of the references to previous results in the text to be obscure. In addition, the basic observational data for the theory of nucleosynthesis, the observed abundances, receive insufficient attention. Misprints and numerical errors appear to average about one per ten pages; many of them are not critical, however.

In summary, most of the basic physical principles necessary to begin work in this fundamental area of astrophysics are presented clearly in this book. It is a welcome appearance.

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Brain Circuits and Body Movement

Neurophysiological Basis of Normal and Abnormal Motor Activities. Proceedings of the third symposium of the Parkinson's Disease Information and Research Center of Columbia University, New York, 1966. MELVIN D. YAHR and DOMINICK P. PURPURA, Eds. Raven Press, Hewlett, N.Y., 1967. xii + 451 pp., illus. $25.

How do we move? The problem of finding out is inherently difficult. It is hard to produce and control movement of the vertebrate animal in the laboratory. The "output stage" of the motor system is a complex array of muscle, tendon, bone, and joint, and the normal activities of the system are not easily observed with accuracy. The neural structures that control its output are many and are not interconnected in any simple, linear fashion; moreover, they are intimately connected with many other, "nonmotor" parts of the brain. But this is the question and the problem which brought scientists and physicians together in 1966 for the third symposium of the Parkinson's Disease Information and Research Center in New York. The result is a book consisting of 17 individual articles and the recorded discussions; it is written in professional language and is addressed primarily to workers in the field. Though the book is not a review, with its discussions and bibliographies it includes or refers to most of what is new knowledge and, in displaying the kinds of questions that are asked and approaches that are used, it permits the reader to judge the prospects for future discovery.

The questions often concern the layout of anatomical circuitry. Oscarsson summarizes his work on pathways connecting peripheral nerve and spinal cord to cerebellum, discovered with the classical methods of electrical shock, potential-recording, and ablation. Ajala and Poppele discuss vestibular connections to cerebellum and spinal cord. Welt *et al.* describe a path from skin and deep receptors in small portions of a limb to columns of cells in the motor cortex, which then project back to muscles within that portion of the limb. Preston *et al.* study differences between cat and baboon with regard to how pyramidal tract neurons of the motor cortex are connected through to spinal motoneurons. Klee and Wagner offer evidence that the spinal afferent fibers that excite the motoneuron across a single synapse contact its dendrite and the fibers that excite it only after several synapses influence mainly its soma. Another question concerns the kind of synapse—excitatory or inhibitory—that exists between cells in a particular pathway. Ito describes how cerebellar Purkinje cells inhibit and cerebellar nuclear cells excite the cells that they contact; Shimazu how inhibitory as well as excitatory neurons exist within vestibular nuclei and what pathways link them; and Purpura *et al.* how thalamus, caudate, putamen, globus pallidus, and substantia nigra are linked by excitatory and inhibitory connections.

Several approaches are aimed at defining the function of an element—a cell or group of cells—in the circuit in which it is placed. One approach asks what kind of output information is made by an element from its input information. Granit and Kellerth discuss how natural stimuli and gamma-motoneurons influence muscle receptors (with a concise summary of what is known about tendon organs and nuclear bag and nuclear chain spindles) and how the output then influences motoneurons. Henatsch, in similar experiments, applies control theory to analyze the input-output relationship and further specify how spindles might operate as elements in a feedback loop controlling muscle tension and length. Eccles, arguing from the type and distribution of information that enters the cerebellum from the spinal cord and the characteristics of the cerebellar machinery that processes it, predicts properties of the cerebellar output. Another way of specifying how an element functions in a circuit is to over- or underactivate it and look for differences in the output of the system: deVilliers *et al.* stimulate various parts of the brain in an attempt to learn more about the tremor of Parkinson's disease; Denny-Brown reviews his work on ablating parts of the brain and deducing from the behavioral deficit what they normally contribute to behavior. A final approach consists of observing the behavior of neurons during the natural behavior of the animal to see if some specific relationship exists between the two—a relationship that might serve as a clue to what the neurons contribute to the circuits that control behavior. Pompeiano thoroughly reviews work showing a "disconnection" of visual and somesthetic pathways during the eye and body movements that occur in dream-sleep, and gives reasons for believing that the vestibular nuclei are fundamentally involved. Evarts describes a new technique in which cell activity is recorded in monkeys during arm movements that they have been taught to make. Cells in the motor cortex that give rise to the pyramidal tract discharge in advance of and in relation to the exertion of force by the monkey during movements of the arm, a causal relationship being thereby suggested.

Two papers are directly concerned with pathologic movement: that of Eldred *et al.*, which demonstrates changes in muscle spindles resulting from immobilization; and that of Mettler, which offers a description of movements altered by brain lesions.

One might wonder how applicable some of these findings are to the patient with Parkinson's disease or to normal man. One problem is that the need to simplify an experiment often results in the choice of an animal that is very different from man, one that may be too different if our object is to learn about human movement. A more serious problem stems from our long habit of simplifying an experiment by surgically simplifying a complicated animal. The problem is that movement—for students of it—consists so completely of stereotyped reflexes and postural adjustments that we at times risk losing sight of what we are trying to explain. But this book gives no cause for pessimism. It illustrates powerful methods for outlining brain circuitry and some promising new methods for discovering how the circuits work.

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