ratory, when given in moderate doses (5 cc or so every hour or two), also provided an adequate stimulus to increased activity. Two other substances, adrenalin and prostigmin, were also found to be effective in raising the sloth from its (anthropomorphically considered) sluggardy. Several other preparations which were tested over several days (thyroid and pituitary, also benzedrine and strychnine solutions) gave negative results.

Raising the body temperature appeared to be the best stimulator; on the average the increments in rate of walking on warming approximated 50 per cent., and several cases showed increases of over 100 per cent. Cortico-adrenal extract was observed to maintain the increased rate of upside-down travel by the sloth for some ten or twelve hours after injection. This is in keeping with the earliest observations on the influence of the cortical hormone in augmenting activity.[1] Prostigmin as well as emotional excitement appeared to bring out the fighting instinct in sloths, along with the greater ability to "run" away.

The rate of progress of the sloth may be given interestingly on a mileage basis. It appeared from several hundred tests that the two-toed sloth normally averaged a little over three hours to the mile, and three-toed animals almost four-and-a-half hours. The slowest individual tardigrades, however, took over six hours for the distance. Under excitation such as that noted above, the mile was possible in about two hours, and in a burst of speed by one animal only, a mile an hour was accomplished.

It is likely that in the wild the higher rates of progress indicated would not obtain, because of difficulties of arboreal travel, lack of stimulus, etc. In some cases the sloth rests, indeed, for weeks on end, in the same place in the same tree. Beebe has written very engagingly on its habits.[2] It may be recalled that the sloth possesses only about one half the amount of muscle (percentally) found in other mammals, and that about one quarter of its weight is made up of stomach and contents—both serious handicaps to fast movement.[3] The present observations indicate, nevertheless, that several fairly effective methods of deslothing the sloth may be employed.

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[1] E. Eagle, S. W. Britton and R. F. Kline, *Am. Jour. Physiol.*, 102: 707, 1932.

[2] W. Beebe, *Zoologica*, 7: 1, 1926.

[3] S. W. Britton, R. F. Kline and H. Silvette, *Am. Jour. Physiol.*, 123: 701, 1938.

SCIENTIFIC BOOKS

PHYSIOLOGY

Physiology of the Nervous System. By J. F. FULTON. London, New York, Toronto: Oxford University Press, 1938. Pp. xv + 675.

IN this extensive work the author has pursued his declared intention of serving the study of clinical medicine and of meeting the needs of the medical student. From this point of view the work has, in the main, been well done, and much valuable material for the student or clinician is included. To the reviewing physiologist, it seems that the book should rather be called "physiological anatomy." By far the greater part of the book is given to anatomical details, and indeed much of the fundamental physiology of the nervous system is so sketchily treated, with important parts of the subject omitted altogether, that a sense of unbalanced emphasis is left in the reader's mind. The entire fields of conditioned reflexes and electrophysiology—the latter a topic of rapidly expanding interest—are omitted; and, though it is explained that their omission is intentional, the book is thereby rendered an incomplete treatment of the subject indicated in the title. There are several evidences of haste in preparation, but this is to be expected in so large an undertaking by such a busy worker.

An admirable feature of the arrangement is the beginning of each chapter with a historical note and the conclusion of each with a concise, well-worded summary. The historical notes are both interesting and instructive, serving to enhance the understanding of present knowledge. The sequence of chapters, beginning with receptors, motor units and elementary reflexes and then proceeding upward through the spinal cord to the cerebrum, is logical and in the main clear, but it involves some repetition, as in the case of postural reflexes.

The author's interest lies in organization and integration, rather than in basic principles and constituent mechanisms. This is frankly stated in the following sentence (p. 71): "The problem of organization is the principal subject of the present volume; the nature of synaptic transmission, important though it always remains, must here be relegated to a few brief paragraphs." The major foundation stone of the physiology of the nervous system is that well-known but little understood event which we call the nerve impulse. There is scarcely a reference to the vast body of research which for a century has been directed to elucidating this phenomenon, and hardly a word of the results of these researches, beyond a brief, but excellent statement of the all-or-nothing principle.

The influence of the author's great teacher, Sher-

rington, is much in evidence, and indeed the chief merit in the book is the broad, philosophical view of organization and integration which emanates from that influence. The minutely detailed account of the researches on stretch reflexes and other features of spinal cord physiology, which occupied the author during his years in Sherrington's laboratory, seems to involve over-emphasis of a specialized topic at the expense of other more fundamental matters, which suffer a corresponding neglect.

