Letters

Metric System in Disguise

The letters of Schubiger and Baer (14 Feb., p. 638) bring to mind the fact that ball bearings have for decades been made to metric dimensions. While diameters and lengths have been expressed in inch units, they are actually round metric sizes translated into long fractions of inches.

W. B. SHEPPERD
621 Route 322,
State College, Pennsylvania

Mutations and Aging

Most of the conflict between Kohn and Curtis (*1*) would appear to be resolved by the autoimmune theory of aging (*2–5*). Although this theory does not cover all aspects of mammalian aging—it is, for example, inapplicable to the loss with age of fixed postmitotic cells such as neurones—it could nevertheless apply to the majority of those degenerative processes that culminate in death.

Cardiovascular diseases are important and representative examples of aging, and the possible etiological significance of age- and sex-specific mortality rate statistics is worth considering. When these rates are plotted against age on log-log scales, remarkably straight lines are obtained for most categories of cardiovascular disease over the whole, or greater part, of adult life (*4*). Depending on the disease, the slope of such lines may vary between about 2.5 and 11; in other words, these age-specific mortality rates are accurately proportional to a constant power of age for the greater part of the life span.

This mathematical form of age-dependence suggests that the initiation of most cardiovascular diseases depends upon a multistage stochastic process, where usually the number of stages or random pathogenic events cannot be greater than about 12. When we consider the pathology of such diseases—involving an astronomical number of cells—such a conclusion is at first sight nonsensical. However, Burnet's "forbidden clone" hypothesis (*2*) offers an escape from this paradox. A small number of "somatic mutations" affecting one or several stem cells could very well generate one or a few clones containing an enormous number of pathogenic cells. In this way several discrete primary events could be amplified, through clonal growth, into a widespread systemic disease. The two basic requirements of the theory are that (i) random events should initiate an amplification process, such as clonal growth, and (ii) the same random events should also produce a pathogenic incompatibility between the "forbidden clonal cells" (or their products) and normal tissue. It has been shown (*5, 6*) that the age-specific patterns relating to the phenotypic manifestation of recognized autoimmune diseases in man are fully consistent with Burnet's forbidden-clone hypothesis. It can be inferred that in some of these diseases the primary pathogenic agents are cell-bound and not humoral autoantibodies.

The statistics of autoimmune diseases (*5, 7*) reveal some interesting and rather complicated sex differences; from a consideration of such details it has been proposed (*4, 7*) that many cardiovascular diseases could be basically autoimmune. Burwell (*9*) has argued that the primary natural role of lymphoid tissue is related to morphostasis; if his view should be substantiated, then any tissue subject to mitotic regulation by lymphocytes ought, in principle, to be vulnerable to autoimmune attack (*5*).

Kohn rightly points out that damage to, or loss of, parenchymal cells can be repaired, even in old age, through regeneration from healthy cells. Although specific gene mutations in parenchymal cells might contribute to another aspect of aging—neoplastic change (and according to a recent analysis [*8*] they very probably do)—it must be presumed that many somatic mutations lead to the death and elimination of cells, followed normally by replacement through mitosis in the healthy stock of cells. Regeneration ensures that no permanent impairment of function occurs. If, however, lymphoid mitotic control cells (*9*) become aberrant through some form of mutation in stem cells, and if they overwhelm the natural defense system (*4–7*), degenerative changes can occur in target tissues through nonrecognition of "self" and an immunological incompatibility.

According to the autoimmune hypothesis, therefore, "somatic mutation" in the stem cells of the lymphoid series should be an important cause of mammalian aging.

P. R. J. BURCH
Department of Medical Physics, University of Leeds, General Infirmary, Leeds, 1, England

References

1. R. R. Kohn, *Science* **142**, 540 (1963); H. J. Curtis, *ibid.*, p. 540; ———, *ibid.* **141**, 686 (1963).
2. F. M. Burnet, *The Clonal Selection Theory of Acquired Immunity* (Cambridge Univ. Press, London, 1959); *Brit. Med. J.* **2**, 645, 720 (1959).
3. R. L. Walford, *J. Gerontol.* **17**, 281 (1962); A. Comfort, *Lancet* **II-1963**, 138 (1963).
4. P. R. J. Burch, *Lancet* **II-1963**, 299 (1963).
5. ——— and N. R. Rowell, *ibid.*, p. 507.
6. P. R. J. Burch, *ibid.* **1**, 1253 (1963).
7. ———, *Am. Heart J.*, in press.
8. ———, *Nature* **197**, 1045, 1145 (1963).
9. R. G. Burwell, *Lancet* **II-1963**, 69 (1963).

NASA's Role Explained

The letter of Philip Siekevitz (31 Jan., p. 143) has typified an attitude which is not only irritating and insulting to scientists in and out of NASA, but, more importantly, potentially dangerous to our country's research efforts in space.

