LIPID-POLYMER INTERACTION IN MONOLAYERS: EFFECT OF CONFORMATION OF POLY-L-LYSINE ON STEARIC ACID MONOLAYERS

Dinesh O. Shah
Surface Chemistry Laboratory, Marine Biology Division Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York

ABSTRACT
Surface pressures and surface potentials of stearic acid monolayers were measured at various pH values in the presence and absence of poly-L-lysine in the subsolution. The presence of poly-L-lysine strikingly influences the state of stearic acid monolayers. Surface potential measurements indicated that the maximum interaction between poly-L-lysine and stearic acid monolayers occurred between pH 10 and 11. Poly-L-lysine solutions exhibited surface activity in the same pH range. Air bubbles covered with poly-L-lysine films showed maximum stability at pH 11. These results indicate that in the pH range 10-11, where coil-to-helix transition occurs in solution, poly-L-lysine has partial or complete helical conformation which causes the slowest rate of drainage of water in bubble lamellae, and which also exhibits surface activity and hence, increases the interaction of poly-L-lysine with stearic acid monolayers. The implications of these findings for lipid-protein associations in biomembranes are discussed.

INTRODUCTION
Lipid-protein interactions are of great interest to understand the structure and function of biological membranes. Various approaches have been taken to elucidate the interaction of lipids and proteins in biological membranes. In recent years, nuclear magnetic resonance and electron spin resonance spectroscopy have been used profitably to investigate these interactions (1-4). Phospholipid bilayers and monolayers have served as useful models for these studies (5-6). The monolayer

*Lamont-Doherty Geological Observatory Contribution No. 1404.

101

approach has been found very useful to understand molecular mechanisms presumably occurring at the cell surface (7-10).

Earlier studies on lipid-protein interaction in monolayers were reported by Schulman and his co-workers (11-12) who investigated the interaction of albumin, globulin and haemoglobin with cholesterol, cardiolipin, alkyl sulfate and alkyl trimethylammonium monolayers. Eley and Hedge (13,14) studied protein-protein and protein-lipid interactions in fibrinogen, thrombin, albumin, lecithin and cephalin monolayers. The interaction of synthetic dihydroceramide lactoside monolayers with globulin, albumin, and ribonuclease was investigated by Colacicco, Rapport and Shapiro (15). These workers (16) have also shown from their studies on the interaction of apoprotein with various lipid monolayers, that the unusual surface activity of apoprotein may be intimately related to the mechanism of formation of the lipo-protein. Recently, Arnold and Pak (17) have investigated protein-protein interaction in monolayers.

To investigate the interaction of water with films, Trapeznikov (18) and Garrett (19) have studied the stability of bubbles covered with a monolayer of surface-active materials. In general, the stability of such bubbles is related to the rate of drainage of water in the bubble lamellae. The interaction of polar groups with water (i.e. hydration of polar groups) impedes the drainage of water in the lamellae, and, hence, increases the time required to reach a critical thickness where bubble lamellae break. Therefore, more strongly hydrated molecules increase the bubble stability. This method was used in the present study to investigate the hydration of stearic acid and poly-L-lysine films.

It has been recognized that both ionic and hydrophobic interactions play a role in the lipid-protein association. A simple model system of stearic acid and poly-L-lysine was selected to investigate various aspects of the ionic interaction in the present studies, since the ionic properties of stearic acid monolayers (20,23) and of poly-L-lysine solutions (24) have been established. The objective of the present studies was to investigate how the ionization of carboxyl groups in the monolayer and the conformation of poly-L-lysine in the subsolution influence interactions at the interface.

**EXPERIMENTAL**

**Materials:** Poly-L-lysine hydrochloride (molecular weight 100,000 - 200,000) was bought from Mann Research Laboratories Inc. (New York, N.Y. 10006). Highly purified (>99%) stearic acid was purchased from Applied Science Laboratories, Inc. (State College, Pa., 16801). Inorganic chemicals of reagent grade and distilled-deionized water were used in all experiments.