mutagens, the detection of mutation at various levels, the estimation of mutation rates, the assessment of the phenotypic effects of mutation, and the prediction of the evolutionary consequences of mutation.

The term "mutation" has been taken here in its most general sense to mean all changes in the genetic material. In keeping with this broad definition, the various authors have discussed the detection of mutation at the level of the nucleotide, the protein, the chromosome, the cell, the individual, and the population. Investigation of each of these levels has its own limitations. For example, the identification of DNA base changes is not sufficient for explaining the mechanisms by which mutations exert their phenotypic effects; studies of mutation in cultured somatic cells may not be applicable to germinal mutation; and documentation of birth defects in populations exposed to mutagens is of little use in arriving at estimates of mutation rates, unless the defects are known to be caused by single genes. In combination, however, the various approaches described are leading to a better understanding of human mutation.

The seven sections of the book are devoted to mutation, selection, and human evolution; mutations at autosomal and X-linked loci; cytogenetic mutation; somatic cell mutation; radiation and mutation; general topics; and concluding remarks. Specifically excluded from consideration are numerical human chromosomal abnormalities, mutations in nonchromosomal structures such as organelles, chromosome breakage in cultured human cells, and spontaneous mutation in wild mammalian populations.

Several papers are of special interest. These include reviews of human chromosome mutation (Jacobs *et al.*) and sister chromatid exchange (Latt *et al.*), a summary of studies in Hiroshima and Nagasaki of the reproductive effects of ionizing radiation (Schull *et al.*), investigations of mutation rates for X-linked diseases (Lubs; Thompson *et al.*; Francke *et al.*), and discussions of the neutralist-selectionist controversy (Crow; Harris). The one paper devoted primarily to work in species other than humans is a review of radiation genetic research in mice (Selby). Recurring themes in the book are the problems that are encountered in attempting to obtain meaningful estimates of human mutation rates (Morton), the advantages and disadvantages of using data from registries (Palmer; Hook *et al.*; Holmes *et al.*), and the need for new approaches to the study of human mutation (Neel).

In view of the enormous effort that has been devoted to the study of human mutation, it is disappointing that progress has been slow and that there is no general agreement about the best way to proceed. This volume accomplishes the difficult task of summarizing a diverse field, one which is of great public concern and in which the need for informed scientific exchange is crucial.

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Neuronal Geometry

Organization in the Spinal Cord. The Anatomy and Physiology of Identified Neurones. A. G. BROWN. Springer-Verlag, New York, 1981. xii, 238 pp., illus. $86.50.

Until recently much of the available information on the details of neuronal geometry in the vertebrate brain came from studies of histological material stained by the use of the Golgi technique, a method developed late in the 19th century, which for mysterious reasons usually impregnates but a few neurons of a region with a silver salt. This stain allows the complex shape and fine extensions of a nerve cell to be visualized in partial isolation from the myriad of other processes and cell bodies in its vicinity. From analyses of Golgi material the renowned Spanish neuroanatomist S. Ramon y Cajal provided a foundation of knowledge about vertebrate neuronal shape and positioning in his *Histologie du Système Nerveux de L'Homme et des Vertébrés*, whose volumes were published in 1909 and 1911 (in Spanish in 1894–1904). The capricious alchemy of the Golgi technique never has been satisfactorily explained, even though variations of it have been employed by a number of subsequent investigators. Though these later workers have expanded our understanding, crucial questions about the intimate structural relationships in the organization of neurons remain unanswered.

A new era began about 15 years ago when it was discovered that the fine pipette electrodes used for intracellular recording of a neuron's electrical activity could also be employed to eject substances by pressure or iontophoresis to mark the cell being studied. Radioactively labeled amino acids and various dyes were the first intracellular markers. Intracellular fluorescent dyes gave dramatic pictures of an isolated neuron whose general geometry and location within a neuropil could be appreciated, making correlation of structure and function possible. In spite of the elegance of the pictures produced, both the radioactive and the fluorescent labels had serious drawbacks: the former required the complexity of autoradiography for visualization, and the dyes used for the latter interfered with cellular function and their fluorescence was evanescent.

Horseradish peroxidase (HRP) came onto the scene as a tool for neuroanatomy in 1973, only a few years after the first intracellular marking of functionally defined neurons had been reported. It initially gained prominence as a substance that could be used to trace long processes of neurons through the mechanism of retrograde transport; under appropriate conditions the extended axon of a neuron picked up and transported the substance back to the cell body, hence "retrogradely." Demonstration of peroxidase was accomplished by histochemical reaction with one of several substrates such as diaminobenzidine, producing a stable coloration that was electron dense and therefore identifiable at the electron microscopic level. However, in 1973, at the same time that the potential of HRP as a retrograde tracer was becoming known, G. Lynch and his colleagues pointed out that under some circumstances the intracellular transport (flow) system of neurons would carry HRP from the cell body distally toward the neuron's processes. In 1976, four laboratories published reports showing that HRP injected from a recording micropipette into a neuron was transported to the local processes of the neuron, permitting relatively uniform staining of its extensive arborizations. Publications in 1976 from the laboratories of Alan Brown in Edinburgh, Scotland, and Elżbieta Jankowska in Göteborg, Sweden, were the forerunners of a series of reports from their groups demonstrating how this technique could be used to correlate morphology and function. Moreover, the 1976 reports from the laboratories of Jankowska and Kellerth included illustrations of the ultrastructure of HRP-marked processes.

