Biochemistry & Physiology: Open Access
ISSN: 2168-9652
Brown, Biochem Physiol 2022, 11:3
Commentary
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Abstract

The feld of molecular biology studies macromolecules and the macromolecular mechanisms found in living things, such as the molecular nature of the gene and its mechanisms of gene replication, mutation, and expression. Given the fundamental importance of these macromolecular mechanisms throughout the history of molecular biology, a philosophical focus on the concept of a mechanism generates the clearest picture of molecular biology's history, concepts, and case studies utilized by philosophers of science.

: Molecular; Biology; Fundamental; Concepts

C **B**

A mechanism for a phenomenon consists of entities and activities organized in such a way that they are responsible for the phenomenon. As an example, consider the phenomenon of DNA replication. As Watson and Crick (1953a) famously noted upon discovery of the structure of DNA, the macromolecule's structure pointed to the mechanism of DNA replication: It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material. In short, the double helix of DNA (an entity with an organization) unwinds (an activity) and new component parts (entities) bond (an activity) to both parts of the unwound DNA helix. DNA is a nucleic acid composed of several subparts: a sugar-phosphate backbone and nucleic acid bases.

Scientists rarely depict all the particular details when describing a mechanism; representations are usually schematic, often depicted in diagrams (see the entry on models in science). Such representations may be called a "model of a mechanism", or "mechanism schema". A mechanism schema is a truncated abstract description of a mechanism that can be instantiated by filling it with more specific descriptions of component entities and activities. An example is James Watson's (1965) diagram of his version of the central dogma of molecular biology:

DNA → RNA → protein.

B

In addition to analyzing key concepts in the field, philosophers have employed case studies from molecular biology to address more general issues in the philosophy of science, such as reduction, explanation, extrapolation, and experimentation. For each of these philosophical issues, evidence from molecular biology directs philosophical attention toward understanding the concept of a mechanism for addressing the topic.

Reduction may be understood in multiple ways depending on what it is that is being reduced (see the entry on scientific reduction). Theory reduction pertains to whether or not theories from one scientific field can be reduced to theories from another scientific field. In contrast, explanatory reduction (often united with methodological reduction) pertains to whether or not explanations that come from lower levels (often united with methodologies that investigate those lower levels) are better than explanations that come from higher levels. Philosophical attention to molecular biology has contributed to debates about both of these senses of reduction (see the entry on reductionism in biology).

E

Traditionally, philosophers of science took successful scientific explanations to result from derivation from laws of nature (see the entries on laws of nature and scientific explanation). On this deductive-nomological account an explanation of particular observation statements was analyzed as subsumption under universal (applying throughout the universe), general (exception less), necessary (not contingent) laws of nature plus the initial conditions of the particular case. Philosophers of biology have criticized this traditional analysis as inapplicable to biology, and especially molecular biology.

E

As discussed earlier in the historical sections, molecular biologists have relied heavily on model organisms (see the entry on models in science). The model organisms that were used to lay down the foundation of molecular biology served as "exemplary models" in contrast to what today are called "surrogate models"—the distinction comes from Jessica Bolker According to Bolker, exemplary models are "representatives of a broader group" and the goal of using them is "to elucidate fundamental or general biological patterns and mechanisms.

While theoretical chimeras seem to further complicate Steel's mechanistic account of extrapolation, actual chimeras also raise questions that Steel does not address. Consider, for example, humanized mice that have been engineered to carry a "partial or complete human physiological system" .These genetically engineered rodents are supposed to make extrapolation more reliable by simulating a variety of human diseases, e.g., asthma, diabetes, cancer, etc.

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Received: 18-Feb-2022, Manuscript No. bcp-22-58159; **Editor assigned:** 21-Feb-2022, PreQC No bcp-22-58159 (PQ); **Reviewed:** 07-Mar-2022, QC No bcp-22-58159; **Revised:** 12-Mar-2022, Manuscript No bcp-22-58159R); **Published:** 19-Mar-2022, DOI: 10- M ž Ø 8-9652- 0003

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The history of molecular biology is in part the history of experimental techniques designed to probe the macromolecular mechanisms found in living things. Philosophers in turn have looked to molecular biology as a case study for understanding how experimentation works in science-how it contributes to scientific discovery, distinguishes correlation from causal and constitutive relevance, and decides between competing hypotheses. In all three cases, the concept of a mechanism is