THE TOPOLOGICAL MODEL OF LIPID VESICLES MADE FROM POLYPRENOLES

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The membrane fractions from prokaryotic and plant tissues contain α-unsaturated polyprenols. The amphiphilic molecule of the plant long-chain polyprenol, hexadecaprenol (C₈₀), consists of a hydroxyl group – the hydrophilic part – and a long, unsaturated isoprenyl chain, mainly of poly-cis configuration – the hydrophobic part. Lipid vesicles were prepared from hexadecaprenol by hydration of a lipid film and investigated using transmission electron microscopy techniques (TEM). The membrane bounding the vesicles consists of two layers. Among these vesicles, there are multibudding structures and fused vesicles. At the cellular level, membrane fusion occurs in the processes of myoblast fusion into myotubes during the development of skeletal muscle, and in the fusion between a sperm cell and an egg cell during fertilization. At the subcellular level, fusion of membrane compartments occurs in all cells as part of intracellular trafficking of vesicles in endocytic and exocytic pathways and in the process of protein biosynthesis and compartmentalization mediated by transport vesicles, both of which are ubiquitous cellular processes. The mechanism of the connection and the fusion processes can possibly be explained by the application of the theory of homeomorphic transformations of topological manifolds, the operation of the connected sum of the manifolds. In this report, the biological cell or subcellular structures are modelled via an arrangement of lipid vesicles bounded by bilayer membranes corresponding to the internal and external layers of the plasma membrane. The analysis shows eight successive topological stages of membrane transformations during the fusion process, and each stage is characterized. The fusion of two membranes can be regarded as a two-stage process: in the first stage, the fusion process between the external layers occurs; in the second stage, the internal layers are fused. The fusion process between two vesicles shows a deformation of the external face of the cell. In conclusion, based on topological models, it is possible to describe and explain the formation of superstructures of prenyl bilayers. This study was financed by the grant awarded to Dr. Krystyna Walińska and Anna Timoszyk, M.Sc. by the Polish Network of Cell and Molecular Biology UNESCO/PAS.