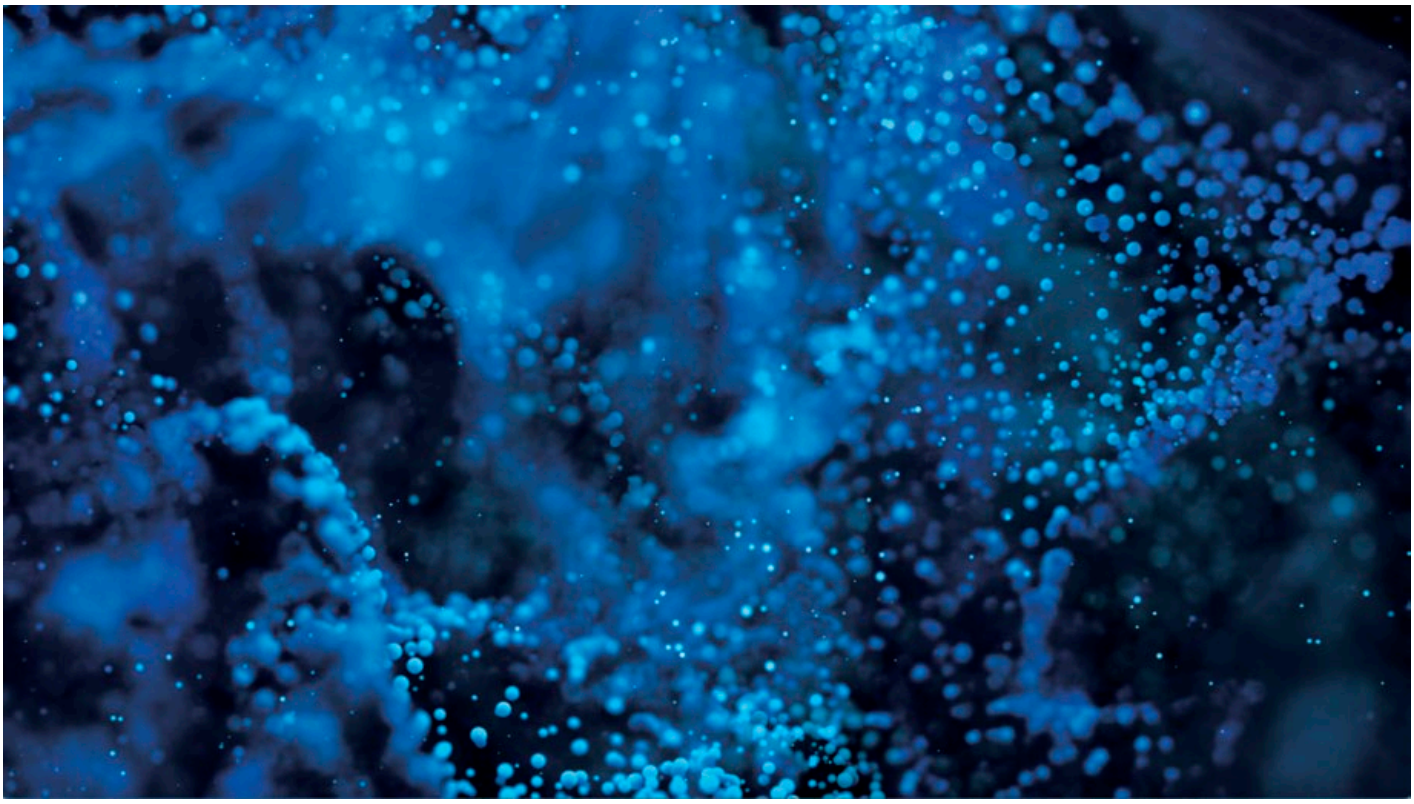
# FORUM

*Issues* regularly receives numerous letters from readers responding to our articles. We print some of them here. A complete collection can be found in our online Forum: https://issues.org/section/forum/.



REBECCA RUTSTEIN and the Ocean Memory Project, *Blue Dreams*, 2023, still from the 2 minute and 40 second digital video.

## HOW OPEN SHOULD AMERICAN SCIENCE BE?

In "The Precarious Balance Between Research Openness and Security" (*Issues*, Spring 2023), E. William Colglazier makes an important contribution to the ongoing dialog about science security, and particularly regarding the United States' basic science relationship with China. As a former director of the Department of Energy Office of Science, I agree with his assessment that rushing to engineer and implement even more restrictive top-down controls on basic science collaboration could be counterproductive, especially without a thoughtful analysis of the impact of the actions that already have been taken to thwart nefarious Chinese behavior.

In our personal lives, we instinctively understand when a relationship is not mutually beneficial and when we are being taken advantage of even when the rules are vague. It is true that the government of China, previously operating from a position of weakness, has pursued a coordinated and comprehensive strategy to harvest US scientific and technological progress and talent through a variety of overt and obscured means. This is frustrating and not sustainable, not least because China is no longer the same techno-economic junior partner it once was. In response, the United States has taken some substantial administrative and policy actions designed primarily to shed light on relationships and conflicts of commitment in sponsored work and in government laboratories, but also to signal a meaningful change in our willingness to be taken advantage of. These are recent developments, and the effects are as yet not understood.

Looking again to our personal, human experience, cutting off contact and refusing to talk even in a difficult relationship is a defensive posture not

# BLUE DREAMS REBECCA RUTSTEIN AND THE OCEAN MEMORY PROJECT

Installation photo by Kevin Allen Photo.

*Blue Dreams* is an immersive video experience inspired by microbial networks in the deep sea and beyond. Using stunning undersea video footage, abstract imagery, and computer modeling, the work offers a glimpse into the complicated relationships among the planet's tiniest—yet most vital—living systems. The video installation flows between micro and macro worlds to portray geologic processes at play with microbial and planetary webs of interactivity.

Microbes are essential to the functioning of the Earth: they produce breathable air, regulate biogeochemical cycles, and are the origins of life on this planet. *Blue Dreams* aims to offer a unique and thought-provoking perspective on the interconnectedness and sublimity of the natural world.

*Blue Dreams* evolved from a year-long collaboration between its five contributors—Rika Anderson, Samantha (Mandy) Joye, Tom Skalak, Shayn Pierce-Cottler, and Rebecca Rutstein—through a grant from the National Academies Keck Futures Initiative's Ocean Memory Project. Anderson, an environmental microbiologist at Carleton College, advised on marine microbial adaptation and resilience, microbial gene sharing networks, and the implications for exoplanet science and astrobiology. Joye, a marine biogeochemist at the University of Georgia and explorer of diverse deep-sea environments, provided insight into the biogeochemistry of vent and seep systems, and the interplay of microbial networks with large-scale ecological processes. Skalak, a bioengineer, provided overall conceptual vision and insight into methods for abstracting the data into system models, including agent-based simulations that could provoke visualization of swarm and collective behaviors. Peirce-Cottler, professor of biomedical engineering at the University of Virginia, created agent-based models of deep-sea microbial growth patterns generated from patterns of original Rutstein paintings. And multidisciplinary artist Rutstein researched, synthesized, abstracted, and layered imagery, animation, video, and sound to create *Blue Dreams*.

**This exhibition runs through September 15, 2023, at the National Academy of Sciences building in Washington, DC.**

## ABOUT THE OCEAN MEMORY PROJECT

By investigating the interconnectivity of the ocean and its inhabitants at different time scales, the Ocean Memory Project, a transdisciplinary group spanning the sciences, arts, and humanities, aims to understand how this system possesses both agency and memory, and how it records environmental changes through genetic and epigenetic processes in organisms and through dynamic processes in the ocean structure itself. The Ocean Memory Project was born out of the National Academies Keck Futures Initiatives interdisciplinary conference, "Discovering the Deep Blue Sea," held in 2016.

consistent with competitive strength or confidence. Moreover, a reactive strategy of shutting doors and closing windows in an attempt to maintain science and technology leadership betrays a lack of understanding of the fungibility of talent in an increasingly educated world, the almost instantaneous and global flow of science and technology knowledge, and the vastly improved intrinsic science capabilities of China.

