# Biohacking: The next scientific revolution?

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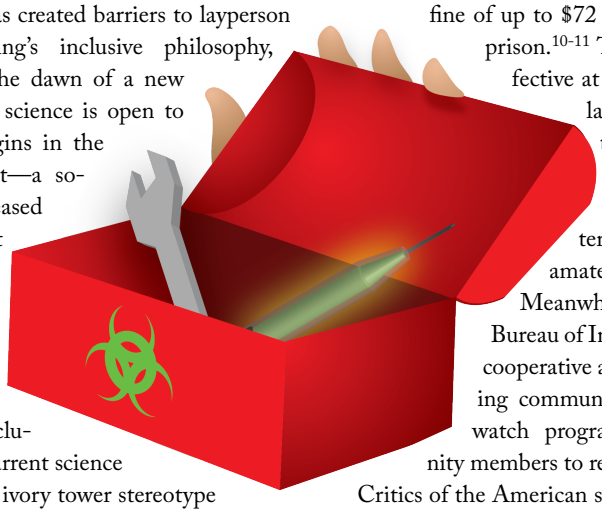
The biohacking movement was catapulted into mainstream attention when AIDS patient Tristan Roberts livestreamed a self-injection with an untested gene therapy vector.[1] Biohacking, also known as Do-It-Yourself Biology, is the technological manipulation of biological systems outside of traditional academic and industrial settings for the purposes of self-improvement, innovation, art, and political expression. Encompassing everything from dieting to the genetic engineering of bacteria, biohacking may seem to lack focus.[3] However, the movement is unified by its ethos: to bring science into the tinkering hands of the general populace.[2] Nascent and replete with biosecurity controversy, biohacking poses a challenge for policymakers.

## ORIGINS

The modern academic and industrial institutions' monopoly on science has created barriers to layperson participation. Biohacking's inclusive philosophy, however, may harken the dawn of a new era in which hands-on science is open to everyone. Since its origins in the open science movement—a societal shift towards increased layperson involvement in research—accessible resources have emerged including community laboratories, online education, and affordable equipment.[4-5] This inclusiveness may enhance current science advocacy and dispel the ivory tower stereotype through its creative and interdisciplinary approach. More lay participants may also drive innovation and competition. The flip side of decentralization is that it may reduce the reliability of results obtained by untrained researchers and devalue formal scientific education. [6]



## SECURITY AND SAFETY

In 2016, the U.S. Director of National Intelligence, James Clapper, named genetic engineering as a Weapon of Mass Destruction (WMD).[7] This decision was based on concerns that allowing non-scientists to tinker with DNA without regulation and formal training could lead to contamination, accidents, or even deliberate bioterrorism. However, contrary to the notion of a rogue bioterrorist operating out of a garage lab, 92% of biohackers carry out experiments under the watchful supervision of community laboratories. [8] Biotechnology companies have also increasingly adopted protocols for screening safe customers and gene synthesis orders.[9] Despite this progress, biosafety education remains under-addressed; almost 30% of biohackers lack a post-secondary education in biology, and they often use improvised equipment. This puts them at higher risk for accidents and contamination.[10-11]

Potential plans to address safety education may include biosafety workshops, formal lab safety certification programs accessible to non-scientists, and community enforcement of safe behaviour.

## POLICY APPROACHES

Policy approaches to biohacking have been polarizing, with extremes exemplified by Germany and the United States. Germany punishes scientific experimentation outside of registered laboratory spaces with a fine of up to $72 000 USD and 3 years in prison.[10-11] This approach may be effective at popularizing community laboratories, yet critics of the German system maintain that such punitive measures deter innovation and drive amateur science underground. Meanwhile, in the U.S., the Federal Bureau of Investigation (FBI) holds a cooperative alliance with the biohacking community via a neighbourhood watch program relying on community members to report suspicious activity.[10]

Critics of the American system question the effectiveness of this self-monitoring. Although the Code of Conduct established by the International Association of Synthetic Biology states that safety, transparency, and peaceful purposes are amongst its core values, there is little tangible community enforcement to punish violations.[11] Although the FBI also spreads awareness on legality and safety, there remains inadequate incentive to shift from garage labs to community laboratories.

## THE FUTURE OF BIOHACKING

Biohacking—with its diverse, collaborative populace, renegade philosophy, and growing community—remains a conundrum for policymakers. Realizing biohacking's potential in furthering the public good requires its proactive integration with current institutions. Ultimately, efforts to properly address pressing security and safety issues should focus on establishing more community laboratories and mandating biosafety training rather than criminalizing layperson scientific curiosity.

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