In a footnote (p. 73) is described how the author once espoused a chemical theory of central nerve function and disposed of rival electrical theories with arguments which, it may be noted, failed to consider the possibility of "reverberation," which was suggested in 1923 and for which a strong case has since been made by Lorente de Nó. The footnote goes on to explain how the author has now abandoned the chemical theory and with equal vigor espoused the electrical theory, just when cogent evidence for a chemical theory is becoming well-nigh overwhelming, without even a reference to experiments which have raised almost insuperable obstacles in the way of the electrical theory.[1] He prematurely accepts the evidence of Eccles, which seemed to rule out the synaptic action of acetylcholine, but which has since been convincingly answered by the work of Rosenblueth and Simeone.[2] In support of the electrical theory he makes dogmatic assertions concerning events in the cell membrane, including reiterated insistence on the unproved assumption that an antidromic impulse causes a discharge which sweeps through the entire nerve cell. This unfortunate bias reaches a climax on page 96, where he takes up the once ignored explanation of after-discharge by reverberating circuits and then states, "it seems unnecessary to discuss alternative hypotheses."

These adverse criticisms impress a reviewer to whom the basic questions appeal as standing at the portal of rational inquiry into the mechanism of conscious life. Not being qualified to pass expert judgment on the anatomical survey, which constitutes the greater part of the book, the reviewer is impressed with the quantity of material which is marshalled to provide an understanding of integration in the nervous system.

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SPECIAL ARTICLES

MICE AS CARRIERS OF PATHOGENIC PLEUROPNEUMONIA-LIKE MICROORGANISMS

Two distinct strains of filtrable pathogenic microorganisms of the pleuropneumonia group have recently been isolated from the brains of mice and shown to possess tissue affinities of such a nature that they can produce in mice two experimental diseases which bear some resemblance to certain phases of rheumatic fever and rheumatoid arthritis in man.[1] Strain A induces a transitory, migratory polyarthritis, multiplies in the brain and in mesothelial cells of the pleura, pericardium and peritoneum, and produces a typical exotoxin which gives rise to choreiform signs. Strain B produces no such toxin, but has an almost specific affinity for the joints in which it gives rise to a chronic, progressive, proliferative, ankylosing arthritis. These two strains are biologically and immunologically distinct from each other, from *Pleuropneumonia bovum* and from pleuropneumonia-like microorganisms that have been isolated from rats in pure culture or in association with *Streptobacillus moniliformis*.[2] These findings clearly suggested the necessity of determining whether or not similar microorganisms could be isolated from patients with rheumatic fever and rheumatoid arthritis, and following this indication, Swift and Brown[3] reported the isolation of pleuropneumonia-like microorganisms from acute rheumatic fever material.

The chief purpose of the present communication is to record certain experiences which indicate the inadvisability of using mice in attempting to isolate such microorganisms from human material. While studying exudates and tissues from patients with rheumatoid arthritis or rheumatic fever, it was found that inoculation of such material, normal synovial fluid or sterile broth into the eyes (vitreous) of mice, yielded positive pleuropneumonia-like cultures with great regularity. In a typical test, material under investigation was injected into both eyes of six 3-weeks-old mice; six days later the eyes were removed with separate, sterile instruments, immersed in anesthetic ether for one to two minutes (this was sufficient to bring about adequate sterilization of the exterior of the eye), incised, and streaked across 30 per cent. ascitic fluid agar. In most instances, innumerable, typical, microscopic, pleuropneumonia-like colonies appeared within two days. With the Rockefeller Institute Swiss stock, at least four or five mice out of each group of six yielded positive cultures from one or both eyes in ten different experiments. The colonies on solid medium resembled those of Strain A; after several transfers on fluid

[1] W. B. Cannon and A. Rosenblueth, *Amer. Jour. Physiol.*, 119: 221–235, 1937.

[1] A. B. Sabin, SCIENCE, 88: 575, 1938; *ibid.*, 89: 228, 1939.

[2] E. Klieneberger, *Jour. Hyg.*, 38: 458, 1938.

[2] A. Rosenblueth and F. A. Simeone, *Amer. Jour. Physiol.*, 1938, 122: 688–707, 1938; *ibid.*, 708–721.

[3] H. F. Swift and T. M. Brown, SCIENCE, 89: 271, 1939.