I believe that instead of defensive measures, the only effective long-term strategy in this race for global science and technology primacy is to out-invest and out-compete. Given transparent scientific relationships not motivated by easy access to resources, we also should not be afraid to work with anyone and particularly in basic research. We benefit from collaboration in part because we generally learn as much as we teach in a meaningful scientific exchange, and in part because our open and confident engagement is a fantastic advertisement for the attractiveness and effectiveness—and, in my opinion, the superiority—of our system and culture of science and technology.

The cost to US science and technology competitiveness and the flow of indispensable new talent of a regime of distrust or punitive control may well be greater than any theft of ideas or emigration of expertise, and disengaging and therefore blinding ourselves to a nuanced understanding of where our increasingly capable competitor is in this global science race may likewise hurt rather than help. Perhaps we should evaluate the effects of the new legal and policy adjustments we have made already, reconsider our end goals, and understand better the costs versus benefits before making further adjustments to the openness of the United States' amazing engine of science and innovation.

**Chris Fall**
Former Director (2019–2021)
US Department of Energy's
Office of Science

I am sympathetic to the familiar and well-reasoned arguments that E. William Colglazier makes, but I can't shake the feeling that reading his essay is like watching a parade of antique cars on the 4th of July.

The US scientific research community, overwhelmingly funded by the federal government and mostly resident in universities, is reeling from increased government scrutiny of its international engagements. Colglazier's arguments and recommendations are thoughtful, responsible pushback against that scrutiny eroding the value—to the United States—of science diplomacy and international scientific engagement. This is all to the good, but hitting the right balance of openness and protections in international scientific collaboration is a sideshow to the center stage events affecting US commercial and defense technological leadership.

These main events are the struggles, both within and among nations, over the role of advanced technologies and innovation—driven in the democracies primarily by private companies—in a new world order of economic and military competition, confrontation, and collaboration (among allies). For the United States, the events center around the pluses and minuses of export controls of advanced commercial products used as sanctions; the impact of technologically advanced multinational companies on US technological sovereignty; government reviews of inbound and outbound foreign direct (private sector) investments; and legislation such as the Inflation Reduction Act, which through its buy American provisions punishes innovative companies operating from nations that are long-standing national security allies.

In the closing sections of his essay, Colglazier argues for leadership from the National Academies and professional societies for more personal cross-border engagement among researchers and government security and research officials. This is a good idea and may help protect the cross-border scientific research enterprise from the worst excesses of government scrutiny and oversight. But the voices that most need to be heard to navigate the current challenges are from the private sector, published more often in the *Financial Times* and the *Wall Street Journal* than in more narrowly targeted journals such as *Science* or even *Issues in Science and Technology*.

Take, for example, the recent interview with the CEO of Nvidia published in the *Financial Times*. In commenting on the recent US prohibition on domestic companies from selling artificial intelligence computer chips to China, he pointed out that "If [China] can't buy from … the United States, they'll just build it themselves." This reveals a fundamental underlying characteristic of the new world order in which commercial and defense R&D and innovation capability is already widely distributed around the world. A simple, seemingly reasonable action to protect US "technological leadership"—drawn from the antique car/Cold War era of US technological dominance—could easily have the exact opposite effect of that intended.

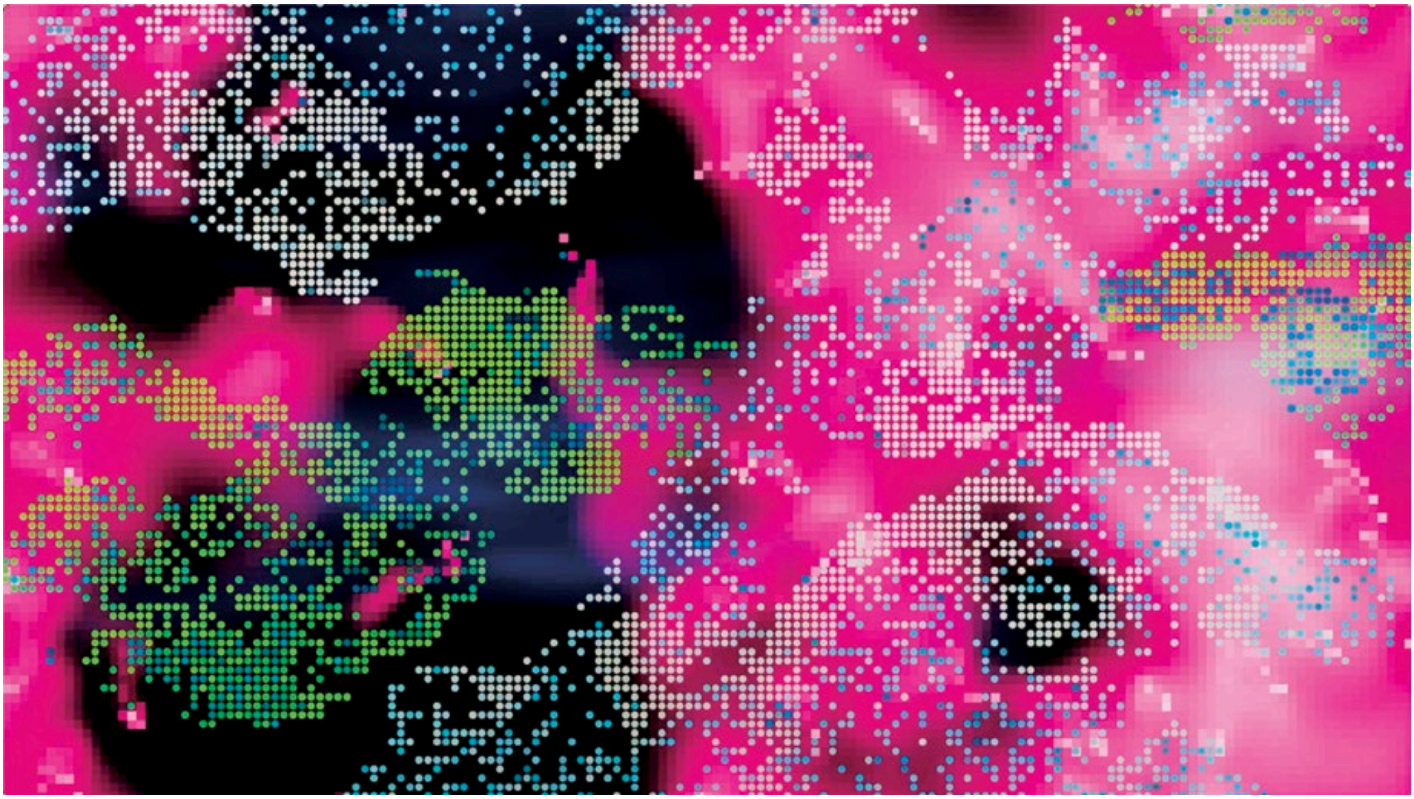
I'd argue that we need a new playbook for commercial and defense international R&D engagement that can live alongside the traditional playbook of science diplomacy. The Biden administration is moving in that direction, by relying heavily on the National Security Council to coordinate the activities of groups such as the National Science Foundation and the National Institutes of Health with the Departments of Commerce and Defense. In responding to current technological challenges in international economics and geopolitics, balancing openness and protection in government-supported international scientific research (and the cross-border activities of universities) is part of the show, but it is not the main event. That role falls to the cross-border activities and collaborations of companies, albeit enabled or impeded by a wide variety of regulation by governments.

**Bruce Guile**
The Applied Research Consortia (ARC) Project

E. William Colglazier offers a critical assessment at a very important time. Almost a decade of scientific exchange between the United States and Russia has been curtailed following Russia's invasion of Ukraine. Over the past half a decade or so, the same is happening with China and several countries in the Middle East. Even US collaborations with friendly allies have become increasingly difficult when risks are perceived differently. Data that US research organizations might normally share freely or develop commonly with collaborators might now be blocked if the parties don't share the same point of view. In this context, I would like to add a few thoughts to the author's excellent description of international collaborations.

