A. INTRODUCTION

In the first edition of this book, the protoplasmic structure, optical properties, surface area and volume, specific gravity, cyclosis and viscosity, and other physical and biochemical properties were described in detail and hence will not be reported here. On the other hand, more recent information stemming from discoveries in electron microscopy (EM) and molecular biology will be presented in this chapter and elsewhere.

Using ultrastructure and cytochemical methods, Estève (1969a) demonstrated that glycogen in \textit{P. caudatum} is present in the form of \( \beta \) particles. Cell fractions have been separated and specific proteins selectively stained with antibodies that carried fluorescent labels. This field of research has been fully reviewed by Finger (1974) in a study of surface antigens of the \textit{P. aurelia} complex. Sometimes the location of a molecule presents a clue to its function. EM studies have identified sites of antigens for the species in which it has been possible to detect antigen on the cilia and pellicle, but not internally (Beale and Kaiser, 1957; Beale and Mott, 1962; Mott, 1963a,b, 1965). Additional references dealing with surface antigen expression and variations are Beale (1952a), Capdeville (1979a,b), Capdeville et al. (1978), and Steers and Davis (1977).

Important for a biochemical characterization of the protoplasm of \textit{Paramecium} are the genetically variable enzymes, the esterases. In \textit{Paramecium}, these enzymes, along with enzyme variations, have been extensively studied by S. L. Allen and Gibson (1971a, 1975), S. L. Allen and Golembiewski (1972), S. L. Allen and Nerad (1978a), S. L. Allen et al., (1971, 1973), Cavill and Gibson (1972), Rowe et al. (1971), Tait (1968, 1970a,b), and Tait et al. (1971).

The hemoglobin of \textit{P. caudatum}, which has been isolated, purified, and characterized by Steers et al. (1981), appears as a single molecular species (mol. wt. 13,500) with an isoelectric point of 4.27 in a pH range of 3–6. The amino acid composition was also defined. Unlike \textit{P. tetrau-
relia (Steers and Davis, 1979), *P. caudatum* exhibited only a single molecular form of hemoglobin in the cell extracts.

Cyclosis, which is the constant streaming or circulation of free cytoplasmic contents in *Paramecium*, has been analyzed and investigated in regard to various external agents. References bearing on cytoplasmic streaming or cyclosis and viscosity are:

Czarska (1965): Cytoplasmic streaming in an electrical field in *P. caudatum*.
Kuźnicki and Fabczak (1972): Cinematographic analysis of cyclosis including reversible cessation in the *P. aurelia* complex.
Sikora and Wasik (1978): Nickel-ion-immobilized paramecia and cytoplasmic streaming in members of the *P. aurelia* complex.
Sikora et al. (1976a–c): Viscosity distribution and profile of cytoplasmic streaming.
Stockem (1977a,b): Phagocytosis and cyclosis in *P. caudatum*.
Yamada (1969, 1974a,b): Comparative study and effects of certain reagents on cyclosis.

Under the various categories in this chapter, a given reference may have been placed arbitrarily under one heading when in reality it may bear on two or more different aspects of research. The literature dealing with the effects of various agents on *Paramecium* is enormous, as shown by the hundreds of specific topical references listed. Hence, in a book of this kind, the results of investigators must of necessity be briefly summarized, but full references are listed for the reader seeking more extensive information.

**B. PERMEABILITY AND MEMBRANES**

Permeability and membrane structure and function are inextricably related in *Paramecium*. Its external region consists of the cortex, with its outer surface, the pellicle, made up largely of membranes: an outermost plasma or cell membrane and a closely applied pattern forming a mosaic and repeating, membrane-limited units called alveoli. The plasma membrane not only envelops the entire body of *Paramecium* but also is continuous with and covers exterior structures such as the cilia. The plasma membrane also lines indentations or invaginations such as parasomal sacs that are located close to all cilia.

Though the alveoli were earlier believed to be separated at septa by 5.0- to 6.0-nm gaps, R. D. Allen (1971) has demonstrated that in *Paramecium*...