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CLASHING CODES OF CONDUCT

Asymmetric Ethics and the Biotech Revolution

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The United States is at a disadvantage in biotechnology development due to asymmetric ethical standards globally. China and Russia will exploit the existing ethical gap by investing in biotechnologies that are controversial in the United States, such as gene editing and synthetic biology. This strategy will enable these states to weaponize U.S. dependency on foreign biotech by restricting access to essential biotechnologies. They can also more rapidly pursue and adopt objectionable military capabilities, such as bioweapons or soldier enhancements.

To prevent adversaries from overtaking U.S. biotech innovation, the United States should adopt a three-step approach. First, it should formalize its guiding principles for biotechnology development and promote these ideals through international institutions. Second, it should expand upon the existing U.S.-China Program for Biomedical Collaborative Research in order to encourage the adoption of U.S. ethics practices by foreign scientists. Finally, the United States should identify biotechnologies where adversaries will have an advantage due to their regulatory environments and invest in competing ethical technologies. By adopting these strategies, the United States can shape the global consensus on acceptable uses of biotechnology and preserve its lead in biotech capabilities.

Key Findings

The last several decades of research and development in biotechnology allowed for the production of low-cost DNA sequencing and the rise of cheap gene editing tools. These technologies will enable biotech innovation to accelerate, promising rapid advancements in biotechnologies.[1] While some countries' bioethical standards may permit them to pursue controversial technologies, the United States will be restrained by its ethical practices. Countries like Russia and China may move to exploit differences in ethical standards to increase U.S. dependency on foreign biotechnologies and develop controversial military technologies.

The United States should follow a three-step approach to maintain its lead in biotechnology and shape international bioethics. First, the United States should work through the Department of Defense (DoD) to formalize its guiding principles for ethical biotechnology development. This process should mirror the DoD's effort to establish ethical principles for the development of artificial intelligence. Second, the United States should expand the U.S.-China Program for Biomedical Collaborative Research to create a consensus on acceptable bioethical practices. Finally, the Defense Advanced Research Projects Agency (DARPA) should establish a taskforce through its Biological Technologies Office (BTO) to identify biotechnologies in which U.S. ethical standards will hinder development. Then, the DoD can strategically invest not only in competing, but also ethical, technologies. By adopting this strategy, the United States will maintain its advantage in biotechnology, allowing it to lead in the creation of global bioethics.

International Divergence in Bioethics

> *Disparity in bioethics anywhere weakens bioethics everywhere.*
>
> Yangyang Cheng, *Foreign Policy*, 2018

A society's values influence its ethical practices and laws, leading to variation in standards among countries.[2] These differences in ethical practices may allow biotechnology research to advance more rapidly in some countries. Existing discrepancies in global ethics already incentivize both medical tourism and ethics dumping, in which patients and researchers travel abroad to avoid domestic regulation. As biotech innovation accelerates, this ethical gap will become apparent in more technologies and practices.[3] This ethical asymmetry will affect various technologies differently and will require a nuanced solution. While it is not the goal of this analysis to make a moral argument regarding the ethical standards of countries, it is essential to highlight how differences in standards will put the United States at a disadvantage in biotech development.

The United States: Regulation Born of Debate

Bioethics emerged in the United States during the 1960s and 1970s in response to the rise of a progressive, individualistic counterculture. The youth movement sought to challenge and refine the moral authority of the previous generation, who were blamed for the Vietnam war and rampant racial injustice.[4] Although this mindset was held by a minority, its attitudes led to new expectations about the role of technology in society, where individuals could be influenced by technology, but safe from its negative consequences.[5] A series of ethical failures, such as the infamous 1932-1972 Tuskegee Syphilis Experiment, led to a comprehensive change in the legal and ethical framework of human subject research.[6] Litigation also was an important tool during this period, as the U.S. court system formalized rights to informed consent.[7]

While patient rights, such as informed consent, are nearly universally accepted in the United States today, several biotechnologies and biomedical treatments are subject to extensive public debate. For instance, there was significant controversy surrounding the development of the cochlear implant to address deafness.[8] While some accept the innovation as an ethical attempt to remedy a disability, others argue that the unnecessary enhancement affronts deaf culture and erases deaf identity. In cases of embryonic stem cell treatment or assisted suicide, public and partisan debate interfere with patients' access to treatment and researchers' ability to study potential solutions.[9] Religion also contributes to these discussions; Judeo-Christian medical values heavily influence U.S. practices.[10] The nature of the U.S. political system also contributes to U.S. bioethical norms. Scientific achievements are subject to intense public scrutiny, with conflicting values often delaying progress.[11] While diverse perspectives are essential to policy development, less informed stances can lead to unjustified concerns and confusion about the underlying facts of the technologies.[12]