First, it is imperative to understand and accept the arguments from the proponents of more research security as well as the defenders of unquestioned openness. They are both valid and need to be listened to. But a word I would add to the conversation on how to move forward is "trust." There must be trust that the research enterprise and principal investigators want to protect what is important to the United States, especially when we see a potential collaborator doing the opposite. Today, the consensus that international collaborations provide benefits is questioned. At the same time, the science community has lost at least some of this trust—otherwise we would not be having these conversations.

The dialogue around protection and trust must engage those at the forefront, in addition to occurring



*Blue Dreams,* 2023, digital video still.

within expert panels and small group discussions. Principal investigators must be provided with opportunities to gain enough information to help them understand any potential risks going forward and get trained in how to deal with them. Or they or their institutions may decide not to pursue a project further. In this matter, there are ideas being explored at the National Science Foundation and elsewhere to provide such platforms for information exchange—and we should all wholeheartedly support those efforts. If home organizations prescribe how to manage the risk, they should take responsibility for the outcome as well—good or bad. As always, authority and responsibility have to line up, independent of what system of control is chosen. Since the research enterprise, the government, and companies and groups in the private sector all benefit from international collaborations, they should also share the risk.

Lawmakers, science funders, and managers of the US research enterprise must understand the opportunity cost of not collaborating, or the nation will be overwhelmed by surprises, underwhelmed by progress, and forced to scramble. Every time I attend a conference in Europe, I learn about progress in emerging technologies happening in countries we have curtailed scientific exchange with. After a few years of learning only second hand, even in the small slice of science and technology I'm engaged in, it is increasingly scary. There are more and more things we don't know. Not seeing means not knowing. I share this experience with many colleagues and it underlines the urgency to restart international collaborations in both directions, albeit with controls applied.

Colglazier concludes that there is "no need to fundamentally change a strategy that has benefited our country so greatly." Almost 80 years of success supports this statement, as do I. But in every collaboration it takes two to tango. If one side changes the rules of engagement, the answer shouldn't be to not collaborate, but to establish a security culture that allows a measured approach.

**Norbert Holtkamp**
Science Fellow, Hoover Institution
Stanford University

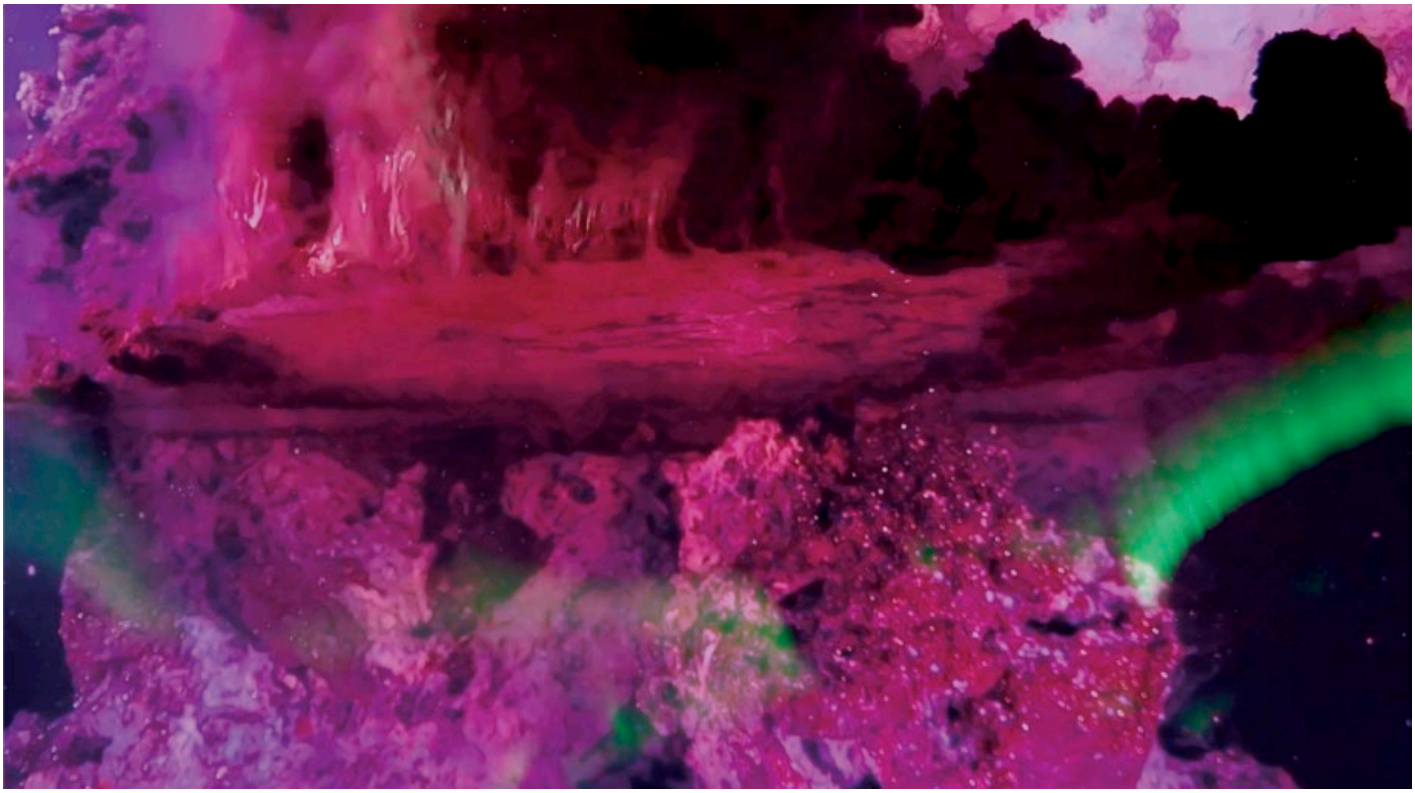
E. William Colglazier rightly points out that scientific cooperation was viewed, 40 years ago, as a low-risk path to strengthen the US-China relationship. The shift in risk assessment from low to high over the decades resulted from China's successful commitment to building a world-leading science and technology sector. However, the solution to the challenge that China now poses for the United States is vastly more complicated than one crafted for dealing with the Soviet Union in the early 1980s.

*Blue Dreams,* 2023, digital video still.

US views on China have shifted rapidly. Imputing nefarious motivations to China, casting its researchers and students as part of a "whole nation" enterprise set on taking advantage of naïve American benefaction, differs markedly from the position espoused just a few years before. In 2010, US cooperation with China was noted by President Obama to be beneficial to the United States. By 2018, cooperation was viewed with suspicion, and China's policy initiatives were met with accusations of fomenting everything from intellectual property theft to industrial espionage. The swift change in rhetoric, from China as a partner to an adversary, suggests political purposes rather than any change in the benefits of scientific cooperation. Chinese nationals and those working with them began to be prosecuted. Noting the change in underlying political atmospherics, cooperation between the two nations began to drop even as US cooperation with Europe was sustained.

Similar to the US relationship with the former Soviet Union, the current views on China, reminiscent of the "Red Scare" and xenophobia, were and are internal to the United States. These views are depriving US research and development of potential benefits of cooperation. Unlike the conditions of global research at the time of the 1982 Corson report, which Colglazier cites, when the United States dominated world science, China is now fully capable of finding alternative sources to working with us. Perhaps it was possible during the Cold War to "contain" the knowledge sector, but in the globalized world of the 2020s, where as much as one-third of all published research is multinational in origin, cutting off China serves mainly to redirect it to working with other scientifically advanced nations.

There is an unstated sense of betrayal in Western nations that scientific cooperation has not resulted in China's political liberalization. The Enlightenment view posits an inextricable link between science and democracy. "Freedom is the first-born daughter of science," said Thomas Jefferson, declaring that the enlightened citizenry participates in an ordered governance. In 1978–79, many US scientists and policymakers thought that if we would open our country to Chinese students and scholars, as President Jimmy Carter offered to China's then president Deng Xiaoping, they would return home with new values more aligned with ours. Behind the science and technology agreements and the welcoming of more than 5.2 million students was the unspoken assumption that the United States would gift China with science, that science would enhance prosperity, and



*Blue Dreams,* 2023, digital video still.

that from this would spring a more open, more market-led, and more liberal China.

