Securing a Risky Future: Co-Constructing Technology and Security in Emerging Biotechnologies

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Summary

This dissertation examines the co-construction of technology and security in the context of emerging biotechnologies. Emerging biotechnologies with security implications, Dual Use Research of Concern (DURC), pose new security risks, raising fears that certain life science experiments could be exploited by malicious actors to inflict harm. The growing debate about DURC experiments has prompted several policy changes in Germany aimed at addressing potential security threats. This work seeks to explore why Germany's policy response to DURC differs from that of other Western nations.

Starting from a constructivist perspective rooted in Critical Security Studies and Science and Technology Studies, this project analyzes how emerging biotechnologies and their classification as security threats are co-constructed. Through social processes, technologies are discursively assigned specific properties. In the case of DURC, these properties are consistently linked to constructions of insecurity, and vice versa.

To illustrate this point, the following dissertation uses a qualitative content analysis of several policy-relevant biosecurity documents from the US and Germany. It demonstrates how emerging biotechnologies are embedded in two main discourses about their promises and risks- namely, techno-fear and techno-fix- which create competing imaginaries of DURC. Additionally, the dissertation shows how risk is used to resolve the conflict between these imaginaries, thereby facilitating DURC implementation. It also highlights the emergence of a global discourse on DURC that influences Germany's policy response.

Zusammenfassung

Diese Dissertation untersucht die Ko-Konstruktion von Technologie und Sicherheit im Zusammenhang mit aufkommenden Biotechnologien. Neue biotechnologische Verfahren mit Sicherheitsrisiken, bekannt als Dual Use Research of Concern (DURC), wecken die Befürchtung, dass bestimmte lebenswissenschaftliche Experimente von sogenannten "Malicious Actors" missbraucht werden könnten, um Schaden anzurichten. Die Diskussion über DURC-Experimente hat in International sowie in Deutschland zu politischen Veränderungen geführt, die darauf abzielen, potenzielle Sicherheitsrisiken zu minimieren. Der deutsche Ansatz unterscheidet sich dabei von den bspw. in den USA gewählten Ansätzen. Diese Arbeit geht der Farge nach, wie sich die Unterscheide erklären lassen,

Dieses Projekt basiert auf einer sozialkonstruktivistischen Perspektive, die in den Critical Security Studies und den Science and Technology Studies verankert ist. Es untersucht, wie aufkommende Biotechnologien und ihre Klassifizierung als Sicherheitsrisiken durch diskursive Prozesse ko-konstruiert werden. Dabei werden Technologien durch Diskussionen mit bestimmten Eigenschaften versehen. Im Fall von DURC werden diese Eigenschaften konsequent mit Vorstellungen von Unsicherheit verbunden - und umgekehrt.

Um dies zu veranschaulichen, verwendet diese Dissertation eine qualitative Inhaltsanalyse, um relevante Biosecurity-Dokumente aus den USA und Deutschland zu vergleichen. Die Analyse zeigt, wie aufkommende Biotechnologien in zwei zentrale Diskurse über ihre Versprechen und Risiken eingebettet sind- den Techno-Fear- und den Techno-Fix-Diskurs - die konkurrierende Vorstellungen von DURC hervorbringen. Zudem verdeutlicht die Arbeit, wie das Risikokonzept genutzt wird, um den Konflikt zwischen diesen Diskursen zu überbrücken und so die Umsetzung von DURC zu erleichtern. Gleichzeitig lässt sich anhand der Analyse die Entstehung eines hegemonialen biosicherheitsbezogenen Diskurses nachweisen, der die Policy bezogenen Entscheidungen in Deutschland erklärt.

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List of Abbreviations

ANT	Actor-Network Theory
BWC	Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction; Biological Weapons Convention
CoC	Code of Conduct
CSS	Critical Security Studies
DFG	Deutsche Forschungsgemeinschaft
DURC	Dual Use Research of Concern
GMO	Genetically Modified Organisms
IR	International Relations
ISU	Implementation Support Unit
KEF	Kommisionen für Ethik in der Forschung
MPG	Max-Planck-Gesellschaft
NRC	National Research Council
NSABB	National Science Advisory Board for Biosecurity
NSD	National Security Directive
OTA	Office of Technology Assessment
QCA	Qualitative Content Analysis
SCOT	Social Construction of Technology
STS	Science and Technology Studies
UNSCOM	United Nations Special Commission
WMD	Weapons of Mass Destruction

1 Introduction: Securing Science – The Invention of DURC

Security practices are fundamental to our daily lives. Alongside concepts such as freedom, democracy, solidarity, justice, and sustainability, security is a large-scale political idea that influences many aspects of our daily experiences and determines what is considered possible, sensible, or necessary. Increasingly, these security practices encompass scientific research, in addition to traditional fields associated with security, such as crime and defense. The widespread emergence and ongoing enhancement of drones on the battlefield (Clapp, 2025b) alongside debate about the military applications of artificial intelligence (Clapp, 2025a), quantum computing (Krelina, 2025), and hypersonic missile technology (T. Wright, 2022)—among other developments—highlight the growing importance of understanding the security implications of scientific research.

Correspondingly, security practices increasingly focus on scientific research. Securing advanced research and technology development against proliferation to hostile states and non-state actors is currently a top priority on the security agenda of many Western states (for an overview of EU Policies see: Héau, 2025). Security policies may limit access to research results if particular research initiatives are perceived as threats. Security influences which technologies are deemed hazardous, who has access to them, and under what circumstances. As a result, security protocols play a vital role in shaping the conduct of scientific research and technological development across an expanding array of disciplines, including chemistry, cryptology, biotechnology, nuclear technology, computer science, missile and space technology, among others.

However, security measures are not solely focused on restricting scientific activities. Science can also be pursued in the interest of security by exploring innovative technologies aimed at enhancing safety. In this context, security policies regulate not only access but also research funding and the prioritization of specific research areas. Consequently, research conducted in the name of security often becomes a funding priority. For instance, last year, the European Commission released a white paper outlining strategies to enhance support for dual-use research—research that can have both civilian and military applications (European Comission, 2024).

This renewed interest occurs against the backdrop of several trends, including the continued relevance of terrorism, with non-state actors increasing their use of drones and other emerging technologies (e.g., Morais Figueiredo, 2024; Pledger, 2001), as well as new geopolitical fault lines, chief among them the Russian-Ukrainian war, which saw the use of several new technologies as well (e.g., Slusher, 2025).

In Germany, the dualism between concerns over the security implications of scientific research, as well as the increased priority of funding research that can contribute to security, can be observed in two recent events. In 2025, the German Science and Humanities Council, an important advisory body to Germany's federal and state administrations concerning issues related to science and academia, published a report outlining how science can contribute to Germany's security, resilience, and strategic autonomy. The report also acknowledges that dual-use research carries the risk of proliferation toward malicious actors, which needs to be managed carefully (German Science And Humanities Council, 2025).

The dualism between science and technology's potential to enhance security and the security risks posed if malicious actors misuse research is at the core of the current debate on the relationship between science and security. Throughout this research project, we will examine how this dualism has emerged and continues to influence how research in certain fields is conducted. To highlight the dualism inherent in science with security implications, we will look at advanced biotechnologies and research in the field of life sciences.

Since 2001, a growing debate has emerged regarding the potential security implications of advanced biotechnology. Research into pathogens has always carried some security concerns because understanding how pathogens operate can be misused to cause illness intentionally. This issue is referred to as the "dual-use dilemma", a concept that has been a part of biological research. In the wake of the 9/11 terrorist attacks in the USA as well as the mailing of Anthrax Letters a few weeks later (Guillemin, 2011), biotechnology has attracted significant attention as a potential source of insecurity. This heightened focus has led to the creation of new government and academic institutions aimed at addressing the security implications of biotechnology.

In early April 2002, the U.S. National Research Council (NRC), which was founded in 1916 and established as an advisory organization through Executive Order 2859, held a meeting in Washington, D.C. Members of the NRC's Committee on Research Standards and Practices to Prevent the Destructive Application of Biotechnology convened to discuss the important task of writing a report on addressing dual-use issues in the life sciences (National Research Council, 2004, p. 143).

It took five additional meetings over two years. In 2003, the 18 committee members completed their work and produced the requested report titled *Biotechnology in the Age of Terrorism*, commonly known as the "Fink Report", after the committee's chairman. In this report, the committee defined criteria for what they termed "experiments of concern" and offered several recommendations for addressing biological research with security implications. A primary recommendation was to establish a permanent institution in the U.S. that would advise the government on biosecurity issues: the National Science Advisory Board for Biosecurity (NSABB). The discussion that followed the Fink Report focused on the relationship between science, technology, and security, leading to significant implications for scientific practice and access to emerging technologies. It also introduced a new category of research known as DURC. This typically refers to civilian research perceived to have security implications that necessitate enhanced security measures.

Since its introduction into the policy discussion, several experiments have been classified as Dual Use Research of Concern (DURC). One notable example occurred in 2005 when Wein and Liu published a controversial study modeling a potential botulism attack on the U.S. milk supply, detailing how such an attack could happen and the amount of botulism that would be required. They argue that smallpox, anthrax, and botulism are among the most concerning possibilities in bioterrorism. Since the first two scenarios had already been modeled, they published their model for the third scenario: the release of botulism in cold drinks (Wein & Liu, 2005).

The study raised security concerns, as "malicious actors" could potentially use its findings to target the U.S. milk supply. Despite these concerns, it was published in full in the Proceedings of the National Academy of Sciences (PNAS). The decision to publish the study was controversial enough that PNAS included an editorial alongside it, which explained the rationale for publishing research with potential security implications after discussions with government officials. In it, the PNAS editorial board emphasized the role of civilian research in enhancing national defense and security and highlighted the importance of open access to scientific findings to promote further research and encourage other scientists to build on this work (Alberts, 2005).

In late 2011, two separate research groups—one led by Ron Fouchier at Erasmus Medical Center in the Netherlands and the other by Yoshihiro Kawaoka at the University of Wisconsin—submitted manuscripts to the journals Science and Nature. These manuscripts described an experiment in which they engineered a strain of the H5N1 avian influenza virus that could be transmitted between mammals and, thus, potentially humans, by airborne means (Herfst et al., 2012). Avian influenza is highly lethal; however, it rarely infects humans, as infection requires close contact with infected poultry, and it does not spread easily between mammals. The experiments conducted by Fouchier and Kawaoka produced intriguing results from a scientific standpoint, demonstrating that airborne transmissibility between mammals was associated with specific genetic mutations. They submitted their manuscripts to prestigious journals for publication.

The National Science Advisory Board for Biosecurity (NSABB) reviewed certain manuscripts and determined that specific sensitive information regarding the engineering of H5N1 to become airborne needed to be excluded. This decision ignited a larger debate about the balance between scientific freedom and security. In early 2012, the World Health Organization (WHO) intervened in the debate, advocating for the full publication of the two papers, as they contained valuable information for influenza researchers globally. Ultimately, the NSABB seemed to have reconsidered its position and recommended the publication of both studies (Rappert, 2014, pp. 4–5).

The two experiments mentioned are by no means the only DURC experiments conducted during that period. Rather, they serve as illustrations to highlight the security practices that emerged following these experiments. Through DURC, a security rationale has been integrated into what is typically civilian research. Identifying something as DURC largely shapes our approach to the research defined as DURC, which, in turn, influences the relationship between security, science, and technology, and society. Consequently, the DURC debate has introduced a discourse that was pivotal in establishing new policies and government bodies, such as the NSABB, within the field of biology and beyond. This discourse has also led to the formulation of new security policies that regulate who can access specific research findings, as evidenced by the debate surrounding the publication of the H5N1 experiments. It has transformed how research is funded and conducted, shaping discussions about security implications at various national, international, and subnational levels.

