SORTING OUT THE EPISTEMIC LEGITIMACY OF NON-HYPOTHESIS DRIVEN RESEARCH

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Recent progress in cellular and structural biology, combined with constantly expanding bioinformatics technology, is changing how we do biological/biomedical research. New high-throughput methodologies permit innovative experimental designs. Much biological and biomedical research nowadays is “non-hypothesis-driven”: experiments are not designed around a specific testable hypothesis. This challenge to the hegemony of the hypothesis poses multiple problems. For philosophers, it yet again calls into question the hypothetico-deductive method (HDM), the established hypothesis-driven strategy for experimental science. For scientists, it raises practical issues about how to evaluate experimental design and the resulting data, and how to determine what research deserves funding. In other words, it raises the question of what is worthy science.

For my analysis, I define hypothesis-driven research as research where a well-articulated hypothesis governs the experimental design. Several different styles of non-hypothesis-driven research exist. With system-driven research, the biological entity under investigation, demarcated as a system, governs the experimental design. With structure-driven research, the molecular structure under investigation governs experimental design. My thesis is that system-driven research, which typically involves high-throughput methodologies collectively known as “omics”, constitutes scientific research on par with hypothesis-driven research. The HDM derives its cogency from its logical structure. I argue that system-driven research is governed by an
epistemic structure, distinguishable from the HDM but similarly powerful. I call this the Omics Experimental Strategy (OES). My objective is to show how the OES operates.

I anchor this analysis in a subdiscipline of proteomics, metalloproteomics, which I helped to develop in the early 2000s. Metalloproteomics aims to identify and characterize all the metal-associated proteins (classic metalloproteins or proteins, including protein aggregates, with metal-binding capability) in a well-defined biological system at a specified state. Methods include selective separation of metal-associated proteins and mass spectrometry. Metalloproteomics is the best approach for solving certain biological/biomedical problems and it can generate significant novel results.

Biological research which attempts to examine a biological system as such, in its complexity, reflects a distinctive epistemological orientation. The OES attempts to be fully inclusive. It proceeds without any prejudice of expectation related to a hypothesis and may reveal ‘surprising’ findings, which would not be found by a chain of hypotheses. With the OES, pattern-recognition plays an important role in examining the experimental data; furthermore, contextualization of findings within the system under investigation is required. Whereas the HDM necessarily generates one hypothesis after another, the OES may generate a further look at the system or, alternatively, one or more hypotheses.

Validation of experimental data with the OES has two key aspects. In terms of experimental design, establishment of and adherence to standards of performance set by experts in the field are crucial for ensuring that data are reliable. In terms of knowledge production, contextualization of the findings in the system itself is critically important. With the HDM, the
findings are evaluated in terms of the hypothesis; with the OES, the findings are evaluated in the context of the system.

In summary, system-driven research constitutes proper scientific research. Its methods are transparent and capable of standardization. It possesses an epistemic structure (the OES) which involves pattern-recognition and contextualization. It may produce novel findings which would not be found by hypothesis-driven experimental designs. Similar arguments can be constructed for structure-driven research; however, devising epistemic structures for other non-hypothesis-driven styles of research poses complex and currently unresolved issues.

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