That this did not occur may cause some observers to reevaluate the relationship between science and government. However, to respond by betraying a core US value of openness does more damage to US science and technology than it does to China. It also does tangible damage to the bilateral relationship, making it much more costly than any sense of security that may ensue. With the asymmetries of the past.

**Caroline S. Wagner**
Professor, John Glenn College of Public Affairs
The Ohio State University

**Denis F. Simon**
Professor, Kenan-Flagler Business School
University of North Carolina at Chapel Hill

## REGULATIONS FOR THE BIOECONOMY

In "Racing to Be First to Be Second" (*Issues*, Spring 2023), Mary E. Maxon ably describes the regulatory challenges to the emerging bioeconomy in the United States. The Biden administration has recognized explicitly the transition from a "chemical" economy to one in which inputs, processes, and products are largely the result of "biology," and has chosen to help facilitate that transition.

The United States regulates products, not technologies. The regulatory paths these products take are defined by their intended use or "regulatory trigger" (i.e., the legal concept determining whether and how a product is regulated) regardless of manufacturing method. Intended use has generally been a good guide in determining which agency has primacy of regulatory oversight, as envisioned in the federal government's Coordinated Framework for the Regulation of Biotechnology, first issued in 1986.

Almost 40 years on, one questions if that is still the case. To paraphrase the Irish playwright and political activist George Bernard Shaw, regulators and the regulated communities are divided by a common purpose—the safe, effective, and yet efficient introduction of products into commerce. Some of these have traversed the regulatory system slowly, but under the aegis of one agency; others have been shuttled among agencies asking approximately the same risk questions. Duplicative regulation rarely provides additional protection; instead, it can make a mash of policy that can undermine public confidence. It further poses enormous costs to manufacturers and the chronically under-resourced and over-burdened regulatory agencies. And we have yet to find a way to estimate

the direct costs and externalities of not developing the bioeconomy.

The examples that Maxon and others cite are products first developed over 20 years ago. What fate will befall products still "on the bench" or yet to occur in their inventors' minds? Many participants in the field, me included, have advocated for the creation of a "single door," possibly placed in a proposed bioeconomy Initiative Coordination Office, through which all (or almost all) products of the bioeconomy would be directed to the appropriate lead agency. Additionally, proposals have been floated to cross-train regulators, developers, funders, and legislators, possibly via mid-career sabbaticals or fellowships, about the various facets of the bioeconomy so that all are better prepared for regulatory oversight. These two steps could provide a mechanism for charting an efficient and transparent regulatory path. They will, of course, require nontrivial effort and coordination among and within agencies known more for their siloed behaviors than their cooperative interactions.

But a larger question lingers: Should we continue to regulate the products of the bioeconomy the same way we regulate the products of the chemical economy? Emerging technologies and their products can often require reframing risk pathways: it's not that the endpoints (risks) are all that different; rather, the nature and kind of questions that characterize those risks can be more nuanced. Fortunately, we have also developed powerful, more appropriate tools to supplant the often irrelevant assays traditionally used to evaluate risks. We have also begun to understand that products posing minimal risks may not require the same regulatory scrutiny as products not yet seen by regulatory systems; these may require different and more complex hazard characterizations. Perhaps in addition to improving administrative paths, we should put some of the nation's best minds toward the continued development of risk and safety assessment paradigms to be used simultaneously with product development so that regulation becomes—and is seen as—part of efficient, relevant, and responsible innovation and not just an unnecessary burden or box-checking exercise.

**Larisa Rudenko**
Research Affiliate, Program on Emerging Technologies, Massachusetts Institute of Technology
Cofounder, BioPolicy Solutions LLC
Former Senior Adviser for Biotechnology, Center for Veterinary Medicine, US Food and Drug Administration

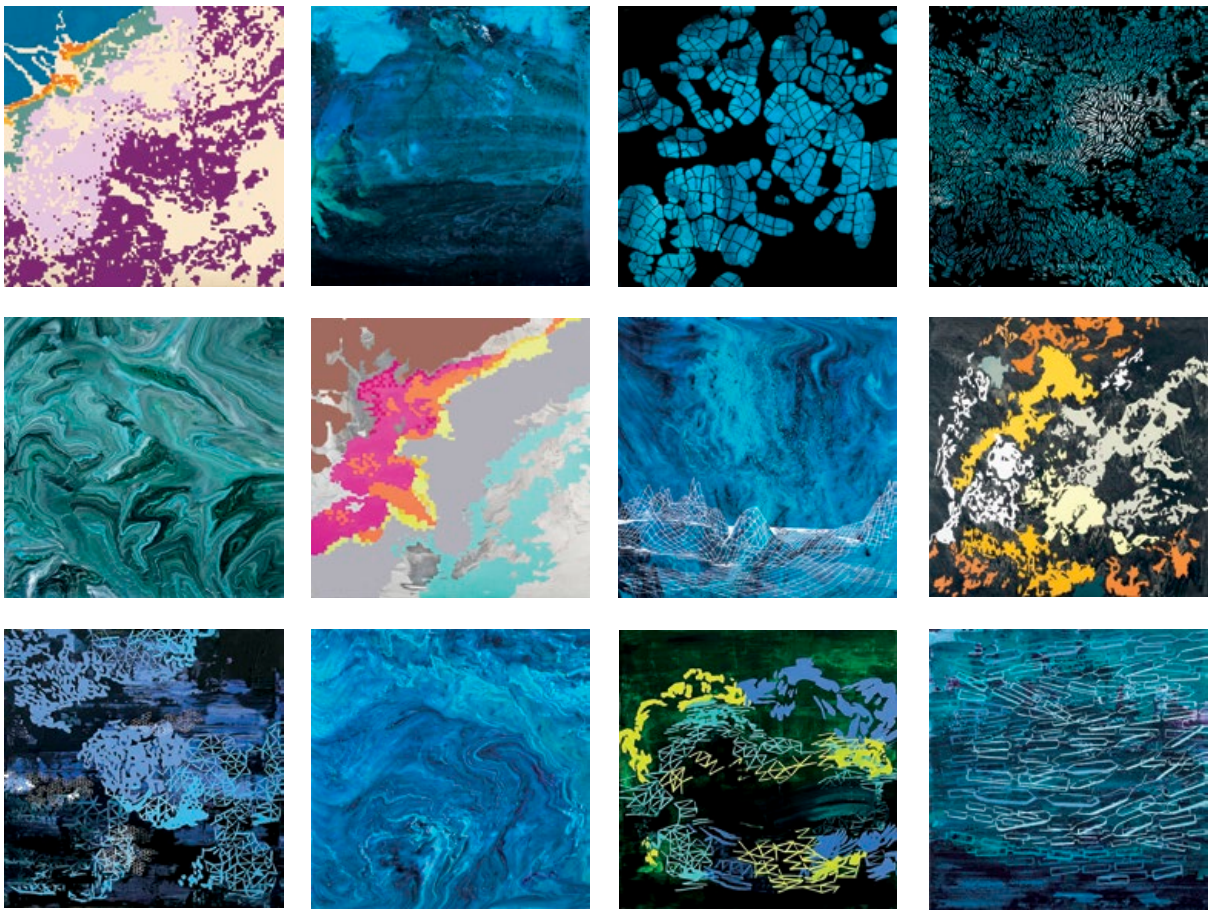
Mary E. Maxon advocates for a coordinated regulatory system as a critical need toward building the biotechnology ecosystem of the future. She's exactly right, but coordination is just one piece of the regulatory puzzle and could be taken a step farther still.

The products that will drive the next century of paradigm-shifting economic growth defy easy definition or jurisdiction. Having witnessed the discussions that take place on products that cross boundaries of agency jurisdiction, I have heard each entity's lawyers and regulatory experts make a clear and cogent case about why their agency has jurisdiction and why the risks of the technology are relevant to their mission to protect the public.

The problem is, they are *all* right in their arguments, which makes reaching consensus a challenge. Navigating their disagreements is particularly difficult when it comes to emerging biotechnologies, where the risk space is uncertain and agencies vary in their comfort level with different types of risk, whether to human health or innovation. In the federal context, this can be paralyzing; lack of consensus creates endless wheel-spinning or logjams, particularly when the parties involved do not share a common executive decisionmaker below the level of the president.

