ANTONY SCHWARTZ, ANDREA VOGEL, AND MARY BROCK

Biosafety Needs to Redefine Itself as a Science

An expansion of today's static definition of biosafety to include research for mitigating risk will advance both science and public safety.

Have you heard the joke about jobs in biosafety? One professional asks another for recommendations to fill an open position. The second says sure, but she first needs recommendations to fill her three open jobs! It's not really a joke: a recent newsletter for biosafety professionals carried multiple job openings from the most senior to the most junior positions. After three years of a pandemic plus the dawn of relatively easy gene-editing and other advances in biotechnology, demand for biosafety workers is rising. But we argue that the worker shortage also stems from a more fundamental issue: biosafety is seen mainly as a compliance issue, not a science.

In an executive order signed in September 2022, President Biden set forth the goal to "elevate biological risk management" as part of a broader effort to advance biotechnology and biomanufacturing. The order specifically noted that the administration's efforts should include "providing for research and investment in applied biosafety and biosecurity innovation." This marks a rare opportunity to nail down a definition of biosafety so that it is established as more than a set of guidelines to be implemented.

Yes, biosafety professionals oversee compliance with regulations, but they also address problems that demand empirical research. Biosafety should be recognized as a hard science of risk management and innovation that requires formal training. Such a change will make for more efficient, improved safety processes as well as encourage better training and greater interest in biosafety as a career. Without this definition, the progress of life sciences research will be hampered by a lack of safety officers and outdated, inflexible practices.

Risk assessment is already at the core of most biosafety professionals' daily work. Some hazards can indeed be mitigated with standardized practices and procedures. However, most circumstances require careful study of the biohazards, the procedures performed, the equipment used, and the mitigation measures available (facilities, containment devices, or personal protective equipment, for instance). Establishing biosafety as an innovative research discipline will enable the field to keep pace with a sector that is going through momentous changes.

None of the definitions of biosafety put forward so far capture the complex, dynamic nature of the discipline. We propose the following: "Biosafety is the study of biological hazards using evidence-based risk-assessment and mitigation measures to prevent accidental exposure to a biological hazard or release to the environment."

Static non-status

Biosafety professionals have been meeting informally since the 1950s. The US Centers for Disease Control and Prevention (CDC) and National Institutes of Health (NIH) joined the gatherings in the 1960s. In those early days, the focus was on regulation and classification. In the 1970s, the four biosafety level designations were established, as were regulations on shipping microorganisms and toxins. Starting in 1984, the CDC and NIH published the *Biosafety in Microbiological and Biomedical Laboratories*, a manual known colloquially as the biosafety bible. The current edition refers to biosafety as merely "the mechanism for addressing the safe handling and containment of infectious microorganisms and hazardous biological materials."

The World Health Organization's *Laboratory Biosafety Manual*, another set of guidelines, defines biosafety as "Containment principles, technologies, and practices that are implemented to prevent unintentional exposure to biological agents or their inadvertent release." These and other descriptions convey biosafety almost passively, as a set of practices to be followed. None acknowledge biosafety as a process of risk assessment that informs risk mitigation strategies.

Given this background, it is perhaps not surprising that many biosafety professionals don't consider their creativity in day-to-day work as innovation or evidence collection. For example, we have been to workshops, nationally and internationally, where colleagues have described doing systematic assessments of waste decontamination of infectious agents with limited resources—not realizing that this is in fact applied research.

Without recognition of the science behind biosafety, such innovative work may not be supported by the institutions where potentially risky experiments are carried out or the funders that underwrite such experiments. Securing time, funding, and other resources to gain knowledge to keep scientists and the public safe can be difficult. As biosafety's scope has grown, practitioners need to formally establish biosafety as its own distinct field of scientific study worthy of funding, with robust infrastructure to support rigorous inquiry.

Here's an example of a useful biosafety investigation with no obvious source of support: lentiviruses—which cause a number of human and animal diseases, including AIDS—have a place in laboratories worldwide as a useful tool for transferring genes into cultured cells. Conventional wisdom assumes that all lentiviral vectors (i.e., the particles that carry the DNA sequences) are taken up by the cultured cells within 72 hours, thus requiring fewer safety precautions thereafter. But further assessments are needed to know if this is indeed the case for various gene inserts, CRISPR modifications, and other advances.

Here's another example: autoclaving is a common technique for sterilizing samples when they are no longer needed. It's used to decontaminate viruses, bacteria, fungi, and other potential infectious agents. Studies that determine optimal autoclaving times for various growth media, freezer temperatures, and container sizes could make a routine process shorter and less complicated while still maintaining safety.

Expanding biosafety to mean "the study of biohazards" will inculcate a mindset of continuous experimentation and discovery that will advance the field—and advance research safety overall. There are precedents for defining or redefining a discipline to influence the direction of the field. Nursing is an example of a discipline that reoriented itself from following rote procedures to embracing a mission—patients' health—while advancing knowledge through empirical research. Public health is also an apt example. Over a hundred years ago, one of the founders of the field, C.-E. A. Winslow, defined it as "the science and the art of preventing disease, prolonging life, and promoting physical health and efficiency through organized community efforts." Definitions like this encourage a broad range of ongoing inquiry and enable a field to secure the funding necessary for conducting research. In biosafety, the lack of such recognition contributes to a dearth of training, qualified personnel, and research support.

Expanding biosafety to mean "the study of biohazards" will inculcate a mindset of continuous experimentation and discovery that will advance the field—and advance research safety overall.

Time and again, biosafety professionals conduct their own research to gather the data needed to make evidence-based recommendations. Official biosafety manuals should formally endorse this in their next updates, and efforts building off the Biden administration's executive order should explicitly seek to advance research capacity in biosafety.

The basic components necessary to define biosafety as the study of biohazards are already ingrained in the field's practice. A definition that reflects this fact can propel the profession and better support the advanced biotechnology and biomanufacturing sectors that rely on it.

Antony Schwartz *is the institutional biosafety officer, responsible official, director of the biological safety division, and institutional contact for dual use research of concern at Duke University.* ***Andrea Vogel*** *is a biosafety specialist and an alternate responsible official at Duke University.* ***Mary Brock*** *is the assistant biosafety officer and an alternate responsible official at Duke University.*