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"Action Currents" Without Rhythmic Contractions and Rhythmic Contractions Without "Action Currents."

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The present-day teaching is that action currents obtained from contracting muscle are due to physico-chemical changes associated with the shortening of the fibres. Against this view is the fact that electrocardiograms have been obtained during experiments in which the heart-beat was, to all appearances stopped, by the removal of calcium from the nutrient fluid or by other means. Similarly, we have been able to show that the characteristic electrogram that is associated with the rhythmic contractions of the bowel persists long after the muscular movements have been stopped by epinephrine.

Rabbits were used, anesthetized with urethane, and with the abdomen open in a bath of physiologic saline solution. The loops of bowel being studied were kept in a layer of mineral oil, which floated on the surface of the salt solution. The electrodes consisted of steel wire serrefines plated with silver and silver chloride, and so suspended on pivots that the movements of the bowel could be recorded simultaneously with the electrogram. A string galvanometer was used. Details of the technic will be published in a paper now in press.

In a typical experiment with epinephrine, 0.15 cc. of a 1 to 1000 solution was injected into the ear vein. Within 10 seconds the contractions of the bowel disappeared while the electrical changes persisted. The only modification in the electrical record consisted of a greater regularity of the waves and a more rapid rate. In one experiment the increase was from 9 to 12 cycles a minute. After 105 seconds the mechanical contractions returned in the lower part of the bowel and the electrical variations were then found to be in phase with them.

In an attempt to explain this phenomenon we were at first inclined to assume that something had happened to one of the links in the chain of chemical processes that bring about contraction in the muscle fibers; to use a metaphor derived from the field of me-

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chanics, the engine continued to run after a clutch of some kind was thrown out. But what sort of a theory could we evolve to explain matters when, after the administration of nicotin, we found that the rhythmic contractions continued unchanged and the electrogram disappeared?

In a typical experiment a short segment of rabbit's intestine was excised and allowed to contract rhythmically in a layer of mineral oil floating on top of warm Ringer-Locke's solution. Simultaneous records were obtained of the mechanical and electrical changes. One-half cubic centimeter of a 1 to 100 solution of nicotin was added to the 80 cc. of Ringer's solution in the bath. Immediately there was a marked disturbance in both records. The muscle contracted down and remained that way while the electrical record showed violent erratic changes. During the next 4 minutes the electrical record consisted of a series of small regular waves, interrupted by erratic variations. Many of the cycles were miniatures of the usual ones obtained during the course of normal rhythmic contractions. After 5 minutes the regular rhythmic contractions of the muscle returned while the electrical record showed erratic changes with very small amplitude. After 14 minutes the mechanical waves were vigorous, the amplitude was larger than normal, and the rate was slowed to 6 a minute. The electrical changes had almost disappeared. After 77 minutes the mechanical contractions were regular and vigorous while the electrical changes had entirely disappeared. At the end of 3 hours the rhythmic contractions became feeble and irregular and after 5 hours they stopped. At no time was there a return of electrical changes.

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Active Immunization Against Tunisian Typhus Fever with Mexican Typhus Vaccine.*

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(Introduced by Hans Zinsser.)

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Several attempts have been made to vaccinate human beings against typhus fever, both with living virus¹ and with killed rick-

* We wish to express our thanks to Doctors Manuel Madrazo and Ruiz Castañeda for their advice and help in the elaboration of the vaccine.

¹ Nicolle, C., and Conseil, E., *Compt. Rend. Acad.*, 1910, **151**, 598.