The changes in scientific conduct resulting from the DURC debate extend beyond the United States; they impact nearly every country with a significant research landscape. In 2012, the DURC debate officially reached Germany. The official account of this development is relatively brief and, at present, not as clear as the broader narrative of DURC in the U.S., which has been documented multiple times (J. Miller et al., 2002; S. Wright, 2006).

In November 2012, Germany's parliamentary commission for technology assessment, known as the *Ausschuss für Bildung, Forschung und Technikfolgenabschätzung*, convened a hearing focused on "security-relevant research". The invited experts represented some of Germany's most prestigious research institutions, including the Robert Koch Institute, the Leopoldina, and the Fraunhofer Society. Their testimonies largely echoed previously articulated views: research should remain free and unrestricted; while research may indeed have implications for security, sensible restrictions could be applied when necessary; and scientists bear a responsibility to ensure their research is conducted not only safely but also securely. However, there is a pressing need for clearer regulations regarding what constitutes research with security implications.

The hearings did not yield immediate tangible outcomes. Subsequently, some parliamentarians directed inquiries to the federal government, seeking information on the extent of federal funding for security-relevant research, but this effort was largely limited in impact. However, in the summer of 2012, the federal government, namely Annette Schavan, the Minister for Education and Research, and Daniel Bahr, the then Minister for Health, assigned the German Ethics Council to produce a report. Citing the H5N1 controversy, the mandate was to summarize existing national and international guidelines governing life science research with security implications, recommend additional measures, and explore the applicability of these guidelines to other fields facing similar challenges (Schavan & Bahr, 2012).

An ethics council report is a significant undertaking; it typically takes several years to complete and involves extensive discussions and expertise. These reports often serve as a reference point in expert discussions and help shape the discourse around a given topic (Fischer & Bauer, 2022). In 2014, the Ethics Council completed its task and published a report entitled *Biosicherheit – Freiheit und Verantwortung in der Wissenschaft* (Deutscher Ethikrat, 2014). The document opens with the controversy surrounding H5N1 and the resulting tensions between the principles of free research and the need for responsible conduct in science. The report from the Ethics Council is thorough, spanning nearly 300 pages. It examines the existing national and international guidelines related to security-relevant research and offers recommendations. Notably, the report argues that there may be a need for new legislative measures to define DURC and to implement binding guidelines to assist researchers in managing DURC-related work (Deutscher Ethikrat, 2014).

The discussion about the applicability and usefulness of legislative measures to govern DURC experiments is one of the central themes in the DURC debate. While the Ethics Council argued in favor of such laws, this view is hotly contested by other actors in the DURC debate. Just a few months before the extensive Ethics Council report was published, one of the most prominent entities in the German research community, the Deutsche Forschungsgemeinschaft (DFG), which is a major provider of research funding in Germany, collaborated with the Leopoldina, the National Academy of Sciences in Germany, to publish a similarly titled report: *Wissenschaftsfreiheit und Wissenschaftsverantwortung*. Some suggest that this timing was not a coincidence; Leopoldina anticipated that the Ethics Council would recommend new legislation and sought to prevent that outcome. Accordingly, the DFG/Leopoldina report implicitly argues that new laws are unnecessary and that the responsibility for regulating DURC should remain with researchers and research institutions, in line with the German tradition of academic self-governance (Deutsche Forschungsgemeinschaft & Leopoldina, 2014).

Both reports were discussed during another round of hearings convened by the Bundestag Science Committee. The 2015 hearings included representatives from Leopoldina, the Ethics Council, and various prominent research institutions, such as the RKI and the University of Marburg. These institutions operate two of the only four high-security labs in Germany. The other two BSL-4 labs are managed by the Bernhard Nocht Institute for Tropical Diseases in Hamburg and the Friedrich Löffler Institute for Animal Diseases, which is now located on the largely closed island of Riems in the Baltic Sea after a few unfortunate incidents.

The hearings concluded that the implementation of new legislation was not recommended. Any legislative measures would require a clear definition of DURC, but the rapid pace of scientific advancement makes this difficult. Experiments with potentially harmful capabilities can emerge in almost any area of life sciences and cannot be defined in advance. Scientists, who possess the best understanding of their fields and the implications of their research, should take responsibility for ensuring their research is secure as part of their ethical obligations. They would need to conduct reviews of their experiments, and research funding would be contingent upon their successful completion of these reviews, particularly if they are seeking funding from the DFG.

Ultimately, no parliamentary intervention was deemed necessary. Instead, scientists would receive support in conducting their reviews through a Commission for Ethics in Research (KEFs), which would be established at each research institution to assist and advise researchers, as suggested by the DFG/Leopoldina report. Since then, this has been Germany’s policy; researchers conduct risk assessments and take appropriate countermeasures, assisted by institutional KEFs (Deutsche Forschungsgemeinschaft & Leopoldina, 2014). Unlike the US, where several new laws were enacted and oversight institutions established to secure dual-use research, Germany has adopted a comparatively relaxed approach of academic self-governance.

With the introduction of DURC as a new concept in biosecurity, we have also observed the implementation of new security policies and governance measures aimed at regulating the dissemination of dual-use technologies. Additionally, there has been a discernible shift in responsibility for security, transitioning from states to researchers, research institutions, and corporations to ensure that dual-use technologies are not exploited by "malicious actors" (Miller & Selgelid, 2007; Rychnovská, 2016b). In these settings, we find comprehensive technical discussions concerning the characteristics of specific technologies and their security ramifications. The process of developing security measures has matured into a technical endeavor, encompassing intricate technical and risk assessments to guarantee that technologies are "secure".

Moreover, we are witnessing significant shifts in the governance of research circulation, particularly those that hold security implications (Rychnovská, 2016a). The H5N1 controversy discussed in the introduction exemplifies the shift in security policy pertaining to dual-use research. When Ron Fouchier published his findings in the American journal Science, he did so without first securing an export license, thereby constituting the export of dual-use research. This publication prompted a brief legal proceeding in the Netherlands concerning Fouchier’s work. Although the case did not culminate in any significant actions, it underscores the increasing scrutiny directed towards dual-use research following the discussions on DURC (Zanders, 2015).

The free exchange of information is often cited as a hallmark of science in DURC publications (e.g., NSABB, 2006, p. 9). Nevertheless, Fouchier's cases exemplify how the DURC debate challenges the prevailing paradigm that equates military research with secrecy and civilian research with transparency. This debate introduces a security rationale that advocates for increased confidentiality in civilian research. In addition to government interventions, the issue of self-governance has also gained significance. Leading journals and publishing houses, including two of the most prestigious, Science and Nature, are now voluntarily conducting security reviews of manuscripts prior to publication (Journal Editors and Authors Group, 2003).

How did we arrive at this point? In the subsequent chapter, I will outline the discursive transformations during the 1990s and early 2000s, which fostered a specific imaginary of biotechnology characterized by a duality: contributing to security while simultaneously posing a threat to it, as initially outlined in this section and reflected in contemporary practices. Understanding this dual imaginary of science as both a threat and a fix to security is essential to comprehend the origins of current practices. As everyday life becomes increasingly technologically mediated, scientific fields become more pertinent to the functioning of modern society and thus bear potential security implications. Consequently, it is vital to understand how the interaction between science and security engenders regulatory practices that may either restrict or facilitate scientific research. Throughout the remainder of this chapter, I like explain my interest in this question and the structural outline of this project.

1.1 Research Interest: Security, Discourse and Critical Theory

When I began working on biosecurity issues, my research was focused on improving governance and oversight of DURC in Germany. I was part of a medium-sized research group consisting of about ten people, funded by the German Ministry of Education and Research (BMBF). The BMBF has a funding line that provides research grants for projects aimed at improving civil security.

The primary goal of our research group was to enhance methods for anticipating the spread of diseases, specifically focusing on naturally occurring diseases. My principal investigators (PIs) and I also examined the intentional release of pathogens. On a larger scale, the dynamics of pathogen spread are very similar, regardless of whether the pathogen occurs naturally or is deliberately released. However, the strategies to prevent the introduction of a pathogen into a population differ significantly.

While discussions about naturally occurring illnesses largely revolve around monitoring the emergence of new illnesses, those regarding intentional releases often revolve around the regulation of technology. Therefore, I directed my efforts toward analyzing high-risk biotechnologies with security implications and finding ways to enhance their oversight systems.

Beginning with my research and at that time knowing very little about biosecurity, Germany's position on DURC seemed peculiar to me as it did not align with my expectations. I had anticipated a comprehensive plan for government oversight, particularly in light of the stereotypes associated with Germany, the significant institutional changes that DURC has prompted in the United States, and Germany's stringent laws on genetic engineering. I expected DURC to provoke efforts for oversight at both the national and international levels.

I envisioned a robust debate akin to previous discussions surrounding stem-cell research and the use of genetically modified organisms in agriculture. I expected a wide variety of stakeholders from politics, civil society, and research communities to engage in an exchange of diverse viewpoints. Instead, I discovered that the German expert community focused on biological weapons and dual-use in life sciences consisted of a relatively small group that could comfortably fit into a medium-sized conference room at the Hans-Böckler Foundation in Berlin Mitte.

Even when the Foreign Ministry seeks expert input on Germany's position in the Biological Weapons Convention (BWC) for the upcoming years, attendance at these meetings remains limited. They typically attract only a handful of researchers involved in the regulation of DURC at their respective institutions, who are directly affected by it. Overall, the turnout does not exceed around 80 participants. During those meetings, there appears to be little debate regarding whether DURC poses a security threat. While disagreements exist on what exactly constitutes DURC, the best ways to address it, nearly everyone in the community agrees that DURC is a security problem.

When I was introduced to this community and its perspectives, one question lingered in my mind: Why? Why was there not more debate? Why was the topic not hotly contested? Why were there so few people involved? Was the topic so deeply rooted in a security rationale that it seemed natural and did not warrant extensive discussion? Most publications focusing on DURC originate from the United States, where there is a lively discourse on the subject. In contrast, bioterrorism has not been a significant topic in Germany. Additionally, Germany does not have the historical legacies of state-sponsored bioweapon programs, at least not after World War I. The German biosecurity debate does not rest on the same structural foundation as the discussion in the US.

At the same time, participants in the German discourse distance themselves from debates surrounding genetically modified organisms (GMOs) or stem cell research. GMO discussions typically center on ethics, safety, lab accidents, unintended consequences, and the question of whether one should pursue every possibility available. In contrast, discussions about DURC are framed as matters of security. This raises the question: if DURC is not biological weapons and is entirely different from GMOs and stem cell research, what is it, and why is it sufficiently significant for the Ministry of Education to finance research into the subject?

Literature from the Critical Security Studies (CSS) field can help us understand the seemingly contradictory nature of DURC. CSS researchers have demonstrated that nothing is inherently a security threat. Instead, something becomes a security threat through the discourse, and what something(s) can convincingly become a threat is influenced by many factors and their interactions (Campbell, 1992; Fierke, 1997). Responses to a threat do not automatically arise from the threat itself. Instead, they are shaped through complex processes. The construction of a threat and the formulation of a response to that threat are closely interlinked. Often, the way we respond to a threat helps to stabilize our perception of what is threatening, and this relationship goes both ways (Huysmans, 2014).

