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Stiefel E I. The coordination and bioinorganic chemistry of molybdenum.
Prog. Inorgan. Chem. 22:1-223, 1977.
[C.F. Kettering Research Laboratory, Yellow Springs, OH]

This review summarized our knowledge of the Mo-containing enzymes and gave a comprehensive overview of the coordination chemistry of molybdenum, highlighting aspects of relevance or potential relevance to the action of Mo in enzymes. [The *SCI*® indicates that this paper has been cited in more than 450 publications.]

Molybdenum in Biology and Chemistry

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In the summer of 1973, Steve Lippard and I drove together from New York to the "Metals in Biology" Gordon Research Conference in New Hampshire. We were both excited by the prospects of the then-embryonic field of bioinorganic chemistry. During the trip, I described to Steve my ideas about the relation of the coordination chemistry of molybdenum (Mo) to the role that Mo plays in enzymes. I had just published the first comprehensive proposal for the mechanism of action of Mo enzymes and was quite current with the recent literature.[1] Steve asked about relevant review articles and I noted that earlier reviews by P.C.H. Mitchell[2,3] and J.T. Spence[4] were dated and did not deal directly with biological aspects of Mo chemistry. We agreed that a new, comprehensive review of Mo chemistry and biochemistry would be timely. Fortunately, Steve recently had been named the editor of *Progress in Inorganic Chemistry*. He invited me to prepare the review.

I started the review in 1973-1974 while on the faculty of the State University of New York at Stony Brook, but the exigencies of teaching coupled with the fact that I was looking for another position made the progress quite slow. In the summer of 1974, I moved to the Kettering Research Laboratory, Yellow Springs, Ohio, as an investigator in the nitrogen fixation mission. The manager, Bill Newton, encouraged me to complete the review. I am grateful for this encouragement, as it would have been easy to concentrate solely on setting up my laboratory and restarting my research programs in my first year at Kettering. Fortunately, Kutty Pariyadath moved with me from Stony Brook to Yellow Springs and was able to carry much of the load in setting up the laboratory.

In retrospect, the writing of the review provided long-term benefits to the laboratory, my research programs, and, I hope, the field. The long-range thinking that led Newton to vigorously support the writing of a review article is all too uncommon nowadays among research managers.

The reasons for the popularity of the review are not hard to discern. Molybdenum has a diverse chemistry that contributes to its use in both technological and biological systems.[5] The bioinorganic chemistry of the Mo enzymes is truly inspirational and challenging for chemists. Thus, nitrogenase is capable of reducing dinitrogen to ammonia at atmospheric pressure and room temperature while the current industrial process works only at high temperature and pressure. Nitrate reductase reduces nitrate specifically to nitrite. These two enzymes reveal the crucial role of Mo in the biological nitrogen cycle. Mo is an essential element for animals (including humans), plants, and most microorganisms. The comprehensive nature of the review, its timeliness in 1977, and its compilation of both the chemistry and biochemistry of Mo made it useful to both biochemists and inorganic chemists, which undoubtedly contributed to its frequent citation.

The connection between the bio(inorganic) chemistry and the coordination chemistry of Mo has grown significantly in recent years.[5,6] It is gratifying to think that the subject of this reminiscence and reference[1] may have been seminal in forging the integration.

1. **Stiefel E I.** Proposed molecular mechanism for action of molybdenum in enzymes—coupled proton and electron transfer. *Proc. Nat. Acad. Sci. USA* 70:988-92, 1973.
2. **Mitchell P C H.** Coordination compounds of molybdenum. *Coord. Chem. Rev.* 1:315-50, 1966. (Cited 50 times.)
3. ----------. Oxo-species of molybdenum-(IV) and -(6). *Quart. Rev.* 20:103, 1966. (Cited 215 times.)
4. **Spence J T.** Biochemical aspects of molybdenum coordination chemistry. *Coord. Chem. Rev.* 4:475, 1969. (Cited 115 times.)
5. **Burgmayer S J N.** Molybdenum enzymes, cofactors, and model systems—the chemical uniqueness of molybdenum. *J. Chem. Educ.* 62:943-53, 1985. (Cited 20 times.)
6. **Spiro T G,** ed. *The molybdenum enzymes.* New York: Wiley, 1985.

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