In an ideal world, this wouldn't matter. Each regulatory agency has a vigorous regulatory process and the ability to bring in additional subject matter expertise when needed. That suggests a flexible process would be best, with a common regulatory port of entry and a fixed amount of time, as Maxon recommends, to determine a cognizant agency. Unfortunately, one person's flexibility is another's ambiguity, and this does not solve the issue of the regulated community of developers who understandably want to shape their data collection around the culture and requirements of the agency with whom they'll be dealing so they can most easily navigate the regulatory process. Moreover, this will lead to inconsistency, as Maxon notes in the case of the genetically modified mosquitos, in which agencies, based on their own cultural norms around risk assessment, will operate under very different timelines and come to different conclusions.

How do you overcome this quandary? What's needed is a third-party arbiter who has the authority to cut through disagreement to establish clear precedents and an evidence base for future decisionmaking that gives industry more certainty about regulatory pathways. The arbiter could also serve as a pre-submission advisory group for developers and agencies. This arbiter could be a White House-based Initiative Coordination Office (ICO), as Maxon suggests, but I would argue that more heft is needed to ensure resolution. One possibility would be a small council, administered by the ICO, with representation at a senior level from the agencies and appropriate White House offices, such as the Office of Science and Technology Policy, the Domestic Policy Council, and the Office of Information and Regulatory Affairs, with clearly delegated authority from the president. When decisions are made, the resulting deliberations could be made public, to give a set of "case law" to the developer and regulatory community and assure the public of the integrity of safety assessments. This would be a very different model than the current and ineffective voluntary approach emphasizing the soft



REBECCA RUTSTEIN, *Artist at Sea Series,* 2016–2021, acrylic paintings on canvas, 18 x 18 inches each.

Rutstein created these paintings as an artist in residence during several expeditions at sea, including aboard the R/V *Falkor* sailing from Vietnam to Guam, the R/V *Atlantis* in the Guaymas Basin, and the R/V *Rachel Carson* in the Salish Sea. On each voyage, she set up a makeshift art studio and collaborated with scientists, working with satellite, multibeam sonar mapping, or marine microbial data being collected. Separate from the *Blue Dreams* exhibition, the National Academy of Sciences has acquired these 12 paintings for its permanent art collection.

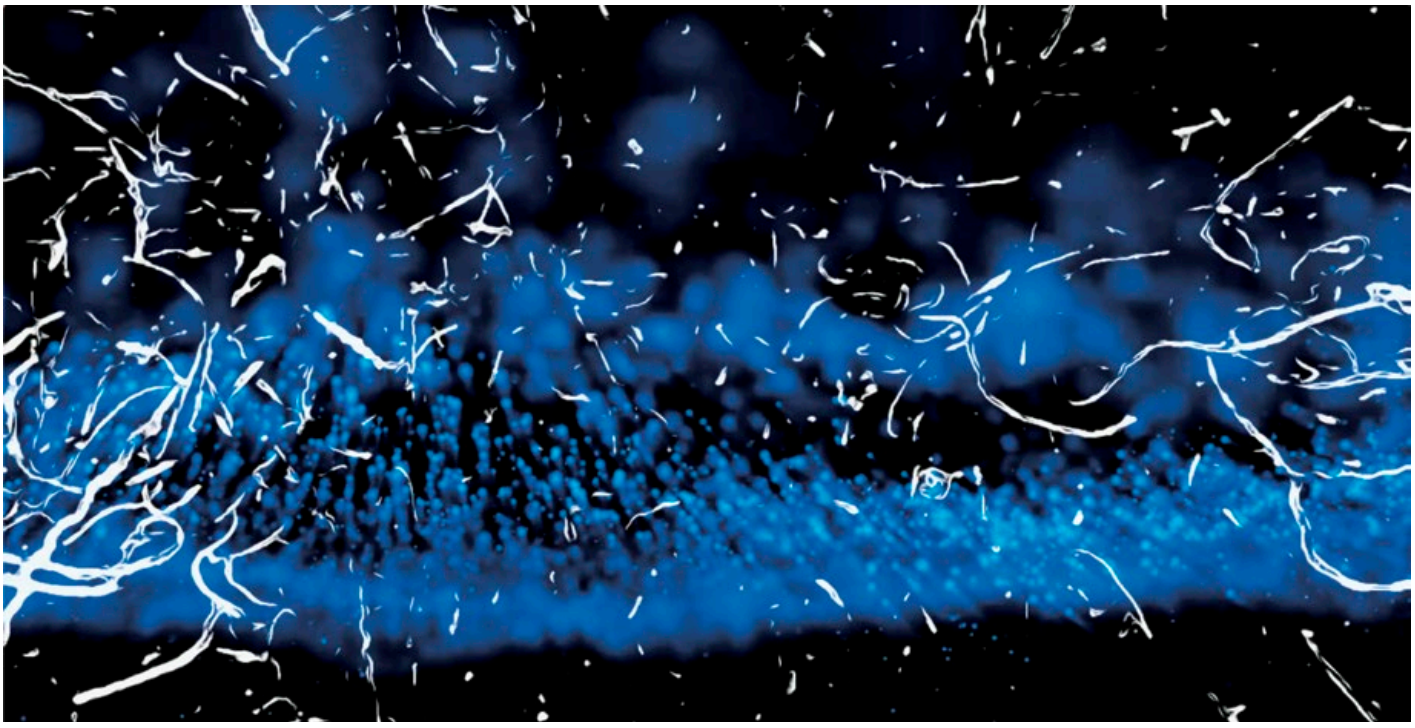
diplomacy of coordination between agencies. Congress could also consider establishing a clear arbiter in future legislation that has power to determine which agency has final decisionmaking responsibility on any individual product.

As the various parties work through options, however, one thing remains certain. New paradigm-shifting biological products will continue to emerge from the US innovation ecosystem, and Maxon is correct that it is time for a parallel shift in thinking about regulation and governance.

**Carrie D. Wolinetz**
Lewis-Burke Associates LLC

For nearly 40 years academic and industrial laboratories have been working on "industrializing" biology, usually referred to as biotechnology. As Mary E. Maxon points out, the process has been extremely successful, but it has been halting and selective. The future potential is enormous and has implications for many sectors of the US economy. To date the vision of a wide bioindustry has been hampered, in part by what can be politely called regulatory confusion. Maxon proposes an ambitious regulatory reform that would clarify and accelerate the regulatory process under the oversight of a new entity, an Initiative Coordination Office that would work with the various agencies identified in President Biden's Executive Order launching a National Biomanufacturing and Biotechnology Initiative. Based on past experience with biotechnology regulation, this suggestion is what is often described as *necessary but not sufficient.*

It is amazing that the core structure for the nation's current regulatory process is still the 1986 Coordinated Framework for the Regulation of Biotechnology. Maxon describes the weakness of that structure, but misses two important elements that must be considered in the development of any new structure. First, the Coordinated Framework places a major emphasis not



*Blue Dreams,* 2023, digital video still.

on the product under review but on how the product was produced. She cites an excellent example of that problem in the case of laboratory-grown mosquitoes where Oxitec failed and MosquitoMate succeed based on how essentially the same product was produced.

The second weakness of the Coordinated Framework is the promise of cooperation between the various agencies that had no strong commitment at the top management level. Each agency official responsible for coordination had very little incentive to "share their turf" with another regulator, often citing the constraints of the enabling legislation. The Coordinated Framework was endorsed unanimously at the Cabinet level, but the message never was heard in the ranks. If the proposed new Initiative Coordination Office is to have any impact, more than new rules are needed. Strong leadership and the articulation of the value and urgency of the bioeconomy to the country is essential. Regulators must realize that their job is not to block new products but to work with their customers to quickly identify any problems and move things through the pipeline smoothly. How a product is produced is an anachronism.

