How research goes viral

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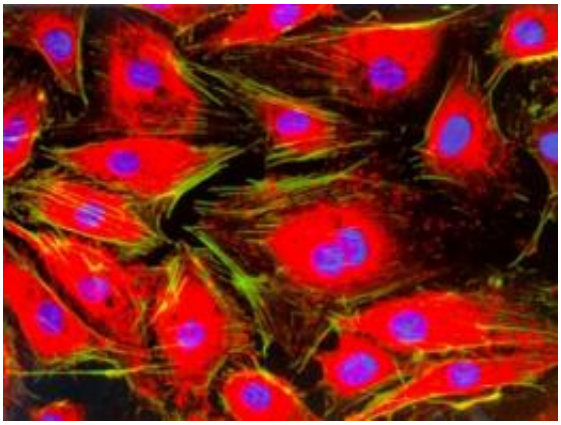

Endothelial cells. Courtesy of Nikon Small Worlds

Scores of interesting new findings from the biosciences may speed around the globe at the click of a mouse, but one thing particularly encourages other researchers to follow up on them: The chance to use the lab materials upon which studies are based.

Indeed, a recent paper co-authored by MIT economist Scott Stern shows that making the physical materials used in lab experiments — such as cell lines, microorganisms or recombinant DNA — available to other scientists can vastly increase the rate at which knowledge flows through the scientific community, as measured by the amount of citations that papers receive.

After all, biologists want to replicate the results they have read about —

and verify them, if need be. From the 1960s through the 1990s, dozens of supposedly different cell lines were contaminated by HeLa cells, which originated with just one person, Henrietta Lacks, a Baltimore woman who died from cervical cancer in 1951. This mistake hampered the ability of scientists to identify the truly diverse mechanisms of cancer.

Thus the handling of research materials, and the confirmation of results, is vital for the advancement of science. If biologists cannot verify prior findings, they are less likely to build upon that work.

“Just because a piece of knowledge is initially produced doesn’t necessarily mean that it can be used by others,” Stern says. “You can have grand discussions about innovation, but in fact, the institutional capacity to make research materials available, so that one generation of scientific work is accessible for others, is quite important. It reduces the cost, and increases the precision and clarity, of the next generation of scientific results.”

More room on the shoulders of giants

In the paper, “Climbing atop the Shoulders of Giants,” published in the *American Economic Review*, Stern and his co-author, Jeffrey Furman of Boston University, study the effects of making research materials available through government-funded institutions known as Biological Resource Centers (BRCs), which function as “living libraries” for life scientists.

Specifically, the researchers focused on materials held by the American Type Culture Collection (ATCC), an institution in Manassas, Va., and the largest such resource center in the world. Stern and Furman looked at what happened when materials pertaining to 108 published articles were suddenly transferred from other, less accessible collections into the

ATCC, and then compared the ensuing citation rates for those papers with a control set of 108 similar articles employing materials whose accessibility did not change during that period.

The citation rates for the papers whose materials were transferred to the ATCC rose by 57 to 135 percent after the biological matter was made available for wider scientific scrutiny. The effect was more pronounced for papers that had not previously enjoyed especially wide audiences. There was a 70 percent gain in citations of articles published in leading biology journals, but a 116 percent gain in citations of articles published in lesser-known journals, perhaps indicating that access to the materials behind the lesser-known results led to a more pronounced boost in confidence in those findings.

“When things become more open, it’s not simply that you get more research, but you get more diverse research,” Stern notes.

Moreover, Stern and Furman conclude that BRCs represent a cost-effective way of abetting biological research. Rather than attempting to replicate results from scratch, having the source materials on hand makes it easier for scientists to build on the original findings. In what the economists acknowledge is a rough calculation, they believe BRCs lower the cost per citation by a factor of 10, meaning knowledge spreads among the scientific community much more cheaply than it would otherwise.

“Almost all this research is paid for with taxpayers’ money, but the ability of that research to be built on depends on whether or not it is embedded in institutions that encourage transparency, certification, that validate research and store materials for a long time,” Stern adds.

Funding productivity

Other economists say the study is important. “It’s interesting in terms of the magnitude of the effects,” says Josh Lerner, a professor at Harvard Business School who studies innovation and entrepreneurship in high-tech industries. “I think BRCs have not been that visible to people outside the biological research academy, so to see how significant they are is striking.”

The paper also underscores how the structure of institutions influences the dissemination of scientific research, Lerner notes. “There is a lot of talk about knowledge flow, but the mechanisms of how it works are often not well understood,” he adds. “This [paper] is a deep dive into an important mechanism to understand that process.”

Stern believes the policy upshot of the finding points toward additional backing for BRCs. “Big areas of the biological sciences can be subject to a lack of coordination that leads to lower research productivity,” he says. “But we don’t fund these institutions at all well.” As Stern and Furman point out in the paper, their results may indicate that organizations such as the National Institutes of Health (NIH) might find additional spending to expand BRCs to be more productive than simply funding additional research projects.

To be sure, in Stern’s view, there has been progress among policymakers in recognizing the extent to which scientific advances depend on previous work. (It was Isaac Newton, incidentally, who wrote that he was “standing on the shoulders of giants.”) For instance, NIH and National Science Foundation (NSF) grants now require plans for making data more accessible to outsiders. And officials in the NSF’s Science of Science and Innovation Policy unit, which quantitatively analyzes the scientific community, are aware of Stern’s findings.

“What matters is that you facilitate a transparent and open process by which people can get the materials they need at reasonable prices in an

efficient way," Stern says, "so that the process of scientific discovery itself is not slowed down."

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