mechanisms at the molecular level will be invaluable. As for scientists themselves, the authors consider that they need to be more humble, admit that they do not have all the answers and make that plain to the public. Science will help in the longer term. But, in the short term, negotiations aimed at reaching a consensus view are far more valuable.

Much of the information that is necessary to reach a consensus on the dangers from particular chemicals is to be found in *Living in a Chemical World*. The book is the proceedings of a conference held in Italy at the end of 1985, and the contributors address all aspects of carcinogenicity from the molecular level to epidemiology, using a whole array of chemicals to illustrate their points. The contents probably live up to the blessing conferred on the conference by Pope John Paul II, who sent his "heartfelt implored apostolic propitiatory blessing for abundant heavenly favour and enlightenment". Interpreting the blessing was far more difficult than following most of the science in the 1,000 or so pages of this book, which provide plenty of enlightenment, much as treasure is to be found along the way in searching for the Holy Grail. □

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Measured progress

R.M. Simmons

Molecular Mechanism of Muscle Contraction. Edited by Haruo Sugi and Gerald H. Pollack. Plenum:1988. Pp.742. \$125, £74.

THE previous volume in this series of conferences on muscular contraction was reviewed for *Nature* (311, 767; 1984) by my former colleague Mike Spencer. Under the title "Spasm? Or rigor?" he used the occasion to make some unkind (and I gather to some readers offensive) remarks about progress in understanding contraction at the molecular level. It had seemed, he wrote, in the early 1970s that a grand synthesis of structure and biochemistry was imminent, the 'muscle problem' would be solved, Nobel prizes would be in the bag. This promise had not been fulfilled, conventional wisdom was in tatters, anarchy ruled and so forth. I believe that this view is in large part demonstrably untrue and that, as a commentary on how quantitative science proceeds, it is completely misguided.

There is, however, no smoke without fire, or for that matter without actual damp. Spencer rightly appreciated that one of the main bars to progress has been the lack of definitive evidence about the nature of the structural change that underlies force generation. In an active muscle it is believed that myosin cross-bridges from the thick filaments interact cyclically with sites on the actin-containing thin filaments, each cycle involving the hydrolysis of a molecule of ATP. At some point in the cycle there is a conformational change, which in the simplest model of the early 1970s is a rotation of the head of the myosin molecule about its point of attachment to actin. We now know a great deal about the relation between the biochemical cycle and mechanical events, with steady and in some cases (such as the use of caged-ATP) spectacular progress. The theoretical formulation of general models of the cross-bridge cycle is well established, and some specific examples have been worked out. There is a long way to go with biochemistry, mechanics and theory, but conceptually the problem seems solved or solvable.

But, to return to structure, although there are now some striking correlations between structure, mechanics and biochemistry, there seem to be unresolved differences between the results of some of the techniques, or their interpretation. At the root of the problem, though, is the fact that the well-ordered cross-bridge arrangement seen in relaxed muscle and in rigor becomes disordered during an active contraction, because cross-bridge cycles are not synchronized. Further, no simple analogue of the force-generating transi-

tion exists. To interpret the changes in contraction will require a combination of some extremely painstaking electron microscopy (with fast-freezing methods now available) and time-resolved X-ray diffraction, plus optical probe and ESR techniques, plus the use of fragments of myosin with NMR and the other techniques. Protein crystallography, the use of mutant animals and site-directed mutagenesis are beginning to make an impact and will assume a greater importance as we get closer to the details of the actin-myosin interaction. With novel motility assays it is becoming possible to examine the interaction at the single molecule level. There has never been a time in the history of research on muscular contraction when such a rich diversity of techniques has been brought to bear on the problem, nor when realistically it has been possible to define a solution.

In many fields a line would have been drawn in the 1970s and we would have had to be satisfied with the then conventional wisdom. But, in biology, muscle is special in two respects. It has an unusually well-organized structure in many tissues so that it is possible to make accurate measurements. Then there is a long tradition of quantitative science in the field, so that the measurements are actually made. My reading of the past two decades is of these two aspects building up to something of a fruition in which measurement informs crude observation and theory in a way that is impossible in many fields.

Several of these structural approaches as well as biochemistry and mechanics are featured in this book, which derives from the third of a series of conferences organized by Pollack and Sugi. One similarity between this review and Spencer's is the complaint that the volume appears two years after the conference. The book has 742 pages of contributions plus discussion, and apart from one or two eccentric entries, and a bias towards the more physiological aspects of contraction, it is fairly typical of what happens at muscle contraction workshops. It is (almost) strictly for the professional, although we have found the previous volumes a useful source of topical papers for advanced undergraduates. In my experience of the biological sciences, research workers are usually either discoverers or measurers. This volume is one for the measurers. □

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• *An Urchin in the Storm* by Stephen Jay Gould. Publisher is W.W. Norton, price is \$7.95. To be published in the UK by Collins. For review see *Nature* 330, 280 (1987).

• *Solid-State Chemistry: Techniques* edited by A.K. Cheetham and P. Day. Publisher is Oxford University Press, price is £15, \$70. For review see *Nature* 329, 115 (1987).