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Modeling in Biology: looking backward and looking forward

ABSTRACT. Understanding modeling in biology requires understanding how biology is organized as a discipline and how this organization influences the research practices of biologists. Biology includes a wide range of sub-disciplines, such as cell biology, population biology, evolutionary biology, molecular biology, and systems biology among others. Biologists in sub-disciplines such as cell, molecular, and systems biology believe that the use of a few experimental models allows them to discover biological universals, whereas biologists in sub-disciplines such as ecology and evolutionary biology believe that the use of many different experimental and mathematical models is necessary in order to do this. Many practitioners of both approaches misunderstand best practices of modeling, especially those related to model testing. We stress the need for biologists to better engage with best practices and for philosophers of biology providing normative guidance for biologists to better engage with current developments in biology. This is especially important as biology transitions from a “data-poor” to a “data-rich” discipline. If 21st century biology is going to capitalize on the unprecedented availability of ecological, evolutionary, and molecular data, of computational resources, and of mathematical and statistical tools, biologists will need a better understanding of what modeling is and can be.

KEYWORDS: biology, model building, model testing, philosophy of biology, subdisciplines of biology.

“Biology” is the study of nature. It dates as far back as our ancestors paid attention to the benefits and hazards of their surroundings. A possible vestige of this study may be the common but not universal fear of snakes and spiders, which could be due to long-ago observations that some are dangerous (Rakison 2018).