the defense contractors now scrambling for SDI research contracts—without hearing some echoes of that earlier apocalyptic fiction? Or read Edward Teller's latest pronouncements without being reminded of Fulton and Edison? To believe that our scientists, engineers, and political leaders are somehow removed from the prevailing cultural mythology may be the most dangerous illusion of all.

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An Interagency Struggle

U.S. Coast Survey vs. Naval Hydrologic Office. A 19th Century Rivalry in Science and Politics. THOMAS G. MANNING. University of Alabama Press, Tuscaloosa, 1988. xii, 202 pp. $21.95. History of American Science and Technology.

During the last third of the 19th century the United States Coast Survey and the Naval Hydrographic Office fought for control of hydrographic research conducted by the federal government. At first glance, these clashes might be dismissed as continuations of the antebellum turf battles between the directors of the Coast Survey and the Naval Observatory, from which the Hydrographic Office was spun off in 1866. In this interpretation, the postbellum clashes resulted from the personal ambitions and jealousies of the heads of the two oldest science bureaus in the federal government, each striving for domination of particular scientific disciplines as practiced within the federal government.

Manning demonstrates that such an interpretation would be much too narrow. The history of the struggle between the Coast Survey and the Hydrographic Office can be used to illuminate larger themes in the history of American science. The clash was an instance of the continuing conflict between civilians and the military for control of government science. It also demonstrated the sensitive balance between basic and applied science within science agencies. Although basic research produced international reputations, applied research provided necessary protection against political attacks.

The history of these two agencies also reveals that the financial health of federal science, like other government activities, may vary according to which party controls the Congress and White House. Utilizing information on some 142 members of Congress, Manning argues that, during the last third of the 19th century, Republicans were generally sympathetic to the expansion of federal support of science. Better educated than their Democratic counterparts, they celebrated scientific achievement and defended the presence of basic science in government agencies. Democrats, in contrast, wished to cut government spending and saw science bureaus as prime candidates for budget reductions. Republican presidents were either supportive or neutral toward science. Grover Cleveland, the only Democratic president during this period, is presented as one of the Coast Survey's greatest enemies. Once again, history shows that politics influences all aspects of American life, even scientific research.

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Contributions of Chemistry

Biotechnology and Materials Science. Chemistry for the Future. MARY L. GOOD *et al.*, Eds. American Chemical Society, Washington, DC, 1988. xx, 135 pp., illus. $24.95; paper, $14.95.

This book is an outgrowth of an American Chemical Society select conference on biotechnology and materials science. In the preface, the society's president, Mary Good, describes its motivation for preparing this slim, attractive, and readable book: "American science, the nation's competitiveness, and ultimately our standard of living may come to depend on these two areas of scientific and technological endeavor." A similar message is also clearly conveyed in Philip Abelson's introduction. Biotechnology and materials science are both highly interdisciplinary fields, with chemistry a major component. This book describes in historical terms the role that chemistry has played in forging these fields and points to the exciting future for chemists and chemical engineers working in these areas. Its 11 chapters are written in nontechnical language by prominent chemists working in these interdisciplinary sciences. The book should be of interest to students, scientists, and administrators interested in hearing of chemistry's contributions past, present, and future to the materials and biological sciences. In particular, it should appeal to chemists with fairly traditional synthetic or physical backgrounds who are in the early stages of broadening their scientific outlooks. Interestingly, many of the authors were trained in more purely chemical pursuits, nearly half having made their early contributions to science in the field of physical organic chemistry.

The first chapters describe several chemical contributions to biotechnology. Many of the methods—peptide and oligonucleotide synthesis, biopolymer sequence and structure determination, spectroscopic methods, and computational approaches—widely used and often taken for granted by the biotechnological community are the results of the pioneering studies by chemists. These techniques along with molecular cloning, monoclonal antibodies, tissue culture, and fermentation technologies form the mainstays of biotechnology. J. K. Barton, H. E. Simmons, S. J. Lippard, and P. B. Dervan describe how these techniques are being used side by side with more traditional chemical methods to attack such problems as the mode of action of biologically active small molecules, including herbicides and antitumor drugs. E. T. Kaiser and G. A. Petsco also see biotechnology as providing the tools to prepare very large molecules with well-defined chemical and structural properties. A recurring theme is that as the biological sciences become increasingly molecular in focus the opportunities for chemists will expand.