In essence, Brown's book describes results obtained by iontophoresing HRP into physiologically identified neurons of the cat spinal cord. By concentrating on his own work and ideas, Brown follows a tradition that was once the rule for philosophical and scientific monographs. The work provides a wealth of illustrative material from the observations made by him and his colleagues. The issues re-

ceiving principal attention are the central terminations of large-diameter primary afferent fibers that originate from the mechanoreceptors of mammalian skin and muscle and systems of spinal neurons that send their processes rostrally to the brain, principally conveying sensory information from the skin. Although much of the work has been described in widely circulated scientific journals, the book brings the ensemble together and adds a number of additional pictures of stained neurons. Considerable space is devoted to light-microscope descriptions of the central terminations of large-diameter myelinated primary afferent fibers from skin mechanoreceptors, one of the group's most important contributions. That different cutaneous mechanoreceptors have their central terminations concentrated in zones and with arrangements more or less distinctive for each type of sense organ may not surprise all readers, but prior to the studies of Brown and his colleagues these facts had not been documented. Brown's inclusion of chapters on central connections of the large-diameter afferent fibers of muscle is understandable given the applicability of the HRP technique and the wealth of physiological information available about the sense organs they serve; however, there was more previous knowledge about the central projections of muscle than those of cutaneous afferent fibers.

Brown's attention to the two ascending somatosensory systems, the spinocervical and the postsynaptic dorsal column pathways, is fitting, since both of these systems receive excitation from cutaneous primary fibers that the Edinburgh group has studied physiologically. In fact, the first experiments using intracellular HRP done by Brown's laboratory were on neurons of the spinocervical projection. These ascending systems of the spinal cord are prominent in the cat. Their functional significance for human beings and other primates is still uncertain.

The 176 illustrations convincingly document the complexity of neuronal structure as represented by the extensive arborizations of the central terminal of primary afferent fibers and of the dendrites of spinal neurons. The observations are a testimony to the potency of approaches that combine functional analysis by electrophysiological recording with equivalently detailed determination of morphology. The data show that the intimate anatomy of neurons is more complicated than had been appreciated from the Golgi technique, which apparently does not provide as complete a demarcation of fine processes as is demonstrated by the intracellular HRP. The book discusses more than the results obtained by Brown and his colleagues, although, as the preface states, that is its principal purpose. There is a relatively extensive but selective discussion of the literature on the spinal cord and an excellent bibliography that of itself might be worth a library's purchase. However, the volume is not and does not pretend to be a treatise on spinal cord function and should not be used as a balanced source for an understanding of the structure or general principles of organization of the mammalian central nervous system. Because the book presents a highly personal view, one should be careful in recommending it to students or neophytes. The degree of emphasis given to contributions made by others may not do justice; demurrals could arise from certain quarters in Sweden. Moreover, there are notable omissions. There is a lack of electron microscopic material except for one figure in the addendum. In addition, there is remarkably little physiology for a book written by a physiologist. Finally, the addendum, which provides some useful information on methods, does not treat the valuable variations used by other investigators.

The book is a splendid tribute to the order and the complexity of the circuitry in the central nervous system of mammals and a pointed warning to those who would ignore the highly specific arrangements in bringing forth theories of neural functioning. It also brings attention to the work of a fine scientist and his colleagues in a fashion that might well be used by others.

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Plasma Physics

Relation between Laboratory and Space Plasmas. Proceedings of a workshop, Tokyo, April 1980. HIROSHI KIKUCHI, Ed. Reidel, Boston, 1981 (distributor, Kluwer Boston, Hingham, Mass.). xii, 418 pp., illus. $58. Astrophysics and Space Science Library, vol. 84.

Space plasma physics deals with phenomena involving an extremely large range of parameters, and it is not surprising that laboratory simulation of, for example, the magnetopause, bow shock, and micropulsations is difficult if not impossible. Scaling laws prohibit the accurate mapping of all important characteristic quantities of space in the laboratory. The interaction between space and laboratory plasma physics has thus been only marginally fruitful.

This book, the proceedings of an international workshop, attempts to change this situation. The book is directed toward laboratory plasma physicists, space scientists, and plasma theoreticians. Astronomers may also find it useful. It covers eight topics, ranging from "exotic" ones such as critical velocity and double layers to more standard ones such as instabilities and turbulence. Each topic is covered by three or four papers, most of which deal with rather specific aspects of limited problems. Interaction between space and laboratory plasma physics can be fruitful in dealing with such limited but well-defined problems.

An excellent example is the study of the so-called critical velocity phenomenon originally introduced by Alfvén in 1954. Alfvén proposed that there exists an upper limit to the relative velocity of a neutral gas and a magnetized plasma. This limit, the critical velocity, is reached when the kinetic energy of the neutral gas equals its ionization energy. In 1975, Alfvén and Arrhenius proposed this effect as an explanation for the "band structure" of the distribution of matter in the solar system. Others believe it to be of importance in the interaction of the solar wind with comets or the Jovian magnetosphere with the moon Io. Acceptance of the idea has been slow, and up until a few years ago the majority of laboratory plasma physicists did not deem it necessary to test the phenomenon. The situation has changed in the last five years or so, however, and today a reasonably large body of data and theory concerning the critical velocity phenomenon exist. Most of it is reviewed in the book. There is also a reasonably large body of data and theory concerning the double-layer phenomenon, although the book's coverage of it is much less complete than one would wish. There are, for example, no papers on numerical simulations, and the treatment of recent theoretical advances is sketchy at best. Other examples of the advantage of using clean, simple, and small-scale laboratory experiments to understand space plasma phenomena are treated in sections on instabilities in the equatorial and auroral electrojet, turbulent and anomalous plasmas, and plasma irregularities. Newly designed active experiments are treated in the last section of the book.

A major shortcoming of the book is its lack of focus. The scope is simply too