Comments and Communications

Toward a More Convenient Method for Expressing the Concentration of Biological Fluids

This is to call attention to a method of designating biochemical concentrations which is both erroneous and anachronistic. The designation in point is the term milligram percent. This ''unit'' is not comprehensible *a priori* and is inadequate for expressing present concepts in enzymology, pharmacology, and biochemistry. Since modern clinical medicine is becoming more and more dependent on these fundamental subjects, it follows that medicine, too, will begin to find this term inadequate.

In clinical biochemistry it has become customary to express the concentration of the more common inorganic ions in terms of milliequivalents per liter. This practice is commendable, and it is to be hoped that the custom will be extended to include iron, iodine, sulfur, phosphorus, and the rest of the ions currently determined.

With the precedent already established, it now becomes adventitious to extend the same principle to organic compounds and express their concentration in terms of millimols per liter. The enzymologists are currently following this practice, and even some pharmacologists are beginning to envision the action of certain drugs on the basis of molecular action. Competitive inhibition illustrates the wisdom of such thought.

In tracing the course of a metabolite through an organism one can easily calculate ratios between successive products and form a rough idea as to lability or metabolic pool size. This could then form a point of departure for more rigorous mathematical treatment. For example, the decomposition of 1 millimol per liter of acetoacetic acid could give rise to 1 millimol per liter of acetone. In corresponding units 10.2 mg% of acetoacetic acid would give 5.8 mg% of acetone. Any resemblance in the latter case is, of course, purely coincidental.

The term ''normal'' as applied to a chemical solution is a rather unfortunate choice of words, and it has been suggested by the present author (*J. chem. Educ.*, 1947, **24**, 200) that it be replaced by the term ''equant,'' abbreviated E. The word, equivalent, could then be abbreviated Eq, and a 1-E solution would contain 1 Eq/l. Such terminology would suffice for most solutions of inorganic ions.

Organic compounds in solution could then be described in terms of molarity. Thus, a solution could be called molar (M), millimolar (mM), or micromolar (μM). Unfortunately, the abbreviation mM has been used by some authors to mean millimols. A more consistent designation would be: Mols, mMols, and μMols.

One of the chief disadvantages of changing from milligram percent to millimolarity is the unfamiliarity with physiological levels in the new form. However, a few studies using the new expressions will quickly establish familiar landmarks. Since it is almost inevitable that the older terminology will become more and more inconvenient, immediate adoption of the newer expressions will shorten the period of confusion.

The recalculation of older data is quite simple, since, to convert from milligram percent to millimolarity, one merely divides by 1/10 the molecular weight. For the reverse transformation one multiplies by 1/10 the molecular weight. If the mM range is too large or too small, one can pass to the μM or M ranges, an advantage not enjoyed by the dubious expression, milligram percent. When calculating dilutions, one cannot deprecate the ease of handling concentrations in terms of molarities.

Habit will, of course, prejudice clinicians and old-line biochemists against the acceptance of the units here suggested. Chemists and investigators of metabolic problems should be quick to see the advantage of the ''new'' system. Should the staid editors of scientific journals eventually succumb to this heresy, the transition would be complete.

CHARLES BISHOP

University of Buffalo Medical School

Bird Navigation in Homing and in Migration

The recent paper by Griffin and Hock (*Science*, April 2, pp. 347–349) provides valuable confirmation of the hypothesis earlier set forth in detail by Griffin (*Quart. Rev. Biol.*, 1944, **19**, 15–31) that homing of birds can be explained, at least in large part, by random searching until familiar territory is reached. It is therefore unfortunate that they have confused the issue by speaking of navigation in migration as if it were clearly the same phenomenon as that displayed in homing.

Actually, there is little or no evidence that these two forms of navigation have the same basis, and, as Rowan (*Science*, August 24, 1945, pp. 210–211) has indicated, there is abundant evidence that they are entirely unrelated phenomena. Homing, if we accept Griffin's considerable body of evidence, is an acquired skill operating through what Griffin terms topographical memory. That it is gradually developed through prolonged experience is well recognized, at least for the racing pigeon. On the other hand, migration (as the term is commonly used, referring to a regular seasonal movement between breeding and wintering grounds that are far removed from each in latitude) appears in many birds to be a strictly inherited tendency. Rowan cites ample cases in support of this view.

This distinction is of great importance in any attempt to assess the endurance and long-range flying speed of birds. If flight direction in migration is instinctive, we may expect many such flights to be completed much more expeditiously than most of the homing flights cited by Griffin. Many flights are geared to the progress of the season or the abundance of food; but when flights are made over unattractive country or over water, we may