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Teach students the biology of their time

An experiment in genetics education reveals how Mendel's legacy holds back the teaching of science, says **Gregory Radick**.

Historians study the causes and consequences of past events, but also consider alternative scenarios. What might have happened, for example, if Britain had stayed out of the war in Europe in 1914? Science historians also ask such counterfactual questions, and the results can be surprisingly instructive.

Take genetics. The past year has seen prolonged celebrations of the work of Gregor Mendel, linked to the 150th anniversary of the paper that reported his experiments with hybrid peas. Mendel's experiments are central to biology curricula across the world. By contrast, the criticisms levelled at Mendel's ideas by W. F. R. Weldon, Linacre professor at the University of Oxford, UK, are a footnote.

From 1902, Weldon's views brought him into increasingly bad-tempered conflict with Mendel's followers. In basic terms, the Mendelians believed that inherited factors (later called 'genes') determine the visible characters of an organism, whereas Weldon saw context — developmental and environmental — as being just as important, with its influence making characters variable in ways that Mendelians ignored. The Mendelians won — helped by Weldon's sudden death in 1906, before he published his ideas fully — and the teaching of genetics has emphasized the primacy of the gene ever since.

The problem is that the Mendelian 'genes for' approach is increasingly seen as out of step with twenty-first-century biology. If we are to realize the potential of the genomic age, critics say, we must find new concepts and language better matched to variable biological reality. This is important in education, where the reliance on simple examples may even promote an outmoded determinism about the power of genes.

But what if Mendelism had never come to dominate genetics in the first place? What if Weldon's perspective had emerged as the winner in that historical battle, and his interactionism, allied to his vivid sense of how variable the real characters of real organisms are (never just yellow or green, round or wrinkled, or any other Mendelian binary), had become the core of the subject? This is where I, and colleagues, have tried to run an experiment.

In a recent two-year project, we taught university students a curriculum that was altered to reflect what genetics textbooks might be like now if biology circa 1906 had taken the Weldonian rather than the Mendelian route. These students encountered genetics as fundamentally tied to development and environment. Genes were not presented to them as what inheritance is 'really about', with everything else relegated to ignorable supporting roles. For example, they were taught that although genes can affect the heart directly, they also affect blood pressure, the body's activity levels and other influential factors, themselves often influenced by non-genetic factors (such as smoking). Where in this tangle, we ask them, is a gene for heart disease? In effect, this revised curriculum seeks to take what is peripheral in the existing teaching of genetics and make it central, and to make what is central peripheral.

Our experimental group consisted of second-year humanities undergraduates. First-year biologists, who were taught the conventional approach, acted as our control. We saw a difference — those students taught the Weldon way emerged as less believing of genetic determinism, and, I suspect, better prepared to understand the subtleties of modern genetics. (The difference was statistically significant, but I hesitate to make much of that, given that numbers were small and there were differences between the groups. I am mindful, too, that it was Weldon who first drew attention to Mendel's own problems with exaggerated statistics.)

With such experiments — bringing insights from the archive into the science classroom — the scientific past can inform and maybe even improve the scientific future. In turn, they suggest a broader vision of collaboration. To advance scientific knowledge, historians and philosophers of science should work in close proximity to scientists, not actually in the lab but right down the corridor. Then, investigations into neglected phenomena and debates that were shut down too soon might provide the spark to serve creative science.

What of Mendel? Some might complain that it is a poor anniversary gift to jettison him from his place of honour in the genetics curriculum. Let me suggest that this grumbling, although understandable, is misguided. If we want to honour Mendel, then let us read him seriously, which is to say historically, without back-projecting the doctrinaire Mendelism that came later. Study Mendel, but let him be part of his time.

Likewise, let our biology students be part of their time, by giving them a genetics curriculum fit for the twenty-first century. If we teach them about Mendel, we should do so not to fill them with slack-jawed wonder at his foundational achievement, but to help them to appreciate how even the most imaginative and rigorous science — and Mendel's was first rate on both counts — bears the stamp of the historical circumstances of its making. To learn that lesson about past science is to bring a welcome level of self-awareness and critical self-reflection to the present. ■

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