LETTER TO THE EDITOR

Influence of Cholesterol in Cell–Plastic Electrodynamic Interactions

Knowledge of the forces involved in cell–substratum interactions could be useful in the development of surgical materials and in designing materials to which blood cells will not adhere (vascular prosthesis) (1–3).

For computing electrodynamic forces it is necessary to know the dielectric function in the entire range of frequencies; see Lifshitz (4), Dzyaloshinskii *et al.* (5), and Fornés and Gocinski (6).

In spite of the limited present knowledge of spectroscopic data for plastics, calculation of the forces can be useful in comparative analysis.

Experimental evidence of the existence of these forces in cell–substratum interactions was shown by Gingell and Fornés (7, 8). Parsegian and Gingell (9) have calculated electrodynamic cell–substratum interactions by considering a simple model of the cell surface.

Nir (10) developed a formalism for reduction of macroscopically derived dispersion forces to two-body interactions for two semiinfinite slabs separated by a thin film. This formalism was applied by Nir and Andersen (11) to calculate the electrodynamic interactions between cell surfaces and by Fornés (12) to observe the possibility of cholesterol affecting intercellular interactions.

Following this formalism we calculate the cell–plastic electrodynamic interaction, taking into account variations in cholesterol concentration. This is done with the intention of observing to what extent cholesterol could affect some prostheses in patients with cholesterolemia.

The composition and dielectric constants of the various layers of the cell surface are the same as those in Ref. (12), namely, surface coat: 0.2 galactose, 0.2 water, 0.6 albumin, $\epsilon = 5$, and plasma membrane: $\epsilon = 5.$; we keep constant the relation between the mole fractions of dipalmitoyllecithin (χ_1) and albumin (χ_2):

$$\frac{\chi_1}{\chi_2} = \frac{0.5}{0.4} = 1.25 = K. \qquad [1]$$

The mole fraction of cholesterol (χ_3) is such that

$$\chi_1 + \chi_2 + \chi_3 = 1. \qquad [2]$$

From [1] and [2] we obtain, as a function of the variation of cholesterol mole fraction,

$$\chi_1 = K\frac{1 - \chi_3}{1 + K} \qquad [3]$$

and

$$\chi_2 = \frac{1 - \chi_3}{1 + K}. \qquad [4]$$

The composition of the protoplasmic interior and extracellular fluid is considered to be 0.1 albumin and 0.9 water. The value of ϵ is considered to be 80 for these mixtures. The membrane and surface coat thicknesses are considered to be 50 and 75 Å, respectively. The coefficients C_{ik} and the frequencies ω_{ik} of all cell substances for calculating the cell–substratum force were taken from (11, 13, 14).

With respect to the plastics parameters the largest contribution to polarizability is from the ultraviolet parameter; then we have (10)

$$\frac{\epsilon(0) - 1}{\epsilon(0) + 2} = \sum_j C_j \simeq C_{UV}. \qquad [5]$$

The average static dielectric constant ($\bar{\epsilon}(0)$) and ionization potential ($\overline{IP}$) of most of the plastics (16) (polyethylene, polypropylene, and polytetrafluoroethylene (PTFE or Teflon)) are $\bar{\epsilon}(0) = 2.2$, $\overline{IP} = 10.15$ eV ($\bar{\omega}_{UV} = 1.54 \times 10^{16}$ rads/s); consequently from [5] we obtain $\bar{C}_{UV} = 0.286$ for these plastics.

The variation of cholesterol concentration was $0.1 \leqslant \chi_3 \leqslant 0.3$. The respective variations in attractive force and energy for a 100-Å cell–plastic distance were 1.114×10^3 dyn/cm$^2 \leqslant F_a \leqslant 1.125 \times 10^3$ dyn/cm^2 and -5.627×10^{-4} erg/cm$^2 \leqslant G_a \leqslant -5.571 \times 10^{-4}$ erg/cm^2.

We observe that the electrodynamic attraction hardly changes because the Hamaker function is almost insensitive to cholesterol variation. This is valid for any value of cell–plastic distance.

With respect to the repulsive force, if the effect of increasing the membrane surface charge density by the presence of cholesterol, Fornés and Procopio (17), is maintained under natural (or pathological) conditions, this will favor an increase in the repulsive force between the cell and the plastic. In this way we conclude that an increase in cellular cholesterol would not increase the normal adhesion of cells on plastics.

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