China: The "Wild East" of Biotechnology

Corruption and limited enforcement undermine China's ethical standards.[13] Its collectivist culture, in which individuals more willingly sacrifice to benefit society, is less likely to hinder research

and development.[14] Chinese cultural beliefs also grant scientists more license to work with human embryos, as Confucianism defines personhood status as only occurring after birth. This perspective fundamentally contradicts what many believe in the United States, as many Judeo-Christians grant personhood status at conception.[15] Confucianism also influences informed consent practices, permitting a family to restrict a doctor from delivering information to the patient. This practice creates a Chinese convention of "family informed consent," rather than "individual informed consent."[16] Again, this norm demonstrates a different understanding of patient consent in which China's ethical practices favor the will of the majority over the will of the individual. As a result of these cultural differences, China may be able to pursue technology that would be heavily regulated in the United States by asserting that such research is needed to benefit of society.

The nature of the Chinese political system also accelerates the pace at which biotechnology develops in China. For instance, China's surveillance state and investment in foreign companies facilitate its access to health data to improve algorithms and increase the efficiency of its biotechnology development.[17] Direct, long-term investment allows for strategic scientific advancement in biotechnology.[18] Although the Chinese Communist Party recently promoted the adoption of ethics in technology, including social credit punishments for misconduct, vague guidelines and limited public debate make consensus on ethics difficult.[19] The recent coronavirus COVID-19 outbreak also introduced new questions regarding the ethics of the Chinese government, which initially silenced concerned doctors. While China's policy has been coordinated and direct, some are concerned that their actions violate patient privacy.[20]

China will export its ethical standards to other countries as it expands its global influence. An increasing number of experts believe that China is attempting to become the global "rule-maker," including in health policy.[21] Thus, as China continues to invest in joint biotechnology research with other countries, Chinese ethics will spread. For instance, China and Russia increasingly collaborate on biotechnology projects.[22] This strategy will allow China to begin shaping global biotechnology norms, threatening U.S. leadership and creating a world in which the United States must change its ethical practices to compete in biotechnology.

Current Consequences of Variation in Bioethics

The accelerating growth in biotech capability will expand the effects of asymmetric ethics in biotechnology.[23] For instance, in 2018, Chinese scientist He Jiankui announced the birth of twin baby girls whose genes had been altered in embryo to resist HIV. The birth of the twins was the first time that human embryos with deliberate germline modifications were carried to term.[24] Should the twins live to adulthood, they will be able to pass down their modifications to their offspring. Although the centralized state allowed China to crack down immediately on what was widely condemned as an unethical experiment, there also is evidence to suggest that the government was aware of the project.[25] The announcement sparked an international debate over the ethics associated with germline editing, demonstrating the diverse attitudes on acceptable uses of these technologies. Beyond this example, the problems associated with asymmetric ethics are already present in practices such as medical tourism and ethics dumping.

- *Medical Tourism.* While insurance companies encourage U.S. citizens to travel abroad to reduce the cost of medical operations, many patients seek treatments that are not available domestically, such as assisted suicide or medications that are not yet approved by the U.S. Food and Drug Administration (FDA).[26] In 2018, more than 1.4 million U.S. citizens participated in medical tourism.[27] Medical tourism is growing considerably, with its global market size expected to reach $179.6 billion by 2026, up from $44.8 billion in 2019.[28]

  Patients may seek stem cell therapies abroad when they are not available in the United States. Embryonic stem cell use is highly controversial domestically, despite the promise of stem cell technologies in treating ailments from leukemia to Parkinson's disease.[29] Federal funding for research in the field varies drastically by administration, preventing the development of a long-term strategy on its use.[30] As a result, patients may choose to seek treatment in China, where ethical standards on embryonic stem cell research are not limited by U.S. religious or cultural beliefs.[31] China currently seeks leadership in embryonic stem cell technology and was the first country in which scientists used embryonic stem cells in a clinical trial.[32]

