ters tell the stories of the early researchers, including Vannevar Bush and the differential analyzer, Hazen and the network analyzer, Edward L. Bowles and the development of a communications option at MIT, and Harold Edgerton and the stroboscope.

In the preface, the authors offer a unifying theme in the notion of "scientific and technological progress," which they understand to be the source of an "environment of continual change" in the nation (p. viii). It is a view rapidly fading among students of science and technology, this idea of technology dragging along the social order. In any case, the authors' progressive faith does not work as an integrating theme. The ideas behind the Institute's Technology Plan, devised in the 1920's but reflecting the Institute's original mission, would have better served the authors. The notion of applying science, as the Institute's founder wrote, to the "arts, manufactures, and commerce" blends well with the principles that guided Dugald Jackson's nearly 30 years as department head. Coupling this with the rising commitment to research after 1910, the authors might have smoothed over the rough joints in the first half of the book. They could have emulated the professional historian and made a study of, for example, the histories of A. Hunter Dupree, Daniel N. Kevles, David F. Noble, Ronald C. Tobey, and Edwin T. Layton, Jr., supplemented with some intensive research in the massive collections of Dugald Jackson's papers in MIT's University Archives and Vannevar Bush's at the Library of Congress.

Fortunately for this richly detailed history of MIT's dominant engineering discipline, continuity comes to the second half of the book with the integrating power of the Second World War, abetted by the personal experience of Wildes, who joined the department in 1926. The war initiated an era of military funding at MIT which today sees no end, decisively shaping the fields of electronics and computer science that have come to characterize the discipline of electrical engineering.

Most revealing of the organizing force of the national security state is the content of the final 11 chapters: eight focus on the work of research laboratories and programs established primarily to pursue military purposes, ranging from the wartime Radiation Laboratory of the Office of Scientific Research and Development to Gordon S. Brown's Servomechanisms Laboratory (later the Electronic Systems Laboratory) to the Lincoln Laboratory and the Computation Center. (The genealogy of MIT's postwar laboratories is as complex as a *Mayflower* family's and can only be hinted at here.) In spite of the extensive documentation throughout the book of the military presence, the authors unfortunately fail to consider its import for the theme of their last, interpretative chapter, "seeking a new paradigm in engineering." After describing a department whose members' work is dominated by industrial and military funding, the authors depict the department and the discipline of electrical engineering as essentially autonomous. This is unfortunate, since it would have been helpful to have the authors' thoughts on the impact of mission-directed research on electrical engineering and computer science in the late 20th century.

In the end, however, it matters little. The authors have told their story with energy and in the detail dear to the hearts of alumni and historians. The persistent federal presence does the rest. That the story is that of the premier home of the leading engineering discipline of our time, moreover, makes it a story of interest to us all.

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"Students [at MIT] studying the action of direct and alternating currents under different conditions, 1919. This kind of laboratory work, repeating earlier experiments, was still leagues away from the kind of participatory teacher-student research on new problems that would begin to evolve in the next decade." [From *A Century of Electrical Engineering and Computer Science at MIT, 1882–1982*]

## Transplanted Neurons

**Neural Grafting in the Mammalian CNS.** ANDERS BJÖRKLUND and ULF STENEVI, Eds. Elsevier, New York, 1985. xxiv, 709 pp., illus. $157.50. Fernström Foundation Series, vol. 5. From a symposium, Lund, Sweden, June 1984.

This collection of papers begins with a brief historical introduction to neuronal grafting by the editors. It continues with contributions ranging from "how-to-do-it" chapters to case histories of patients with Parkinson's disease who have had brain grafts of their own adrenal glands. In between are detailed accounts of the cellular anatomy and electrophysiology of grafts, axonal growth in and around grafted tissue, and the synthesis and release of dopamine, acetylcholine, and several peptides and hormones from grafted neurons. Finally there is a 26-page bibliography of material from before the turn of the century through 1983.

The volume is much more like a book than the usual collection of isolated chapters discussing the latest results of each participant. This is well illustrated by the section on methodology. There are seven chapters that cover the preparation of both the host tissue and the neuronal graft. Procedures are described for making small explants of neural tissue and also cell suspensions that can be injected into the host. Implantation sites include the cerebral ventricles, the brain parenchyma itself, and the anterior chamber of the eye. Technical details are more complete than in reviewed articles. Anyone who has tried to track down technical procedures, each article refering to the one that preceded it, can appreciate how useful such a compilation can be. This feature alone makes the book worthwhile for someone contemplating experiments using these techniques.

