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The limits of molecular explanations of cell functions



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For more than 14 years I have been working on the question whether individual mammalian cells have the ability to integrate the numerous exogenous signals impinging on them every second, and to set the priorities for their cytoplasmic and genomic responses. More simply put, can cells express something that resembles rudimentary 'intelligence', i. e. are they teleonomic, perceptive, synergistic, data-processing and problem-solving? If the answer is 'yes', then today's concept of cells as biochemical automatons would need revision, because the interactions of single molecules alone cannot account for the required integration of biological functions all across a single cell that contains some 10^{13} macromolecules.

The experimental evidence collected over the years suggested that cells, indeed, have such abilities and that the centrosphere is the likely location of the cytoplasmic control and integration mechanisms.

Nevertheless, the concept of the 'molecular cell' is rapidly spreading. As a result, today's cell biologists have had to come to terms with the increasing 'molecularization' of their fields; indeed many seem to consider that molecular analyses of cellular functions are the only acceptable approaches to cell biology.

I came to the Wissenschaftskolleg in order to write a book that discusses the concepts, methods, experimental evidence and application of discussion of 'cytoplasmic intelligence'. It turned into two long articles, one entitled "In defense of 'non-molecular' cell biology" which tried to discuss critically and in detail the limitations of the paradigm of molecular interactions as method of explanation of whole cell function. It will

appear in the 'International Review of Cytology', volume 120. The other, entitled, "The fitting of the fittest" tries to examine the question whether there are special mechanisms of variation that seem to preserve the exquisite fitting of parts of biological systems, including genomes and cells. This article has been submitted to the 'Perspectives in Biology and Medicine'. Further below, the Yearbook 1988/89 offers a brief summary of its contents.

The work of this year has deepened my conviction that we are at the threshold of a new era of biology. It replaces the old rather mechanistic explanations of the actions of genomes, cells, organisms and ecologies which are based on rigid physical and chemical mechanisms alone with explanations that leave more room for the unpredictable actions of individual molecules, cells, organisms and populations. It poses even sharper the old question about the relationship between freedom and determinism and the significance of 'selfish', individual actions for the mechanisms of variation and the outcome of natural selection.