The distressing element related to the continued development of the bioeconomy is not just the absence of a functional and meaningful regulatory framework. Without public confidence in the results, even approved products will not be successful in the marketplace. Over the past few years, we have seen an alarming degradation of public confidence in government guidance and in scientific information, even that produced by highly qualified experts. Reversing this trend is going to be an enormous challenge, but may be far more important than the development of a robust regulatory framework. Initiatives such as BioFutures, created and administered by the philanthropy Schmidt Futures, can play a significant role in this process, but they need to stand back and look at the whole pipeline of the biofuture transformation.

**David T. Kingsbury**
Former Chief Program Officer for Science (2004–2008)
Gordon and Betty Moore Foundation
Former Chair (1985–1988), White House Biotechnology Science Coordinating Committee

Mary E. Maxon packages nearly 30 years of biotechnology governance into a call for action that cannot be ignored, centered on aligning regulations with the times. Indeed, of all the issues that plague the future of the US bioeconomy, a regulatory structure that no longer suits its regulatory context is worthy of special consideration.

Maxon presents examples of biotechnologies that have been delayed or even lost, ultimately due to deficits in "biocoordination." While I second Maxon's suggestion that the Initiative Coordination Office, if established in the White House Office of Science and Technology Policy, should support agency collaboration on horizon-scanning, transparency, and guided

processing for future biotechnologies, coordination needs to be central to the framework, not an accessory to it. As long as its individual regulatory elements (the Environmental Protection Agency, Department of Agriculture, and Food and Drug Administration, among others) lack the infrastructure to "share regulatory space," the current federally established Coordinated Framework for the Regulation of Biotechnology will continue to present gaps in coordination that threaten the bioeconomy.

Moreover, in considering ways to establish a regulatory framework that scales with future biotechnology, it will be essential to incorporate more public input and community reflection into the regulatory process. Maxon recommends the use of enforcement discretion as a strategy to fast-track new products that agencies consider low risk. This raises broader questions, however, of who determines safety and who determines risk? People and communities perceive risk differently, based on their lived experiences and their perceptions of what they have to lose. The same is true for safety, which also needs a collective definition that is grounded by social considerations. Creating a transparent decisionmaking process for biotechnology that integrates public input starts with redefining of risks and safety as a collective.

To put it plainly, if the nation maintains a collaboration that is built upon poor communication, then we ought not expect coordination. While collaborative governance is found throughout the US regulatory system, advancement will require acknowledgement of the regulatory problems that result from such governance strategies. In 2012, the Administrative Conference of the United States released a report titled *Improving Coordination of Related Agency Responsibilities*. When addressing the concept of shared regulatory space, the report states: "Such delegations may produce redundancy, inefficiency, and gaps, but they also create underappreciated coordination challenges." As Maxon cleverly points out, this coordination challenge is petitioning for the creation of a regulatory framework for the bioeconomy—not just biotechnology.

To build on the author's observations, concerted and deliberate policy action is crucial for fostering a regulatory ecosystem that advances the bioeconomy—subject, of course, to public trust—and increases national competitiveness, both now and in the future.

**Christopher J. Gillespie**
PhD Candidate, Department of Entomology and Plant Pathology
North Carolina State University

## ASKING THE HARD QUESTIONS

As an executive at the most innovative university in the United States and a graduate of what I call "a liberal arts college masquerading as an engineering school," I find it refreshing when scholar-leaders in science, technology, engineering, and mathematics—the STEM fields—speak both passionately and eloquently about the arts and humanities. Thus, I found the interview with Freeman A. Hrabowski III (*Issues*, Spring 2023) particularly rewarding.

Although West Point launched the United States' first school of engineering in 1802, my alma mater, the US Air Force Academy, is perhaps the most technologically forward-thinking of all the military service academies. But as Hrabowski reminds us, "If we are simply creating techies who can only work with the technology, we're in big trouble." The same can be said of our future turbocharged, technologically enhanced officer corps. They too must be deeply rooted in what makes us human, especially when generative artificial intelligence is beginning to distort our collective conceptualization of "knowledge."

Raised in the Deep South during the throes of the Civil Rights movement, Hrabowski draws a direct line from the sense of agency he gained while participating in Dr. Martin Luther King Jr.'s Children's March in Alabama (an act that landed him in jail) to not only advocating for more Black PhDs in STEM but actually producing more of them. Hrabowski accomplished this heady task by completing what he identifies as among the most difficult tasks one can attempt: changing an institution's culture—in this case, at the University of Maryland, Baltimore County. "To change the culture, we must be empowered to look in the mirror and to be honest with ourselves," he reflects, if you'll pardon the pun. Looking in the mirror, Hrabowski and his colleagues changed expectations, proclaiming and proving that underrepresented minority students can and will do math as well as their counterparts. But even after a successful 30-year run as a university president (when the average tenure is closer to six), Hrabowski's efforts to promote improved outcomes for students, pre-K to PhD, haven't slowed.

With a $1.5 billion scholars program funded and named in his honor by the Howard Hughes Medical Institute, Hrabowski has taken his crusade to even higher levels. Acknowledging that despite his team's Herculean efforts, the average number of Black students earning PhDs in STEM fields has moved from just 2.2% of all PhD STEM graduates to 2.3% in the recent past, Hrabowski realizes his work is far from done. Just as important, he is quick to note that less than 50% of students starting college graduate in six years, regardless of race.

Reflecting on his lifelong work, Hrabowski asks, perhaps rhetorically, but perhaps not: "What is it going to take to create a professoriate that will make exceptional achievement in STEM by people of color the rule rather than the exception?" One certainty: Freeman Hrabowski won't stop asking that and even more difficult questions, just as he has been doing for the past four decades

**Chris Howard**
Executive Vice President and Chief Operating Officer
Arizona State University

## STOP PATCHING!

In "How to Keep Emerging Research Institutions from Slipping Through the Cracks" (*Issues*, Spring 2023), Anna M. Quider and Gerald C. Blazey raise interesting questions about how to address the misalignment in distribution of federal research dollars and students from diverse communities being educated in science, technology, engineering, mathematics, and medicine—the STEMM fields—across the full range of higher education institutions. If we wish to produce a diverse STEMM workforce for the twenty-first century, the authors explain, we need to recognize and consider how to address this mismatch.

Historically, institutions have usually been targeted for attention when agencies have been directed, largely by congressional action, to develop strategies and "carveouts" to affect the distribution across the full range of institutions. Quider and Blazey rightly point out the limits of such carveouts and special designations to achieve the goal of contributing to increased diversity of the STEMM community. Research support in institutions can provide research opportunities to next-generation scholars and researchers from diverse communities. Research participation has also been demonstrated to support retention of these students in STEMM as well as to promote their choice for graduate education, thus addressing the critical need for faculty diversity.

The difficulty in directing research support to a wider range of institutions cannot be underestimated. Institutions that have received even small advantages in research investments over the decades will present proposals not only where the ideas are excellent, but where research infrastructure is more than likely to be superior as well, advantages having accumulated. Institutions that have not enjoyed such investment may have excellent researchers with excellent proposals, but, lacking research infrastructure, they may not be as competitive as the research behemoths. Carveouts allow for a section of the playing field to be leveled, where similarly situated institutions can compete. The authors note that although a number of carveouts have been created, not all funding "cracks" have been plugged. Missing from the litany of special programs are so-called emerging research institutions that are also taking on the critical role of contributing to the diversity of the STEMM community.

While the carveouts have been important to developing and maintaining research capacity across a larger range of institutions, they only delay needed reforms that are more systemic, directing how only a small share of total research and development funding is deployed while leaving the overwhelming majority of funding to the same set of institutions that have always topped the list of those receiving federal R&D support.

It is easy to have conversations about spreading the wealth in a time when budgets are expanding. But even when they are, such as in the doubling of the National Institutes of Health's budget, they do not necessarily lead to a different distribution of supported institutions. Considering a flat funding environment, what would a reordering of strategic priorities that guide investment look like? Actions would include:

- Ensuring widely distributed research capacity across a range of criteria.
- Re-examining the research agenda and the process of setting it—who establishes, who benefits, and who is disadvantaged.
- Specifically addressing the environment in which research is being done—that it be free of bias and allow all to thrive.
- Harking back to the "Luke principle" I articulated previously in *Issues* (https://issues.org/united-states-scientific-institutions-diversity-malcom), all research investments, in whatever the institutions, should include attention to equity and inclusion in developing the scholars and workforce of the future as a central element of supporting excellence and addressing the diversity-innovation paradox.

