the farther reaction 13 proceeds to the right (and, by assumption ii, the same applies to reaction 12). The loss in free energy accompanying the formation of the insoluble sulfide is given by

$$-\Delta F_s = 2.303\ RT\ pK_{sp}. \quad (14)$$

Here K_{sp} is the solubility product constant for the metal sulfide, and T is the absolute temperature. Then, according to assumption ii, and Eqs. 9, 10, 11, and 14, it follows that

$$T = log\ K_i = (m) \times (pK_{sp}), \quad (15)$$

where m is a proportionality constant and T is the innate toxicity,

Equation 9 may then be written as

$$L = pI^* = S + (m)\ pK_{sp}. \quad (16)$$

This equation predicts that a plot of the negative logarithm of the metal-ion concentration just necessary to produce death against pK_{sp} will be linear. The theory also allows only one adjustable parameter (S) per organism. Regardless of the organism studied, therefore, the innate toxicity of a particular ion will be the same; but the susceptibilities of the various organisms to poisoning by the ion will be expected to differ. Thus, a plot of pI^* versus pK_{sp} for the various organisms should result in a family of straight lines with the same slope m but with different intercepts.

Typical results obtained for the enzyme "diastase" (*10*), the paramecium (*11*), the planarian (*4*), and the stickleback (*5*), are presented in Fig. 1. The lines have all been drawn with the same slope. Completely analogous results have been obtained for *Fundulus* eggs (*3*) and the enzyme urease (*8*).

A thorough statistical treatment of these and other data taken from the literature is being made and will be presented elsewhere. Numerous qualitative and semiquantitative observations have been and are being collected from a great variety of fields. The results obtained thus far seem to indicate a rather widespread applicability of the theoretical treatment.

References and Notes

1. R. H. True, *Proc. Am. Phil. Soc.* **69**, 231 (1930).
2. W. Seifriz, *Science*, **110**, 193 (1949).
3. A. P. Mathews, *Am. J. Physiol.* **10**, 290 (1904).
4. J. R. E. Jones, *J. Exptl. Biol.* **17**, 408 (1940).
5. ———, *ibid.* **16**, 425 (1939).

6. I wish to acknowledge with gratitude the generous support from Research Corporation of New York and the University of Texas Research Institute that, in part, made possible this investigation. This report was presented as a paper before the Texas chapter of the Society of the Sigma Xi, 9 Feb. 1954.

7. G. B. Kistiakowsky and W. H. R. Shaw, *J. Am. Chem. Soc.* **75**, 866 (1953).
8. W. H. R. Shaw, *ibid.*, in press. The other types of inhibition have also been treated in this paper.

9. Several other important factors are doubtless involved, but space does not permit their detailed consideration here. For example, as a first approximation, it has also been assumed that (i) the concentration of the toxic ion within the organism is the same or a constant fraction of its external concentration; (ii) all the metals considered attack the same key enzyme; (iii) the affinity of the metal for the —SH group is independent of the enzyme to which the group is attached.

10. H. McGuigan, *Am. J. Physiol.* **10**, 444 (1903).
11. L. L. Woodruff and H. H. Bunzel, ibid. **25**, 190 (1909).

Howard Bishop Lewis, Biochemist

THE death of Howard Bishop Lewis on 7 March 1954, following an illness of 14 months, brought to an end the illustrious career of a great biochemist, an ardent scholar in many fields, and a warm human being.

Dr. Lewis was born in Southington, Connecticut, on 8 November 1887, the son of Frederick A. and Charlotte R. (Parmelee) Lewis. At Yale, the award of the Chamberlain prize for the best entrance examination in Greek, followed by prizes in chemistry, the calculus, and Latin composition during his undergraduate years, gave early evidence of his brilliant mind.

After completing his doctoral work at Yale under the supervision of Lafayette B. Mendel, he served for 2 years as an instructor of physiological chemistry at the University of Pennsylvania (1913–15), and then joined the staff of the Chemistry Department at the University of Illinois, where he remained until 1922. At this time, because his inspirational leadership, sound research, and outstanding talent as a teacher had become nationally recognized, he was called to the University of Michigan as chairman of the Department of Physiological Chemistry in the Medical School. He held this position until his death in 1954. In addition to his duties in the department, Dr. Lewis was also the director of the College of Pharmacy from 1933 to 1947.

The scope of his activities outside the university are too numerous to present in detail. Because of an unusual breadth of knowledge and skill of expression, his editorial work was most noteworthy. He has served on editorial boards of five national journals.

