Cell Fusion

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Preface

Over the last decade the volume *Membrane Fusion*, edited by Poste and Nicholson, has probably served as one of the major sources of review information on fusion in membrane systems. Since its publication much new information has been collected. New methods of inducing fusion have been invented or discovered, and new applications for fusion have been found. The need for an up-to-date monograph that covers and integrates these subjects, reviews established material, and rationalizes and integrates the old and the new is thus obvious. This book is the product of efforts to meet this need.

Most of the current work in the field of membrane fusion takes place within the context of intact or modified cells. Hence this book emphasizes the plasma membrane. Each chapter is either a review, a report, or a short historical overview, depending, respectively, on whether the subject is large in scope and has a long history, or the subject is in such an early stage of development that most of what is known is still in the hands of a relatively small number of investigators and is best covered in report form.

Since all fusion research involves either the goal of learning more about how fusion occurs or the goal of achieving a delivery function, this book covers both fundamental and applied topics. It is expected that workers concerned with chapters dealing primarily with one of these two goals might, sooner or later, have a look at the other chapters for new ideas. This book is geared toward recognition of current trends and rapidly developing ideas and techniques. Also, it recognizes fusion as it relates to today's biotechnology scene. In this regard plant systems have often been overlooked as systems for study and subjects for chapters in cell fusion books despite the fact that plants not only are essential for the

existence of all animal life but, as the reader will appreciate, also have some novel characteristics of significance for fusion research.

This book is divided into four parts of roughly equal importance. The first two parts are devoted to fusion mechanisms and mechanism-related phenomenology in cell membranes and artificial membranes, respectively. In Part I, *Fusion in Plasma Membranes*, the authors and topics were selected to illustrate the successful application of some novel experimental approach or unique biological characteristics to study fusion in some plasma membrane. The material covered was selected to emphasize depth rather than breadth.

In Part II, *Fusion in Model Membranes*, we devote attention to studies which involve artificial membranes, i.e., vesicles or liposomes. Although these membranes are rarely reconstituted with more than one or two of the many lipid components found in natural membranes or with the lipid asymmetry and integral proteins known to exist in natural membranes, they nevertheless are almost the only practical way to have a simple and clean experimental system to simplify the complex fusion-related interactions at molecular levels and analyze the effects of lipid structure and chemical factors on membrane fusion events. Indeed much, if not most, of what we know about fusion in membranes has come from work with vesicle systems. The chapter by Siegel and the chapter by Szoka are complementary reviews. The first author emphasizes a more conceptual perspective while the second emphasizes a more empirical viewpoint. A newcomer to the field of membrane fusion would do well to read these two pace-setting chapters before any of the others. The next two chapters summarize the effects of chemical conditions on vesicle fusion and survey protein modulation of vesicle fusion, while the remaining chapters specialize in the major topics of acid-induced fusion, polyethylene-glycol-induced fusion, and the development of a formalization of membrane fusion based on physical principles. The last chapter deals with a newly recognized experimental variable—hydrostatic pressure as a probe of fusion mechanisms. A book on fusion would not be complete without a section on fusion in model membranes, and a reader should at least develop an appreciation for what has been learned from them.

The next two parts are devoted to those researchers primarily interested in achieving a goal via a process in which fusion is but one step. Part III, *New Membrane Fusion Methods*, reviews electrofusion and describes the laser-induced fusion method. Both of these fusion methods are new, having been discovered or developed in the last half decade, and depend on physical effects rather than changes in chemical conditions brought about by added substances. Laser-induced fusion is significant because it is probably the only way to selectively fuse two cells in a tissue mass at one specific point in time without disturbing the surrounding cells. Electrofu-

sion can potentially induce high yields with high time resolution and is attracting much interest as an efficient and convenient fusion method. Our own experimental investigations on the mechanisms of electrofusion are beginning to reveal that electrofusion may be more than just another fusion method. Rather it may reveal additional new knowledge relevant not only to fusion phenomena but also to membrane structure and properties.

In Part IV, Applications of Membrane Fusion, we not only give examples of how electrofusion can be used to obtain better monoclonal antibodies, improve plant genetic engineering procedures, and make a unique measurement of membrane elasticity properties but also present an overview of how fusion was exploited in somatic cell genetics studies, a description of the red cell ghost microinjection technique, a review of chemically induced plant protoplast fusion, and finally a review of novel methods of selecting desired fusion products out of the many that are produced.

Finally, I would like to thank all of the authors for their fine contributions and acknowledge the American Red Cross, National Headquarters Sector, for support during the editing of this book.

The work on this volume was completed after the American National Red Cross moved its research activities from Bethesda to the Jerome H. Holland Laboratory for the Biomedical Sciences in Rockville, Maryland.

Rockville, Maryland

Arthur E. Sowers

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