While we could stand up another targeted effort to address the cracks pointed out by the authors as a stop-gap

*Blue Dreams,* 2023, digital video still.

measure, it is time to re-examine the overall research support structure in light of today's needs and realities. Stop patching!

**Shirley M. Malcolm**
Senior Advisor and Director of SEA Change
Former Director of Education and Human Resources Programs
American Association for the Advancement of Science

I applaud Anna M. Quider and Gerald C. Blazey for drawing attention to the critical importance of emerging research institutions (ERIs) in the nation's research ecosystem. ERIs are often dominated by students of color from low-income families, who may not have been admitted to a major research university or could not afford such a school's tuition and cost of living. Or they may simply have preferred to enroll in a smaller university, perhaps closer to home.

We have dozens of ERIs in California, and most are dominated by underrepresented minorities. The California State Universities are excellent examples of institutions that are in same category as the authors' home institution, Northern Illinois University, in that they do not benefit from additional federal funding simply because they are geographically located in a state that has a number of major R1 universities.

I worry that if the nation does not embrace all ERIs, the disparities between the haves and have nots will become even greater and the nation will not fully achieve its research and diversity goals. I have firsthand knowledge of these disparities since I graduated from an emerging research institution. However, I am also an example of the potential of these students to contribute to the national research priorities.

**Roger M. Wakimoto**
Vice Chancellor for Research & Creative Activities
University of California, Los Angeles

Installation photo by Kevin Allen Photo.

## NURSING AND THE POWER OF CHANGE

In "The Transformation of American Nursing" (*Issues*, Summer 2023), Dominique A. Tobbell presents a fascinating, complicated, and multidetermined case for the post-World War II development of PhD programs in nursing. Built around the faith that there was a "nursing science"—akin to but foundationally different from the dominance of "biomedical science"—the white women (and they were almost exclusively white women) used financial support from the federal government's health scientists' programs to first earn PhDs in related disciplines such as sociology, education, and psychology and then to translate borrowed concepts into the ideological stance and the practice of nursing.

Some initiatives were spectacular successes: the changes that coalesced around nurse Hildegard Peplau's intellectual translation of Henry Stack Sullivan's interpersonal theory of human relationships forever changed nursing practice into one that focused intensely of what we now call (and teach and research as) patient-centered care. Others were as spectacular failures: the edict from nursing's national accreditation association that all schools had to teach nursing content and practice specifically organized around one of the models Tobbell describes was a mercifully short-lived disaster after it became apparent that classroom content had no relation to clinical experiences.

Such unevenness, of course, is hardly unique to any knowledge-building enterprise. My question is why, after more than 80 years of this enterprise, are people outside the narrow confines of my discipline still puzzled when they learn of my PhD and hear the term "nursing science." I honestly do not blame them. And I think this points to yet another source of tension that the history of PhD education in nursing elucidates: should knowledge-building in nursing or in any another discipline be a "top down" or "bottom up" experience?

In nursing, we have evidence of the power of change driven by collaborations among clinicians at the point of intersections with patients in need of care. The nurse practitioner movement, for example, came about in the same political,

social, and technological contexts and among the added pressures of shortages among primary care practitioners. In response, collaborative, entrepreneurial efforts of physicians and nurses seeking expanded opportunities came together in individual dyads across the country to experiment with shared responsibilities for medical thinking, medical diagnosis, and prescribed treatments. Similarly, in coronary care units, dedicated to ensuring the survival of "hearts too young to die," the new technology of electrocardiology brought physicians and nurses together to learn how to read rhythm strips. Both groups quickly learned, again together, that it was not necessary to have to wait for a physician to intervene in life-threatening emergencies as nurses could interpret arrythmias and respond immediately with life-saving protocols. Our current health care system now organizes itself around these two innovations.

The PhD in nursing, by contrast, came about as a solution to a problem that only a relatively small group of nursing educators identified. It would be a new form of knowledge generation, albeit one distanced from the bedside and imbricated with the knowledge-generating tools most valued by the biomedical establishment. It was, I would suggest, an essentially political and prestige process. And really interesting questions remain to be asked. Did the status position of nursing in clinical care and knowledge development necessitate a surrendering to the stronger and more privileged epistemological position of medicine for its own validity? Will nursing's claims that it "asks different questions" survive the collapsing of boundaries between acute and chronic care needs of patients? And, to me most important, does the inherently interdisciplinary knowledge that we know nurses need to practice fail to translate into a knowledge agenda when it exists within an academy and a culture that knows only firm disciplinary boundaries?

**Patricia D'Antonio**
Carol Ware Professor of Mental Health Nursing
Director, Barbara Bates Center for the Study of the History of Nursing
University of Pennsylvania

## NAVIGATING INTERDISCIPLINARY CAREERS

In "Finding the 'I' in Interdisciplinarity" (*Issues*, Spring 2023), Annie Patrick raises important challenges for both interdisciplinary research—an oft-cited, rarely achieved aim in contemporary scholarship—and qualitative research more broadly. Many norms of traditional inquiry implicitly encourage the separation of the researcher from the research, a condition that Patrick compellingly argues against. The received wisdom is that researchers should leave their backgrounds, traditional or otherwise, "at the door." This is a necessary critique of bracketing—where researchers consider what assumptions they bring to a research endeavor and then set them aside for the purposes of conducting and analyzing the phenomenon—and its implications.

As an interdisciplinary researcher myself, I know from experience that explicitly sharing points of commonality and difference within diverse teams is essential for the conduct of fulfilling research. After all, researchers are people first. What I find especially powerful in Patrick's essay is the insistence on the human element of social science research for both the researcher and the researched. As she writes, "they were not simply informants or categories of data, but actual humans." Why might Patrick be intimidated by the engineering faculty at Virginia Tech? She has seen patients and their families at their absolute lowest and quickly earned their trust and care. The faculty are only human, too.

Similarly, I see her work explaining the real-life challenges of the student experience to faculty as reminding them that students are human, too, and have a whole host of embodied needs and experiences outside of classroom performance. Implicitly, Patrick calls the academy to task for treating humans with impersonal language such as "informants" and encourages researchers to claim our backgrounds that inform our research, and hopefully informs our groundwork as well.

I find Patrick's call to action through groundwork to be a useful corrective. "When I saw something going wrong," she writes, "my every professional instinct was to intervene." As researchers, if we see something truly wrong and harmful taking place, shouldn't we intervene? Her essay also reminded me of the gendered professions of both engineering and nursing. Despite being historically associated with men and women respectively, the emphasis on weed-out culture in both areas and how that interacts with gender could be something to further consider in the future. For these and other reasons, I appreciate this powerful and thought-provoking essay and its lessons very much.

**Saralyn McKinnon-Crowley**
Incoming Assistant Professor, Higher Education Studies & Leadership
Baylor University

## ADDING HUMANITY TO ANATOMY LESSONS

In "When Our Medical Students Learn Anatomy, They See a Person, Not a Specimen" (*Issues*, Spring 2023), Guo-Fang Tseng provides a wake-up call to treat anatomy as a humanistic as well as a scientific discipline. This is not new, as a move in a humanistic direction has been evident for some years and across a variety of countries and cultures. However, within the Silent Mentor Program that Tseng describes, it goes considerably further than generally found elsewhere, with far more involvement of family members at every stage.

The Silent Mentor Program is conducted within a Buddhist culture. Should this be normalized and viewed as

the ideal practice for those in different societies with varying religious or cultural perspectives? As arguments in favor, the practices have led to major increases in body donations within these communities, and they have enhanced the humanity and empathy of clinicians.