The course of materials science has largely paralleled that of biology, in that a largely empirical, macroscopic science has, in recent years, become a molecular science. As is described in W. P. Slichter's and W. A. Goddard's chapters, materials scientists are now able to build structures from the ground up, beginning with atoms or molecules and progressing toward microscopically defined macroassemblies, a capability with increasing importance to materials science. In the final chapters of the book, G. M. Whitesides, M. S. Wrighton, and J. Economy provide very brief overviews of some of the more chemical aspects of electronic devices, materials for energy production, and composites. As is true for the other chapters, these discussions serve to whet the reader's appetite for more substantial, technical discussions.

The book is a good testament to the commitment of the American Chemical Society to support and influence the future of all aspects of chemical research. The editors have obviously expended a considerable amount of effort to ensure a degree of homogeneity, both in illustrations and textual style, that is unusual in a collective volume. The page layout and quality of the illustrations make for easy, enjoyable reading. More documentation and lead references for the interested reader would have been helpful, as the number and type of references are highly variable from chapter to chapter (and many do not have any references). Also, the strict avoidance of technical terminology or chemical details (even benzene is defined, as a six-membered ring of carbon atoms) is, at times, cumbersome and limiting. These limitations notwithstanding, it is likely that this book will be widely read and enjoyed by chemists and nonchemists alike.

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Evolutionary Trends

The Evolution of Complexity by Means of Natural Selection. JOHN TYLER BONNER. Princeton University Press, Princeton, NJ, 1988. xii, 260 pp., illus. $40; paper, $13.95.

Among the shadowy concepts intoxicating many an evolutionary thinker, perhaps the headiest is that of progress. From at least the Greeks on, there has been a tendency to array life's diversity, both past and present, in some directional pattern, as most famously canonized in the Great Chain of Being. Yet, though much eloquence and passion have been unleashed upon the subject, and simple-minded linear models have been rightly dispensed with, the existence of progress in biological evolution remains a matter of much debate.

In his latest book J. T. Bonner provides some fresh observations by approaching the problem from the perspective of developmental biology. After starting with a basic overview of Darwinian evolution, this ambitious little book ranges through such diverse topics as size increase in the fossil record, size and ecology, and even animal behavior. Though such breadth is thought-provoking, the combination of so many ideas with a sometimes freewheeling discourse left me longing for more coherence. This may not be so much a matter of Bonner's style, which is genteel and pleasantly chatty, as of the demands of trying to write a book geared to both peers and general readership on such a difficult and far-reaching topic. Gems of intellectual insight are there, in number, but they are often embedded in a matrix of description and basic information.

Most of the insight comes from Bonner's approaching "progress" by couching it in terms of complexity, avoiding much of the semantic confusion over definitions. Of course complexity itself can be a fuzzy concept, but Bonner is clear about what he means: increasing complexity is associated not only with increasing number of components but also with increasing number of kinds of components. This agrees with the current thinking on hierarchical systems in general, in which complexity is seen as measured in terms not only of number but of kinds of interactions. A massive interstellar cloud has many interactions but is not very complex compared to an amoeba.

What emerges from this as the general theme of the book is that since the origin of life natural selection has increased the upper limit of complexity of individual organisms, as measured by kinds of cells (internal complexity), and of complexity of ecosystems, as measured by number and kinds of individuals (external complexity). The common nexus of both kinds of complexity is body size: with increasing body size, the number of cells and cell types per individual increases while the number of individuals and types of individuals decreases.

The main conclusions drawn from this are: (i) The increase in body size often seen in evolutionary time does not necessarily lead to greater net complexity at the resulting size. This is because, though internal complexity increases with size, there is a concurrent decrease in external complexity. (ii) The units of internal and external complexity are subject to counteracting selection for both isolation and integration.

These conclusions, and the themes behind them, struck me as hollow. Increasing body size demands increase in cell types owing to functional or constructional needs. Larger organisms are rarer and less diverse owing to ecological energetics. So what? The most intriguing connections, those between the hierarchical levels, are left untouched. Perhaps Bonner's approach is too reductionist (that is, cellular). A more holistic view is needed to capture emergent connections. Nevertheless, though Bonner's approach may falter in explaining the whys of complexity in evolution, this book is very good at explaining the hows of building complex organisms through both ontogenetic and evolutionary time. That, plus other snatches of insight, make it a worthwhile read for serious evolutionists. It would also be a good springboard for a lively upper-level course in evolution.

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