These two foundational premises, central to critical and constructivist approaches to security, underpin this research project. First, nothing is inherently a security threat in isolation. There are objective dangers in the world; however, whether or not they are dealt with as security threats depends on discursive processes (Campbell, 1992). Second, responses to threats do not arise automatically; rather, the processes that define something as a threat and those that shape the responses to it are interdependent. This indicates that DURC does not automatically constitute a threat based on its intrinsic qualities; instead, it becomes one through social dynamics. Furthermore, the German response to DURC, which I am studying in this project, is not merely a direct reaction to perceptions of DURC, but rather stems from complex interwoven social processes.

The implications of DURC reach far beyond its immediate context, offering critical insights into the interplay between emerging technologies and security. It serves as a template for various fields and a compelling lens to explore how the complexities of the interplay between science security are translated into political action. With its robust research landscape, significant economic influence, and a history of collaborative governance in science, Germany is an exemplary case study into the dynamics of the DURC discourse. Between the reports of the Max-Plank-Gesellschaft (MPG), DFG and Leopoldina on the one hand and the Ethics Council report on the other, Germany faced two competing options for regulating DURC. The first relied solely on the self-regulation of researchers, while the second contemplated legislative measures to govern DURC. Germany opted for the former as its mode of governance.

From these considerations, two key questions guide this project:

a) How did DURC come to be perceived as a threat in Germany?
b) Why did Germany choose the path it did?

As technology increasingly assumes the role of a security threat—an issue not confined to life sciences or DURC but relevant across a range of emerging technologies—this exploration is essential and throughout this project, we will examine not only how DURC became an issue for security policy but also the emergence of a global, hegemonic discourse on DURC, which helps to explain why Germany adopted the position of the MPG/DFG/Leopoldina in its governance of DURC.

1.2 New Security Practices, Little Research

Although technology and security are crucial elements of modern life, there is surprisingly little research examining their interplay from a perspective that emphasizes the contingent nature of both. Security studies tend to view technology as a subordinate to security. Technology is either seen as an object of security making, or security is seen as technologically mediated. In the first instance, scholars examine how certain technologies have become objects that need to be secured against proliferation. Stemming mostly from the arms control field, these studies examine the security policies surrounding certain technologies, such as nuclear weapons (Guillemin, 2005; Jacobsen, 2014; Zmorzynska & Jeremias, 2012; MacKenzie, 2001; MacKenzie & Spinardi, 1995). In the second instance, studies stemming mostly from the field of Critical Security Studies focus on how routine security practices have become mediated through the use of technologies. Here, a focus is placed on surveillance and visibility, and how certain technologies make things visible (or not) to security practitioners (Bengtsson et al., 2019; Jeandesboz, 2016; Neal, 2009; Rothe, 2020).

By subordinating technology to security processes, these studies often oversimplify technologies and overlook the simultaneous construction of technology and security. Processes of security and technology making are deeply interrelated, as will become evident from the empirical analysis in this thesis. In the context of critical research, it is crucial to capture these dynamics and employ a holistic view of the security-technology nexus. Perceptions and constructions of technological capabilities influence how something is perceived as a security issue. Simultaneously understanding a technology as a security issue has severe implications for how a technology can be employed and, consequently, for "what it can do".

By relying on constructivist approaches to technology and security, this study can trace the simultaneous construction of security and technology that occurs in these instances. Security making in the context of technologies is always technology making and vice versa. In doing so, I rely on Huysmans' (2014) writing about security as well as Grint and Wollgart's (1992) constructivist approach to technology. Using Jasanoff's (2014) sociotechnical imaginaries, this project will show how technology and security making become entangled by imagining positive or negative futures. Through the utilization of document analysis to illustrate the central themes within the biosecurity discourse, it becomes evident how these documents project certain socio-technical futures and how security is enacted concerning those futures. Such an approach promptly redirects focus toward risk as a pivotal epistemological instrument for securing a socio-technical future.

In this study, I will examine two sets of documents. The first set includes foundational documents of DURC, focusing on the U.S. debate from 2004 to 2010. This sample provides an overview of how security and technology related to DURC were initially constructed. The second set centers on the debate in Germany around 2012, which is particularly intriguing for several reasons. First, the approach to DURC in Germany is rooted in a history distinct from that of the U.S. Second, Germany's DURC policy emphasizes the self-governance and responsibility of life scientists. By contrasting these two cases, we can identify both differences and similarities in how DURC is perceived as a security threat. The analysis clearly demonstrates the emergence of a dominant discourse that leads to a comparable construction of DURC in both the U.S. and Germany, while some local nuances account for the differences.

The analysis conducted here can show how the mutual construction of technology and security leads to imaginaries about desirable and undesirable futures, which accounts for why DURC is addressed as a security challenge. In the DURC discourse, biotechnology is perceived as holding immense promises for the future. Simultaneously, it is envisioned as something that can also lead to a threatening, undesirable future. In this context, security techniques, like risk, are used to seemingly foster a desirable future and hinder an undesirable one. The role of risk in DURC discourse as a technique that enables and legitimizes research and the co-constructions of technology and (in)security leads to restricting and enabling security policy choices. I am also able to conclude why DURC is addressed through a self-governance system in Germany, as the centrality of risk-related techniques give primacy to the researchers' knowledge, depoliticizing the security practices and giving responsibility for securing DURC to the researchers.

1.3 Covid-19 and Structure of This Project

This project took place at the peak of the COVID-19 pandemic. Originally designed as an ethnographic research endeavor focusing on in-person interactions among biosecurity professionals, this methodology became unviable from late 2019 until approximately 2023. For once, in person meetings were no longer feasible. Furthermore, many biosecurity professionals were suddenly reassigned by their home institutions from dual-use and arms control issues to COVID-19-related tasks, rendering them unavailable as interview partners. This situation also accounts for an apparent gap in the biosecurity literature from 2019 onward. Regarding this project, the COVID-19 pandemic necessitated several methodological adjustments, primarily a transition from ethnographic research and interviews to content analysis. These changes will be further elaborated in the methods section. Accordingly, the structure of this project had to be adapted towards a "contactless" approach to address the research questions.

In line with this new approach, I will use the following sections to engage more with the discourse surrounding DURC to outline how, what I have described as a laissez-faire position, became the dominant policy solution in Germany. I have already outlined the institutional history of DURC above. From this starting point, we need a certain amount of theory to understand what we see here. Accordingly, the second chapter will provide the theoretical background for this project, drawing on constructivist approaches to security and technology, which I understand as constructions. In DURC, both constructions become entangled and produce certain accounts about technology and security, which I have termed techno-fix and techno-fear. Both accounts are archetypes about the future and DURC experiments' role in it. The theory section will also take a closer look at risk. Risk is a specific epistemology that we find in the security field. It is a particular way of making sense of the world around us. Throughout DURC documents, we constantly encounter risk as an epistemology and as a tool to decide between accounts of techno-fix and techno-fear.

Throughout the next chapter, I will introduce some theoretical concepts stemming from Critical Security Studies and post-structuralist Science and Technology Studies that can help explain how security and technology interact with one another to bring about socio-technical imaginaries of the future that shape policy in the now. In doing so, I will, for the most part, rely on the writings of Huysmans to describe a concept of security that uses everyday modes of interaction and is constructed vis-à-vis the object it regulates. Additionally, I will use Grint and Woolgart's constructivist theory of technology to demonstrate that the object (technology/DURC) that security attempts to regulate is not a static backdrop but, in turn, a dynamic construction that changes with how it is approached. Combining the two theories allows us to account for the co-production of technology and security in DURC. Lastly, Jasanoff's idea on socio-technical imaginaries is used here to describe how the co-production of technology and security becomes important for DURC policy.

The methods section will first outline my research approach. This project is built on a critical foundation that relies on an engagement with the relevant community of researchers. Through this approach, my own work in the community and the knowledge I gained in participating in DURC discussions becomes an important "tool" for approaching the selected documents. Turning our attention to the methodology employed throughout his project, the fourth chapter will introduce discourse as the main instance through which DURC is constructed and maintained as a security threat.

In doing so, I will rely on the discourse conceptualization outlined by Jäger and Jäger (2007) and introduce the discourse as the instance through which meaning is made. In turn, I will introduce Asdal and Reinertsen's (2022) document analysis as an approach to studying the discourse. Documents are important sites in DURC as they reflect and structure the discourse. Thus, using documents as "windows" into the discourse is a viable approach to examine the meaning-making in DURC. In analyzing the documents, I will rely on a method for qualitative content analysis outlined by Schreier (2012; 2014), and, in the course of the third chapter, I will also describe the selection of my sample, my approach to conducting the content analysis, and my coding frame and codes.

The first empirical chapter will examine the emergence of DURC in the Fink Report. In this chapter, I will focus on threat construction and its entanglement with the notion of an ever-faster-evolving research landscape that is foundational for DURC. The chapter will also include several references to the broader biosecurity discourse and other documents to show how the discourse emerged from the field. The second analytical chapter turns its attention to the NSABB reports. In it, I will continue to examine the role of technology constructions and how they interact with threat constructions. Additionally, the chapter will highlight the conceptualization of biotechnology as beneficial to society before turning our attention to the privileged role assigned to scientists throughout the DURC discourse. The third empirical chapter will focus on the German debate. I will compare the DURC discourse in the MPG/DFG/Leopoldina reports and the Ethics Council report. By examining the role of risk and science's relationship with the public constructed in DURC discourse, we can highlight key differences between the reports. Doing so allows us to show the emergence of a global DURC discourse and how the Ethics Council report breaks with this discourse, indicating why the Ethics Council position was not the case policy option for Germany.

In this chapter, I have introduced a certain duality observable in the interaction between science and security. Security practices appear to both enable and restrict scientific research and technological development concurrently. Understanding this duality is essential for understanding contemporary security practices and their influence on the conduct of science within specific fields. Using DURC and its regulation in Germany as an example, this project will demonstrate how the discourse surrounding DURC fosters a conceptualization of science that embodies this duality and consequently engenders specific security practices. In the subsequent chapter, I will present an overview of DURC and its historical development to establish a contextual background for the emergence of DURC.

2 Dual Use, DURC, and the History of Biological Weapons

The previous chapter examined why DURC serves as an excellent case for analyzing the link between security and technology. While it has significant implications for the broader relationship between science and security, DURC remains relatively unknown to the public. This topic is primarily discussed among a small group of biosecurity professionals who share a common sense of history and a collective understanding of security issues arising from it. Much of this knowledge is implicit within their community. This shared historical perspective is crucial for grasping the current discussions surrounding DURC, which often touch on the technical facets of biological weapons, their proliferation, and the regulatory framework developed by the biosecurity community over the years. Important terms such as "proliferation", "hostile or offensive purposes", and "bioterrorism" all center around a common concern: the creation of biological weapons.

As a concept, DURC draws on a peculiar mixture of security rationales and discourses about (in-)security. It borrows security rationales from the 1972 ban on biological weapons as defined by international law, the Cold War's logic on dual use and export controls intended to prevent militarily relevant goods from reaching adversaries, and more recent concerns related to terrorist attacks with weapons of mass destruction (WMD)—issues that intensified after the First Gulf War and especially following the Aum sect's 1994 chemical weapons attack on the Tokyo metro. The insecurities surrounding DURC merge these discursive strands, focusing on legality, proliferation, terrorism, and research ethics.

