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Effects of Pressure on Lipid Lateral Distribution in Membranes

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The view, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

12a. DISTRIBUTION/AVAILABILITY STATEMENT

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12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This final report summarizes the work being completed in the funding period (7.1.1988-6.30.1991). Ten papers have been published as the result of the ARO support. The most important results are summerized as follows. The Birks model is not good for describing the pyrene fluorescence in membranes. We have developed a better model and have used this new model to study the lateral distribution and lateral diffusion coefficient of pyrene-10-phosphatidylcholine in dimyristoyl phosphatidylcholine vesicles. We continue to work on this subject, namely, the effects of pressure on lipid lateral distribution in membranes.

14. SUBJECT TERMS

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Final Report

1. **ARO Proposal Number:** 25506-LS-H

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3. **Title of Proposal:** Effects of Pressure on Lipid Lateral Distribution in Membranes.

4. **Grant Number:** DAAL03-88-G-0018

5. **Names of Institution:** Meharry Medical College
&
Mount Sinai Medical Center

6. **Principal Investigators:** Dr. Parkson Lee-Gau Chong (P.I.)
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Mount Sinai Medical Center

7. **Progress Report Date:** October 10, 1991

8. **Progress Has Been Made**

A. Statement of the Problem Studied

The goals of this research are:

(i) to develop a general method describing the relationship between the photophysical model and the fluorescence parameter,

(ii) to use this general method to evaluate the adequacy of the Birks model in describing pyrene fluorescence,

(iii) to use this general method to derive a new model which can satisfactorily describe pyrene fluorescence in membrane systems,

(iv) to use the new model to determine the lateral distribution of pyrene-labeled phosphatidylcholine in membranes,

(v) to determine the lateral distribution of pyrene-labeled lipids in membranes at high pressures, and

(vi) to study other membrane phenomena at high pressures.

B. Summary of the Most Important Results

(i) The Birks model proved to be failed in the case of membrane systems. We have demonstrated that the three-excited model proposed in our paper provides a better description of pyrene fluorescence in membranes.

(ii) Based on the three-state model, the lateral diffusion coefficient of the pyrene-labeled phosphatidylcholine is determined to 23 um^2/sec in the liquid crystalline phase of dimyristoylphosphatidylcholine vesicles and 2.6 um^2/sec in the gel phase.

(iii) The implication of our data is that the fluorescence data of a membrane probe depends on the lateral distribution of the probe molecule in the membrane, and

(iv) It is found that pressure assists ethanol in forming the highly ordered interdigitated gel state of dipalmitoylphosphatidylcholine. The pharmacological implication is that ethanol toxicity in terms of lipid interdigitation will be enhanced under pressure.

C. List of All Publications and Technical Reports

1. Chong, P.L.-G., Capes, S. and Wong, P.T.T. (1989) Effects of Hydrostatic Pressure on the Location of Prodan in Lipid Bilayers: A FT-IR Study. Biochemistry, 28, 8358-8363.

2. Sugar, I.P. and Chong, P.L.-G. (1989) Determination of the lateral Distribution of Lipid Molecules in Two-Component Membranes.

Evaluation of Pyrene Fluorescence Data. in Biomedical Modelling and Simulation (eds. Eisenfeld, J. and Levine, D.S.), J.C. Baltzer AG, Scientific Publishing Co. pp. 73-78.

3. Sugar, I.P. (1989) Stochastic Theory of Nonequilibrium Phase Transitions. Application to Phospholipid Bilayer Membranes. J. Phys. Chem. 93, 5216-5224.

4. Kao, Y. L., Chong, P. L.-G., and Huang, C. (1990) Time-Resolved Fluorometric and Differential Scanning Calorimetric Investigation of Dehydroergosterol in 1-Stearoyl-2-caprylphosphatidylcholine Bilayers. Biochemistry, 29, 1315-1322.

5. Chong, P. L. -G. (1990) Interactions of Laurdan with Membranes at High Pressures. High Pressure Research, 5, 761-763.

6. Kao, Y.L., Chong, P.L -G., Huang, C. and van der Meer, B.W. (1990) Dynamic Motions of 1,6 Diphenyl-1,3,5-hexatriene in Interdigitated C(18):C(10) phosphatidylcholine Bilayers. Biophys. J. 58, 947-956.

7. Sugar, I.P. (1991) Use of Fourier Transforms in the Analysis of Fluorescence Data. 1. A General Method for Finding Explicit Relationships between Photophysical Models and Fluorescence Parameters. J. Phys. Chem. 95, 7508-7515.

8. Sugar, I. P., Zeng, J., Vauhkonen, M., Somerharju, P. and Chong, P.L. -G. (1991) Use of Fourier Transforms in the Analysis of Fluorescence Data. 2. Fluorescence of Pyrene-labeled Phosphatidylcholine in Lipid Membranes. Test of the Birks Model. J. Phys. Chem., 95, 7516-7523.

9. Sugar, I. P., Zeng, J. and Chong, P.L. -G. (1991) Use of Fourier Transforms in the Analysis of Fluorescence Data. 3. Fluorescence of Pyrene-labeled Phosphatidylcholine in Lipid Membranes. A Three State Model. J. Phys. Chem., 95, 7524-7534.

10. Zeng, J. and Chong, P.L.-G. (1991) Interactions between Pressure and Alcohols on the Formation of Interdigitated Liposomes. A Study with Prodan Fluorescence. Biochemistry, 30, 9485-9491.

D. Scientific Personnel Supported by this Project and Degrees Awarded during this Reporting Period

Mr. Junwen Zeng, a graduate research assistant (100% time)
Ms. Yvonne L. Kao, a graduate research assistant (10% time)
---No degree was awarded during this reporting period.