Preface

To preserve tissue by freezing is an ancient concept going back presumably to the practice of ice-age hunters. At first glance, it seems as simple as it is attractive: the dynamics of life are frozen in, nothing is added and nothing withdrawn except thermal energy. Thus, the result should be more life-like than after poisoning, tanning and drying a living cell as we may rudely call the conventional preparation of specimens for electron microscopy. Countless mishaps, however, have taught electron microscopists that cryotechniques too are neither simple nor necessarily more life-like in their outcome.

Not too long ago, experts in cryotechniques strictly denied that a cell could truly be vitrified, i.e. that all the solutes and macromolecules could be fixed within non-crystalline, glass-like solid water without the dramatic shifts and segregation effects caused by crystallization. We now know that vitrification is indeed possible. Growing insight into the fundamentals of the physics of water and ice, as well as increasing experience of how to cool cells rapidly enough have enlivened the interest in cryofixation and produced a wealth of successful applications.

The abundance of methods and the proliferation of papers using cryotechniques make the choice difficult for the newcomer and also an old hand may run into problems on starting out in a new direction. Therefore, we thought the time was ripe to sift the grain from the chaff and to evaluate the present state of the art. With a field so diverse, this cannot be the task for a single authority. We succeeded in getting leading experts to write selective and critical reviews on aspects of major interest. The selection of topics is subjective as we do not intend to present a comprehensive textbook. For example, we refrained from including a chapter on freeze-fracturing and -etching, since these well-established methods are exhaustively treated in earlier books and review articles.

The baseline for the whole book is given by three chapters on the physics of water and ice, the physics of specimen preparation and the effects of radiation damage. From these contributions, it should become clear what is known and what has to be borne in

mind when planning cryopreparation. This part is followed by four chapters on the general methodology: cryofixation, cryoelectron microscopy of vitrified specimens, cryoultramicrotomy, freeze-substitution and freeze-drying. None of these is a mere description of equipment or a collection of recipes, because we believe that, at present, the prescription of methods without critical advice would impede rather than promote the "art" of specimen preparation. Six shorter contributions treat various, more specialized techniques, each of them with its own particular potential for the future: high pressure freezing, freeze-etching of macromolecules, high resolution metal replication, immunolabelling, autoradiography and scanning electron microscopy of cryospecimens. The last two chapters treat the cryofixation of dynamic events and defined physiological states, two fields where the advantages of rapid freezing techniques are especially evident. The appendix contains a short recapitulation of safety hazards and how to prevent them.

A novel feature of this multi-author book was an editorial conference of the authors *after* completion and precirculation of their contributions. This meeting was held at Ringberg Castle in Bavaria, November 19–21, 1986. We are greatful to the Max-Planck-Society for their hospitality at this convention centre and to the German Society for Electron Microscopy for generous sponsorship. The conference not only helped to avoid overlap, but also to speak the same language (see Glossary). Due to open-minded and constructive criticism from all participants, every single contribution has been substantially improved. We hope that the spirit and the enthusiasm of this meeting have been transferred to this book and will stimulate further research.

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