

in nature different species of *Aplysia* generally select food types that are most nutritious for them, whereas in the laboratory this selectivity breaks down. It is important that both classes of investigators know that *Aplysia* completes its life cycle in only one year, a fact that must have important implications for the role of learning in its life, for the rapidity of learning, and for the longevity of memory. Students of the well-studied circadian rhythmicities in *Aplysia* will learn here that, whereas *Aplysia californica* are active during the day, several tropical species that are normally active at night become diurnal in the laboratory. All students of molluscan nervous systems should be aided by the explanations of the often confusing twists and turns of the nerve cord and ganglionic fusions that occur in gastropods during evolution and again in modified ways during ontogeny.

Another major value of the book's breadth of information stems from the fact that many "aplysiologists" are specialists who use these animals simply because of the ease with which their nervous systems can be studied. Such investigators must in the course of their work observe phenomena or characteristics that would be of value to understanding some other aspect of the animal's biology. The investigator who is biologically knowledgeable is in a position to recognize the significance of incidental observations. For example, Hughes and Tauc might have dismissed their discovery that there was a homolog of the right giant cell of the abdominal ganglion in the left pleural ganglion as merely one more example of the oddities and complications produced by torsion and detorsion rather than correctly recognizing it as evidence that the ancestral left pallial ganglion had become part of the left pleural rather than the left abdominal ganglion, as older theories had supposed; this sort of revision can alter views of phylogenetic relationships.

Another major benefit to be derived from *Behavioral Biology of Aplysia* is a wealth of ideas for further work. The leads given are many and often fascinating, and answers to many stimulating questions seem within reach. For example, in this as in the earlier book is described a large amount of physiological work on cell R15 of the abdominal ganglion, which displays circadian rhythmicity and a whole range of plastic phenomena; we learn here that when the cell fires it secretes a substance that promotes water retention, which should provide the key to understanding the functional implications of the plasticity and

rhythmicity. In the chapter on development of the nervous system, observations are described that suggest that the formation of axosomatic synapses on undifferentiated neuron somata triggers the outgrowth of primary unipolar processes and secondary branches, whereas subsequent growth and differentiation are dependent upon a readily isolatable substance that is secreted into the ganglia by surrounding non-neural support cells. Such information will suggest all sorts of experiments to the developmental neurobiologist. Later in the chapter, we find that searching for adult food in the environment occurs some days before the ability to consume the food develops, and an incomplete version of eating behavior emerges about a day before functionally competent feeding patterns are seen. Given that the neural circuitry of feeding behavior is well on its way to being unraveled, the possibility of elucidating the significance of these precursors to the development of full feeding behavior is obvious.

A central set of questions revolves around the circuitry controlling comparable behaviors in related species. A number of behaviors such as feeding, escape locomotion, withdrawal, and simple forms of learning are now being successfully analyzed at the cellular level in a variety of opisthobranchs. The kinds of questions raised by the cell-by-cell comparisons that are becoming possible are well illustrated by the analysis of feeding behavior. Among the opisthobranchs are forms that get food by scraping seaweed, that bite and swallow it, and that are carnivorous and seize their prey by extending their radulas. How is circuitry modified to produce the variations in behavior? Is a constant set of homologous nerve cells involved? Do their connections change, or are more subtle quantitative variations responsible for changes in the behavior pattern? Do features that are phylogenetically plastic also tend to be plastic in the face of experience? When nonhomologous cells are involved, do similar circuits for similar behavior patterns nevertheless evolve? Although definitive answers are not yet at hand, interesting pieces of information are becoming available. For example, one neuron, the metacerebral giant cell, has already been found to be common to pulmonate mollusks and the opisthobranchs and to have roughly similar but not identical effects on circuitry for feeding behavior in several animals from both subclasses. Analyses at this level should help us to see how natural selection modifies nervous systems to produce new behavior patterns.

