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# The Language of Living Matter

How Molecules Acquire Meaning



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# **Abstract of the book chapters**

## **Chapter 1: Language: Gateway to the World**

Starting from the idea that the world is recognizable to us because it is structured like a language, this chapter develops an overarching concept of language, leading from the structures of human language to the language of structures. A universal feature of linguistic forms is their inherent context-dependence. While this is immediately apparent in human language, it also applies to quite different areas of the structures of reality. Examples from quantum physics, genetics, Gestalt psychology, sociology and epistemology demonstrate this. All these examples support the structural understanding of language and its application to natural phenomena, the idea on which this book is based.

## **Chapter 2: Truth: The Regulative Principle of Cognition**

This chapter follows a historical perspective, continuing a line of philosophical thinking that led to modern linguistic philosophy, bringing language to the center of epistemology. Reviewing the history of philosophy, we are forced to perceive philosophy itself as a language mechanism generating new figures of thought by perpetually recombining and crystallizing a finite set of elementary ideas – just as the innumerable chemical substances originate from a relatively small set of chemical elements. This view of the genesis of new ideas is exemplified by retracing the development of the concept of truth – from Greek antiquity to modern times.

## **Chapter 3: Methods: Ways of Gaining Knowledge**

Whether and to what extent the meaning content of natural phenomena is accessible to the exact sciences has long been a subject of controversy. At the center of this debate lies the scope of the scientific method, based as it is on simplification, abstraction and idealization. For this reason, hermeneutics, which aims at understanding meaningful phenomena through interpretation, has become the counterpart to the analytical method of scientific explanation. This chapter presents arguments to refute the principal objections to the

reductionist research program and provides evidence that there is no need for a methodological reorientation of the exact sciences.

#### **Chapter 4: Unity: The Deep Structure of Science**

The traditional scientific landscape is split into the exact sciences and the humanities. Therefore, any attempt to approach the concept of meaning through the exact sciences must be judged as an attempt to close the gap between the two domains of scientific thinking. In fact, in the exploration of complex systems in Nature and society, a new type of science has emerged in the past decades, denoted as “structural science”, which may be able to bridge that gap. The structural sciences set out to investigate the overarching structure of reality, independently of whether a given structure belongs to non-living or living matter or whether it represents an artificial or a natural system. An outstanding example of this structural thinking is the overarching concept of language, which is at the center of this book.

#### **Chapter 5: Limits: Insides into the Reach of Science**

Employing the concept of Turing machines and algorithmic information theory, one can draw far-reaching conclusions regarding the generation of semantic information. In particular, it can be demonstrated that there can never be an information-processing machine that can generate meaningful information from nothing. The result is reminiscent of the impossibility of a “perpetual motion machine”, which is well-known in physics. Accordingly, any receiver of a piece of meaningful information needs, to understand and to process that information access to background information that is at least as complex as the information to be understood. This theorem is the most general and precise form of the context-principle of information. It enables us to draw far-reaching conclusions regarding the prebiotic origin of genetic information.

#### **Chapter 6: Perspectives: Designing Living Matter**

This chapter demonstrates that language is a general principle of nature that is rooted exclusively in physical and chemical laws. Revealing the “grammar” of this language may be expected to lift modern biotechnology to a new level. At the same time, the concept of molecular language opens the door to a deeper understanding of the origin and early evolution of life. It is shown that

linguistic pre-structures can already emerge in self-reproducing nucleic acids under prebiotic conditions. Accordingly, the first steps toward life must be regarded as a language-driven evolution of biological macromolecules that led to the protoforms of life. This phase of evolution was non-Darwinian, since it was driven exclusively by a natural selection of the phenotypic properties of nucleic acids. Only after the nucleation of the genetic code did molecular systems become the object of Darwinian evolution – that is, evolution by adaptation.

## **Chapter 7: Epilog: Nature's Semantics**

Animate Nature can be considered figuratively as the book of life whose “words” are living beings and their interactions. Just as the words of a written text combine to form a meaningful whole, living beings as elements of biological diversity form an immeasurably complex network of actions and interactions, in which each organism is assigned to its place by evolution. In other words, the language of Nature is, as it were, the “hyperlanguage” of living matter. In the truest sense of the word, this language is a “living” language and, as such, it is subject to constant change. To deal responsibly with Nature, we have to take account of her semantics at the borderlines of construction and destruction, stability and instability, order and chaos. Only in this way can the dynamic order of Nature be maintained in the face of invasive human activity.