The study of the effect of nervous stimulation on processes connected with the assimilation of glucose by the liver is therefore a natural development of the previous study. We already know that the mouse liver at body temperature emits radiation only (or predominantly) in the visible region [5, 4], but after administration of glucose an ultraviolet component appears temporarily and the visible component is weakened [4]. These data could thus serve as the starting point.

EXPERIMENTAL METHOD

A small (1.5-2 cm^2) area of the surface of the liver was exposed in an unanesthetized rabbit and a small segment of the vagus nerve was exposed in the neck, and electrodes placed beneath it. The duration of the stimulating pulses was 1 msec, their frequency 40 Hz, and their intensity 40-50% of that inducing initial slowing of the heart beat. The liver was moistened with physiological saline at a temperature of 37-38°C. Radiation was recorded on a biological detector with exposures of 10-15 sec [2]. A few minutes before exposure, glucose (2 ml or 6 ml of a 25% solution, i.e., 0.5 or 1.5 g) was injected subcutaneously into the rabbit's thigh.

EXPERIMENTAL RESULTS

The experiments, which included a large series of repeated exposures, separated by 2-min intervals, occupied a considerable time, and for this reason the different variants could not be accommodated on the same animal. However, the following results were sufficiently clearly obtained on 10 rabbits (four control and six experimental).

In the control series with injection of glucose but without nerve stimulation, the radiation was characterized by a curve which was smooth after a small dose of glucose but which fluctuated after a larger dose (Fig. 1a, b).

In the experimental series the radiation emitted by the liver of rabbits in which the vagus nerve was stimulated after administration of glucose was characterized by alternation

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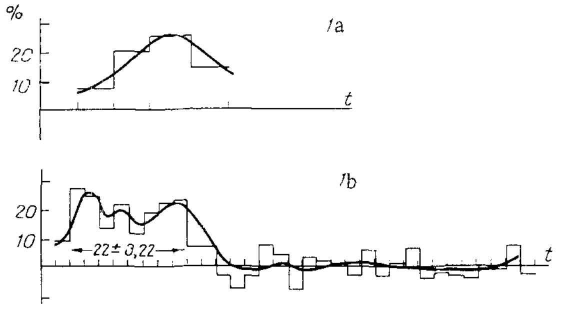

Fig. 1

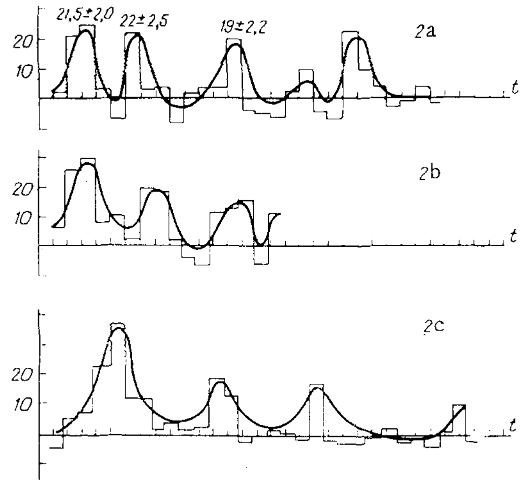

Fig. 2.

Fig. 1. Radiation emitted by the liver after injection of glucose into a rabbit: a) 0.5 g, b) 1.5 g. Here and in Fig. 2: abscissa, time (in min); ordinate, increase in number of budding yeast cells in irradiated culture compared with control.

Fig. 2. Radiation emitted by liver in response to simultaneous action of glucose and electrical stimulation of vagus nerve: a) 0.5 g, b) 0.5 g, c) 1.5 g.

of periods of distinct but short maxima and longer periods of absence of mitogenetic radiation (Fig. 2). The total duration of this reactive phase amounted to 40-45 min after injection of glucose.

