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books

Biology and 'physics envy'

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What Makes Biology Unique? Considerations on the Autonomy of a Scientific Discipline
by Ernst Mayr
Cambridge University Press, Cambridge, UK
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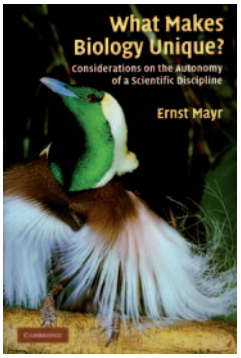

It is amazing that at the age of 100, Ernst Mayr could still produce a stimulating book. The arguments in *What Makes Biology Unique? Considerations on the Autonomy of a Scientific Discipline* are simple and straightforward, and will help many biochemists and molecular biologists to clarify their thinking about evolution. Mayr has discussed most of the themes in the book before (such as his division of Darwin's theory into five independent sub-theories). However, even those familiar with the general arguments will welcome the updates, and others will find a clear discussion of some basic ideas that are too often misunderstood.

Apart from the insistence that biology is not reducible to chemistry and physics, to which I return later, the book covers many useful themes. Twelve chapters span topics such as evolutionary theory, the maturation of Darwinism, influences on modern thought, species, selection, the origin of humans and astrobiology. The main strength of the book is that each topic is discussed clearly, and is often broken down into simpler ideas to allow components to be evaluated or tested separately. A particularly strong feature is Mayr's destruction of orthogenesis, the 'Onward and Upward' model of evolution that still dominates much current thinking (especially from molecular biologists untrained in evolution). Orthogenesis implies an almost inevitable advance to a higher state: prokaryotes to eukaryotes, unicellular to multicellular organisms, primates to humans. This line of thought predominated until the New Synthesis of the 1930s–1950s finally accepted Darwin's insistence on testable microevolutionary mechanisms. In Darwinian thinking, there is no predetermined state or goal of evolution; species may evolve towards simpler states (reductive evolution), stay much the same, or evolve to more complex beings. Backwards, sideways, and occasionally forwards!

Similarly, Mayr uses the history of evolutionary thought to give a devastating deconstruction of Kuhn's theory of irreducible paradigms in science. Kuhn hopelessly confused the philosophy of science with the sociology of scientists, and was one of the two leading anti-'science' writers of the twentieth century. Mayr shows that sometimes there were many competing evolutionary ideas co-existing over many decades. Similarly, earlier empirical studies (Hull *et al* (1978) *Science* **202:** 717–723) show that the initial (1860–1870) acceptance of evolution by biologists was independent of their age, which contradicts another unsupported Kuhnian assertion. These studies reinforce the conclusion that Kuhn had little knowledge of how science either does, or should, function.

I liked Mayr's point that Charles Darwin was really the first to develop 'secular science'. In the mid-nineteenth century, science was still largely seen under a natural theology (intelligent design) umbrella and was used to illustrate the wisdom of the Creator. This view of science was popularized by a series of books in the early nineteenth century, the Bridgewater Treatises. Although there were earlier hints, Darwin's theory was (rightly) seen as allowing the possibility of a Creator-free science.

Throughout the book, the discussion is always easy to follow, with no hiding behind big words with new meanings. Despite my positive response, I have concerns with one key issue. The book's subtitle, 'Autonomy of a Scientific Discipline', is the answer. Why would any modern scientist want to consider biology autonomous, and thus irreducible to physics and chemistry? Isn't this just lingering 'physics envy' among biologists, in a day when many physicists have 'biology envy'?

In reality, we already know that there is nothing in biology that is inconsistent with physics, chemistry and mathematics. In one of the most fundamental biological experiments in the twentieth century, Harold Morowitz and colleagues took cysts of the complex multicellular brine shrimp *Artemia* down to 2.2 degrees Kelvin (less than –270 °C), left them for six days, then slowly warmed them to room temperature, where they revived, grew and reproduced. At such low temperatures, information on energy levels, positions and velocities of electrons is lost; the only information left is about the chemicals and their relative positions. This tells us (as discussed in Penny D (2005) *Biol Philos* **20:** in the press) that the composition and organization of chemicals is all that is required for a system to be alive. It is extremely unlikely that there is anything in living systems that cannot be reduced to chemistry and physics.

Similarly, 'emergent' properties are a normal part of the changing scale of measurement in science; there is no need to declaim against the limits of 'reductionism'. Emergent properties are a routine part of science and we always operate at the appropriate scale of analysis; we don't need special relativity or quantum mechanics to design a simple bridge across a stream. There is no reason for biologists to worry that biology is capable of being reduced to chemistry and physics. Nothing changes in biology—we will still have the same exciting research.

Overall, this excellent book will help many molecular biologists understand the underlying structure of mainstream evolution much better. Just ignore the bits about biology being autonomous—it is great that biology no longer needs physics envy.

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