

level and the 1 and 2 hour periods. A summary of the results obtained is given in Table II.

One individual showed no change in the proteins during this test. All of the others showed changes in one or all of the fractions but no correlation could be found between the protein variations and the blood sugar level, or the type of sugar curve. In 3 cases the albumin decreased and the globulin increased while in 1 case the reverse of this was true. In the other cases both proteins gave the same type of change.

*Summary:* The Wu method for protein distribution as modified by Gibson gives a rapid, accurate method for determination of plasma proteins. Protein is used as a standard. During glucose tolerance tests there is no relation between the protein distribution and blood sugar as is found with hemoglobin and the blood sugar.

## 5665

### An Electrophysiological Study of the "Simple" Reflex Circuit.

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It is generally conceded that there are no well isolated reflex arcs. Nervous energy released in the reflex arc sense organs spreads apparently to immediately circumjacent and even to distant and perhaps to all parts of the central nervous system.\* Positive evidence pertaining directly to this point has been furnished by recent experiments.<sup>1</sup> In the rat it has been demonstrated that the electrical energy released in the reflex arc sense organs was conducted to all parts of the cerebral cortex studied. These studies did not disclose the possible immediacy of spread of the electrical energy in the cord. The energy recorded in the cortex might have reached there by relatively sharply delimited circuits to spread subsequently to all cortical fields. It might have reached there by way of all of the afferent spino cerebral-paths. To shed further light upon this particular problem as well as upon the general problem of mass responsiveness in the central nervous system the present study was undertaken.

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\* The morphological concomitant of this physiological concept is presented by Michaels, J. J., *J. Nerv. and Mental Disease*, in press.

<sup>1</sup> Travis, L. E., and Herren, R. Y., *J. Comp. Psychology*, 1931, in press.

The apparatus used consisted of 2 identical, non-interfering, resistance coupled amplifiers, acoustically and electrically shielded which gave identical reproduction of any impressed voltage with respect to wave form, phase, and amplitude. With 2 equally sensitive, approximately critically damped oscillograph elements the complete apparatus made possible the faithful simultaneous recording of electrical currents from varyingly separated parts of the nervous system. The recording of the instant of stimulation was accomplished by means of a specially devised vacuum tube circuit which upon the striking of a small copper plate over the tendon activated an oscillograph element. Time values of 0.001 second used for reading the reflex conduction latencies were furnished by a General Radio Type 377 low frequency oscillator. Both sets of electrodes consisted of 1 mm. apart silver wires sharpened to needle points and covered with a thin coat of insulating bakelite varnish. The ends of the needles were bared 0.5 mm. and coated with silver chloride.

The animals used were full grown white and hooded rats. The cord was prepared for electropuncture with the animal under general ether anesthetic. Experiments were conducted under light ether anesthetic. In all of these experiments the Achilles reflex of both sides was used to study electrical conduction in the cord. The rat was suspended in such a way as to permit free action of the hind extremities.

Upon striking the Achilles tendon electrical currents consistently appeared in both halves of the cord. They may or may not appear simultaneously (Fig. 1). There seemed to be no significant and consistent differences between contralateral and ipsilateral reflex

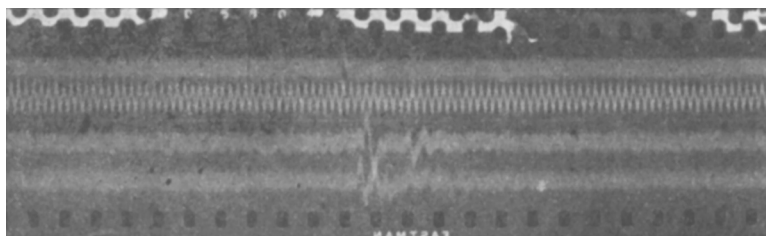


FIG. 1.

Record of electrical changes in the right and the left side of the cord as a direct result of Achilles reflex stimulation. Reading from above downward the first record is of the instant of striking the Achilles tendon, the second of time in 0.001 second interval values, the third of electrical changes in the left side of the cord, and the fourth of electrical changes in the right side of the cord. The conduction latency for the left side of the cord was read as 0.0025 second and that for the right side of the cord was read as 0.0015 second.

conduction latencies (Table I). Furthermore according to our readings the distance of the point of insertion of the electrodes from the spinal cord origin of the sciatic nerve did not make any consistent difference in the latencies.

