It will be observed that Ration B contains no added fat, but it was supplemented with 10 mg of linoleic acid daily per rat. Ration A contains no added fat except the 2% of cod liver oil. Since neither ration supplies the quantity of fatty acids that is necessary for a normal rate of growth, even if the vitamin supply is adequate, a ration was prepared which contains additional fat. Ration C contains 8% of lard, also a more generous allowance of the water-soluble vitamins. In all 14 male and 5 female rats have received this ration and up to the present their growth rate is about the same as that of rats in the stock colony. Three males, Nos. 7385, 7391, 7392, Fig. 1, attained an average weight of 368 g in 18 weeks. They are in excellent condition and heavier than stock colony males of the same age. Each of them has sired 2 normal litters. Jukes[2] reported that a ration which contains no water-soluble vitamins, other than those now recognized, will permit female rats to attain maturity and bear litters. However, his animals grew at a subnormal rate and reared only a small proportion of their young.

The minimum amounts that will maintain normal growth have not been determined, but it is our experience that when the water-soluble vitamins are supplied at the levels commonly employed the growth rate is suboptimal. When choline was omitted from Ration C the growth rate was severely depressed. When omitted from Ration A the growth rate was unchanged.

At present it seems that the 8 vitamins included with Ration C are all that the rat requires to attain normal weight maturity, though it is possible that the basal ration may conceal some unsuspected vitamin. However that may be, in any search for unrecognized vitamins an examination of the quantitative interrelations of the recognized vitamins is of crucial importance.

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Experiments on Stimulation of Nerves by Alternating Electrical Fields.

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It is customary to consider the nerve axon as a cylinder with a porous surface through which pass ions of positive sign. The ions

[2] Jukes, T. H., PROC. SOC. EXP. BIOL. AND MED., 1940, 45, 625.

of the opposite sign remain on the inner side of the surface and this process of diffusion is said to continue until equilibrium is reached. The result is a cylindrical double layer of charges separated by a semipermeable membrane. Stimulation is viewed as a breakdown of this equilibrium state with a resultant shuffling of the charges at the point where the stimulus is applied. This state of ionic chaos moves down the axone as a zone of depolarization and constitutes the nerve impulse. Nerves may be stimulated by mechanical pressure, by heat, by various acids, and by electric current.

The setup used involved a pair of condenser plates 9½ x 4 inches separated by a distance of 7 inches. A potential difference of approximately 10,000 volts was established between these plates at a frequency of 60 cycles. A preparation consisting of the sciatic nerve and the gastrocnemius muscle of the frog was employed. The preparation was extended on a carefully cleaned glass slide and placed between the plates of the condenser.

Under these conditions it was possible to rotate the glass slide carrying the preparation to form any desired angle with the electrical lines of force between the condenser plates. Beginning at 90 degrees, the slide was rotated alternately to one side and the other of this line by increments of 5 degrees. The results indicated that the effectiveness of stimulation varied as some direct function of the longitudinal component along the nerve axis. Beginning at 70 and 110 degrees, the intensity of contraction increased until at the maximum it became tetanic.

The following experiment was then performed: The glass slide bearing the preparation was returned to its original position of 90 degrees with respect to the field. A segment of the distal end of the nerve was bent so that it formed a 90 degree angle with the rest of the nerve and thus became parallel with the electrical lines of force. No results were forthcoming until this distal segment was approximately 18 mm long; at this point faint twitches appeared in the muscle, especially on the break of the current; at 30 mm there was clonus; and at between 35 and 40 mm there was tetany. These values differed perceptibly with different preparations, and with the same preparation as a function of its freshness.

The analogue of this experiment was next performed. The distal end of the nerve was left at right angles to the electrical lines of force but the proximal end, or that nearest the muscle, was made parallel to the field. When this was done, it was found that as little as 5 mm of the proximal part of the nerve was needed for the production of pronounced tetany in the muscle.

When the sciatic nerve was cut at its point of entrance into the muscle tissue of the gastrocnemius, no results could be secured by placing the muscle preparation in the field. The result was uniformly negative regardless of the orientation of the muscle in the field. Similar negative results were obtained when the region of the nerve immediately proximal to the muscle was painted with ethyl alcohol. These experiments serve to demonstrate that the results described are associated with the phenomenon of nerve stimulation and conduction and are not due to artifactual stimulation of the muscle itself.

An experiment bearing upon the possible artifactual stimulation of the nerve by the glass slide is the following. The preparation was placed in a narrow rectangular glass container, and the system rotated in such wise that the long axis of the nerve was parallel to the lines of force of the field. When the potential difference was applied to the condenser plates, the muscle went into a state of tetany. With the field on, saline solution was poured into the container. As soon as the solution covered the bottom of the vessel the tetany instantly disappeared and the muscle became completely flaccid.

The above result may be interpreted as meaning that the electrolyte surrounding the nerve acted as an electrostatic shield and prevented the electrical lines of force from disturbing the electrical equilibrium of the nerve. This fact serves also to account for our inability to induce convulsive symptoms in white rats placed in an electrical field of 7000 volts per inch gradient. Possibly the fluids of the body were acting as an effective electrostatic shield.

These findings are in harmony with the additional fact that the reaction of the muscle was more marked when the preparation was somewhat "dried out." Immediately after dipping it in saline solution, only short twitches on the make and break of the circuit were usually obtainable under conditions which gave definite tetany when the nerve was relatively dehydrated.