DURC fundamentally represents a dual-use dilemma. Biosecurity experts and government agencies frequently contend that technological advancements, along with influences such as digitalization, globalization, and the emergence of violent non-state actors (e.g., terrorism), lead to new insecurities linked to technologies with dual-use capabilities (e.g., Ienca & Vayena, 2018; Reppy, 2006). When considering the historical context of biological weapons, conversations about DURC typically take place within this common framework of security-making. In this context, biotechnology is often viewed as particularly concerning due to its dual-use nature. Moreover, it is perceived as appealing to non-state actors because of its significant destructive potential and its perceived ease of use. This assessment of biotechnology is rooted in a distinct historical narrative that I aim to outline in this section.

Consequently, this chapter serves as a research puzzle of sorts. In the upcoming sections, I will explore several key concepts and historical narratives significant to the biosecurity community, which are frequently discussed among biosecurity professionals. My goal is to clarify how these concepts are understood and applied in the field. To achieve this, I will incorporate various "native terms" like "misuse", "legitimate purposes", and "malicious actors". This will be particularly important in the next section, where I will discuss the biosecurity community's evolving understanding of dual use as a security concern. Literature about biological weapons and their security implications often originates from the biosecurity community itself, serving dual purposes in this research project. It not only provides the historical context for DURC but also serves as a lens into the biosecurity discourse, reflecting a collective knowledge base. Therefore, I aim to present the issue as significant portions of the community perceive it. This section should be regarded not as an unbiased historical account but rather as an insight into the pertinent discussions

2.1 DURC – The Embodiment of Dual Use in the Life Sciences

The concept of DURC inherently intersects with a more extensive discussion surrounding dual-use technology. The dual-use dilemma is particularly significant in the life sciences. Biotechnology is often described as a "quintessential dual-use technology" because nearly all research focused on understanding diseases and developing cures has the potential to be misused for harmful purposes, such as promoting the spread of disease or evading counter-measures like vaccinations or treatment (e.g., Reppy, 2006, p. 3). Dual-use control is a key concern within the biosecurity community. However, biosecurity professionals frequently argue that the effectiveness of dual use as a mechanism for regulating the proliferation of technology—primarily through export controls—has become increasingly challenging due to the global spread of high technology. New strategies are needed to prevent the dissemination of DURC into the hands of malicious actors (e.g., Atlas & Dando, 2006).

Security strategies that address dual-use implications, particularly in relation to the vulnerabilities posed by contemporary biotechnological advancements, play a crucial role in the ongoing discourse. Technology serves as a fundamental component of warfare and armed conflict. The roles of small arms, armored vehicles, and military aircraft exemplify this relationship, where possessing superior technology is perceived as an advantage in armed conflict. Technological innovations have functioned both as instruments of security and as potential sources of insecurity. While new weapons promise enhanced security when used by allied forces, they also retain the potential to be employed as threats by adversaries. However, the importance of technology in bolstering security transcends the realm of military innovations. For instance, on September 14, 2022, Ursula von der Leyen, then President of the European Commission, remarked during her State of the Union address, "[t]he Russian military is repurposing components from dishwashers and refrigerators to repair their military equipment […]" (von der Leyen, 2022).

The employment of semiconductors originating from civilian applications in military hardware exemplifies the persistent concerns surrounding dual-use technology. The concept of dual use has undergone significant evolution since its inception in the early 20th century. Today, it refers to civilian technologies that may be used as weapons or utilized in military conflicts. Numerous emerging technologies, including 3D printing, drones, and computing systems, serve both benign civilian purposes and potential applications in military operations. When applied in civilian contexts, these technologies possess considerable economic value; however, as instruments of warfare, they can lead to the proliferation of means of violence. Many dual-use technologies have become integral to the contemporary civilian economy. For example, the absence of computers has become unthinkable for the majority of the populace. Likewise, advanced biotechnology has led to various pharmaceutical advancements, resulting in new drugs, treatments, and vaccines that are vital to modern society. Both examples illustrate that the regulation of dual-use items frequently results in what is termed a "wicked problem“, characterized by the absence of straightforward solutions (Koblentz, 2014).

The concept of dual use has been a prominent feature in the arms control and disarmament community since the 1940s. During this time, certain civilian research, primarily related to nuclear research and technology, was viewed as a potential threat to national security, particularly if accessible to the Eastern Bloc (McLeish, 2007b). Due to its roots in the Cold War and the nuclear arms race of that era, dual-use technologies originally referred to goods, materials, knowledge, or any other commodities that, while intended for legitimate civilian purposes, can also be utilized in the construction of weapons of mass destruction (Dubov, 2014, p. 449).

The term "dual use" has evolved in meaning over time. In contemporary discourse, it encompasses a much broader concept than merely referring to weapons of mass destruction. Currently, the most prevalent interpretation highlights the military-civilian divide in technology. In this context, dual-use commodities are those that can effectively operate in both domains, often requiring only minor adaptations (Dubov, 2014; Reppy, 2006).

During the Cold War, it was relatively easy to keep research knowledge secret. The most sensitive research was classified and conducted in government research facilities by staff who were sworn to secrecy (Maurer & Fischer, 2010). During the 1980s, a significant shift occurred as civilian research and development began to surpass many military development initiatives, particularly in the realm of computer technology. The military found itself in urgent need of these advancements and acquiring them from the civilian market often proved to be more cost-effective than pursuing their development through military projects. This trend was especially evident with the emergence of the latest "Revolution in Military Affairs", which emphasized network-centric approaches to warfare (e.g., Singer, 2009). Consequently, militaries increasingly relied on commercially available civilian computer technologies that were widely circulated among the general population. Since then, there has been a notable increase in the transfer of civilian technologies to military applications, leading to a greater use of "off-the-shelf" components in military projects (e.g., Molas-Gallart, 1997).

Emerging dual-use technologies from the civilian sector present new challenges for security practices and proliferation control. Civilian technologies that could be used for harmful applications are often widely available and deeply integrated into everyday life and production processes. For example, while computers can be used for offensive purposes and play a crucial role in network-centric warfare, they are also readily accessible to civilian populations. As a result, numerous companies are available to meet the demand for such technologies. This situation contrasts sharply with the Cold War era, when dual-use technologies typically originated from a single source that could be easily regulated. While traditional export regimes can limit the transfer of technology from member countries to other states, they are relatively ineffective if the state that has jurisdiction is not a member and, therefore, is not bound by those export control regimes (McLeish, 2007). Today, controlling dual-use items has become much more difficult, as they can be obtained from various sources across different jurisdictions (Reppy, 2006). This widespread accessibility allows malicious actors multiple avenues to acquire dual-use technologies, thereby evading existing regulatory measures (Rappert, 2007).

Throughout the 1990s, another trend emerged that profoundly impacted the dual-use discussions, as non-state actors were becoming perceived as the main security concern. These actors often intermingle with domestic and foreign civilian populations. Controls over access to technologies are no longer regulated along the clear distinctions of the Cold War, and keeping a malicious actor in the civilian population from obtaining access to dual-use technologies while simultaneously not obstructing the access of the general population to those resources is nearly impossible (Evans, 2016; Ienca & Vayena, 2018).

This is particularly relevant today because, in the context of dual-use control, knowledge about processes is often more critical than controlling the physical object itself. Computer science serves as a prime example of this situation. Although there are many legitimate reasons for owning a computer, these devices can also be used for offensive purposes. Engaging in such activities requires a specific set of knowledge, making access to this information potentially more concerning from a security perspective than access to the physical hardware. The same argument applies to 3D printing and biotechnology, where there are many valid reasons for possessing specific physical items (e.g., 3D printers or bioreactors). However, the specialized knowledge needed to convert these items into weapons raises significant concerns. The increased digitalization and democratization of science have further complicated the challenge of controlling this knowledge (Ienca & Vayena, 2018).

The selected examples demonstrate that maintaining a clear distinction between civilian and military applications is becoming increasingly challenging. Many technologies operate at the intersection of these categories, embodying characteristics of both. Additionally, the end of the Cold War, coupled with economic globalization and the rising significance of non-material aspects of technology, undermines the effectiveness of traditional dual-use controls that primarily focus on export restrictions (Reppy, 2006, pp. 7–8).

The potential transition of research from civilian applications to offensive uses represents a significant concern for the biosecurity community, professionals who address security issues related to the life sciences. Within this community, such scenarios are referred to as the "misuse" of research when findings intended for civilian purposes are repurposed for hostile objectives. In light of the aforementioned changes and challenges to dual-use governance, DURC exemplifies the security issues surrounding the misuse of biotechnology.

In the context of the arms control framework that heavily influences biosecurity, technological development is generally categorized as either belonging to the military sphere—conducted for "hostile" (offensive or illegal) purposes—or to the civilian sphere, which involves legal or peaceful applications, such as civilian research (vaccinations, and biodefense research under the BWC).

However, DURC complicates this division, as it primarily involves civilian experiments conducted for peaceful purposes that simultaneously pose significant security concerns, exceeding what is typically considered "normal" dual use.

2.2 A Brief History of Bioweapons: From Anthrax to Anthrax

The dual-use potential of biotechnology is central to the discussions surrounding DURC. As biotechnology is primarily considered a civilian technology, it is more accessible to non-state actors than other types of weapons of mass destruction. Therefore, many discussions on DURC not only reflect the changing dynamics of dual use but also tackle wider issues related to terrorism concerning weapons of mass destruction, particularly biological weapons.

Bioterrorism emerged as a significant security issue in the 1980s. In the context of this research project, it is essential to understand that the perception of bioterrorism is not seen as an objective reality but as a conceptual idea shaped by evolving discourse. This change in narrative began even prior to the 2001 anthrax attacks in the US. The narrative surrounding bioterrorism correlates with a broader shift where terrorism increasingly replaces the threat narratives established during the Cold War, particularly from the mid to late 1980s. The narrative surrounding bioterrorism gained traction during the 1990s, especially after the US-Iraq war under the Clinton administration, and peaked with the anthrax attacks in 2001. While some research exists on the US perspective, the evolution of bioterrorism concepts in Europe is mostly unexamined, particularly before 2001, but the aftermath of 9/11 bioterrorism received increased attention in Europe too.

The discourse on bioterrorism arises from an engagement with historical narratives, particularly those related to the biological weapons programs of the Soviet Union and Iraq. Furthermore, the discussion encompasses themes from a specific narrative about new forms of religiously motivated terrorism that emerged after the Cold War, culminating in the 9/11 attacks on the World Trade Center and the anthrax bioterrorism incidents in the U.S. in 2001. For this reason, I have included a brief overview of biological weapons and their history. Much of the history surrounding biological weapons has been documented by the same biosecurity community currently engaged in discussions about DURC. Thus, this historical account not only serves as a primer on past events but also reflects the shared knowledge within this community. It offers both historical context and insights into the biosecurity discourse, presenting common reference points that are widely recognized among professionals in the field.

In this chapter, I will examine several important aspects of the bioweapons discourse. I will begin by outlining what defines a biological weapon, followed by a historical overview of bioweapons. Initially, bioweapons were seen as a novel and obscure concept during World War I, but they were later considered a viable alternative to nuclear arms soon after World War II. During this time, Western nations, particularly the United States, operated extensive bioweapons programs. The US program later shifted its focus toward defensive research following the 1972 ban on biological weapons, which likely contributed to the prominence of biosecurity issues in the US. The second focal point of my discussion is the establishment of the Bioweapons Convention in 1972, which prohibited biological weapons and has become a crucial institution for dialogue on biosecurity matters, including DURC, today. The third section will explore the so-called "*illegal programs*", particularly those of the Soviet Union and Iraq that emerged after 1972; these programs serve as key reference points in the DURC conversation. Finally, the fourth section will address the rise of bioterrorism as a significant security threat. Our narrative culminates in 2001, where I will underscore three pivotal events that contributed to the onset of DURC.