- *Ethics Dumping.* Ethics dumping occurs when researchers conduct research abroad in order to circumvent legal, ethical, and cost restrictions in their home country. This practice is commonplace in the U.S. pharmaceutical industry.[33] In 2011, the Department of Health and Human Services reported that the number of foreign trials for U.S. medications had increased 2,000 percent over 20 years, driven by the desire to cut costs, find willing test subjects, and avoid red tape.[34] In 2017, 90 percent of new approved therapies included testing outside of the United States and Canada.[35] The sites of these trials vary widely, including China, Eastern Europe, and India.[36] While performing clinical trials on foreign patients presents its own ethical questions, the travel of researchers abroad to test their work demonstrates a meaningful difference in scientific regulations across borders.

  Compliance with U.S. laws and ethical regulations creates unnecessary costs and burdens in drug development. For instance, companies are often unsure about which agency they report to and endure long waiting periods to bring goods to market. These burdens decrease innovation and the competitiveness of U.S. products.[37] As a result, companies seeking to cut costs have increasingly turned to testing their drugs abroad. In some cases, host countries encourage the relocation of biotech companies to their shores, as they hope to invest in high-tech innovation. However, this investment is accompanied by conditions requiring companies to transfer their technologies and data to their new hosts.[38]

Peer Competition in Biotechnology

> *The country that once led the world in inventing technology's future, in other words, now risks lagging behind, especially given China's planned increases in investment.*
>
> Susan Hockfield, *The Age of Living Machines*, 2019[39]

China and Russia are interested in developing biotechnology to rival the United States, and both have ethical standards that will spur rapid innovation. This challenge to U.S. leadership is

becoming increasingly time-sensitive, as the decreased cost of sequencing the human genome and the development of cheap gene editing tools will allow biotechnology to proliferate.[40] Indeed, the global biotech market is expected to increase from $417 billion in 2018 to $795.7 billion by 2026.[41]

Chinese Investment

China identified biotechnology as an investment priority in its 13th Five-Year Plan and 'Made in China 2025' policy. The country expects its biotech industry to exceed 4 percent of its GDP by 2020.[42] Although the Chinese market is still less than one-tenth the size of the U.S. biotechnology market, it has expanded rapidly, growing at an average annual rate of 15 percent during the 12th Five-Year Plan.[43] Motivated by demographic changes and rising healthcare costs, Beijing directed over $600 million annually to biotechnology research and development, pioneering the genetic engineering of various plants, mammals, and even humans.[44] Experts estimate that government expenditures combined with relaxed regulatory barriers will help maintain the upward trend in the Chinese industry.[45] While many of these experiments have been proof-of-concept efforts, their controversial nature has prevented them from being undertaken outside of China. This investment challenges the United States' leadership in biotech innovation and share of the global market.[46]

Chinese investment in the U.S. biotechnology sector is also increasing rapidly, growing 187 percent in 2017 alone.[47] Specifically, China is investing in U.S. antibody and protein therapeutics, gene and cellular therapy, and general biopharmaceuticals.[48] While most investment appears to be from private Chinese actors seeking financial returns, strategic investing also is occurring, as the Chinese government influences company decisions through regulatory approvals and coercion.[49] Although both U.S. and Chinese biotechnology sectors benefit from this investment, there are persisting concerns over intellectual property theft.[50] For instance, China gained access to patented biotechnology and gene sequencing equipment intellectual property rights by investing in U.S. biotechnology companies. Further, in 2013, the Beijing Genomics Institute acquired the U.S.-located Complete Genomics, granting them access to "gene sequencing equipment intellectual property rights, and the development of domestic equipment production."[51] Despite these concerns, some criticize recent legislation regulating foreign investment in biotechnology, arguing it is a threat to U.S. innovation.[52] Nevertheless, this investment demonstrates China's desire to lead in the biotech field, as well as build on the innovation currently occurring in U.S. biotech.