Although the book as a whole, which consists largely of strings of facts that cannot yet be assembled into a coherent picture, will be most valuable to investigators of opisthobranch nervous systems and behavior and to systematists looking for new clues to help unravel the somewhat unsettled phylogeny of the mollusks, the chapter on learning, arousal, and motivation should be of great interest to the more general reader. It reviews experiments on learning that go beyond what were discussed in *The Cellular Basis of Behavior* and, I believe more important, discusses a variety of observations on interactions between different kinds of behaviors and behavioral states (for example, what effect do the presence of food and "food arousal" have on defensive behaviors?). The investigation of interactions between well-defined behavioral systems with known circuitry is one of the most exciting challenges of the near future, and this chapter provides an enticing introduction. Kandel engages here in some intentionally simplistic discussion of such concepts as drive, motivation, arousal, and sensitization that may not sit well with some readers. But the result is bound to be critical appraisal that will clarify our thinking and promote cellular analysis.

In sum, *Behavioral Biology of Aplysia* will fill a vital role for serious students of *Aplysia*'s nervous system and behavior. It also contains a great deal of material that will intrigue general neurobiologists willing to take the time to immerse themselves in some 400 pages of "aplysiology."

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Surgeons Observed

Forgive and Remember. Managing Medical Failure. CHARLES L. BOSK. University of Chicago Press, Chicago, 1979. x, 236 pp. \$15.

This account of surgical education is a model of careful field research and sociological analysis. Bosk set out to discover how the quality of performance in a social role is monitored and evaluated in the setting of a small group. He selected surgical training as a setting where performance is tangible, radically "open" to inspection, and routinely subject to strict surveillance. Surgical work, clearly, is among the most visible of tasks, far less vexed by intangibles of inter-

pretation than, say, internal medicine or psychiatry. The method of investigation employed was participant-observation, that firsthand immersion in a social situation that seems on the surface to be natural and straightforward but is in fact devilishly complex and difficult to bring off. Bosk spent 18 months looking and listening, questioning and noting, becoming so far as possible a member of two surgical services at an elite teaching hospital. The time was well spent, since he is able to bring us an insider's view of the making of surgeons and at the same time illuminate more general sociological considerations of how control of performance is exercised and how professionals discipline themselves and others.

The main points of the book are that the training of a surgeon is conducted on both moral and technical themes, that the morality of aspirants is more critically interrogated by their teachers than is their technical facility, and that the social control exerted upon surgical practice is almost exclusively a matter internal to the surgical hierarchy.

The core of the analysis is directed to the several types of errors that surgeons in training (and in practice too) are seen to commit. These are characterized as technical, judgmental, normative, and quasi-normative. Technical errors are the expectable mistakes that occur in surgical procedures, such as an ineptly knotted suture; judgmental errors, again entirely expectable, involve choosing an incorrect operative strategy; normative errors, by far the most serious and heavily censured, are those that constitute a flouting of the code of responsible conduct by which surgeons live, such as neglecting a patient's needs in favor of one's own comfort and convenience or failing to report to a superior when a course of treatment has gone awry; quasi-normative errors occur when a house staffer willfully deviates from particular procedures favored by the attending surgeon under whom he or she is working. Since surgeons are self-regulating to an extraordinary degree, the committer of normative error is seen to be threatening the very moral foundation of the profession. Technical error can be corrected (usually) and is ordinarily forgiven; normative error may or may not be correctable, but it is not readily forgiven because it is thought to reside in the character of the individual, to be an enduring defect that will recurrently undermine the work of the surgical group. Bosk's title, *Forgive and Remember*, refers to the custom of "forgiving" technical and judgmental errors while at the same time "remembering" them in the

event they come to constitute a pattern of technical incompetence. Through the use of rich quotations and astute observations, we are shown how the various errors occur and just what steps are taken in dealing with them; here surgery comes alive for the reader.

The surgeon's world presents itself as active (surgery is described as a "body-contact sport"), fraught with technical and moral hazards, self-confident, somewhat arrogant and elitist, and in a certain sense precarious: fragile human beings doing God-like things. Bosk evinces a fine sympathy for the rigors of the role, a sympathy that far too many medical sociologists have forsworn. Of the book's many admirable features, none is more salient than the methodological appendix, "The field-worker and the surgeon." Here, in a candid report on his field experience, Bosk presents a fresh and instructive view of this type of investigation. It should be required reading for any aspiring or experienced social scientist.

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