Biology as a Weapon

A biological weapon is generally understood as a weapon of mass destruction that consists of two primary components: a) a biological agent and b) a delivery system. The delivery method can involve bombs, munitions, or other devices specifically designed to disseminate the biological agent

(Guillemin, 2005). The most important devices are bombs, especially cluster ammunition and spray tanks that can be mounted under airplanes. Biological weapon agents have also been loaded into ballistic missiles with varying ranges. Theoretically, a homemade explosive device, like the one used for the attempted Ricin attack in Cologne 2018 (Ricin Plot Bigger than Initially Suspected, 2018), designed to disseminate as pathogens would also be considered a delivery system, albeit a crude one. During the 2001 Anthrax attacks, anthrax was mailed directly to its intended targets. The delivery system here is the simplest; when an individual opens the letter, the anthrax is disseminated by opening itself (F. L. Smith, 2014, pp. 21–22).[1]

The biological warfare agent (BWA) serves as the primary payload of a biological weapon. Most biological weapons employ aerosolization to disperse the agent, intending for it to be inhaled by the targeted individuals, leading to illness. While biological weapons can include additional harmful substances that assist in disseminating the BWA (such as explosives), the BWA remains the primary vector through which biological weapons are intended to inflict harm. The BWA can consist of any microbial or other biological agent or toxin chosen for use in a bioweapon (Guillemin, 2005, pp. 2–6). Historically, pathogens responsible for infectious diseases, such as plague and anthrax toxins, were the primary biological weapons agents used in weapon programs. Throughout history, a number of different pathogens have been evaluated for their use in bioweapons (Cieslak et al., 2018). With recent advances in biological research, using other BWAs is generally thinkable. However, using such BWA agents is, following current wisdom, not probable as significant technical challenges are involved.

To cause an infection, BWAs generally need to contact the mucous membranes of a host (at least for humans and animals; plant pathogens exhibit different behavior). Therefore, the primary defense against a biological weapon is to limit exposure through measures such as gas masks. Another strategy involves using vaccinations to prevent infections. Historically, most bioweapons programs included both offensive and defensive components. While defensive components focused on developing vaccinations and cures for biological weapons, offensive components aimed to circumvent these defenses. Thus, it is difficult to estimate how many people would be affected by a bioweapon because the effectiveness of measures to limit the spread of an illness depends on numerous variables (e.g., Guillemin, 2005; Wheelis, 2004).

Nevertheless, disease and warfare have a long history together; in fact, during early times, the diseases that accompanied invading armies were often more effective tools for expansion than the armies themselves (Wheelis, 2004, p. 15). As deaths from illness routinely outnumber those as a direct result of the hostilities themselves, controlling infectious diseases has been and remains one of the primary aims of military medicine, as reducing the number of soldiers incapacitated by illness provides significant tactical and strategic benefits to an army. This might help to explain the allure that biological weapons held to some military planners as a means to increase the burden of disease on an opposing force and civilian population to gain an advantage (Wheelis, 1999, p. 8).

Until the discovery of germs, illness was feared but little understood. With the discoveries of microorganisms during the 19th century, germ theory, the idea that diseases are caused by pathogenic organisms that can spread between hosts, established itself as the dominant scientific paradigm (Guillemin, 2005, p. 3). From the second half of the 19th century onward, advancements in disease study, facilitated by technological developments such as microscopes and rudimentary laboratory equipment, enabled breakthroughs in the field. In 1858, Louise Pasteur published his theory that specific microorganisms caused illness. In 1876, Robert Koch proved Pasteur's theory by tracing the life cycle of *Bacillus anthracis*, the bacterium that causes anthrax (Guillemin, 2005, p. 23). Germ theory and understanding the causal links between microorganisms and disease outbreaks dramatically improved public health. It allowed the systematic control of disease outbreaks so that by the 1920s, Western

[1] Here, it is questionable how far a letter constitutes a delivery system, but for the sake of argument, it shall be one.

societies were rarely threatened by sudden outbreaks that disrupted social order (Guillemin, 2005, pp. 20–21). However, besides improving public health, the discovery of microorganisms and their causal links to disease outbreaks also provided the foundation for modern, scientific bio-weapons programs throughout the years to come.

2.3 Biological Weapons before 1972

By understanding the causal mechanisms that lead to illness, biological weapons have garnered attention as tools of war that could be employed in interstate conflict. Scientific advancements have rendered it feasible to produce pathogens suitable for utilization as bioweapons. This progress has been facilitated not only by breakthroughs in pathogen research but also by extensive technical innovations. The evolution of biological and chemical weapons has similarly depended on numerous inventions, such as the airplane and efficient gunpowder for artillery shells, which have enabled the dissemination of biological and chemical agents. Notably, the advancement of bioweapons often occurred concurrently with the development of chemical weapons programs at the onset of the 20th century, as various states fortified their arsenals with biological and chemical weaponry.

Generally, most biological weapons programs transitioned through three distinct phases, initiating from the early 20th century. The initial phase, characterized as the offensive phase, persisted until 1972, when the Biological Weapons Convention prohibited the development of biological weapons. During this period, the development of biological weapons was virtually permissible (only their utilization was restricted), and most significant powers conducted extensive bio-weapons programs to varying degrees. The second phase commences with the Biological Weapons Convention of 1972 and is characterized as the defensive phase. The BWC prohibits the production and development of biological weapons, yet it permits defensive research, which the majority of programs have predominantly concentrated on since 1972. The third phase initiates in the early 1990s, particularly in Western countries. Defensive research regarding biological weapons becomes significantly more focused on the potential for terrorist utilization of such weapons rather than state use. Therefore, the third phase can be understood as a shift in the nature of the threat, transitioning from state use of strategic weapons to biological weapons being utilized as tools by terrorist groups (Guillemin, 2005, pp. 11–14).

While defensive components aim to protect soldiers from biological weapons and naturally occurring illnesses, offensive programs seek to develop biological weapons for use against an enemy. Throughout the history of biological weapons programs, the line between these two components is often blurry, as insights into defense against illness can also be applied to develop offensive capabilities. Nevertheless, distinguishing between these components can be useful, as when I discuss biological weapons programs, I (and most others) typically refer to their offensive aspects. Prior to World War II, biological weapons programs never reached the scale of their chemical counterparts. Due to technical difficulties, they had only limited tactical value on the battlefield. However, biological weapons benefited from several technological advancements during the war (and shortly after), as the technology for disseminating chemical weapons and the introduction of airplanes addressed some of the challenges faced by bioweapon programs. Soon, some military theorists and life science researchers envisioned a role for biological weapons as strategic arms, delivered by long-range bombers and designed to wreak havoc on enemy city centers and industrial areas, where the civilian population might lack protective gear and gas masks (Guillemin, 2005, pp. 6–8).

World War I & the Geneva Protocol

The early history of biological weapons programs is particularly obscure due to the secrecy surrounding numerous documents. Consequently, the existing literature on this subject is relatively limited, as biological weapons were not extensively employed during conflicts. Whereas chemical weapons were widely utilized during World War I, biological weapons played a minimal role, primarily serving as instruments for sabotage against animals (SIPRI, 1971b, p. 111). Germany engaged in a sabotage campaign using anthrax and glanders to infect pack animals intended for shipping to French and British forces from neutral countries, mainly the US (before it entered the war itself) and Romania and possibly in Spain and Norway. The success of those campaigns remains unknown (Guillemin, 2005, p. 21; Wheelis, 2004, pp. 17–18).

The use of biological weapons in World War I is largely a historical footnote. Post-war, chemical weapons gained more attention, and the Peace movement grew, resulting in the League of Nations and several disarmament conferences (Guillemin, 2005, p. 6). The 1925 Geneva Protocol is the first modern document banning biological weapons. It remains in force today and serves as a significant reference in international contexts, alongside the BWC.

Overall, the conferences where a failure as state parties could not agree on arms trade restrictions. The proposed site document, however, was signed on 17 June 1925, thereby producing the *Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare* affectionately known as the *Geneva Protocol* and remains to be a fixture in the disarmament community (SIPRI, 1973, p. 21). While the majority of significant powers embraced the Geneva Protocol, in an intriguing turn of history, the increasingly isolationist United States, which initially proposed the treaty, signed but did not ratify the document until 1975 (Guillemin, 2016, pp. 23–24). The Protocol banned the use of biological and chemical weapons. However, use in this case meant "first use"—an essential caveat as the Geneva Protocol allows for retaliation "in kind" against an attacker using unconventional weapons. Thus, offensive research on, as well as the production and stockpiling of biological weapons, was technically legal under the Protocol as they could be used for retaliation in kind.

The peace movement after World War I was short-lived, and soon after the first, the Second World War started. It is often said that, like their chemical counterparts, biological weapons did not play a role in the European theater during this conflict. Fear of reprisals in kind, technical drawbacks, and moral objections are generally listed as reasons why no unconventional weapons were used during the Second World War (Guillemin, 2016, p. 18). Yet, like so much about the Second World War, this perspective is distinctly Eurocentric, as unconventional armaments of all kinds were used in Asia. The one significant exception to the "Biological Weapons where never used in conflict" rule is Japan’s Unit 731, which gained dubious fame as the principal perpetrator of massive war crimes related to CBW. Japan used biological (and chemical) weapons during its invasion of Asia in several horrifying instances, including human testing on captives and against the civilian population (Guillemin, 2017).

The Legal Programs – Canada, UK, US Before 1972

During the 20th century, numerous states maintained biological weapons programs of varying scope and formality. The collective knowledge about these programs and their implications provides an important contextual backdrop against which DURC is constructed and negotiated. Most of these programs commenced around the time of World War II, as major powers prepared for armed conflict. This is particularly evident in the case of the British program, where rumors and newspaper articles alleged a widespread German biological weapons initiative, prompting British efforts to develop biological weapons as a form of retaliation should such weapons be deployed against the United Kingdom (Guillemin, 2005, pp. 40–42).

In 1940, a small biological research unit was established within the chemical warfare research program at Porton Down, located in southern England (SIPRI, 1971a, pp. 117–118). The unit comprised 40 to 50 staff members. In 1942, however, it was determined that the biological warfare initiatives required additional resources beyond what Britain could supply. Consequently, a collaboration was established between Great Britain, the United States, and Canada to consolidate efforts in the development of biological weapons. The British program underwent a predominantly offensive and primarily defensive phase, although the distinctions between these phases were initially ambiguous before being downgraded due to Britain’s independent nuclear capabilities in the 1950s. Subsequently, Britain’s biological weapons program shifted from being comparable to nuclear weapons development after World War II to a primarily defensive stance (Balmer & van Courtland Moon, 2016, pp. 45–46).