To gain further insight, my colleague Mike R. King and I conducted a study to explore why in most academic settings in the Western world cadavers in the dissecting rooms of anatomy departments are routinely stripped of their identity. This has meant that medical and other health science students have been provided with limited, if any, information on the identities or medical histories of those they are dissecting. The study, published in *Anatomical Sciences Education* in 2017, identified four ways that the cadavers were treated: total anonymization; nonidentification, low information; nonidentification, moderate information; identification, full information. We concluded that at the heart of the debate is the altruism of the donors and the integrity of those responsible for the donors' bodies.

We further concluded that if potentially identifying information adds value to anatomical education, it should be provided. But other values also enter the picture, namely, the views of the donors and their families. What if the families do not wish to go down this road? This demonstrates that the direction outlined for the Silent Mentor Program depends upon full acceptance by all parties involved, with the families' views being uppermost.

Then there are the students. It is unlikely that in a pluralist society all will want as much personal information about the body as possible. Thus, there must be a balance achieved between the students' emotional or psychological reactions and the pedagogical value of the information.

The situation is more confused in some societies where certain ethnic or cultural groups oppose the donation of bodies on cultural grounds, so that students belonging to these groups must overcome an antipathy to the process of dissection. For them, identification of the bodies would likely be a step too far.

While the Silent Mentor Program is situated in a Buddhist society, it does not represent all Buddhist perspectives. For instance, donation programs in Sri Lanka have been the norm for many years, with Buddhist monks giving blessings for the afterlife of the deceased person, in the deceased's home prior to the cadaver being transferred to a local university anatomy department. After receipt of the cadaver, all identification marks are removed, thereby maintaining the anonymity of the deceased. The relatives have no further contact with the remains. Following dissection, Buddhist ceremonies are conducted by monks, thereby placing the whole process of donation and dissection within a Buddhist context, with participation by students and family members.

This represents a variation on the Silent Mentors Program, encouraging altruism and involving the family in some aspects of the process of teaching anatomy within their own Buddhist context. This demonstrates that more than one model may serve to achieve humanistic ends.

**D. Gareth Jones**
Department of Anatomy
University of Otago
Dunedin, New Zealand

## WHO CAN YOU TRUST?

In "Enhancing Trust in Science and Democracy in an Age of Misinformation" (*Issues*, Spring 2023), Marcia McNutt and Michael M. Crow encourage the scientific community to "embrace its vital role in producing and disseminating knowledge in democratic societies." We fully agree with this recommendation. To maximize success in this endeavor, we believe that the public dialogue on trust in science must become less coarse to better identify the different elements of science that can be trusted, whether it is science as a process, particular studies, which actors or entities are trusted, or further distinctions.

At the foundation of trust in science is trust in the scientific method, without which no other trust can be merited, warranted, or justified. The scientific community must strive to ensure that the scientific process is understood and accepted before we can hope to merit trust at more refined levels. Although trust in the premise that following the scientific method will lead to logical and evidence-based conclusions is essential, blanket trust in any component of the scientific method would be counterproductive. Instead, trust in science at all levels should be justified through rigor, reproducibility, robustness, and transparency. Scientific integrity is an essential precursor to trust.

As examples, at the study level, trust might be partially warranted through documentation of careful study execution, valid measurement, and sound experimental design. At the journal level, trust might be partially justified by enforcing preregistration or data and code sharing. In the case of large scientific or regulatory bodies, these institutions must merit trust by defining and communicating both the evidence on which they base their recommendations and the standards of evidence they are using.

Recognizing that trust can be merited at one point of the scientific process (e.g., a study and its findings have been reported accurately) without being merited at another (e.g., the findings represent the issue in question) is essential to understanding how to develop specific recommendations for conveying trustworthiness at each point. Therefore, efforts to improve trust in science should include the development of specific and actionable advice for increasing trust in science as a process of learning; individual scientific experiments; certain individual scientists; large, organized institutions of science; the scientific community as a whole; particular findings and interpretations; and scientific reporting.

However, as McNutt and Crow note, "It may be unrealistic to expect that scientists … probe the mysteries of, say, how nano particles behave, as well as communicate what their research means." Hence, a major

challenge facing the scientific community is developing detailed methods to help scientists better communicate with and warrant the trust of the general public. Thus, the current dialogue surrounding trust must identify both specific trust points and clear actions that can be taken at each point to indicate and possibly increase the extent to which trust is merited.

We believe the scientific community will rise to meet this challenge, offering techniques that signal the degree of credibility merited by key elements and steps in the scientific process and earning the public trust.

**David Allison**
Dean
Distinguished Professor
Provost Professor
Indiana University School of Public Health, Bloomington

**Raul Cruz-Cano**
Associate Professor of Biostatistics, Department of Epidemiology and Biostatistics
Indiana University School of Public Health, Bloomington

## TRAINING MORE BIOSAFETY OFFICERS

The United States has long claimed that there is a need to focus on the safety and security of biological research and engineering, but we are only beginning to see that call turn into high-level action on funding and support for biosafety and biosecurity governance. The CHIPS and Science Act, for example, calls for the White House Office of Science and Technology Policy to support "research and other activities related to the safety and security implications of engineering biology," and for the office's interagency committee to develop and update every five years a strategic plan for "applied biorisk management." The committee is further charged with evaluating "existing biosecurity governance policies, guidance, and directives for the purposes of creating an adaptable, evidence-based framework to respond to emerging biosecurity challenges created by advances in engineering biology."

To carry out this mouthful of assignments, more people need to be trained in biosafety and biosecurity. But what does good training look like? Moreover, what forms of knowledge should be incorporated into an adaptable evidence-based framework?

In "The Making of a Biosafety Officer" (*Issues*, Spring 2023), David Gillum shows the power and importance of tacit knowledge—"picked up here and there, both situationally and systemically"—in the practice of biosafety governance, while at the same time stressing the importance of the need to formalize biosafety education and training. This is due, in part, to the lack of places where people can receive formal training in biosafety. But it is also a recognition of, as Gillum puts it, the type of knowledge biosafety needs—knowledge "at the junction between rules, human behavior, facilities, and microbes."

The present lack of formalized biosafety education and training presents an opportunity to re-create what it means to be a biosafety officer as well as to redefine what biosafety and biosecurity are within a broader research infrastructure and societal context. This opening, in turn, should be pursued in tandem with agenda-setting for research on the social aspects of biosafety and biosecurity. It is increasingly unrealistic to base a biosafety system primarily on lists of known concerns and standardized practices for laboratory management. Instead, adaptive frameworks are needed that are responsive to the role that tacit knowledge plays in ensuring biosafety practices and are aligned with current advances in bioengineering and the organizational and social dynamics within which it is done.

Proficiency in biosafety and biosecurity expertise today means attending to the formal requirements of policies and regulations while also generating new knowledge about the gaps in those requirements and a well-developed sense of the workings of a particular institution. The challenge for both training and agenda-setting is how to endorse, disseminate, and assimilate the tacit knowledge generated by biosafety officers' real-life experiences. For students and policymakers alike, a textbook introduction to biosafety's methodological standards, fundamental concepts, and specific items of concern will surely come about as biosafety research becomes more codified. But even as some aspects of tacit knowledge become more explicit, routinized, and standardized, the emergence of new and ever valuable tacit knowledge will always remain a key part of biosafety expertise and experience.

Gillum's vivid examples of real-life experiences involving anthrax exposures, the organizational peculiarities of information technology infrastructures, and the rollout of regulations of select bioagents demonstrate that, at a basic level, biosafety officers and those with whom they work need to be attuned to adaptability, uncertainty, and contingency in specific situations. Cultivating this required mode of attunement among future biosafety professionals means embracing the fact that biosafety, like science itself, is a constantly evolving social practice, embedded within particular institutional and political frameworks. As such, it means that formal biosafety educational programs must not reduce what counts as "biosafety basics" to technical know-how alone, but ought to prioritize situational awareness and adaptability as part of its pedagogy. Biosafety and biosecurity research such as that envisioned in the CHIPS and Science Act will advance the training and work of the next generation of biosafety professionals only if it recognizes this key facet of biosafety.

**Melissa Salm**
Biosecurity Postdoctoral Fellow in the Center for International Security & Cooperation
Stanford University

**Sam Weiss Evans**
Senior Research Fellow in the Program on Science, Technology, and Society
Harvard Kennedy School