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# TASAKI I. (Jpn J Physiol. Vol 1: p.1-6, 1950)

# ELECTRICAL EXCITATION OF THE NERVE FIBER

PART I. EXCITATION BY LINEARLY INCREASING CURRENTS

ICHIJI TASAKI I

Since Kelth Lucas (3) reported his classical experiments, there has been a considerable amount of work dealing with the problem of excitation of nerve or muscle by linearly increasing currents (Fabre (3), Balar (1), Sudi (4) and others). The experimental results obtained with artificially isolated single nerve fibers, which are presented in this paper, seem much simpler and more decisive than the previous results obtained with nerve trunks.

### метно

Total's large motor nerve fibers were used for the experiments. The internotal stretch of the nerve fiber was alled on a "bridge-insulator" (5), and nonpolarisable electrodes were immersed in the pools of Ringer's fluid on both sides in the figure was used. Two breaks contacts of a fleinholter pendulum (K, and K) were opened in succession; charging of the condenser C (20 Ap.) was started by opening the first contact K, and the discharge was begun by breaking the contact Ks. As the electrical resistance of the preparation on the bridge-insutance of the contact of the contact of the condenser of the contact of the contact of the contact Ks. As the electrical resistance of the preparation on the bridge-insu-



Fig. 1. Experimental arrangements used for imulating single nerve fibers.

\* 田崎一二
This paper except for its appendix was received for publication. February 22, 1944 b

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contacts or the pendulum was less than 0.1 onm.
With this stimulating circuit, the temporal configuration of the potenti
difference applied to the nerve fiber can be given by the formula

where  $V_i$  represents the voltage given by the potential divider. If the time under consideration is far smaller than RC (= 1 sec.), the voltage can be regarded

#### $V(t) = V_i t / RC$

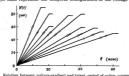
Electrical responses of the nerve fiber was observed by means of a Braun tube. The action current was amplified with a four-stage resistance-capacity coupled amplifier. Figures on the screen of the Braun tube was photographed with a Leica camera.

### RESULTS

(1) The relation between the latent period and the voltage-gradient. The time-interval from the start of a linearly increasing current to the appearance of the action current at the site of stimulation is here designated as the latent period. When the rate of increase of the stimulating voltage was varied by changing the final voltage Vin the above-stated formula, the latent period was

found to vary inversely as the gradient of the voltage.

Fig. 2 gives an example of the experimental results obtained. In this figure
the straight lines represent the temporal configuration of the voltage applied to



cles indicate the moment at which the action currents appeared at the site of stimulation when the nerve fiber was excited by the voltages represented by the straight lines. 12° C.

the nerve fiber: they rise linearly, until they abruptly change into horizontal the corresponding to the slow decline of the voltage following the break of the cond contact in the stimulating circuit. The circles in the figure indicate the company as which the electrical responses of the fiber present

moments at which the electrical responses of the fiber appeared.

As has been well-known, stimulating voltages with small gradients failed to elicit electrical response in the nerve fiber. For the gradients greater than a

#### EXCITATION OF NERVE FIBER, I

reached an approximately constant value which was approximately equal to (or slightly greater than) the rheobasic voltage of the fiber. The minimal gradient of the stimulating voltage, at which the stimulus could barely excite the fiber, was in some fiber greater than 1 mV/msec, and in others less than 0.2 mV/msec.

(3) The relation between the liminal collage and the solutor-gradient. The stimulating voltage obtainable by the use of the stimulating circuit shown in Fig. 1 shows a configuration as given in Fig. 3, top. The time of voltage-increase of could be varied by changing the distance between the two contacts K<sub>1</sub> and K<sub>2</sub>. The final plateau value v of the voltage could be controled by changing the final voltage V<sub>1</sub>.

as limit vottage  $r_s$ , and the vottage  $r_s$  consequently the voltage-gradient) was changed at each fixed value of d, and the limital value of c, which is the latter of c consequently in the voltage-gradient was changed at each fixed was considered as c consequently c consequently

liminal v value for d=10 msec., a condenser of the capacity of  $4\,p\mathbb{R}$  was used. The observation was begun with stimulating voltages of well above treshold. As the final value of the voltage was decreased step by step at a given time of ascent d, the latent period of the action current was lengthened correspondingly. And, when the latent period reached the time of ascent d at that