The data indicate that the electrical energy conducted to the central nervous system along the sciatic nerve is relayed immediately upon its arrival to both halves of the cord.

For the rat Travis and Herren<sup>1</sup> determined the Achilles reflex response latency (the time elapsing between the striking of the Achilles tendon and the appearance of electrical changes in the gastrocnemius muscle) to be 6.7 sigma. The Achilles reflex arc

TABLE I.  
Reflex Conduction Latencies in the Spinal Cord.

Rat	Position of Electrodes in Relation to Spinal Cord Origin of Sciatic Nerve	Latency in 0.001 second			
		Contralateral		Ipsilateral	
		Mean*	Range	Mean*	Range
1	One segment posterior			2.9	2.5—3.5
2	Same "	2.3	2.0—2.5	2.0	2.0—2.0
3	" "	2.1	1.5—2.5	2.7	2.5—3.0
4	" "	2.3	2.0—3.0		
5	" "	2.2	2.0—2.5	2.2	1.5—2.5
6	" "			2.0	2.0—2.0
7	" "			3.3	3.0—4.0
8	One segment anterior	3.0	3.0—3.0	2.5	2.5—2.5
9	" " "	1.8	1.5—2.5	2.0	2.0—2.0
10	" " "	1.8	1.5—2.0	2.9	2.0—3.5
11	" " "	2.5	2.0—3.0		
12	" " "	2.6	2.5—3.0	2.7	2.5—3.0
13	" " "	3.0	2.0—4.0	2.2	2.0—3.0
14	" " "			2.5	2.0—3.5
15	Two segments "	4.1	4.0—4.5	3.0	3.0—3.0
16	" " "	2.5	2.5—2.5		
17	Four " "	3.0	3.0—3.0		
18	" " "	2.4	2.0—2.5	2.5	2.0—3.0
19	" " "	2.6	2.0—3.0	2.9	2.5—3.0
	Mean	2.5		2.5	

\* Average from 3 to 10 readings.

consists of at least the receptor, an afferent path, a synapse in the cord, an efferent path, muscle end-plates, and the effector. The conducting circuit dealt with in the majority of the animals in the present study consisted of at least the receptor, an afferent path to the cord, and an afferent path in the cord. This latter afferent path may be the spinal cord portion of the afferent component of the sciatic nerve. It may be a separate central afferent path. Comparing 6.7 sigma with 2.5 sigma (the time elapsing between the striking of the Achilles tendon and the appearance of electrical

changes in the cord) we note that the latter value represents slightly more than one-third of the former. Although anatomically we placed the electrodes at a point about midway in the Achilles reflex arc our mean latency value is much less than half the mean Achilles reflex response latency value. Electrophysiologically considered, the segment of the cord containing the assumed central portion of the Achilles reflex arc is not the half-way point in the arc. Either more structures or structures with higher resistances to the passage of the electrical changes we are studying must lie between this commonly conceded mid-point and the responding muscle tissue than between the sense organs and such a cord center.

The relatively great variations in latencies found in not only different rats but also in the same rat, although not readily understandable, may be partially explained in that from rat to rat and from record to record in the same rat the depth of anaesthesia varied.

In its possible effect upon the dynamic relationships existing between higher and lower neural levels and upon the conducting circuits mediating between these levels this implied irradiation of the reflex influence would appear to be highly significant.

## 5666

### **"Nucleoprotein" and Non-Protein Substance Isolated from the Gonococcus. I. Preparation.\***

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The preparations described below were made from 12 to 18 hour cultures of gonococci grown on an agar medium<sup>1</sup> containing a tryptic digest of egg-white from which the heat-coagulable proteins had been removed. The organisms were taken up in saline, centrifuged, washed and again centrifuged until well packed. They were then extracted by suspending each cubic centimeter of packed, moist organisms in 200 cc. of N/100 NaOH and allowing the suspension to stand over night in the refrigerator. After removal of the bac-

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<sup>1</sup> Miller, C. P., and Castles, R., *Proc. Soc. Exp. Biol. and Med.*, 1930, **28**, 123.