Semiotic modelling of biological processes

João Queiroz[ab] & Charbel El-Hani[ab]

[a] Research Group in History, Philosophy, and Biology Teaching, Institute of Biology, Federal University of Bahia, Brazil.
[b] Graduate Studies Program in History, Philosophy, and Science Teaching, Federal University of Bahia/State University of Feira de Santana, Brazil. Graduate Studies Program in Ecology and Biomonitoring, Federal University of Bahia, Brazil.

Course description:

Here we introduce biosemiotics as a field of research that develops models of life processes focusing on their informational aspects. Peirce's general concept of semiosis can be used to analyze such processes, and provide a powerful basis for understanding the emergence of meaning in living systems, by contributing to the construction of a theory of biological information. Peirce's theory of sign action is introduced, and the relation between 'information processing' and sign processes is discussed, in fact, a semiotic definition of information is introduced. Three biosemiotic models of informational processes, at the behavioral and molecular levels, are developed, first, a model of genetic information processing in protein synthesis; second, a model of signal transduction in B-cell activation in the immune system; and, finally, a model of symbolic non-human primate communication. We also address some perspectives for the development of applied semiotic research in fields such as Artificial life, cognitive ethology, cognitive robotics, theoretical biology, and education.

Key words: biosemiotics, semiosis, emergence, genetic information, B-cell activation, non-human primate communication, C.S.Peirce

LECTURE 1

I. Theoretical semiotics
I.1- Foundation of Peirce's philosophy of signs
I.2. 'The essential nature and fundamental varieties of possible semiosis'
I.2.1. Semiosis, meaning and the action of signs
I.2.2. Sign, Object, Interpretant
I.2.3. The subdivision of the object
I.2.4. The subdivision of the interpretant

LECTURE 2

II.1- Multi-level model of emergent semiosis
II.1.1. Central Characteristics of Emergentism
II.1.1.2. Varieties of Emergentism
II.1.1.3. Irreducibility

II.1.1.4. Downward Causation/Determination
II.1.1.5. Unpredictability

LECTURE 3

II.1- Multi-level model of emergent semiosis
II.1.2. Levels of Semiosis: A General Model
II.1.3. Stanley Salthe's basic triadic system
II.1.3.1. Micro-level of semiotic processes
II.1.3.2. Focal-level of semiotic processes
II.1.3.3. Macro-level of semiotic processes

LECTURE 4

III.1- Semiotic systems
III.1.1. James Fetzer's semiotic systems
III.1.2. Fundamental classes of semiotic systems
III.1.2.1. Iconic semiotic systems
III.1.2.2. Indexical semiotic systems
III.1.2.3. Symbolic semiotic systems

LECTURE 5

V.1- Biological aplications
V.1.1- Genetic information system
V.1.2. 'Gene' and 'information' as conceptual problems
V.1.3. Applying the general model of levels of semiosis to the genetic information system
V.1.4. Semiotic analysis of transcription
V.1.5. Semiotic analysis of translation
V.1.6. What is information?
V.1.7. What is a gene?

LECTURE 6

V.2.1. Semiotic processes in the immune system
V.2.2. Modeling a signaling process in B-cell activation
V.2.3. Applying the general model of levels of semiosis to B-cell activation
V.2.4. The necessity of semiotic models of signaling
V.2.5. What is signaling?

LECTURE 7

V.3.1- Non-human primate communication
V.3.1.1 An overview
V.3.1.2. The meaning of alarm calls in vervet monkeys
V.3.1.3. A neurosemiotic modeling of vervet monkey alarm calls

V.3.1.4. A semiotic discussion of context-modulated meaning in pigtailed macaques.
V.3.1.5. Symbolic communication in chimpanzees and bonobos

LECTURE 8

VI – Perspectives for applied biosemiotics (provisional version)
VI.1. Semiotics and Alife
VI.2. Semiotics and cognitive robotics
VI.3. Semiotics and cognitive ethology
VI.4. Ecosemiotics
VI.5. Semiotics and theoretical biology
VI.6. Semiotics and education

SHORT ACADEMIC BIOGRAPHY

João Queiroz
[queirozj@ecomp.uefs.br, www.semiotics.pro.br] is a Professor at the Graduate Studies Program on History, Philosophy and Science Teaching (UFBA/UEFS). He holds degrees in linguistics and communication, and a Ph.D. in communication and semiotics (Catholic University of São Paulo). His interests include C.S.Peirce's Semiotic and Pragmatism, Biosemiotics and Cognitive Science.

Charbel El-Hani
[charbel@ufba.br] is a Professor at the Institute of Biology, Federal University of Bahia, Brazil, where he coordinates the Research Group in History, Philosophy, and Biology Teaching. He is the chair of the Graduate Studies Program in History, Philosophy, and Science Teaching from Federal University of Bahia and State University of Feira de Santana, since 2004. He obtained his Bachelor degree in Biology from Federal University of Bahia; his Master degree in Education from Federal University of Bahia; his Doctoral degree in Education from University of São Paulo. His main research interests are in Science Education Research, Theoretical Biology, Philosophy of biology, Biosemiotics, and Animal Behaviour.