Let us attempt to form some idea of the dynamic changes in the substrate corresponding to the character of radiation. There are no grounds for attributing decisive importance in this case to chemical factors, such as the secretion of adrenalin in response to vagus nerve stimulation. It is more likely that the alternation of the states which, though evolving, is reproducible in its rhythm, i.e., temporal regulation, is linked with the spatial coordination of processes resulting from interaction between the whole and its parts. The general view is based on the propositions of the theory of the biological field, according to which changes in the molecular substrate are continually standardized by the "whole — the actual field of the cell population," which, moreover, depends at each given moment on the state of each individual cell, i.e., which also is continuously evolving [1].

To provide a stronger basis for this view let us turn to some other experimental data. It has been shown that not only administration of glucose leads to the appearance of ultraviolet radiation from the liver, but cooling the normally metabolizing liver (without any chemical load) also induces a burst of ultraviolet while preserving visible radiation [3]. Consequently, unbalanced molecular constellations (UMC) with different energetic potentials are constantly maintained in the cells, but UMC of the ultraviolet levels are not found in radiation at body temperature. It must be assumed that energy discharges (and also, necessarily, the absorption of energy) took place normally mainly by a series of steps, and that the quanta of energy liberated in the course of these processes correspond to visible (and also infrared) radiation, but not to ultraviolet. It is also evident that stepwise discharges, i.e., a continuous exchange of energy between constellations and labile structures, must be connected with their disturbances, recoveries, and changes of configuration. This purely dynamic equilibrium is disturbed by cooling or by injection of glucose, although the mechanisms of the disturbances are different. Cooling, by inhibiting enzyme processes, depresses the general level of metabolism and thereby induces degradation of UMC, associated with radiation. The attachment of glucose molecules to excited, highly labile UMC, however, can be regarded as a mechanical load on the constellation, which not only deforms, but disturbs them, inducing degradation emission also. Under these circumstances glucose receives activation energy necessary for subsequent conversions. Simultaneous weakening of visible radiation can evidently be explained on the grounds that the addition of glucose to the less labile UMC induces predominantly various deformations, and not disturbances, reducing their powers of fluorescence on the average. This is how we represent the first stages of interaction of glucose with the cell substrate when the tone of the vagus nerve is normal (relatively low in the rabbit).

However, the influence of weak nerve stimulation is realized in a different way. It is assumed that the oscillating character of the chain processes, assigned by the rhythm of stimulation, increases the dynamic character of the nervous substrate and of the substrate of the liver cells, stimulating pulsating sources of cell fields and having a more effective vector action on the excited molecules [1]. In consequence of this saturation of the cells with UMC increases, indicating intensification of degradation emission from the liver. However, because of coupled interaction between the whole and its parts, even a small increase in the strength of the coordinating action of the whole on the molecular substrate may lead to considerable changes in the character of the processes taking place.

On the basis of all that has been said, let us define the state of a substrate under the influence of nervous stimulation and of stimulation by glucose. "Fragments" of constellations, disturbed by the attachment of glucose, and deformed by the glucose molecule, i.e., elements not typical of the normal state, become involved in the dynamics of its reactions. Accordingly, gradients or even discontinuities of structural states, not typical of normal, also arise in the general orderliness of the substrate. However, according to the propositions of the field theory, changes of this sort intensify the coupled mechanisms of interaction of the whole and its parts, directed toward smoothing the gradients. Smoothing means a process evolving with time, i.e., the dynamic elaboration of parity between the spatial parameters of the processes and the mean resultants of the vector fields and the consequent averaging of the energetic potentials of elements of the substrate, most probably to the energy levels of visible radiation. However, these processes are stochastic, i.e., the possibility of deviations from the average states and of accumulation of constellations with high energy levels still remains although, in accordance with the general character of the process, this possibility is less frequently realized.

This representation corresponds formally to the observed dynamics — short bursts of mitogenetic radiation, separated by longer periods of absence of radiation. It is suggested that glucose, activated by highly excited UMC, metabolizes during these intervals, using energy of molecular elements of average levels of excitation.

These general considerations, which of course do not rule out the activity of enzymes, thus emphasize the regulation of the state of the substrate based on continuous interaction between the whole, partially hidden in the case of a substrate of lower orderliness by the statistical character of the molecular processes, and manifested more brightly during nervous stimulation, which prolongs and as it were quantizes the whole process.

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