After two brief chapters on immunology, in which one learns little except that the brain and anterior chamber of the eye appear to be immunologically privileged sites, one arrives at the crux of the matter: what can transplanted neurons really do? A convincing and rather thorough (48 chapters, 562 pages) case is made that they can do practically anything a normal neuron can do. Neurons retain to a large degree the ability to organize themselves into tissues resembling those they normally would have formed, especially if transplanted from embryos into neonates. For example, a fetal cerebellar primordium transplanted to the cerebellum, cerebral cortex, or anterior chamber develops almost as a mini-cerebellum (Björklund *et al.*; Sotelo and Alvarado-Mallart). And fetal retina similarly placed onto the superior colliculus not only develops all the normal cell and plexiform layers but can even mediate light-evoked synaptic responses in the host tectum (McLoon and Lund and their co-workers). Histochemical and immunological markers show that cells also retain their ability to synthesize normal transmitters and peptides. These substances can be released both in response to $K^+$-depolarization, as is described for monoamines in grafts of substantia nigra detected by electrochemical methods (Hoffer *et al.*), and after electrical stimulation, as is demonstrated electrophysiologically for cholinergic neurons transplanted into a host hippocampus previously deprived of its normal cholinergic input (Segal, Björklund, and Gage). Many examples are given in which axonal projections to and from the rest of the brain are also appropriate for the type of tissue transplanted, although this is not an invariant finding.

What are neural transplants good for? Right from the beginning a major hope has been that it will eventually be possible to repair damaged neuronal circuits by transplanting neurons. Work presented in this volume suggests that at best one can still only be hopeful. The only successful reversals of lesion-induced behavioral deficits are those that depend not on the restoration of specific neuronal pathways but on diffuse transmitter release. The development of normal neuronal architecture within the graft and connections between it and the host brain has so far required fetal donors and usually relatively young hosts, both of which will be difficult to obtain in humans. Nevertheless, for certain disorders such as Parkinson's and Alzheimer's diseases restoration of specific circuits may not be required to alleviate many of the symptoms, and transplants of cells capable of releasing dopamine or acetylcholine into the extracellular space may be helpful. In contrast to this more speculative hope, however, the importance of transplantation in studying neuronal development and specificity of synaptic connections has been established over decades, not in mammals but in lower vertebrates like frogs, newts, and fishes. Now that mammalian transplantations have become feasible as well, similar studies can be made in higher vertebrates; several chapters in this book represent important beginnings in this direction.

The volume is not a review. It is too long, and each contributor is too much interested in presenting his or her recent results. Nor is it a substitute for refereed journals. Many of the chapters provide insufficient data to make possible a critical evaluation of the results. What it does remarkably well is to present the range of experimental problems currently addressed by work on transplantation in sufficient detail that the reader can decide if the technique is useful in pursuing his or her own interests and, if so, how to proceed.

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## Plant Mitochondria

**Higher Plant Cell Respiration.** R. DOUCE and D. A. DAY, Eds. Springer-Verlag, New York, 1985. xvi, 522 pp., illus. $104.50. Encyclopedia of Plant Physiology, New Series, vol. 18.

Plant mitochondria, like their animal counterparts, have as a major role the driving of the synthesis of adenosine triphosphate with free energy released during the oxidation of intermediates of the tricarboxylic acid cycle. In that regard, plant mitochondria have many features in common with animal mitochondria, including a similar morphology, the presence of four multicentered electron transfer complexes plus a proton translocating adenosine triphosphatase, and a similar lipid composition. They also have many unique features, including the presence of a cyanide/antimycin A–resistant electron transfer pathway, the ability to oxidize external reduced forms of nicotinamide adenine dinucleotide (NADH) and nicotinamide adenine dinucleotide phosphate (NADPH), the presence of a rotenone-resistant bypass for internal NADH oxidation, the presence of malic enzyme in the mitochondrial matrix, carrier-mediated transport of nicotinamide adenine dinucleotide ($NAD^+$), the ability of leaf mitochondria to decarboxylate glycine oxidatively during photorespiration, and the large size and complexity of their DNA.

In contrast to standard textbook discussions of mitochondria and their functioning during respiration in eukaryotic organisms, which consistently fail to note the extent to which plant mitochondria deviate from the "norm," *Higher Plant Cell Respiration* clearly delineates both those characteristics that plant mitochondria have in common with other mitochondria and those that are unique to plant mitochondria and the plant respiratory process.

Workers interested in mitochondria and respiratory metabolism, whether in plants or in animals, will find that the book contains a comprehensive, up-to-date review of the subject. It also provides a compilation of the progress that has been made in the 25 years since the first publication of a volume of the *Encyclopedia of Plant Physiology* covering plant respiration. No comparable volume has appeared since, and progress has certainly been sufficient to warrant a review of the field at this time. There are many reasons for the progress, but one of the most important is the appearance of procedures to isolate active, purified mitochondria from a wide range of plant sources. Such procedures have made it possible to study the low respiratory control values, the cyanide-resistant oxygen uptake, and the oxidation of externally added NADH in plant mitochondria, among other factors, and to exclude the possibility of their being artifacts caused by mitochondrial damage during the isolation procedure. The recent use of Percoll gradients has allowed chloroplast-free mitochondria to be readily isolated from most chlorophyll-containing plant tissues. As is pointed out in several chapters, the unique aspects of oxidative metabolism that are related to photosynthetically active tissue and the role of