Similarly, the Canadian and United States programs were originally established out of concern that Germany might deploy biological weapons in North America. Given Germany's biological sabotage efforts during World War I, such apprehensions were not entirely unfounded. Additionally, these programs served as a contingency plan to retaliate in kind should Germany employ chemical or biological weapons in Europe or against allied or Soviet forces (Balmer & van Courtland Moon, 2016, p. 53). Although Canada continued to be a relatively minor participant in UK/US/Canadian cooperation, the United States segment would evolve into one of the most significant programs in the history of BW, managed by the military with the assistance of civilian scientists who provided counsel on offensive and defensive aspects (Balmer & van Courtland Moon, 2016).

Similar to many other programs, the United States' initiative can be categorized into offensive and defensive phases: The offensive phase commenced during World War II with the objective of rapidly developing biological weapons and persisted beyond the war until 1969 to investigate the potential applications of offensive biological warfare mechanisms (Balmer & van Courtland Moon, 2016, p. 53). It was maintained during the Cold War due to concerns regarding a Soviet biological weapons program and to explore alternatives to nuclear weaponry, particularly in scenarios involving limited warfare (Balmer & van Courtland Moon, 2016, p. 76; van Courtland Moon, 2006). The offensive phase continued until 1969, when the Nixon administration unilaterally decided to cease bioweapons development, thereby paving the way for the subsequent establishment of the Biological Weapons Convention (BWC) in 1972. Until that time, the United States' program remained among the most significant efforts to incorporate offensive biological warfare capabilities into arsenals (Balmer & van Courtland Moon, 2016, pp. 53–60).

This brief summary does not adequately represent the scope of the United States' program. Considering the scale of most biological warfare initiatives, the American efforts were substantial. Most programs remained at the research and development stage, involving a few dozen scientists (with numbers fluctuating over time due to shifts in administrative priorities, which generally declined in most countries discussed with the development of nuclear weapons). At certain points, such as during World War II, the US program employed between 3000 and 4000 personnel at Camp Detrick, the primary bioweapons facility in the United States. The program encompassed multiple facilities and extensive open-air testing sites. Moreover, it advanced well beyond the R&D phase, resulting in the production of a significant quantity of munitions ready for deployment (van Courtland Moon, 2006). In general, the biological warfare programs during World War II demonstrated that biological weapons could be employed for purposes beyond sabotage. Subsequent programs conducted after the war built upon this foundation to establish biological warfare as a matter of strategic importance (SIPRI, 1971a, pp. 123–124). The notion that the technical challenges related to biological weapons can be surmounted, thereby enabling such weapons to result in casualties comparable to those caused by nuclear weapons, is significant. This concern will reemerge later in discussions related to bioterrorism. However, it demonstrates the enduring impact of the US bioweapons program on the collective mindset of the biosecurity community.

With the advent of nuclear weapons, Western states diverted their focus away from biological weapons as strategic arms. The introduction of nuclear armaments diminished the principle of retaliatory response in kind, as nuclear weapons served primarily as a deterrent against attacks involving weapons of mass destruction. Concurrently, the United States government faced increasing pressure from civil society organizations (e.g., Pugwash, Federation of American Scientists) to follow the Geneva Protocol and renounce the use of chemical and biological weapons (Guillemin, 2005, pp. 112–130; van Courtland Moon, 2006, pp. 33–41). In 1967, President Johnson established a new policy of no-first-use concerning chemical and biological weapons. Negative media coverage regarding the deployment of chemical weapons, such as deforestation and riot-control agents during the Vietnam War, along with a series of accidents, engendered skepticism regarding the United States' programs

(Tucker & Mahan, 2009). Ultimately, when Richard Nixon assumed the presidency in 1969, increasing domestic and international pressure prompted a congressional review of the United States' policies concerning the development and utilization of chemical and biological weapons. This review culminated in President Nixon formally renouncing biological warfare and implementing restrictions on chemical weapons development, thereby paving the way for the adoption of the Biological Weapons Convention on November 25, 1969. Consequently, the offensive US biological warfare program was dismantled in the early 1970s (Lentzos, 2016, p. 8).

The End of an Era: Nixon and the BWC

Nixon's renunciation of biological weapons resulted in two key decisions. Firstly, with the advice and consent of the United States Senate, Nixon ratified the Geneva Protocol, a significant measure towards the universal adoption of the treaty. Secondly, the United States expressed its support for a British proposal advocating a comprehensive ban—extending beyond a mere prohibition on first use—of biological weapons (Guillemin, 2005, pp. 126–127).

In 1968, Great Britain submitted a working paper to the Eighteen Nation Disarmament Committee, a UN initiative involving states from the East, West, and the Non-Aligned Movement, which was reconstituted in 1969 as the UN Conference on Disarmament (United Nations Office for Disarmament Affairs, n.d.a). The United Kingdom advocated for the implementation of additional instruments to reinforce the Geneva Protocol and called for the early conclusion of a new convention aimed at prohibiting microbiological methods in warfare (SIPRI, 1971b, pp. 254–259). The British proposal to distinguish chemical and biological weapons—ostensibly to clarify legal ambiguities associated with the Geneva Convention—initially faced opposition from the Soviet Union. Nevertheless, in 1972, the USSR revised its position and, alongside the United Kingdom and the United States, became the first signatory to the Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction, commonly known as the Biological Weapons Convention (Guillemin, 2005, p. 127) (for more detailed overview over events leading up to BWC see SIPRI 1971b; for witness seminar see: Balmer & van Courtland Moon, 2016).

The Biological Weapons Convention prohibits the development and stockpiling of biological weapons in any form. It is notably the first treaty to ban an entire category of weapons, a fact that the Implementation Support Unit (ISU)—a small office affiliated with the BWC responsible for administrative matters and public relations—eagerly highlights (United Nations Office for Disarmament Affairs, n.d.b). Although the BWC explicitly prohibits biological weapons, it permits defensive research, which introduces a grey area concerning the production of minimal quantities of biological agents to understand their mechanisms. However, the treaty currently lacks a verification mechanism. The BWC not only forbids the use of biological weapons in warfare but also strictly prohibits their development, stockpiling, or procurement. To date, approximately 180 states are party to the convention, and they convene at least once every five years for a review conference in Geneva.

Over the past decades, an intersessional process has been established between review conferences (or RevCons for short). Meetings during the intersessional process do not possess decision-making authority but are held regularly in Geneva to deliberate on specific issues and to prepare for the subsequent RevCon. Delegates from state parties, staff members from the United Nations and other international organizations, researchers, and non-governmental organizations (NGOs) attend these meetings. While the latter are not granted the right to participate in discussions during the meetings—except for a brief statement in which NGOs may address the assembly—they often organize side events, presentations, and panels conducted within the United Nations premises, attended by delegates and other researchers. Many researchers regard the Biological Weapons Convention meetings as among the most important events of the year, where the community meets and engages in dialogue. Consequently, the BWC functions as a regulatory mechanism and a vital forum for the research community to present and exchange ideas. This role is of paramount significance for the DURC community.

2.4 Nominal Compliance and Illegal Programs: After 1972

On the surface, BWC appeared to conclude the global development of biological weapons. Signatory states were explicitly prohibited from developing, stockpiling, and employing biological weapons. With the majority of nations becoming signatories and ratifying the treaty, the normative stance against biological weapons established by the BWC is now nearly universally accepted. However, a significant caveat persists: the BWC permits defensive research but does not precisely delineate what constitutes defensive research or when defensive research transitions into offensive research. Conversely, certain projects—such as the United States' reconstruction of Soviet-made anthrax bombs—have challenged the boundaries of the BWC and spurred discussions regarding the interpretation of the treaty (J. Miller, 2001).

Apart from these ambiguous areas, several nations explicitly breached the Biological Weapons Convention (BWC): the Soviet Union, Iraq, and South Africa engaged in the development and stockpiling of biological weapons, thereby flagrantly violating their obligations under the convention. While South Africa maintained a relatively minor program primarily focused on developing weapons for assassinations, Iraq's program was considerably more extensive and operated on a military scale. The Soviet Union's biological weapons program can only be characterized as massive, sophisticated, and alarming. I will omit further discussion of South Africa, as its involvement is less pertinent to the understanding of DURC. Conversely, the programs conducted by Iraq and the Soviet Union are of significant importance due to the substantial concerns they raised regarding the proliferation of biological weapons in Western nations. These activities thereby contributed to the context for what would later be known as the DURC debate.

The Soviet Union

The Soviet biological warfare program was highly advanced, extensive, and considered extremely clandestine. Prior to 1972, the Soviet Union conducted several smaller programs starting from 1920; however, what renders the USSR's biological weapons development particularly perplexing is that it only commenced after the Biological Weapons Convention (with the Soviet Union as one of the initial signatories) came into force (Geissler & Moon, 1999). Zilinskas and Leitenberg probably wrote the most authoritative account of the Soviet biological warfare efforts (Leitenberg et al., 2012), however as with many biological weapon programs, much of it is shrouded in secrecy.

The USSR commenced a modest initiative to develop biological weapons following World War I, driven by the considerable losses endured during the conflict and the experiences with chemical weapons employed against (then) Russian troops during the war (Geissler & van Courtland Moon, 1999; Kuhn & Leitenberg, 2016, p. 81). By the time it commenced, it was not significantly different from comparable programs and was primarily operated by the military with a relatively small staff (Geissler & van Courtland Moon, 1999). By the conclusion of the 1960s, this initial-generation program had not yielded any noteworthy outcomes. (Leitenberg et al., 2012, pp. 43–47). From the onset of the 1970s, the USSR recommenced its biological warfare efforts and initiated the second phase of its biological warfare program. This subsequent phase was not solely under military auspices but was primarily managed by civilians.[2] This second-generation program would evolve into the largest (arguably most sophisticated) program in existence, exceeding even that of the United States, and persisted until the dissolution of the Soviet Union in 1991/92 (Guillemin, 2005, p. 144; Hart, 2006).

The second Soviet bioweapons program employed an estimated 40.000 to 65.000 personnel (Leitenberg et al., 2012, p. 700). It involved 40–50 massive R&D, production plants, and test facilities (Kuhn & Leitenberg, 2016, p. 107). In addition to its scale, the Soviet program was also highly sophisticated, as the second-generation biological warfare program employed advanced genetic engineering techniques to develop a range of agents exhibiting characteristics that are not naturally

[2] There is a complex military/civilian/state/party relationship going on there which for example Zilinskas and Leitenberg explore at length (Leitenberg et al., 2012).

occurring (Hart, 2006, p. 143; Kuhn & Leitenberg, 2016, pp. 82–92). Following the dissolution of the Soviet Union, several facilities associated with its biological warfare program were either dismantled or repurposed for civilian applications with the assistance of international support.

The Soviet program is notable due to its magnitude, complexity, and confidentiality. The prolonged secrecy emphasizes the challenges associated with verifying adherence to the Biological Weapons Convention and may be of particular interest to the traditional arms control community. For the purpose of my argument, I wish to highlight two additional points: First, the application of bioengineering techniques. The significance of bioengineering cannot be overstated, and heightened concerns regarding the role of scientific advancements in the context of biological weapons are increasingly prevalent (J. Miller et al., 2002, p. 80). The second aspect relates to the scale of the USSR program, as its termination and the subsequent dismantling of its facilities caused concerns in the West about certain members of its workforce potentially offering their expertise to other state or non-state actors. The dissemination of skills and (tacit) knowledge through the migration of scientists subsequently heightened apprehensions regarding non-state actors acquiring biological weapons. What can be seen here is that many of the concerns pertaining to bioweapons and non-state actors can be traced back to the uncovering of the Soviet biological weapons program.

