NMR and Fluorescence Study of Phospholipid-Gangliosid Interactions in Model Membranes

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The importance of plasma glycolipids and their implication in the interactions of a cell with its environment was already outlined some years ago (1).
The object of this study are intramembrane interactions of two glycolipids, namely, GM1 and GD_{1a}-gangliosides. These two gangliosides were first isolated and then incorporated into 1,2-dipalmitoyl-sn-3-glycerol-phosphatidylcholine (DPPC) vesicles at a Gangliosid to DPPC molar ratio of 1:8, 1:6, 1:4 and 1:2. The interactions between hydrophilic parts of these lipids were investigated with NMR spectroscopy (^{13}C T_1-relaxation time). In order to estimate the interactions in the hydrophobic region of the bilayer, 1,6-diphenylhexatriene (DPH) was also incorporated and the temperature dependence of the degree of its fluorescence polarisation determined.
In the presence of each of both gangliosides a shortening of the T_1-relaxation time of choline-methyl-^{13}C was observed below (at 37°C) and above (54°C) the gel-to-liquid crystalline transition of the phospholipid. Interestingly, not only the incorporated gangliosides but also the gangliosides which had been added to the suspension containing the DPPC-vesicles, were able to shorten the T_1-relaxation time of choline-methyl-^{13}C. This implies that the decreased mobility of the choline-methyl-group cannot be explained only in terms of steric hindrances produced by the big, fully hydrated hydrophilic part of the ganglioside. The interactions between the hydrophilic parts of the lipids, i.e. hydrogen bonds, must also be considered in the case of added gangliosides.
The measurements of the fluorescence polarisation show that the gel-to-liquid crystalline transition is above 42°C in DPPC-vesicles containing gangliosides. This increase in transition temperature is directly proportional to the amount of incorporated ganglioside. Noteworthy, this increase of the transition temperature takes place only when the gangliosides are incorporated into DPPC-vesicles but not when the gangliosides are added to the DPPC-vesicles suspension.
These results show that the gangliosides are able to interact with phospholipids in a manner which modifies the physical properties of the lipid bilayer of the membrane.

The support of this study by the Max-Planck-Gesellschaft is gratefully acknowledged.

(1) Laine, R.A., Stellner, K. and Hakomori, S.-I. (1974): in Methods in Membrane Biology, Ed. E. Korn, Plenum Press, Vol.II, 205 - 244