

Preface

Does the world really need another general biology text? The answer is, quite honestly, "No!" There are many adequate and a few good books already on the market. Yet I have produced another work in the field because I feel my emphasis is unique. This text, organized on the basis of the "levels" approach, is divided into three parts. The first section deals with the big picture, starting with populations and communities of organisms interacting together. The second section deals with whole organisms as communities of cells. And the third section discusses cells as units of interacting molecules and atoms. Throughout the book I have stressed regulation and control of these systems of organisms, cells, and molecules more extensively than most introductory works. However, the most striking departure from current general biology books occurs because of the placement of the population and communities section first in the book and the cell section last.

In the past fifteen years there has been an almost unanimous tendency on the part of authors and instructors to begin biology courses with chemistry and cell biology. There were good reasons for this. First, the tremendous strides made in molecular and cellular biology in recent years have resolved old questions and opened new vistas. Launching the course with these fresh insights gave new vigor and life to old material. Second, emphasis on chemistry from the beginning compensated for woefully inadequate preparation in this subject on the part of many beginning biology students, and the subject matter stood in stark contrast to that in textbooks published before 1960. Third, the "cell first" approach seemed to intellectually satisfy many of us who taught general biology; intuitively, it seemed reasonable to start with "single" units (cells) and progress to more complex units, such as organisms and populations.

However sound this approach seems to the sophisticated teacher, it has far less appeal to the beginning student. First, the student is seldom an expert in chemistry. He does not think in terms of molecules. His world and his experiences are whole organisms and communities. Thus there is great pedagogic value in approaching the field of biology from a familiar vantage point rather than from the more nebulous realm of exergonic reactions, electron transport, and cyclic AMP. It is logical to begin with the basic interactions that we see in our daily life and to ask questions and seek answers in progressively finer detail. It

is only in retrospect that the cell seems simple; this is seldom the view of the student.

A second disadvantage of the cell-first approach is that the major theme of evolution, which permeates and should, in my opinion, dominate the field of biology, is lost in the normal textbook shuffle of chapters. At best it stands as a separate chapter somewhere in the middle or end of the book and at worst it is almost relegated to a footnote in the history of biology. For too long we have not provided biologists and teachers with adequate backgrounds in basic evolution. The beginning student must appreciate the fact that the structure and function of cells and whole organisms are best understood by asking how these patterns arose and what are the environmental forces operating on the organism to shape its adaptation to a given environment. It is not merely fortuitous that seals, sharks, whales, and certain extinct aquatic reptiles have similar fin patterns. It is not an accident that plants all rely on chlorophyll *a* for photosynthesis.

Third, the cell-first instructor frequently finds himself mentioning the names of plants, microorganisms, and animals as illustrations for a point, even though students have little or no understanding of what these organisms are or their relationship to one another. This problem is even more acute if anatomy and physiology are discussed before evolution and diversity are treated. How can one appreciate the evolutionary implications of the chemical structure of cytochromes from cells of different species if the subject of evolution has not been discussed or if the student does not understand the assumptions inherent in the evolutionary analysis? How can one discuss seed formation without an understanding of vascular-plant evolution and a knowledge of the names of organisms? In meeting these problems the instructor is continually saying, "This relationship will be more obvious to you later"—or the basic relationships are ignored altogether and the student is left to follow along as best he can.

The current organization alleviates these types of problems. In addition, by beginning with the subjects of evolution and ecology, the text is faithful to the sociological climate of today, in which people are more readily aware of the havoc and destruction that is created by a Santa Barbara oil spill, a fleet of supersonic airplanes, an energy crisis, or a famine. We can no longer ignore the interdependence of living organisms and their resources. This concern is reflected

by placing the principles of ecology early in the book so that the student is more likely to raise questions of paramount interest to the future. I believe that this orientation raises the level of ecological and sociological awareness to issues that might easily slip by with another approach. Whatever the reader's stand on questions that involve the side effects of birth-control pills, the relative merits of vasectomies, the harvesting of organs for transplants, genetic manipulation of human beings, the dilemma of feeding starving people only to raise the population to new heights and potentially cause more starvation—we must realize that these problems, which have biological roots, are yet to be resolved.