According to some experts, China may soon surpass the United States as the leader in technology, threatening U.S. economic interests.[53] While technological advances tend to diffuse and provide wider economic benefits in the long term, it is possible that the barrier to delayed market entry could be particularly high in the short term. A delay in development as a result of ethical practices could limit the United States' ability to compete in emerging biotechnology.[54] Thus, if the United States' ethical regulations prevent early investment in emerging biotechnologies, it is possible that directed Chinese investment could prevent U.S. market access and limit the sector from attracting U.S. private investment. In fact, China has already used this strategy to undercut U.S. industry, preventing U.S. private investment and production of solar panels.[55]

Russian Investment

Although Russia is lagging in the race for biotech innovation, it too has expanded its investment in biotechnology. In 2019, Russia established the Council for Biotechnology Development to coordinate biotech policy and industry development.[56] Russia also created three platforms to advance biotechnology, titled Bioenergy and Bioresources (Biotech 2030), Medicine of the Future, and Bioenergy.[57] Early in 2012, Russia adopted "The Comprehensive Program for Development of Biotechnology in the Russian Federation through 2020," which attempted to address Russia's lag in biotechnology development and use.[58] Overall, these plans demonstrate a willingness to engage in biotechnology, but difficulty achieving their goals due to economic stagnation.[59]

Russia also increased collaboration with China in technology and military sectors, gaining access to biotechnologies that they were unable to produce on their own.[60] In 2018, a joint investment fund between Russia and China financed the creation of Russia's largest biotech lab, which was designated to study genetic and molecular research.[61] By working together to overcome their countries' weaknesses, Russia and China could be cultivating a tech and economic relationship to challenge U.S. strength in biotechnology.[62]

Implications of Asymmetric Bioethics

> *Research in genome editing conducted by countries with different regulatory or ethical standards than those of Western countries probably increases the risk of the creation of potentially harmful biological agents or products.*
>
> James Clapper, *Former US Director of National Intelligence*, 2016[63]

Rapid biotech innovation will create several security challenges for the United States. Countries with different ethical practices could more rapidly develop innovative drugs and biotech capabilities, increasing U.S. dependency on foreign supplies of medications and treatments. They also will be better positioned to develop and deploy military biotechnologies, including bioweapons and human enhancement technology. While the timelines of these threats vary by technology, addressing them will require long-term, dedicated effort.

Weaponized Dependency

By subsidizing and expediting research and development in biotechnologies, China could increase its chokehold on global medicine, causing the United States to become further dependent on its rival for lifesaving treatments. Already, China dominates the generic prescription drug market.[64] During the recent U.S.-China trade war, U.S. policymakers were concerned that China would disrupt the supply of essential medications.[65] These concerns have been echoed during the COVID-19 outbreak, as the likelihood of antibiotic shortages in the United States increased due to dependence on Chinese production.[66] China seeks to expand its hold on the biopharmaceutical industry by revising its regulations and product approval system to expedite and incentivize drug innovation, rather than specializing in the generic market.[67] The 'Made in China 2025' policy establishes specific targets for the number of firms certified for exports and number of

technological breakthroughs expected.[68] By shifting from generics to innovative drugs, China could close the gap in medical biotech with the United States, increasing U.S. dependency on foreign drugs.[69] China could later leverage this dependency against the United States, actualizing a fear expressed during the recent trade war.[70]

China also faces fewer restrictions as it addresses the global organ shortage. While an estimated 300,000 Chinese patients are in need of a transplant, only 16,000 are likely to be completed.[71] Until recently, China was able to reduce this disparity by harvesting organs from criminals sentenced to death. However, international pressure forced China to curb the practice, leaving a wide gap in available organs.[72] To confront this concern, Chinese researchers have turned to the biotech arena, developing ways to grow human organs in other mammals, such as pigs or monkeys.[73] While scientists conduct similar research in the United States, ethical regulations only authorize the chimera embryos to grow for one month. In China, however, a pig-primate chimera was carried to term. Spanish scientists have also traveled to China to avoid domestic regulations and create human-monkey hybrid embryos.[74] By permitting the research and development of these controversial gene-editing experiments, China positions itself as a key actor in redressing the global organ shortage, granting it significant influence internationally.

The Russian Ministry of Industry and Trade also is interested in developing the country's pharmaceutical capabilities.[75] The government body designed a Pharma 2030 initiative, which strives to achieve medicine security.[76] As a result, Russia is focusing on domestic production of medications, including biopharmaceuticals.[77] Given the low cost of clinical trials and easily available subject pools in Russia, the Russian drug development process is faster compared to the United States.[78] Should Russia succeed in its efforts to develop its own innovation sector, U.S. superiority in pharmaceutical innovation could be challenged. Russia also is collaborating with China to develop its biopharmaceutical capability forging a new high-tech partnership.[79] This coordinated investment and sharing of ethical norms could allow Russia and China to overtake U.S. biopharmaceutical development.