His broad interests in the fields of medicine and nutrition may be judged by his national committee assignments. From 1936 until his illness, he was a member of the council on foods and nutrition of the American Medical Association. In 1941–42, he served on the council of the American Institute of Nutrition, as vice president of the institute in 1941–42 and as its president in 1943–44. From 1945 to 1948 he was a member of the Division of Medical Sciences of the National Research Council, and from 1947 to 1952 he was chairman of the Michigan Nutrition Council. In December 1952, shortly before his illness, he served as

chairman of a symposium on nutrition held at the St. Louis meeting of the American Association for the Advancement of Science. In all these activities, to insure their success, he gave freely of his energy and enthusiasm.

A review of Dr. Lewis' contributions to medical education would not be complete without a reference to his long period of service (1935–50) on the National Board of Medical Examiners. I recall the long hours that Dr. Lewis gave to this arduous work at a time when he was already carrying a double load in the College of Pharmacy and the Medical School.

Over a period of years, however, none of his extracurricular responsibilities were as important to him as those connected with the American Society of Biological Chemists. He served as its secretary in 1929–33, its vice president in 1933–35 and as its president in 1935–37, and he was a member of the council in 1937–40 and in 1941–42. Many biological chemists who hold responsible positions today remember gratefully the efforts made in their behalf when, for many years almost singlehandedly and with minimal secretarial service, Dr. Lewis operated the Federation Placement Service. His willingness to accept this heavy burden was motivated by his desire to know personally all his colleagues and to be in a position to assist them. Indeed, his warm regard for his fellowmen, his students, and his associates was one of his outstanding characteristics. It was a matter of great pride that for many years he knew by name not only all the members of our society but many members of our sister groups in the Federation of American Societies for Experimental Biology.

His research papers and review articles, numbering 177, indicate a wide range of interests. His first paper (1913) dealt with the metabolism of the hydantoins and his last paper (1953) dealt with the ergothioneine content of blood. His major research, however, was concerned with the metabolism of the amino acids and particularly with that of the sulfur-containing amino acids and related compounds. An invitation, in 1940, to give a Harvey lecture on "The significance of the sulfur-containing amino acids in metabolism" was in recognition of his international reputation in this field. Another group of papers by Dr. Lewis and his students is concerned with the detoxication of foreign compounds in the animal body. More recently, an extensive series of studies on the production of experimental lathyrism in the white rat have been made.

Although his tremendous energy was siphoned into many channels, Dr. Lewis held firmly to the belief that his main responsibility at the university was that of a teacher. Thousands of students at the undergraduate level, as well as at the graduate level, who listened to his lectures at the University of Michigan will testify that he never failed in this task. During a period of 30 years at Michigan, he was rated by the students as one of the most effective teachers of the medical faculty, not only because of the excellent organization and presentation of his lectures, but because he had the gift of stimulating the interest of the students beyond that of the classroom requirements. He was continually in demand both on and off the campus as a speaker on scientific programs. He rarely refused these invitations, although his daily schedule of work was already overwhelming.

His appointment in 1947 to a distinguished professorship at the University of Michigan, designated as the John Jacob Abel Professorship in Biological Chemistry, was in recognition of his high scholastic standing. In 1949 he was elected to the National Academy of Sciences.

In 1915, Dr. Lewis married Mildred Lois Eaton. He is survived by her and two daughters, Charlotte and Elizabeth. Many of the social activities of the family revolved around their common love of music. The faculty and graduate students recall many pleasant evenings around their fireside. Dr. Lewis, no mean "chef," usually served one of his specialties at these intimate gatherings.

A hobby in which he had established himself as an authority was philately. Although in later years his crowded schedule did not permit him to attend the meetings of the stamp club or to participate in its programs, he nevertheless was an ardent collector until the time of his illness.

Dr. Lewis was born on a farm and throughout his busy career retained a love for the soil. To see him at his best was to watch him work in his garden, in which he took great pride. The appeal of the outdoors became greater in his later years, when his campus and national commitments became more and more pressing. He always looked forward with great anticipation to his short vacation periods, during which he and his family could tramp the mountain trails near their summer home in New Hampshire.

Those of us who were privileged to know and to be associated with Dr. Lewis held him in great esteem. We regarded him highly as an educator and investigator, and we respected and loved him as a colleague and friend. One of his outstanding characteristics was his ability to inspire his students to make the most of their talents. He frequently quoted from Pasteur, "Chance favors the mind that is prepared" to support the view that hard work and not luck is important in research work.

In completing this memorial to Dr. Lewis, nothing expresses our sentiments better than a line from a resolution read at the executive faculty meeting of the Medical School: "He taught the value of ideals and high standards of accomplishment, and gave to his pupils many guiding principles which have contributed to their enduring happiness and success in the profession of medicine and allied fields of science."

A. A. CHRISTMAN

Department of Biological Chemistry, University of Michigan, Ann Arbor