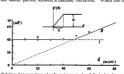


Fig. 3. Relation between time of voltage-increase d and liminal voltage v in a mot-

was still decreased, the action current of the fiber was found to disappear. Fig. 3 gives a typical example of the results obtained. The liminal voltage v showed a striking constancy for a wide range of the time of ascent d. When the voltage gradient approached the minimal gradient of that fiber, the liminal voltage showed an increase, including a gradual transition from the straight

# DISCUSSIO

The experimental results described above seem to be nothing new. In the

# ІСНІЛІ ТАЗА

results obtained by Keith Lucas (3) for the toad's muscle, we find a few figure resembling those shown above. With the experimental arrangements adopted by Sugi (4), the minimital gradient of the muscle appeared to show a very smal value, and the rise of the final voltage corresponding to the strippidit lim If states above was not observed. In the experiments in which nervo trushs were used the deformation of the stimulating current by the surrounding inactive tissue and the difference in the minimal gradient in the constituent nerve fibers seen

The result of the experiment of Fig. 3 shows us very clearly that a linearly increasing voltage excites a single nerve fiber when it rises above the rhe-boasic voltage at a gradient greater than the "minimal gradient." of the fiber. It will be shown in the subsequent papers that this conclusion is of great significane in dealing with threshold conditions in excitation of single nerve fibers with slowly increasing voltages.

# SUMMAR

Isolated single nerve fibers of the toad were excited by voltages increasing linearly at varying rates. It was concluded that a linearly increasing voltage is effective in evoltage an electrical response in the fiber when it rises above the rheobasic voltage at a rate greater than the minimal gradient of the fiber-fiber linear li

# ve reached th

- BLAIR, H. A. J. Gen. Physiol. 15: 731, 1932.
   FABRE, P. C. R. Acad. Sci. Paris. 184: 699, 1496, 193
   LUCAS, KEITH. J. Physiol. 36: 251, 1907.
- LUCAS, REITH. J. Physiol. 39: 251, 1907.
   Sugi, S. Nihon Sèiri Z. (Japanese) 4: 95, 193
   TASAKI, L. Amer. I. Physiol. 125: 367, 1939.

# APPENDIX

Although six years have passed since the manuscript of this paper was first submitted to the editorial board of the Japanese Journal of Medical Science, it seems to me still worthy of publishing this manuscript in its original form. I add to this paper, on this occasion, oscillograms which support the conclusions stated in the paper.

The property of the experimental arrangements used for taking the picture furnished in Figs. 3 and 6. Linearly rising votages were obtained by charging a condenser through a high mutual conductance pentode (6002). The stimular as condenser through a high mutual conductance pentode (6002). The stimular was started by means of a gas discharge table (thrystron) of which the grid was connected to the sweep circuit. The voltage generated by the sweep circuit was such that the deflection (XI) plate of the Braun tube was, first strongly because of the contraction o

# EXCITATION OF NERVE FIBER.

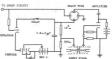


Fig. 4. Arrangements used in the experiments of Figs. 5 and 6.

circuit and the grid of the thyratron, a rectifier (selenium) was connected

The linearly rising voltage thus obtained was led to one of the deflection polars of the Braum tube, and the voltage was tapped as no tapply to the nerve liber. The action currents of the fiber was amplified with a 4-stage amplifier simplified in the diagram) and was led to the other Y-plate. The input resistciance was reduced to such an extent that the electrical responses of the fiber were just perceptible on the screen of the Braun tube. As insulation of the preparation with the bridge-insulator was perfect, the stimulating current flowing through the nerve fiber introduced on appreciable disturbance into the records

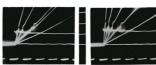


Fig. 5. Oscillograph records of the linearly rising voltages, obtained by means of the lectrical circuit shown in Fig. 4, with marks of the action currents on their courses. Right and left, taken from two different preparations at 11° C. The bars in the middle show th effection of the electron beam by constant voltages of 0, 50, 100 and 150 volts. Time markstreamed at 75 october new constant voltages of 0, 50, 100 and 150 volts.

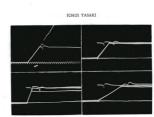


Fig. 6. Oscillograph records corresponding to the data of the experiment of Fig. 3.

The linearly rising voltages were made to change into slowly declining (almost constant) voltages by opening the charging circuit by means of a relay operated by another hyvastrom toolse. Constant voltages of the rheobasic strength were also photographed on the films.