Biological organization—A new look at an old problem

The cell theory, or cell doctrine, which states that all organisms are composed of similar units of organization, called cells, was first enunciated in 1839 and has remained one of the foundations of modern biology. This idea predates other great paradigms in biology, such as Darwin's theory of evolution (1859), the rediscovery of Mendel's laws of inheritance (1900), and the establishment of comparative biochemistry (1940). Although ultrastructure research and molecular biology have added much to the cell theory, and it has retained its eminent status in biology, the cell theory faces two ongoing problems.

First, the cell theory began as, and to a great extent remains, a structural idea. This structural view, which is found in most textbooks, describes the components of a cell and their fate in cell reproduction. Today, however, biology focuses on DNA and its informational features, and the description of a cell needs to catch up with this contemporary view of life. The cell is, and needs to be described as, a unit of self-control. That is, the description of a cell needs to incorporate ideas about how information is converted to structure. The second problem with the cell theory is historical: It first gained prominence along with the organismal theory, which is the idea that the organism has its own structural features apart from those of cells. The ensuing debate over which of the two structural theories better explains biological organization, especially in protists, has never been resolved sufficiently by structural criteria.

A resolution to both problems can be found by restating the cell and organismal theories in terms of criteria of self-control and then viewing them as existing at different levels of biological organization. Levels of control is the subject of hierarchical theory; hence, organisms can be better described by a hierarchical than a mainly structural perspective. In this article, I explain the relationship between the cell theory and hierarchical theory. I begin by developing both theories and then try to reconcile them.

by Robert W. Korn

The cell theory–organismal theory controversy

In 1838, Theodor Schwann and Matthias Schleiden were enjoying after-dinner coffee and talking about their studies on cells. According to his biographer (Frédéricq 1884), when Schwann heard Schleiden describe plant cells with nuclei, he was struck by the similarity of plant cells to cells he had found in animal tissues. The two scientists went immediately to Schwann's lab to look at his slides. Schwann published his book on animal and plant cells (Schwann 1839) the next year, a treatise devoid of acknowledgments of anyone else's contribution, including that of Schleiden (1838). He did, however, summarize his findings into three famous conclusions about cells:

- The cell is the unit of structure, physiology, and organization.
- The cell retains a dual existence as a distinct entity and a building block in the construction of organisms.
- Cells form by free-cell formation, similar to the formation of crystals.

The first two statements are still acceptable, although the third is clearly wrong. Before Schwann's publication, there were two rival theories on how cells form—one claiming free-cell formation and the other claiming cell division. Schwann picked the wrong one—free-cell formation—because he failed to consider all available theoretical ideas. The correct interpretation of cell formation by division was finally promoted by others and formally enunciated in Rudolph Virchow's powerful dictum *Omnis cellula e cellula* ("All cells only arise from pre-existing cells"; Wilson 1896).

The cell doctrine reached its present-day eminence in 1896 with the publication of E. B. Wilson's *The Cell in Development and Heredity*, which was an accumulation of what was known about the roles of cells in embryology and chromosomal behavior. Nevertheless, some biologists held stubbornly to the idea that nerve organization remained an important exception to the cell theory because some fibers appeared to come from nonliving substances. But even this final resistance to the cell theory succumbed with Ross Harrison's convincing demonstration (Harrison 1907) that neurons in culture arise only from other nerve cells.

The cell is usually investigated by three approaches: characterizing structural components, identifying the biochemical activity of the components, and noting how the components multiply and segregate during cell division. In 1952, a fourth approach to the study of the cell began when the mathematician John von Neumann developed a theory of self-reproducing automata, in which he viewed cells as self-regulating machines. Although others had previously described cells as machines, it was von Neumann who emphasized the importance of internal control and who provided the formalism behind this feature. He proposed that such a machine would have three components: an assembler, to make another automaton; an information tape, to direct the activity of the assembler; and a tape recorder, to

Thinking About Biology

David Fraser Fraser-Harris

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explore these topics in some depth providing the opportunity for them to discuss the technical presentations with conference participants In all 275 submissions were received for the conference 105 of which were accepted after thorough review by 3 or 4 referees for presentation at the conference and inclusion here Providing a valuable overview of the latest developments the book will be of interest to all those working in the fields of design studies and intelligence engineering *Ergonomics in Design* Francisco Rebelo,2022-07-24 Ergonomics in Design Proceedings of the 13th International Conference on Applied Human Factors and Ergonomics AHFE 2022 July 24 28 2022 New York USA **Passionate Minds** Lewis Wolpert,Alison Richards,1997-09-25 The popular stereotype of the scientist as mad boffin or weedy nerd has been peddled widely in film and fiction with the implication that the world of science is far removed from the intellectual and emotional messiness of other human activities In Passionate Minds distinguished scientist Lewis Wolpert investigates the style and motivation of some of the most eminent scientists in the world In this stimulating collection of conversations scientists in fields as diverse as particle physics and evolutionary biology explore how their backgrounds have shaped their careers and discoveries how being an outsider or an innocent can play an invaluable role in overcoming conventional barriers to new understanding Being a little crazy does seem to help As Nobel laureate for physics Sheldon Glashow says If you would simply take all the kookiest ideas of the early 1970s and put them together you would have made for yourself the theory which is in fact the correct theory of nature so it was like madness These personal explorations with individual scientists are not only accessible and truly fascinating in their insights into the minds of some of the greatest men and women of science but they also provide a strong case that the life and works of our leading scientists are at least as illuminating and interesting as the personalities of the latest literary prizewinners A sequel to A Passion for Science this book will delight and intrigue scientists and non scientists alike *The Biology of Cancer* Robert Allan Weinberg,2007 Disc contains the figures from the book additional sidebars from the text movies and audio files of mini lectures **Documents of the Senate of the State of New York** New York (State). Legislature. Senate,1904 **Annual Report** University of the State of New York. High School Department,1905 **The Laws of Heredity** George Archdall Reid,1910 **The Larger Aspects of Socialism** William English Walling,1913 **Coloured Thinking and Other Studies in Science and Literature** David Fraser Fraser-Harris,1928 **Evolution and the Diversity of Life** Ernst Mayr,1997 The diversity of living forms and the unity of evolutionary processes are themes that have permeated the research and writing of Ernst Mayr a Grand Master of evolutionary biology The essays collected here are among his most valuable and durable contributions that form the basis for much of the contemporary understanding of evolutionary biology School Science and Mathematics ,1908

Thinking About Biology Book Review: Unveiling the Power of Words

In a global driven by information and connectivity, the energy of words has be more evident than ever. They have the ability to inspire, provoke, and ignite change. Such could be the essence of the book **Thinking About Biology**, a literary masterpiece that delves deep in to the significance of words and their impact on our lives. Compiled by a renowned author, this captivating work takes readers on a transformative journey, unraveling the secrets and potential behind every word. In this review, we shall explore the book is key themes, examine its writing style, and analyze its overall impact on readers.

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