Students of anatomy and those interested in historical studies owe Doctor Hoernle a debt of gratitude for this interesting volume which was made possible by his painstaking and able studies in a field that is practically unknown to the general reader. The volume is besides a fine piece of book-making.

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THE INTEGRATIVE ACTION OF THE NERVOUS SYSTEM. By Charles S. Sherrington, Liverpool. New York, Charles Scribner's Sons, 1906. With 85 figures, xvi + 411 pages. Cloth, \$3.50.

Professor Sherrington's book, which is the series of lectures given at Yale University, has been so many times and so ably reviewed that a systematic review of the book is entirely unnecessary. For example, the significance of the book has been especially well brought out by McDougall in *Brain*, vol. 30, 1907.

On the other hand, although too late to review the book, it may be legitimate to point out certain features which have proved of especial value in the teaching of neurology. The first chapter indicates these features. On the histological side, the theory that in the central nervous system the neurones are independent has been steadily gaining ground through the work of Cajal, Van Gehuchten and others, while on the embryological side conclusive proof has been given by Harrison that the motor nerve to its terminal plates on the skeletal muscle is a process of a single cell. Professor Sherrington gives us evidence on the physiological side. He shows that in function, the reflex arc, involving at least three neurones, has certain characteristics different from nerve conduction and that these differences can be explainable on the hypothesis that there is a plain of separation between the two neurones. These differences are: "(1) Slower speed in reflex arcs; (2) less close correspondence between the moment of cessation of stimulus and the moment of cessation of the end effect; (3) less close correspondence between rhythm of stimulus and rhythm of end effect; (4) less close correspondence between the grading of intensity of the stimulus and the grading of intensity of the end effect;

considerable resistance to passage of a single nerve impulse, but a resistance easily forced by a succession of impulses; (6) irreversibility of direction instead of reversibility as in nerve trunks; (7) fatigability in contrast with the comparative unfatigability of nerve trunks; (8) much greater variability of the threshold value of stimulus than in nerve trunks; (9) refractory period, "bahnung," inhibition, and shock, in degrees unknown for nerve trunks; (10) much greater dependence on blood circulation, oxygen, etc.; (11) much greater susceptibility to various drugs—anaesthetics." The loss of time in reflex arc conduction takes place in the gray matter, and can be explained on the theory that in passing from one neurone to a second the impulse must pass through a zone of protoplasm less highly specialized by conduction than are the neurofibrils. The place of showing of the impulse, where the impulse possibly passes from one neurone to the other, Professor Sherrington calls the synapse.

The second point which we have found of especial interest is that in the medusæ, where anatomists have shown that the nervous system is made of a diffuse nerve net, instead of individual neurones, where there is no specialization of dendrite and axone, the characteristics of reflex arc conduction depending on the synapse are not found. The number of impulses corresponds closely with the stimuli both in number and in rhythm, and there is complete reversibility of conduction, or the impulse is transmitted in all directions from the point of stimulus. Sherrington points out that in nerve conduction and reflex arc conduction there is a refractory phase, but that in the medusa from the observations of Bethe the refractory phase is probably referable to the nerve net, and in the intestine from the work of Magnus the refractory phase is referable to the intrinsic nerve plexus of Auerbach. That is to say in some movements in invertebrates and in some of the movements under control of the sympathetic system in vertebrates the refractory phase is peripheral and belongs to the nerve conduction, while in the more highly specialized movements the refractory phase is central. This seems to suggest to the anatomists that the controversy over the neurone theory may have been due to a reading of results found in one form into another form—and that the simpler relations found in the nerve net of the medusa may be repeated in the sympathetic system of the higher forms.

Sherrington goes on to develop the significance of the more highly specialized or synaptic type of conduction for the skeletal muscles in a series of conceptions that are most helpful in presenting the tracts of the nervous system to students. The first of these is the conception of a common path. He makes plain that the receptive neurone of an arc carries only impulses generated at its own receptive point and hence may be called a *private* path, while the efferent or motor neurone may be excited by a variety of impulses from the various private paths, and hence may be called a public or *common* path. The second of these important conceptions is that of reciprocal inhibition, which is most clearly illustrated in Fig. 37 on page 108. In the medusa there is only the movement possible, the contraction of the bell, but in the antagonistic muscles of the legs of vertebrates, for example, sensory impulses from the skin and the flexor muscles may stimulate a flexion reflex, which must involve an inhibition of the extensors. This he showed experimentally in an animal so prepared that the flexors could not act. Stimulation of the proper skin area gave inhibition of the extensors. The reciprocal inhibition for reflexes on the opposite side as well as on the same side is illustrated in the figure just quoted. The reciprocal inhibition he shows to be a central or synaptic phenomenon. The third general point is that while the motor nerves represent the final common path, the short tracts of the cord and brain stem represent also common paths. These common paths may be used successively by unlike reflexes, but simultaneously by like reflexes. This shows that these common paths, the short tracts in anatomical terms, are a "coordinating mechanism, which prevents confusion by restricting the use of the organ to but one action at a time."

The first part of the eighth chapter gives a valuable review of the experimental work on cerebral localization. The rest of the book is purely physiological with many interesting suggestions, such as the idea that the short tracts are the organs of nervous integration of a segmental series, that the cerebellum is the head ganglion of the proprioceptive system, that is the system of sensory impulses from the organism itself, while the cerebrum is the head ganglion of the distance receptors.

Florence R. Sabin.

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