In spite of the rationale for text organization, I recognize the great diversity in teaching technique and orientation; consequently, each of the three sections of the book can stand somewhat separately. It is possible to begin a course with either the section on the cell or the section on the organism and proceed to the other two parts of the text, in either order. To achieve this flexibility, in contrast to the normal text, certain topics, such as the cell, genetics, and the origin of life, are considered in more than one section. The topics gain strength from this approach, and this modest redundancy has the added advantage of providing a built-in review mechanism for the student. Therefore, genetics is treated from a population viewpoint in Chapter 3 but from a cellular viewpoint in Chapter 28. Although at first glance this may appear awkward, in reality the opposite is generally the case; restatement of the principle is welcomed when the point of view is altered. This is especially apparent when dealing with the material on the origin of life. The subject is treated in a general way in the beginning of the book, together with a thumbnail sketch of the origins of the universe and solar system to put the earth and its organisms in the largest possible perspective. But the subject is reopened in Chapter 32, where new insights are offered to students as they are nearing the end of the course with a wealth of biological background now at their command. Having the origin of life treated in both the beginning and end of the book also emphasizes, albeit subtly, the unity of biology and brings the text full cycle, returning to the central theme of the book—evolution.

I have supplied a number of pedagogic aids for the student. At the end of each chapter after the first,

there is a concise summary. I have provided for each chapter a list of selected readings for those readers who wish to pursue certain topics. As a student can go to the library and easily obtain general textbooks on a subject, I have focused on the more recent well-written and well-illustrated references. Articles in *Scientific American* and *Science*, journals found in virtually all libraries, are given top priority.

A number of questions for each chapter have been prepared. Serious attempts to answer these will reward any student. The questions confront the reader with a direct challenge to his or her memory and test understanding of general principles. In many cases the questions are innovative and cannot be answered by taking a superficial approach. Many queries can serve as intriguing topics for analysis in discussion sections or recitation groups.

At the end of the text there is an extensive and complete index, which is essential for any serious reader. Also, since the subject of biology is replete with terms and definitions that fade with time, I have supplied a glossary, which provides a much handier reference to terms than the index.

A Personal Comment on Gutenberg's Folly

Little did Johann Gutenberg know the anguish he was to cause me when he invented his movable printing press. For without it, I never would have been seduced by Macmillan into writing another biology book.

When it all began, it seemed to be a good idea. Now, years later, after my first blush of excitement as I signed the contract, I am unmistakably older, sucked dry of my pretentious illusion that this was to be a great text. I am instead smitten by the fact that there are more fine biology texts on the market now than when I wrote my first sentence. Yet there is some solace even in that. I know others have suffered the same agonies of straining for clarity, looking for the clever analogy, seeking the perfect diagram to imprint on the reader's mind for all time—only to find that things could be better.

Helping me worry through the text and kneading my life into its daily shape was my wife—who for all

her loveliness and intelligence interrupted me. I am sure, on more than one occasion, when I was in a fit of celestial brilliance and creating the most beautiful prose in the world, only to have it vanish to vapor with the more prosaic call, "dinner time." Still, she must be thanked, for she kept my body and soul together, and she even made the ultimate sacrifice and read and criticized the text. Several of my colleagues made valuable suggestions regarding particular chapters: Chapter 1, Douglas Riggs, Carmelo Privitera, Evelyn Schlenker; Chapters 2, 3, 9, 10, 11, C. Privitera, E. Schlenker; Chapters 6–8, Philip Sze; Chapters 11–15, Peter Gold, William Atwill; Chapters 16–19, Charles Fournier, Charles Kaars; Chapters 20–24, David Carlson; Chapters 25 and 26, Lloyd Davidson; Chapter 28, Norman Strauss; Chapter 29, Morton Rothstein; Chapter 30, Harold Segal; and Chapter 31, Reed Flickinger. In addition, I wish to thank several anonymous reviewers, who read sections of the book and made important comments. Such reviewers, both kind and unkind, improved the manuscript. I welcome similar constructive remarks from readers of the book, anonymous or not.

Then there is Mary Juhl to thank, along with Marge Cannon, Donna Schnittker, Lynn Mills, and Effie Balsdon, for their faithful transcription of my scribbled lines into readable type. Eleanor Golder, my staff assistant in many courses, helped discover reference books with great dispatch and smoothed my daily teaching load in incalculable ways with her persistence and attention to details. In addition, she read the entire book and made invaluable suggestions for its improvement. James Stamos aided in the photographic work. I especially thank the many book companies and individuals who allowed us to reprint figures and photographs. Special acknowledgment is given to these people and organizations in the figure legends.

In contrast to the above thank-yous, I have mixed feelings about the people at Macmillan who talked me into writing the book years ago and who made me finish it. I suppose that in time, when I am rested, I will come to view them, along with Johann Gutenberg, as not bad folks after all.