CORRESPONDENCE

In Vivo Difficulties

SIR,—The use of the terms "in vitro" and "in vivo" is now deeply entrenched in the scientific literature. They are used to denote the difference between experiments performed outside the living organism (although often with living tissue, and those carried out inside the organism. The use of the two terms, although hallowed by time, sometimes causes difficulty, especially as editors of learned journals differ in the extent of their tolerance and degree of their pedanticism. Some editors are prepared to accept the terms virtually as the author proposes, irrespective of syntactical or scientific niceties. Some turn a blind eye to their suspiciously foreign sound and are prepared to admit them as current English usage. Others, more severe, by clapping the terms in italics, clearly still regard them as aliens against whom the innocent reader must be warned. Hyphens between the two parts of each term are not usually required, but on occasions have been insisted upon by the illiberal of outlook. Although strictly "in vitro" and "in vivo" are adverbial phrases (and are only so used by cognoscenti) they are now often misused as adjectives. Hence one reads of "in vitro experiments" and the even more disgraceful "in vitro results". Even "semi-in-vivo" (hyphenated surely) experiments have recently been threatened. Fowler, unfortunately, wrote before such indignities became common, and has nothing to say on the matter.

With due awareness of Lord Chesterfield's famous maxim, I should like to suggest the introduction of two new words to replace "in vitro" and "in vivo". These would be the simple adjectives "vitral" and "vival" respectively. The new words are short, their derivation is etymologically pure and their meaning by past association) is clear, when referring either to the tests themselves or to the results of tests. Moreover, they will never need italics or hyphens. Reference to various technical dictionaries has disclosed, perhaps surprisingly, no prior use of such adjectives. Although their introduction, it is realized, would not be so traumatic as the introduction of SI units, nor so subversive as the substitution of "retinol" for vitamin A′, there are bound to be views in favour of the status quo and it would be interesting to hear them.

Yours faithfully,

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Billion Confusion

SIR,—Teodor Juskiewicz (*Nature*, **228**, 297; 1970) referred to the American practice of using the word "billion" to mean 10^9 instead of 10^{12} and he appealed to American colleagues not to use the misleading term parts per billion.

I support Juskiewicz's appeal and suggest that it is time that some agreement was reached to avoid misunderstandings, which can arise by the use of this, at present, equivocal word.

To my mind the word "billion" means a million to the power of two, similarly "trillion" means a million to the power of three and so on using suitable prefixes added to the root "-illion" for numbers of the type 10^{6n} (where n is an integer).

There is some need for a simple name for the number 10^9 which would be preferable to the rather clumsy "thousand million". The word "milliard", obviously familiar to Juskiewicz and, I understand, currently used in France, seems an obvious choice. Furthermore, this word could form the basis of a system of naming large numbers of the type $10^{(6n+3)}$ in the same way that "million" has for the 10^{6n} numbers. Thus 10^{15} would be called a billiard and 10^{21} a trilliard, and so on.

Yours faithfully,

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Molecular Mass

SIR,—Dr Edsall has explained (*Nature*, **228**, 888; 1970) the useful distinctions that should be preserved among the expressions, molecular mass, relative molecular mass (commonly called "molecular weight") and molar mass. These quantities have respective dimensions: mass, unity ("dimensionless") and mass x (amount of substance)$^{-1}$. The common unit of molar mass (not its dimension) is the gram per mole (symbol, g/mol or g mol^{-1}). Among recognized units of molecular mass is the unified atomic mass unit (symbol u), defined as the fraction 1/12 of the mass of an atom of the nuclide ^{12}C (1 u = 1.660 53 $\times 10^{-27}$ kg approximately), and for which Dr Edsall recommends the simpler name, dalton, widely used by biochemists. (His examples of different statements expressing the same fundamental facts should have read: "the molar mass of protein X is 25,000 g mol^{-1}", "the molecular mass of protein X is 25,000 daltons", and "the relative molecular mass (that is, molecular weight) of protein X is 25,000".)

The 14th General Conference of Weights and Measures (CGPM) of the International Bureau of Weights and Measures, convening in 1971, will consider a recommendation approved in 1969 by the International Committee on Weights and Measures (CIPM) to include the mole as a base unit of the International System of Units (SI), besides the six base units on which the system was established in 1960 (the metre, the kilogram, the second, the ampere, the kelvin, and the candela). The additional base unit is needed to introduce SI units for the "molar" physical quantities (molar volume, molar mass, molar heat capacities, molar enthalpy of formation, etc.). The appropriate physical quantity corresponding to the concept that different substances have natural molecular constitutions (the word "molecular" here being used in a broad sense to include any specified constituent entities, whether they be molecules, atoms, ions, ion pairs, or other aggregates) has not until recently been identified by a commonly recognized name. The name, "amount of substance", has now been adopted by the International Union of Pure and Applied Chemistry, the International Union of Pure and Applied Physics, and the International Organization for Standardization to define a physical quantity proportional to the number of constituent entities of that substance (molecules or other entities, such as may be specified by a chemical formula). The proportionality factor is the same for all substances and may be taken to be the reciprocal of the Avogadro constant. A unit for the physical quantity, the mole, has long been recognized. The definition given by the CIPM in 1967, confirmed in 1969, and included in the draft proposal prepared for the 14th CGPM introducing the mole as a base unit in the SI, is as follows[1]:

> The mol is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon 12.
>
> Note: When the mol is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles.

If the 14th CGPM accepts the mole so defined as an SI base unit, then the SI unit of molar mass will be the kilogram per mole (kg mol^{-1}). This unit is large for ordinary chemical purposes and the common unit, gram per mole (1 g mol^{-1}