Controversial Military Capability

Both the Russian and Chinese militaries are investing in biotechnology. For instance, the Chinese People's Liberation Army has invested in gene editing and human enhancement technologies. In the 2017 edition of *Science of Military Strategy,* the textbook for the PLA's National Defense University, China identified biology as an arena for military engagement.[80] The Chinese Communist Party also is adept at acquiring medical data both at home and abroad, which enables them to create better algorithms and achieve faster advancements in gene-sequencing.[81] The Chinese can use this military investment to generate and adopt military biotechnology more rapidly than the United States.

Russia's military is also interested in applications of biotechnology. While the United States collects DNA from soldiers to identify their remains if they are killed in battle, the Russian military takes genetic testing one step further by tailoring soldier assignments based on their genetic profile.[82] While it is unclear if this method of assignment will reap significant benefits for the Russian military, the "Genetic Passport" raises many concerns regarding privacy and racial

profiling, making it unlikely to gain support in the United States.[83] There also is significant speculation on the extent of Russian bioweapons development. While there is no concrete evidence that the former Soviet bioweapons development program still exists, the infrastructure of the program is still usable. Researchers also discovered an increase in Russian disinformation campaigns hinting that the United States is failing to comply with the Biological Weapons Convention (BWC). Russia could capitalize on these allegations to justify its own treaty violations.[84] Based on these trends, experts demand increased transparency from the regime.[85]

There are two categories of military technology in which the United States may be hindered by its ethical practices: bioweapons and human enhancement. Given the demonstrated interest of both China and Russia in such biotechnologies, Washington must recognize U.S. disadvantages in these areas and formulate policy to maintain its current lead.

- *Bioweapons.* In 2019, the U.S. House Homeland Security Subcommittee on Emergency Preparedness, Response, and Recovery argued that the United States is not prepared to respond to a biological attack.[86] Thus, differences in ethical standards and compliance with international bioweapons norms remain a significant concern.[87] Most states are party to the BWC, which seeks to prevent signatories from developing and using bioweapons. However, the agreement's lack of enforcement mechanisms make it impossible to determine signatory compliance.[88] Given the dual-use nature of biotechnology, biodefense programs also generate concern that states could be developing bioweapons.[89] New gene-editing tools make it easier and more cost efficient to edit and invent pathogens. The National Academies of Sciences, Engineering, and Medicine identified this capability as a matter of highest concern.[90] Under-enforcement may provide space for countries to explore the development and use of biological weapons, eroding the norms against the their use.[91] States could turn to bioweapons if other options are limited, as the weapons are comparatively low cost, difficult to attribute, and have the potential for widespread impact.[92]

  Gene-editing also creates the possibility for states to use gene drives as a weapon. By modifying an organism to spread a desired trait through its population, gene drives have the potential to be weaponized to spread disease or destroy a population of key species.[93] While the U.S. military is currently investing in this technology to serve as a protective measure against those who would seek to harm U.S. agriculture, the program emphasizes its safety procedures and affirms that it does not fund open release of the developed organisms.[94] Alternatively, countries with different bioethical standards, regulation, and enforcement may be more likely to intentionally or accidentally release a gene drive, leading to significant and unexpected consequences.

- *Human Enhancement.* While the U.S. military is likely to pursue and adopt human enhancement technologies, their ability to compete with countries whose ethical practices and regulations may allow for rapid development of this technology is unclear. A new study from AARP Research demonstrates that the U.S. population is concerned about the adoption of human enhancement technologies, particularly those associated with cognitive ability and gene editing.[95] The public will require extensive oversight and regulation to ensure appropriate use of these technologies. This policy will slow their adoption in the

United States compared to other countries with different ethical and legal practices. As a result, the military will find it difficult to compete in enhanced soldier capabilities.

