Correlation Between Lewis Blood Group and Secretor Character in Man

A NEW blood group character, designated as 'Lewis', was first described by Mourant[1], who found that the blood of 25 per cent of English people contained the Lewis factor, and that this group character is independent serologically of the *ABO*, *MN*, *Rh*, *P*, Lutheran and Kell systems. Somewhat later, Andresen[2] described 'anti-L sera' which are now known to be anti-Lewis sera. These sera agglutinated the red cells of 21 per cent of adult Danes and the cells of about 70 per cent of Danish children less than seven months old. Andresen put forward the view that the Lewis blood group was inherited by means of two allelomorphic genes L and l, the three possible genotypes being LL, Ll and ll. The data observed indicated that anti-Lewis serum agglutinates the red cells of adults if they are of genotype LL only, whereas in young children the genotype Ll is also detectable.

I have observed that the Lewis blood group character is intimately correlated with the secretor–non-secretor status within the *ABO* classification, Lewis-positive adult persons being non-secretors. This statement is based on the results obtained in the determination of the secretor type of twenty Lewis-positive and forty-two Lewis-negative persons. The twenty Lewis-positive persons were all non-secretors. Of the Lewis-negatives, forty-one were secretors and one (group A_1) was a non-secretor. On the basis of probability, it would appear that this result cannot be attributed to chance. In this sample the proportion of non-secretors is somewhat in excess of that found in the general population; there has, indeed, been a deliberate selection of Lewis-positive persons.

The classification of persons as secretors or non-secretors for the *A*, *B* and the so-called *O* factors was made by agglutination inhibition tests, using freshly collected and boiled saliva as inhibiting agent. The salivas from persons of group *A* (6 Lewis-positive, 19 Lewis-negative), *B* (1 Lewis-positive, 2 Lewis-negative) and *AB* (1 Lewis-positive, 2 Lewis-negative) were tested for inhibition of α- and β-agglutinins respectively. The salivas from persons of group *O* (12 Lewis-positive and 19 Lewis-negative) were examined with the following 'anti-*O*-sera': (1) Serum from a rabbit immunized with blood group substance obtained and purified from ovarian cysts of secretors of group *O*[3]. (2) A selected specimen of serum from the eel *Anguilla vulgaris*[4,5]. (3) Serum from a chicken immunized with suspensions of *Shigella Shigæ*[5]. Group *O* erythrocytes believed to represent the genotypes LL, Ll and ll of Andresen were agglutinated to the same titre by these sera.

Preliminary observations show that the salivas of Lewis-positive persons (non-secretors of the *A*, *B* and *H* substances) may inhibit the action of a strongly agglutinating dose of anti-Lewis serum at a dilution of 1 : 100 or more. The salivas of most Lewis-negative persons, possibly heterozygotes, show some power of inhibiting the action of Lewis agglutinins. Other salivas from Lewis-negative persons do not neutralize anti-Lewis serum.

Witebsky and Klendshoj[6] observed that the water-soluble substances in the secretions of those persons, classified as non-secretors owing to their inability to secrete the *A*, *B* or '*O*' (now called *H*)[7] substances, were nevertheless similar in general chemical properties to the *A*, *B* and *O* substances. A mucoid material possessing chemical characters common to the group substances and isolated from pseudomucinous ovarian cyst fluids obtained from secretors and non-secretors has been examined. The material inhibits completely and at high dilutions the action of two to three strongly agglutinating doses of anti-Lewis serum on Lewis-positive *O* cells[8]. Investigations in this field are being continued.

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[1] Mourant, A. E., *Nature*, **158**, 237 (1946).

[2] Andresen, P. H., *Acta Path. Microbiol. Scand.*, **24**, 616 (1947).

[3] Morgan, W. T. J., and Waddell, M. B. R., *Brit. J. Exp. Path.*, **26**, 387 (1945).

[4] Jonsson, B., *Acta Path. Microbiol. Scand.*, Supp., **54**, 456 (1944).

[5] Grubb, R. (in preparation).

[6] Witebsky, E., and Klendshoj, N. C., *J. Exp. Med.*, **73**, 655 (1941).

[7] Morgan, W. T. J., and Watkins, W. M., *Brit. J. Exp. Path.*, **29**, 159 (1948).

[8] Annison, E. F., and Morgan, W. T. J. (unpublished observations).

Equations of Piezoelectricity

RECENTLY, Dr. Richard K. Cook[1] has criticized as errors certain equations in my book[2] in which mixed units occur. In particular, he points to my Eq. (1), which expresses the energy stored in a crystal upon which an arbitrary mechanical strain and an arbitrary electric field are impressed. His assertion that "the reader is therefore obliged to examine closely the origin of the formulæ he uses" would be more convincing if he had cited instances in which an incorrect conclusion has been drawn from Eq. (1). This equation is:

$$\xi = \tfrac{1}{2}\sum_{h}^{6}\sum_{i}^{6} c_{hi}S_hS_i + \tfrac{1}{2}\sum_{k}^{3}\sum_{m}^{3} \eta''_{km}E_kE_m + \sum_{m}^{3}\sum_{h}^{6} e_{mh}E_mS_h + \tfrac{1}{2}\frac{J\rho C\theta^2}{T} + \theta\sum_{h}^{6} q_hS_h + \theta\sum_{m}^{3} p_mE_m,$$

where the c's are elastic constants at constant field, the S's are strain-components, η'' is the dielectric susceptibility of the clamped crystal, E the field-strength, e a piezo-electric stress-constant, J is the mechanical equivalent of heat in ergs per calorie, ρ is the density, C the specific heat in cal.gm.$^{-1}$ deg.$^{-1}$, T the absolute temperature, $\theta = \Delta T$ is a small change in temperature, q is a thermo-elastic constant, and p a pyro-electric constant.

Dr. Cook's objection is to the use, in the same equation, of the co-ordinate S along with E, which may be regarded as a generalized force.

It should be recalled that mixed units occur in some of the classical equations in thermodynamics. In piezo-electric theory, following the method of thermodynamics, they were used by Voigt, for example, on p. 816 of his "Lehrbuch der Kristallphysik"; they occur in the treatment of electro-elastic phenomena by Born, and in such handbooks as that of Geiger and Scheel and the "Encyclopädie der mathematischen Wissenschaften". There is therefore nothing novel in the use of mixed units in certain energy equations. It is true that in interpreting the derivatives of my Eq. (1) it is necessary —as was also the case with Voigt—to distinguish carefully between internal and externally impressed