monoamine oxidase inhibitor and to block α-adrenergic receptors [6]. It can accordingly be considered that the autonomic and EEG phenomena accompanying the pressor response are based mainly on adrenergic mechanisms, whereas the depressor responses are based on a different neurochemical mechanism. It follows from the work of Val'dman et al. [2] and of Teplov and Vasil'eva [8] that the electroencephalographic and autonomic manifestations of depressor responses evoked by stimulation of the hypothalamic nuclei have a predominantly cholinergic mechanism.

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EFFECT OF A HIGH-VOLTAGE CAPACITOR DISCHARGE ON OPTICAL PROPERTIES OF FROG HEART MUSCLE

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A high-voltage capacitor discharge caused a sharp increase in the intensity of flux of plane-polarized light passing through a strip of frog heart muscle. This may indicate changes in the optical properties of the tissue due to conformational changes in the membrane proteins.

KEY WORDS: high-voltage discharge; heart; optical properties.

Experiments on a cell membrane model based on the use of frog skin showed that an electric discharge induces changes in its transmembrane potential, in the parameters of the volt–ampere characteristic curve, and in permeability to sodium, potassium, and calcium ions [1-3].

All these changes are evidently a reflection of momentary structural changes in the cell membranes at the time of the electric discharge.

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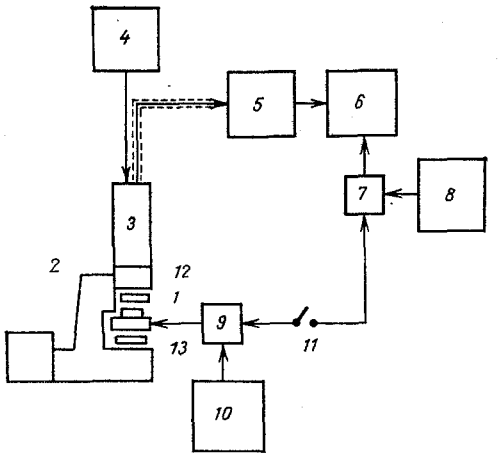

Fig. 1. Scheme of apparatus to study action of discharge on optical properties of frog heart muscle. Explanation in text.

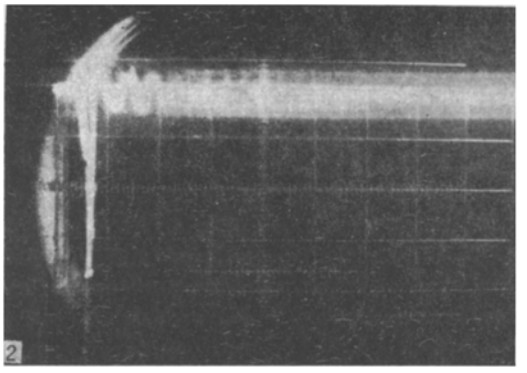

Fig. 2

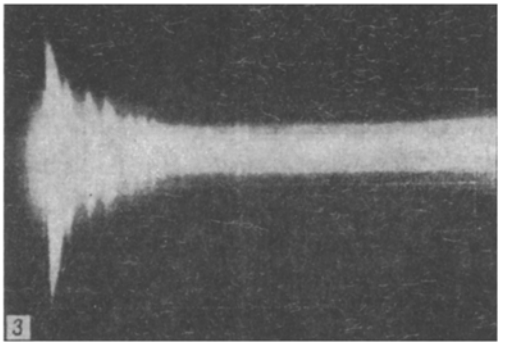

Fig. 3

Fig. 2. Recording of discharge currents (tissue; voltage 1 kV). Scanning speed 1 msec/cm.

Fig. 3. Photic flux (frog heart muscle; voltage 1 kV). Scanning speed 50 msec/cm.

The object of this investigation was to study the action of a high-voltage capacitor discharge on the optical properties of a strip of frog heart.

EXPERIMENTAL METHOD

A strip of frog heart was placed in a cell between two glass plates and nickel electrodes so that an electric discharge and a beam of polarized light could be passed through it. A block diagram of the apparatus is shown in Fig. 1. The cell (1) was placed in the ML-1 luminescence microscope (2) between two crossed polaroids (12 and 13). The beam of light passing through the cell and the polaroids fell on the photocathode of an FÉU-39 photoelectronic multiplier (3), the voltage for which was supplied by a VS-23 high-voltage stabilized rectifier (4). The signal from the photoelectronic multiplier was led to a UIS-2M amplifier (5) and then to an S-1-54 oscilloscope (6). The sweep of the oscilloscope was triggered by application of a potential from the voltage source (8) through a relay (7) activated by the button (11). The discharge from the ID-1-VÉI defibrillator (10) was transmitted to the cells through the relay (9). So that the oscilloscope would be triggered a little earlier than the beginning of the discharge, the actuation time of the relay (7) was less than the actuation time of the relay (9). The signal was recorded from the oscilloscope screen by means of a "Zenit" camera.

EXPERIMENTAL RESULTS AND DISCUSSION

In preliminary experiments in which the cell was replaced by an equivalent resistor, the pulse was photographed at different discharge voltages. The duration of the signal was found to be 3-5 msec. The discharge consisted mainly of two parts: an exponential drop of the current (duration 1 msec) and a damped oscillatory process. When the cell containing the biological object was included in the scheme, the parameters of the discharge were practically unchanged (Fig. 2).

Strong luminescence was observed during the action of the high-voltage capacitor discharge on the muscle; its total duration depended on the voltage of the discharge and was 15-100 msec with a voltage of 0.5 kV and 100-350 msec with a voltage of 1.0 kV.

The luminescence in response to discharges of different voltages had common properties, consisting of intense luminescence actually during and just after the discharge (first 15-25 msec), followed by a decline along an exponential curve (Fig. 3). In this part of the process single flashes were observed, the intervals between which showed a tendency to increase. The total duration of luminescence was about two orders of magnitude greater than the duration of passage of the discharge itself.

In the writers' view the increase in intensity of photic flux is evidence of changes in optical properties due to conformational changes in the membrane proteins [4, 5, 7]. There are two most probable causes of configuration changes in cell membranes. The first is the direct action of the electric discharge on hydrogen bonds or hydration layers stabilizing the three-dimensional structure of macromolecules. Second, an indirect effect through a change in the physicochemical parameters of the medium in the immediate vicinity of the protein molecules cannot be ruled out. Structural changes in membranes can be regarded as a cause of changes in their permeability [3, 6].

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