Biotechnology innovators hope to provide soldiers with advantages ranging from disease resistance to enhanced cognition.[96] However, the United States may develop these technologies at a disadvantage, while adversaries rapidly proceed without adhering to U.S. ethical or legal standards.[97] This ethical framework can influence even nonpermanent enhancement technologies. For instance, during the Soviet invasion of Afghanistan from 1979 to 1989, Soviet soldiers were unknowingly given Meldonium, a drug used to increase endurance and oxygen-carrying capacity.[98] Although the use of this medication may not have provided long-term benefits to the Soviet military, it demonstrates the willingness of potential adversaries to forgo the consent of their soldiers and use biotechnology to achieve short-term goals.[99] Given this demonstrated willingness to allow and encourage the use of enhancement technologies, U.S. soldiers may be required to compete with soldiers who, from the U.S. perspective, are unethically enhanced.[100]

Recommendations

It will be increasingly difficult for the United States to compete in a world that does not share its bioethics. However, this dilemma does not need to result in a 'race to the ethical bottom.' Rather, the United States should continue ethical biotechnology development.

To influence international bioethics and maintain its lead in this key technology, the United States should adopt a three-step approach. First, the DoD should formalize guiding principles for ethical biotechnology development. Second, the United States should expand on the current, NIH-run U.S.-China Program for Biomedical Collaborative Research in order to generate international consensus on bioethics. Finally, DARPA should create a taskforce through the BTO to identify technologies in which U.S. ethical standards will hinder its technology development.

Although a 2019 Report by the U.S. Army Combat Capabilities Development Command Chemical Biological Center contends that ethical attitudes of China and Russia towards developing technologies have not been verified, the practices of medical tourism and ethics dumping suggest that their bioethics differ from those in the United States.[101] As a result, it is imperative that the United States address this asymmetric ethical framework. The United States should adopt these proposed solutions while these technologies have yet to mature, allowing it to use its current lead in biotech to shape and formalize international bioethics. By investing in U.S. biotechnology today, the United States can prevent a costly future in which it is outpaced by its peers in this key technology.

Formalize and Promote U.S. Bioethical Standards

In order to effectively influence global bioethics, the United States should formalize its guiding principles in biotech development. The DoD should replicate its process for formalizing guiding ethics for the use of AI in combat and non-combat environments. In 2019, DoD tasked the Defense

Innovation Board to meet with AI experts, academics, ethicists, lawyers, human rights experts, and business leaders to research and create its guiding principles for AI development.[102] The DoD should take a similar approach to develop guiding principles for the development of biotechnology. By creating public goals, limits, and ethical guidelines for biotechnology development, the United States can guide the domestic public and private sectors in conversations on bioethics. A clear set of guiding principles will also grant the United States leverage to consistently condemn international violations and will serve as guidelines for countries developing their own bioethics. Furthermore, the principles will be particularly useful while these technologies are young, as it will help states manage the development of these technologies.

In order to promote these standards, the United States should additionally re-engage with the U.N. Educational, Scientific, and Cultural Organization (UNESCO). The United States' perspective is underrepresented in the current U.N. Inter-Agency Committee on Bioethics given the its decision to withdraw from UNESCO, which is a key player in the U.N. Inter-Agency Committee on Bioethics. UNESCO also created the International Bioethics Committee (IBC), which serves as the only global forum for bioethics.[103] By re-engaging with UNESCO, the United States would have a legitimate platform to engage with international bioethics. While it is generally accepted that developed states are unlikely to follow recommendations published by UNESCO, developing states still rely on the organization for guidance in establishing their own bioethics, making this an important step in formulating global norms.

Create Consensus Through Collaboration

The NIH should next increase collaboration with China through the U.S.-China Program for Biomedical Collaborative Research.[104] The NIH should expand this program to include culturally conscious training on bioethics and increase exposure of foreign scientists to U.S. ethical standards. Simultaneously, this strategy would invigorate the U.S. biotechnology industry. Industry leaders support this tactic, as the current targeting of Chinese researchers and students by U.S. funding and immigration has created a climate of fear that will ultimately hurt the domestic biotechnology industry.[105] Instead, the industry advocates for U.S. leadership in collaboration as the best way to ensure the national interest.[106] This solution would require the NIH to continue their work addressing intellectual property theft, making participation guidelines and requirements clear to international researchers.[107]

Stimulate Ethical Bio-Innovation Domestically

DARPA should establish a task force through the BTO to identify specific technologies where the United States will lag in biotechnology development as a result of ethical regulation. The DoD can then invest in competing, but still ethical, technologies. By investing in alternative biotechnology, the United States will be able to maintain leadership in biotech, as well as minimize the gap in capabilities that may result from the asymmetric ethics among countries.

