
THE CELL SURFACE

IN ANIMAL EMBRYOGENESIS AND DEVELOPMENT

Edited by

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General preface

Research on membranes and cell surfaces today occupies center stage in many areas of biology and medicine. This dominant position reflects the growing awareness that many important biological processes in animal and plant cells and in microorganisms are mediated by these structures. The extraordinary and unprecedented expansion of knowledge in molecular biology, genetics, biochemistry, cell biology, microbiology and immunology over the last fifteen years has resulted in dramatic advances in our understanding of the properties of the cell surface and heightened our appreciation of the subtle, yet complex, nature of cell surface organization.

The rapid growth of interest in all facets of research on cell membranes and surfaces owes much to the convergence of ideas and results from seemingly disparate disciplines. This, together with the recognition of common patterns of biological organization in membranes from highly different forms of life, has led to a situation in which the sharp boundaries between the classical biological disciplines are rapidly disappearing. The investigator interested in cell surfaces must be at home in many fields, ranging from the detailed biochemical and biophysical properties of the molecules and macromolecules found in membranes to morphological and phenomenological descriptions of cellular structure and cell-to-cell interactions. Given the broad front on which research on cell surfaces is being pursued, it is not surprising that the relevant literature is scattered in a diverse range of journals and books, making it increasingly difficult for the active investigator to collate material from several areas of research. Thus, while scientists are becoming increasingly specialized in their techniques, and in the nature of the problems they study, they must interpret their results against an intellectual and conceptual background of rapidly expanding dimension. It is with these conflicting demands and needs in mind that this series, to be known under the collective title of **CELL SURFACE REVIEWS**, was conceived.

CELL SURFACE REVIEWS will present up-to-date surveys of recent advances in our understanding of membranes and cell surfaces. Each volume will

contain authoritative and topical reviews by investigators who have contributed to progress in their respective research fields. While individual reviews will provide comprehensive coverage of specialized topics, all of the reviews published within each volume will be related to an overall common theme. This format represents a departure from that adopted by most of the existing series of "review" publications which usually provide heterogeneous collections of reviews on unrelated topics. While this latter format is considerably more convenient from an editorial standpoint, we feel that publication together of a number of related reviews will better serve the stated aims of this series – to bridge the information and specialization "gap" among investigators in related areas. Each volume will therefore present a fairly complete and critical survey of the more important and recent advances in well defined topics in biology and medicine. The level will be advanced, directed primarily to the needs of the research worker and graduate students.

Editorial policy will be to impose as few restrictions as possible on contributors. This is appropriate since the volumes published in this series will represent collections of review articles and will not be definitive monographs dealing with all aspects of the selected subject. Contributors will be encouraged, however, to provide comprehensive, critical reviews that attempt to integrate the available data into a broad conceptual framework. Emphasis will also be given to identification of major problems demanding further study and the possible avenues by which these might be investigated. Scope will also be offered for the presentation of new and challenging ideas and hypotheses for which complete evidence is still lacking.

The first four volumes of this series will be published within one year, after which volumes will appear at approximately one year intervals.

George Poste
Garth L. Nicolson
Editors

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T-Cell Recognition of Virus-Infected Cells – R.V. Blanden (Canberra)

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Interaction of Viruses with Model Membranes – J. Tiffany (Oxford)

Cell Fusion by Sendai Virus – Y. Hosaka (Philadelphia) and F. Shimizu (Sendai)

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Preface

Over the past two decades the study of growth, differentiation and morphogenesis in the developing embryo has shifted in emphasis from preoccupation with descriptions of changing morphology at the tissue and cellular level to concern with the subcellular events and molecular mechanisms underlying these complex processes. Elusive as the final answers remain, there is now a general consensus that the cell surface is of major importance in regulating many aspects of differentiation and morphogenesis. The surface regions of cells, by their influence on cell growth, division, adhesion, movement and recognition, assume a central regulatory role in determining the complicated series of cellular interactions involved in the orderly development of tissue systems within the embryo.