Iraq

This leads us to the second program worth noting in this context. UN inspectors officially uncovered the Iraqi biological weapons program following the conclusion of the first Gulf War. I specify "officially" because there were suspicions and assumptions about its existence well before, particularly within US intelligence communities, yet there was no formal confirmation at that time (Trevan, 1999, pp. 113–129; 2016). Iraq's biological weapons program can be delineated into two distinct phases: the initial phase predates the Saddam Hussein regime. Conducted between 1974 and 1979, this phase, akin to numerous other biological warfare initiatives, originated as an extension of a broader chemical weapons effort. The program was subsequently revitalized in 1983, with this second phase continuing until approximately the conclusion of the Gulf War in 1991 involving the United States and Iraq.

Although it is presumed to have been inactive following the 1991 Gulf War, the existence of the facility was later revealed by UNSCOM inspectors. These inspectors compelled Iraq to acknowledge its existence in 1995 and to dismantle the Al Hakam facilities, Iraq's primary research and production site, under United Nations supervision in 1996. Nonetheless, the often strained relationship between UNSCOM inspectors and Iraqi officials, who attempted to conceal the extent of Iraq's biological weapons research, led several security practitioners—particularly within the United States—to believe that Iraq continued its chemical and biological warfare activities beyond 1995. This assumption played an important role in the prelude to the 2nd US-Iraq war in 2003 (Trevan, 2016, pp. 119–121).

The discovery of Iraq's biological warfare program was a considerably more significant process than this summary might indicate, as it profoundly influenced debates in the United States and the Western world regarding biological weapons. The revival of Iraq's biological warfare program in the 1980s was suspected by Western intelligence agencies even prior to its official confirmation. Iraq, in its biological warfare efforts, procured human pathogenic Anthrax strains from the American Type Cultures Collection, an institution comparable to a library for life science researchers, from which microorganisms can be ordered for research purposes. The recognition that Iraq possessed Anthrax generated considerable concerns about inadequate protection of military forces and civilians prior to the US-led Gulf War in 1991. The apprehension that Iraq might deploy biological weapons against US-led coalition forces prompted extensive procurement of mobile detectors, protective gear, and vaccine development. Concurrently, fears emerged that Iraq could smuggle biological weapons into the United States to be used as terrorist weapons against the unprotected civilian population, thereby shifting focus towards the necessity for preparedness and response to bioterrorist threats (J. Miller et al., 2002, pp. 109–113).

The US and Western narrative on biological weapons evolved significantly during the 1991 Gulf War, as concerns shifted from a Cold War, state-centered perspective to the emerging threat of the Rogue State-Terrorist-WMD nexus. The potential for Iraq to provide non-state groups with WMDs to attack US civilians fueled fears about the spread of knowledge, scientists, and materials from the Soviet Union to rogue nations or terrorists. While the BWC essentially ended the development of bioweapons in state-run programs, biological weapons remained a perceived threat. However, focus has shifted from interstate conflict to biological terrorism, prompting former biological warfare programs—now mainly engaged in defensive research—to prioritize protection for both soldiers and civilians (Guillemin, 2005, pp. 148–155; S. Wright, 2006).

In regard to the construction of DURC, four implications from the history of state-run bioweapons programs can be identified within the biosecurity community. The United States program suggests that bioweapons could be utilized as strategic arms with significant destructive capacity. The Soviet program resulted in two implications: firstly, it demonstrated that biological weapons efforts can be maintained clandestinely; secondly, it sparked a debate regarding the workforce previously engaged in these efforts and the potential for tacit knowledge among scientists and technicians to be sold to the highest bidder. The Iraqi program, conversely, fueled concerns about the potential use of biological weapons in terrorist attacks targeting civilian populations. As we approach the 1990s, these four discursive themes influence a new phase in the discussion concerning biological weapons, focused on the potential use of bioweapons by non-state actors.

2.5 The Great Bioterrorism Scare

Bioterrorism constitutes a significant aspect of the DURC debate. Concerns related to DURC primarily originate from the risks associated with bioterrorism, as DURC discussions frequently focus on the possible use of novel technologies by bioterrorists and small-scale, state-sponsored bioweapons initiatives.

During the 1990s, bioterrorism emerged as a novel security concern and rapidly progressed to a significant potential threat within the United States security apparatus. The focus on bioterrorism cannot be exclusively attributed to the priorities of a single administration. The development of bioterrorism as a national security issue was an incremental process, commencing in the late 1980s during the presidency of Ronald Reagan, gaining momentum under President George H. W. Bush, and becoming a major concern during the administration of Bill Clinton. Consequently, this issue has become an essential element of national security, with senior officials expressing growing apprehension regarding the threat of bioterrorism directed at the United States.

The emergence of bioterrorism as a potential threat is embedded within a broader shift in the security landscape. During the 1990s, generally more attention was given to terrorism, especially terrorism with WMDs and biological weapons occupied (and still do) a particular spot in the imagination of security practitioners. Bioterrorism was becoming the "[…] sexiest of all the terrorism threats and it was becoming a cash cow" (Bruce Hoffman cited in: S. Wright, 2006, p. 100). With bioterrorism being perceived as one of the primary threats, new institutions and massive spending programs were established to counter this perceived threat during the Clinton administration.

Bioterrorism is a rare occurrence, with only a handful of incidents reported. A relatively comprehensive list can be found in Tucker (1999), Carus (1998), and Wheelis et al. (2006). A list of the more noteworthy bioterrorism attempts usually includes R.I.S.E., a group consisting of two male college students who planned on contaminating the Chicago Water Supply with typhoid. R.I.S.E.'s motivation remains somewhat obscure; ostensibly, the organization aspired to eradicate all humans in pursuit of environmental preservation, with the aim of repopulating the planet and establishing a society in "harmony" with nature. The two founders of R.I.S.E. were apprehended when they attempted to recruit additional members, who appeared less inclined toward the destruction of civilization and subsequently informed authorities about R.I.S.E.'s plans. The group was apprehended prior to the dissemination of any pathogens. Overall, R.I.S.E. likely lacked the specialized technical expertise and resources necessary to execute a worldwide terrorist operation, and even executing a successful attack on the Chicago water supply appeared to be beyond their capabilities. Conversely, R.I.S.E. is frequently regarded as an example of a "doomsday" organization that may have an interest in biological agents (Carus, 2000, pp. 55–70).

The second significant incident was initially not recognized as an attack. In 1984, the Rajneeshees, a cult based in Oregon, deliberately contaminated several restaurant salad bars in a small town, resulting in food poisoning among the local residents. The objective was to influence the election, and the cult anticipated that widespread food poisoning would deter potential voters from participating. Additionally, the Rajneeshees appeared to have experimented with biological warfare agents for other purposes. The plot was only uncovered in 1995 when the former leader of the cult provided testimony to law enforcement authorities. Prior to this revelation, the incident was presumed to be a case of contaminated food (Carus, 2016, 2000). In addition, several US-based white supremacist groups were apparently planning attacks involving biological weapons; however, often, it is unclear to what extent these plans progressed and if they were technically feasible (Carus, 2016; Tucker, 1999).

The examples provided above serve solely as illustrations and do not constitute an exhaustive list, as nearly every instance of bioterrorism prompts discussion. Are impractical plans for deploying biological weapons considered bioterrorism? How about "white powder incidents", where a benign substance mimics anthrax or ricin? What distinguishes terrorism from ordinary crime, and do plans for mass-scale attacks belong in the same category as assassination attempts involving bio-toxins? Analyzing bioterrorism proves to be intricate; authors typically come from policy backgrounds, where the analysis often intertwines with advocating for greater acknowledgment of bioterrorism as a pressing security issue.

Most authors treat bioterrorism as an incontrovertible occurrence, the probability of which can be assessed through scientific methods. A review of the literature on bioterrorism reveals a substantial body of work on the subject. Numerous scholars analyze the risks and threats associated with bioterrorism (Ackerman & Moran, 2004; Atlas, 1999; Ben Ouagrham-Gormley, 2014), the feasibility of a bioterrorist attack (Ackerman & Moran, 2004; Tucker, 2001; Wein & Liu, 2005), and past bioterrorist activities (Carus, 1998; Tucker, 1999). On the other hand, there are relatively few studies that engage in a critical analysis of bioterrorism and explore how it emerged as a security threat (J. Miller et al., 2002; Sprinzak, 1998; S. Wright, 2006). Therefore, the majority of works cited herein serve concurrently as primary and secondary resources. They offer descriptions of bioterrorism and simultaneously contribute to a narrative concerning their research subject. In this discussion, emphasis is placed on the more alarmist perspectives, as these were the ones that gained significant traction during the formative years. Nonetheless, even within the literature emphasizing policy considerations, these perspectives do not constitute the exclusive viewpoints on bioterrorism. Numerous authors assert that substantial challenges are associated with the production and utilization of biological weapons, particularly for non-state actors (Kelle et al., 2006; Revill & Jefferson, 2014; Tucker, 2001).

The rise of bioterrorism as a pertinent security issue in the late 1980s and 1990s stems from various contextual factors, including discourses that occurred concurrently and intersected with bioterrorism (Guillemin, 2005, pp. 157–166). The initial fundamental factor can be found in the (re-)emergence of multiple diseases during the 1980s and 1990s. The biosecurity sector refers to this as emerging and re-emerging infectious diseases, indicating novel illnesses or those that had been absent for an extended period. Several diseases have elicited concerns in this context. For instance, hemorrhagic fevers, including the Ebola and Marburg virus, as well as cholera and respiratory ailments such as tuberculosis (Heymann, 2003, p. 192). However, the most significant factor is likely HIV/AIDS and the discourse that emerged around it. HIV is an illness that first appeared in the early 1980s. It rapidly became a serious health threat—an emerging disease that was previously unknown at that time—and quickly propagated through diverse populations, resulting in substantial loss of human life.

Re-emerging infectious diseases exerted a significant influence on public discourse from the mid-1980s through the 1990s, to the extent that Tomes characterizes the issue as akin to moral panics (Cohen, 2011), as a "Germ Panic" where wide attention has been directed towards germs, illness, and preventative measures (Tomes, 2000). Consequently, public health emerged as a significant (in)security issue during the 1990s, with arguments suggesting that major disease outbreaks could potentially undermine the state's capacity to function effectively. The economy might incur substantial damages, and vital state institutions, such as first responders, law enforcement, and the military, could be severely impacted by a (re-)emerging disease. The depletion of skilled laborers could cause an economic crisis, thereby leading to political instability. Additionally, high infection rates among military personnel could compromise the operational effectiveness of affected units. The example utilized to substantiate this argument is the impact that HIV/AIDS exerted on several African nations (McInnes, 2006). This sentiment is perhaps most accurately exemplified by a statement delivered by United Nations Secretary-General Kofi Annan during a United Nations Security Council session in 2000 concerning the repercussions of HIV/AIDS, in which he remarked that "[...] the impact of AIDS in Africa was no less destructive than that of warfare itself" (United Nations Secretary-General, 2000).

The second factor contributing to the salience of bioterrorism as a security concern has already been addressed in the preceding section. Implications stemming from the discoveries related to Iraq and the Soviet Union's bioweapons programs substantially enhance the prominence of a bioterrorism security narrative. During the administrations of Reagan and Bush Sr., the diminishing Soviet threat in the final years and following the conclusion of the Cold War was supplanted by concerns regarding a "Rogue State – Terrorists – Weapons of Mass Destruction" triangle. This paradigm presumes a connection between certain states, terrorist organizations, and the potential use of weapons of mass destruction against the United States, where "rogue states" might employ biological weapons as a less costly alternative to nuclear arms. Several reports from that period indicated that "third-world nations" hostile to the United States are increasingly willing and capable of developing such capabilities or willing to transfer their unconventional weapons to terrorist groups acting on their behalf. These concerns evolved into a "shared sense" within Washington policy circles throughout the 1980s and 1990s (S. Wright, 2006, pp. 63–66).

