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The report on bioelectrical signaling work done by Michael Levin and colleagues (PHYSICS TODAY, March 2013, page 16) omits the fact that better results were obtained many years ago. R. O. Becker considered axial electric signals in light of the ability of salamanders to regenerate limbs.[1] With A. A. Marino, he used biological effects of electrical signals[2] to stimulate the regrowth of portions of amputated limbs in rats;[3] Becker also demonstrated that those limbs usually do not regenerate;[4] and he and others showed that cartilage and bone are electrically active.[5]

References

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■ **Levin responds:** Roderic Lakes adds an important point; the modern work on bioelectricity was indeed inspired by that of earlier researchers in the field, including not only Robert Becker and Andrew Marino but also Elmer Lund, Harold Burr, Lionel Jaffe, Harold Beams, and many others. However, the results discussed in Johanna Miller's story are very different from prior work in several ways; for brevity, I mention just a few.

First, the signaling revealed by the recent research is contained in the spatial distribution of cell membranes' resting potential (V_{mem}) across tissues—very different from the extracellular electric fields and ion currents studied by prior workers.

Second, this work merges the control of shape *in vivo* by bioelectric gradients with molecular biology techniques. For the first time, we know the proteins that create and control the gradients, and we know the exact molecular steps that convert those physical events to downstream genetic targets. The field has advanced over earlier work by mechanistically linking physiological changes to the crucial molecular-genetic pathways that they control; in Becker's work, the molecular mechanisms that enable electric fields to control regeneration were a complete mystery.

Third, while work with applied electric fields had shown impressive ability to turn on a regenerative response, the recent results are the first demonstration of reprogramming tissues into entirely different organs. The remarkable ability of V_{mem} levels to create complete organs such as eyes in nonstandard places or to suppress tumor formation not only reveals completely novel aspects of the role of bioelectricity in the specification of growth and form but also suggests very exciting new opportunities for regenerative biomedicine.

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Correction

August 2013, page 38—In box 2, the longitude and latitude labels in the figure were reversed. ■