The capacity of the cell surface to discharge these regulatory functions reflects the high degree of specificity and functional diversity displayed by this structure in different cells. These properties, in turn, reflect the fact that the plasma membrane is a dynamic structure which is able to undergo structural and functional changes in response to both genetic regulation and environmental stimuli. The modulation of cell surface organization by both intra- and extracellular factors not only provides a mechanism whereby highly specific patterns of surface organization can be generated in different cell types (i.e., differentiation), but also enables differentiated cells to modulate their surface properties in response to specific physiological stimuli.

In discussing the role of the cell surface in development, we cannot treat it as an isolated entity. It is a structure that is highly responsive to events occurring in both the intra- and extracellular compartments. In addition to its unique role in regulating the flow of substances between the intra- and extracellular environments, it is becoming clear that subtle changes in the topographic arrangement of macromolecules in the plasma membrane and its associated structures can serve as a powerful mechanism for transmission of "information" between the outside and inside of the cell. Reaction of a cell with extracellular factors, including other cells, may generate structural rearrangements of membrane

components which, in turn, may result in alterations in intracellular metabolism, including possible changes in gene expression. The altered intracellular organization produced by an event occurring at the cell surface may then act as a feedback mechanism to stabilize existing surface organization or, alternatively, may impose entirely new arrangements of surface determinants with resulting change in cell surface properties. Is it these sequences of reciprocal information transfer between the intra- and extracellular compartments that drive cells along the pathways resulting in cytodifferentiation and the emergence of histotypic organization? Although the answer to this question is not known at present, the role of the cell surface as an exquisite mechanism for coupling the intra- and extracellular compartments is made possible by trans-membrane functional linkage between the various components of the plasma membrane and membrane-associated structures. This feature of membrane organization enables information to be transmitted in both directions across the membrane via various combinations of cooperative, allosteric and transductive coupling mechanisms.

The impressive range of physical, chemical, cytological, ultrastructural, immunological and genetic techniques which have been introduced in recent years to study membrane organization have also been embraced by developmental biologists. This has resulted in significant progress in our efforts to understand how changes in cell surface properties influence the complex processes of differentiation and morphogenesis in the developing embryo. This progress is reflected in the thirteen reviews presented in this volume which examine various aspects of cell surface function and cellular interactions in development.

We recognize that a subject as diverse as cellular interactions in embryogenesis cannot be treated adequately in a single volume. We have therefore included a number of reviews dealing with general aspects of the important topics of fertilization, cleavage, implantation, placentation, the immunobiology of development, cell communication and specification of cell position, morphogenetic cell movements and inductive tissue interactions. These articles discuss data obtained from a wide range of cell, tissue and organ systems, and each article offers an extensive bibliography. The few remaining reviews are devoted to discussion of development in three organ systems, the heart, the limb and the immune apparatus. These systems were selected largely because they represent areas of research in which considerable progress has been made recently. Equally detailed and impressive information on the importance of the cell surface in differentiation and morphogenesis are available for such tissues as muscle, cartilage, bone, connective tissue and for nerve cells and blood cells. These topics have been reviewed in detail in many publications in the last few years, and it was considered appropriate to confine discussion of these systems to the more general articles contained in this volume. An attempt has been made throughout this volume to achieve a balance between discussion of events occurring at the tissue and cell level and those at the subcellular and molecular level. This provides a blend between the older, but nonetheless elegant, descriptive data from classical embryology and data obtained in the newer era of

developmental biology.

The contributors to this volume most receive ultimate credit for whatever success it achieves. To them we express our thanks and our appreciation of their willingness to accept editorial suggestions. We are also grateful to the many other individuals who contributed to the production of this volume. Particular thanks go to Adele Brodgerski, Molly Terhaar, Judy Morey, Alice MacKearnin and Shirley Guagliardi for their assistance in preparing the edited manuscripts. Finally, we thank Dr. Jack Franklin of North-Holland for his encouragement and help in starting this new series.

George Poste
Buffalo, New York
December, 1975

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