This step will allow U.S. biotechnology to thrive without excessive foreign funding by focusing domestic support on local businesses.[108] Thus, U.S. companies can turn to Washington for funding,

rather than foreign funding, decreasing the risk that China will gain an advantage from forced technology transfer. Increasing domestic support through DoD investment has precedent in the manufacturing sector. In the National Defense Authorization Act for 2019, Section 846 created a Defense Manufacturing Communities Support Program with the goal of making "long-term investments in critical skills, facilities, research and development, and small business support in order to strengthen the national security innovation base."[109] In this way, the aerospace and shipbuilding industry were bolstered, and the United States worked to create stable defense supply chains. By following a similar protocol, the United States can target biotechnology innovation through strategic investment.

Finally, this strategy will allow the United States to counteract investor hesitancy in biotechnology. Already, DARPA plays a significant role in the biological sciences, as the field's high-risk nature disincentivizes private investment in biotechnologies.[110] Specific investment in ethical technologies of interest will be essential to maintain U.S. leadership in biotechnology and compete in an environment that does not share U.S. bioethics.

Conclusion

> *To advance human good and avoid harm, biotechnology must be used within ethical constraints. It is the task of bioethics to help society develop those constraints and bioethics, therefore, must be of concern to all of us.*
>
> Dr. Edmund Pellegrino, *Former Chairman of the President's Council on Bioethics*[111]

Asymmetric ethics among countries will put the United States at a disadvantage when competing in biotechnology. Countries like China and Russia will be able to better pursue controversial biotechnologies as a result of their ethical standards. This gap could allow these countries to weaponize U.S. dependency on foreign biotechnology and put the U.S. military at a disadvantage.

Biotechnology has been identified by the Worldwide Threat Assessment as an economic, military, ethical, and regulatory challenge.[112] However, this problem is more than simply the technology. The asymmetric ethical framework is critical to understanding the threat that biotechnology poses to the United States. To avoid a gap in technological capability as a result of an ethical discrepancy, the United States should formalize its own bioethical standards, increase collaboration in research with countries of concern to normalize its ethical practices, and invest in ethical biotechnologies. By implementing this strategy, the United States will be able to guide international bioethics and promote its own innovation, minimizing the gap between U.S. biotech capabilities and those of countries with different practices.

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[1] Sean Harper and Beth Seidenberg, "Why Now is the Golden Age of Biotech," Westlake Village Biopartners, last modified February 4, 2019, http://westlakebio.com/why-now-is-the-golden-age-of-biotechnology/; Susan Hockfield, interview by Hope Reese, *Five Questions for Susan Hockfield: The Dawn of the Biotech Revolution,,* Undark, May 17, 2019, https://undark.org/2019/05/17/five-questions-for-susan-hockfield-biotech-revolution/.

[2] Cortney Weinbaum et al, "Ethics in Scientific Research: An Examination of Ethical Principles and Emerging Topics," *RAND Corporation,* 2019, https://www.rand.org/content/dam/rand/pubs/research_reports/RR2900/RR2912/RAND_RR2912.pdf According to the American Medical Association's Code of Ethics, ethical responsibilities should be of the highest priority. For this reason, it is important to recognize and study the differences in ethics, rather than the differences in laws, between countries. However, for the purposes of this paper, it is recognized that the same cultural values that lead to the development of ethical practices are often reflected in a country's laws, so there is significant overlap.

[3] "Top Ten Bio Convergence Trends Impacting the Future Operational Environment," Mad Scientist Laboratory, Tradoc Army, last modified March 8, 2018, https://madsciblog.tradoc.army.mil/31-top-ten-bio-convergence-trends-impacting-the-future-operational-environment/. While the focus of this paper is on the implications of asymmetric ethics in biotechnologies, the asymmetric ethical framework applies to other emerging technologies as well. For instance, different ethical standards on privacy may affect the development and use of artificial intelligence.

[4] Jeremy R. Garrett, Fabrice Jotterand, and David Cristopher Ralston, *The Development of Bioethics in the United States*, (Dordrecht; New York : Springer, 2013), 88-91.

[5] Ibid.

[6] Ibid, 174-75; "How Tuskegee Changed Research Practices," *CDC*, last modified December 14, 2015, https://www.cdc.gov/tuskegee/after.htm. Past ethical failures may limit the credibility of the United States in global bioethical discussions.

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