SYMPOSIUM: LIPID MONOLAYER AND BILAYER MODELS AND CELLULAR MEMBRANES. PART II.

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R. M. BURTON, Program Chairman

Part II

Dr. H. Ti Tien (Michigan State University, East Lansing, Michigan): I consider it a special honor to have been asked to serve as chairman for this morning's session, since I believe this is the first symposium in which the bimolecular lipid membrane (or BLM) is one of the featured topics for discussion.

Those whose work has no connection with cellular membranes, perhaps are not acquainted with the bimolecular lipid leaflet model. The model is traceable to the experimental work of Gorter and Grendel, who suggested the bimolecular lipid leaflet idea after spreading monolayers on a Langmuir trough with lipids extracted from red blood cells. Therefore, the theme of this symposium in going from lipid monolayers to lipid bilayers, and finally to cellular membranes is following a logical and orderly sequence. However, as most of you know, the development of science is far from logical and orderly. Let me illustrate this point by recalling certain stages in the development of bimolecular leaflet model for cell membranes.

The classical experiments of Gorter and Grendel were done in the 1920's, Davson and Danielli proposed their model for the plasma membrane in the 1930's, and the idea of the lipid bilayer became widely accepted by the 1950's. Today, in the 1960's, however, the bimolecular lipid leaflet concept as the central basis for cellular membranes is being challenged from several quarters. This is not the place to go into the pros and cons. I, for one, if not most of you, believe that the lipid bilayer has something to do with cell membranes. Otherwise, perhaps, we would not be here today.

Although various modifications have been made, the idea of a bimolecular lipid layer as the fundamental basis for all cell membranes has dominated the thinking concerning the molecular structure of cell membranes for almost half a century. But the history of bimolecular lipid membranes (BLM) as experimental structures is a very recent one. Therefore, perhaps, it is not out of place for me to say a few words about the origin of BLM.

The work began with Rudin and his associates in 1959–61. They first studied lipid monolayers and multilayers (the Langmuir-Blodgett type), and then they played with soap bubbles and films. I use the word "played" because it is difficult to find a suitable word to describe their initial experiments when they were literally blowing soap bubbles with the equipment purchased from the local toy shop! They realized, however, that a soap film in air in its final stage of thinning has a structure which may be pictured as two monolayers sandwiching an aqueous solution. This picture of the so-called 'black' soap films had been suggested many years ago by Gibbs and more recently by Overbeek, Mysels, Corkill and others. Once they recognized this structure together with its molecular orientation, Rudin and co-workers simply proceeded to make a film of two monolayers sandwiching an organic phase in aqueous solution. As far as forming a BLM ("black" or bilayer lipid membrane) is concerned, there is not a lot to it. Experimentally, perhaps, it is easier than spreading a monolayer at an air-water interface.

I should like to add that Rudin's group did a bit more than just making BLM in aqueous solution. For instance, they measured the electrical properties such as resistance, capacitance and dielectric breakdown strength of these black lipid membranes. They estimated the thickness to be between 60 to 90A by preparing electron micrographs. They also measured water permeability by an osmotic method. In addition, they found that when certain proteins were allowed to adsorb onto the BLM, this lipo-protein system could be made electrically excitable. This, in essence, is the brief history of the bimolecular lipid membranes. (For a review, see H. T. Tien and A. L. Diana, Chem. Phys. Lipids, *2*, 55, 1968.)

Before I introduce our speakers for the morning session, let me just stress one more point. That, today, we are able to manipulate a film or membrane in aqueous solution about two molecules in thickness owes much to prior developments in surface and colloid science, which as evidenced from the title of this symposium is well recognized by the organizers of this meeting.

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