Siekevitz begins by asking, Why have "a middleman" (NASA) in research in geophysics, geomagnetics, solar physics, and so forth? Many of the observations necessary to answer questions pertinent to the universality of earth-bound observations must be made in outer space. Our atmosphere, although necessary for the maintenance of life, obscures a whole host of phenomena that bear on the structure and origin of the earth and the universe. No group in private enterprise or at an endowed institute can afford to build the necessary "middleman"—the booster rockets—to carry the instruments beyond the atmosphere where they can make their measurements. In many ways, NASA's program

in space sciences is exactly what Siekevitz pleads for—direct support of research in these fields; and the experiments are most often designed and programmed by university scientists (as for example, Van Allen, Whipple, Goldberg).

Siekevitz next says that the "inclusion of molecular biology among the beneficiaries of space research is particularly ludicrous." But the real point is not, as he puts it, the question of spores in space, but the question of the universality of life, and the impact that a positive (or a negative) answer would have on the question of the origin of life. Our observations on both micro- and macromolecular biology today are little more than descriptive analyses, and we are probably sampling from only one "test tube" among the millions or billions (or more) present in the universe. To give an example of an intramural NASA research program of importance to molecular biology, the formation of adenine, guanine, amino acids, and ATP, from simple starting materials and under conditions probably similar to those found on a primordial planet, has been shown by Ponnamperuma and his coworkers at this laboratory. Anyone involved in any phase of "molecular" biology must realize the value of further extensions of this synthetic approach to understanding the origin of biological molecules. Additionally, NASA grants are held by Calvin, Marmur, and N. O. Kaplan, among others, all doing basic biological research.

The point at which Siekevitz completely exposes his unawareness of the intent of the NASA program is with his statement, ". . . in my opinion the only scientific research arising out of space technology, out of NASA, is a byproduct of the military usages of the space program." Like many others who have not taken time to find out, he does not realize that "activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States . . . shall be the responsibility of, and shall be directed by, the Department of Defense," not NASA.

Since its founding, NASA has taken great pains to devote its main efforts to the peaceful, scientific use of space. NASA's work does impinge on the military aspects of space exploration. It is impossible to do otherwise when dealing with the development of vehicles designed to carry the huge payloads necessary for successful experimentation in space. But NASA's assignment is one of scientific inquiry and development of space technology. Even though the greatest expenditures at present are going into an effort superficially the least scientific—man in space—the rationale for this effort must be apparent: The complete scientific usefulness of the possibilities that space opens up will be achieved only when the scientist himself can leave his earth-bound observation post. NASA is obliged to carry the sphere of research endeavor out of terrestrial laboratories; the ultimate fulfillment of its mission is such an exciting prospect that imaginative minds need no further elaboration.

ROBERT B. PAINTER
Cellular Biology Branch,
NASA, Ames Research Center,
Moffett Field, California

Biology Departments Should Buy Natural Preserves

This communication is addressed to colleges and universities and particularly to their departments of biology. It proposes that they have a responsibility in the preservation of the sources of materials used in their studies and that they should institute active programs of land purchases to insure the availability of scientific values.

Many areas once used for collection of biological specimens and for field trips are now lost to the scientific community. Forests have been cut, bogs have been drained, and prairies have been plowed under. Stands of virgin hardwoods and conifers in Wisconsin and Michigan have practically disappeared, and the virgin prairies of Illinois and Iowa no longer exist except in old cemeteries and occasionally in railroad rights-of-way. Urbanization and flooding of valleys behind dams are now changing the ecology of the whole country.

Schools have acquired valuable lands through private gifts and through the efforts of groups such as garden clubs and nature conservancies, but these procedures, in spite of all good intentions, are haphazard, inefficient in selection of areas of high scientific value, and often too slow. It is therefore urged that schools purchase tracts that are now or are potentially important to their biologists. Perhaps departmental budgets for equipment and research should be increased so that the purchases could be made by the departments. The funds involved are small when compared with the monies justifiably spent by other departments on equipment that may become obsolete in a very few years. Scientific areas for the most part become more valuable with age. Furthermore, careful selection of sites can well serve to perpetuate rare biological species that are disappearing as their habitat is being restricted or changed. This program would also permit the establishment of laboratories in their natural state which could be kept private and undisturbed. There is ample precedent for departmental administration of experimental tracts of land; the applied biologists, the agronomists, and the animal husbandry men have been doing it for years.

The important functions of a school are the collection, preservation, and dissemination of information; a heavy responsibility is entailed in the guardianship of sources of information. The community of biological scientists must realize that the "open range" as a source of material is disappearing and they must act to protect their own interests as well as the larger interest of society.

A botanist on the staff of a famous university was exercised because a small privately owned bog was to be sold and would no longer be available as a rich source of specimens and as an area for field trips. He expressed concern over the possibility that an organization such as the Nature Conservancy could not or would not advance the comparatively small sum needed to buy it, but his response to the suggestion that his department of botany should buy it as part of its investment in research was that such a procedure was impossible.

The botanists of a large midwestern university were recently deploring the loss of a red oak complex as a prime research area; the red oaks have been cut, leaving the maples and the white oaks. It now has little value as a research and teaching area. This is only one more instance of the failure of a school and its botanists to act.

This letter carries no implication that there should not be full cooperation between the scientific community and conservation agencies; they should continue to furnish all possible mutual assistance.

L. F. YNTEMA
R.R. 1, Box 159, Wadsworth, Illinois