These concerns were also manifested in contemporary documents. In order to exemplify the discourse on bioterrorism and new technologies, I have chosen the Office of Technology Assessment (OTA) reports here: In response to the Lockerby and Beirut bombings, the Congressional Office of Technology Assessment authored two reports in 1991 and 92, respectively, titled "Technology against Terrorism", which are relatively influential documents as they reflect the security narratives of the time and outline which issues should receive increased research funding. The OTA reports explicitly addressed the threat of bioterrorism and established a perspective on the matter that would subsequently become emblematic of the Clinton administration (S. Wright, 2006, pp. 64–65). Referencing the attacks by the Rajneeshee cult in Oregon as examples of the growing inclination among terrorist organizations to acquire unconventional weaponry, the 1991 report states that the technical challenges for terrorist groups to obtain biological weapons are not "insurmountable", while estimating that such an attack could result in hundreds of thousands of deaths. Additionally, the 1991 report explicitly warns about the danger of states arming terrorist groups with CBW (U.S. Congress, Office of Technology Assessment, 1991, pp. 21–22).

The 1992 report reiterates the points made in the previous report and adds that recent advances in the life sciences could make biological weapons available to terrorist organizations. In the report, biological weapons are conceptualized as entities that are simple to produce and could, in theory, be stockpiled in substantial quantities within the United States or Europe, prepared for potential deployment in an attack (U.S. Congress, Office of Technology Assessment, 1992, pp. 35–37). Throughout the reports, biological weapons are regarded as a significant threat to both civilian populations and military forces. This underscores the necessity for enhanced civilian protection initiatives, representing a policy transition from an exclusive focus on military force safeguarding. To mitigate the apparent deficiency in protective capabilities, the report advocates for the substantial expansion of biodefense initiatives aimed at developing technological solutions to the issue, such as vaccines and sensor technologies. Notably, these measures were considered prior to the Iraq War (for

Iraq see: J. Miller et al., 2002, pp. 98–123; U.S. Congress, Office of Technology Assessment 1992, pp. 40–43). Although the two OTA reports are significant documents concerning the evolving discourse on biological weapons, they received limited attention from the Bush Sr. Administration. Their importance was only recognized under the subsequent Clinton administration (S. Wright, 2006, p. 64).

During the administrations of President Reagan and President George H. W. Bush, a discourse emerged linking rogue states with terrorist organizations and weapons of mass destruction. Biological terrorism was deemed to be increasingly feasible due to the widespread availability of biotechnology. Sprinzak (1998) describes this line of reasoning as the "capabilities proposition"—a discourse in which the possibility of doing something inevitably leads to the thing being done—which culminates in the concept of "Superterrorism Scare".[3] Increasing capabilities in the area of biological weapons are attributed to terrorist organizations. Simultaneously, the availability of raw materials from diverse civilian suppliers, including medical companies, advances in contemporary biotechnology—which have diminished the need for specialized skills—and the potential transfer of knowledge and trained personnel from dismantled bioweapons programs to non-state actors are frequently cited justifications for a "capabilities proposition" (Sprinzak, 1998, pp. 112–113).

2.6 New, Sacred Terror

While documents such as the OTA report advanced concerns regarding terrorism involving unconventional weapons, terrorism itself did not hold a prominent position on the security agenda during the late 1980s. The Cold War persisted, and relatively few terrorist incidents involving the United States transpired during this period. This situation altered in the 1990s, when a series of terrorist activities during the Clinton administration elevated terrorism to a central concern on the security agenda and expedited the development of the Rogue State –Terrorist Group –WMD triangle as a primary security issue (S. Wright, 2006, p. 65). The 1993 World Trade Center bombing, along with the 1995 bombing of the Alfred P. Murrah Federal Building in Oklahoma City, are two incidents cited as having contributed to an increased concern regarding terrorism as a security threat (Benjamin & Simon, 2002, pp. 219–255; S. Wright, 2006, pp. 70–71). Terrorism evolved from merely being considered "a nuisance to be attended to" into a significant strategic threat. Subsequently, rogue states and terrorist organizations began to assume roles previously held by the Soviet Union (Benjamin & Simon, 2002, pp. 219–255).

Perhaps the most consequential acts of terrorism in the context of bioterrorism did not occur in the United States but in Japan. In 1995, Aum Shinrikyo, a radical religious sect, released Sarin gas in the Tokyo subway system, resulting in 13 fatalities and approximately 1.000 injuries. This incident marked a pivotal moment in the discourse on biological terrorism, as many analysts of that era regarded Aum Shinrikyo's attack as evidence that a new form of religiously motivated terrorism was emerging (S. Wright, 2006). The ascent of Aun Shinikyos, along with Al Qaeda, generated narratives about what Daniel Benjamin and Steven Simon refer to as "The Age of Sacred Terror". In this period, terrorism is characterized as having transitioned into a new phase, whereby terrorists driven by political ideologies have been supplanted by those motivated by religious zeal, who are considered to be beyond negotiation (Benjamin & Simon, 2002, p. 420).

From the mid-1990s, bioterrorism started to capture the imagination of a broad group of security professionals. Fueled by popular novels (Clancy, 1996; Preston, 1999), terrorists using WMDs became a first-tier security threat, with bioweapons changing from a failed military innovation to "the poor man's nuclear bombs" (North Atlantic Assembly, 1996). By the end of the Clinton administration, the connection between terrorists, biological weapons, and rogue states was common knowledge among many security practitioners. Simultaneously, bioterrorism became more and more a self-fulfilling

[3] With Supperterorrism, Sprinzak describes the fear that terrorists would conduct an attack with unconventional weapons, leading to hundreds of thousands of fatalities.

prophecy as new study centers (e.g., at Johns Hopkins) were set up and exercises held (UPMC Center for Biosecurity, 2005; O'Toole et al., 2002) that reinforced this particular discourse.

With reports advocating for the advancement of novel technologies—including research into pathogens that would currently be considered DURC—and the enhanced integration of public health measures into the security framework, we observe a convergence of natural and intentionally caused outbreaks. Several authors from that period contend that bioterrorism fundamentally constitutes a public health concern, as the consequences of a bioterrorist attack are indistinguishable from those of a naturally occurring outbreak. Such incidents are addressed through standard procedures: identifying the pathogen involved, determining its transmission mechanisms, and formulating appropriate interventions (McDade & Franz, 1998). Therefore, the identification of an outbreak as intentionally caused would necessitate the use of surveillance techniques comparable to those employed for effectively intervening in naturally occurring outbreaks, as well as the application of interventions similar to those used for naturally occurring diseases. Consequently, this presents the initial argument that the United States should proactively address such incidents by resolving existing deficiencies in pertinent areas, including the development of effective diagnostic tools, enhancement of communication between public health and security authorities, increasing awareness among public health practitioners regarding bioterrorism, and preparing for bioterrorist events by establishing stockpiles of various vaccines (McDade, 1999).

Over the subsequent years, numerous reports addressed the research and development requirements of the United States to defend itself against terrorism involving biological and chemical weapons. Several of these reports originate from the research community itself, asking how their investigations can support efforts in combating terrorism (Institute of Medicine, 2002; Institute of Medicine & National Research Council, 1999; National Research Council, 2002a, 2002b). Despite slightly different framings, the reports concur on the necessity of enhancing the nation's defenses against such an attack, with an increased allocation of research funding. This encompasses investments in medical research, as noted: "[E]ven if the best possible public health infrastructure existed and responses were as rapid as needed, we might still be faced with a disease that could not be countered" (Institute of Medicine, 2002, p. 7). In defense against biological threats, the argument is that we must focus not only on known pathogens but also on unknown threats. This requires both applied biodefense research and foundational research to better prepare for an uncertain future (Institute of Medicine, 2002, p. 7).

2.7 2001 – The Emergence of DURC

In the concluding section of this chapter, I wish to examine the year 2001. The year 2001 served as a pivotal point for many of the discursive strands discussed earlier in this chapter, as several events occurred that considerably influenced the DURC discourse.

The initial incident was 9/11. Extensive literature has been authored concerning the terrorist attacks that occurred on September 11th, 2001, and the profound impact these events have had on the conceptualization of security, to the extent that (critical) security scholars frequently cite 9/11 when delineating a specific timeframe (Amoore & de Goede, 2008; de Goede, 2018; R. Jackson, 2005; Kennedy-Pipe & Rengger, 2006). Given that extensive literature has already addressed the subject, I shall refrain from providing a detailed discussion of 9/11 here. It is nevertheless evident that the events of 9/11 reaffirmed terrorism as a top-tier security threat, establishing it as the primary security concern and expediting the initiatives established during the 1990s.

The second event I would like to discuss occurred immediately following the September 11th attacks and represents the sole significant bioterrorism incident in recent history: The 2001 anthrax letters. In early October 2001, an individual was admitted to a hospital due to inhalation anthrax, a highly atypical condition that immediately raises questions regarding the source of exposure. It was subsequently established that, one week after September 11th, an individual mailed five letters containing anthrax to media outlets in New York and Miami. A second batch of letters, postmarked October 9th, was sent to two United States senators (Carus, 2016; Guillemin, 2011).

Anthrax refers to both the pathogen and the associated disease. It can be acquired through skin contact and inhalation, with inhalation typically presenting more severe symptoms. Due to its high environmental stability, anthrax is considered a prime bioweapon agent and has been extensively utilized by various bioweapons programs (Cieslak et al., 2018; Garrett & Hart, 2009, pp. 9–10). Investigations into the anthrax strains utilized in the 2001 attacks identified them as the "Ames-Strain“, a specific strain of anthrax exclusive to biodefense laboratories. Subsequently, United States law enforcement authorities commenced efforts to determine who had access to the relevant pathogens. In 2008, the Federal Bureau of Investigation (FBI) accused Bruce Ivins, a United States biodefense and anthrax specialist, of mailing the threatening letters. Considerations regarding Ivins's psychological state, as well as the possibility that he aimed to highlight the necessity for the then-failing anthrax vaccination program, were discussed as potential motives for his actions. However, Ivins committed suicide prior to his arrest, and his precise motivation could never be conclusively clarified (Carus, 2016, p. 187).

The 2001 anthrax letters may be regarded as a significant milestone, akin to the Aun Shinikyo attacks of 1995. During that period, the anthrax incidents prompted widespread public panic, leading to increased purchases of duct tape, plastic sheeting, bleach, and antibiotics. Similar to the earlier Aun Shinikyo attacks, security experts in the United States interpreted the anthrax letters as evidence that non-state actors had surmounted both technical and moral barriers associated with bioweapons, thereby suggesting that additional acts of bioterrorism could ensue. This perception, coupled with perceived notable deficiencies in the United States' biodefense strategies, resulted in a substantial increase in biodefense expenditures, building upon initiatives initiated during the Clinton administration. Additionally, the anthrax attacks prompted the enactment of several new legislative measures aimed at tightening regulations concerning the possession of pathogenic agents. For instance, the US Public Health and Bioterrorism Preparedness and Response Act is particularly noteworthy for imposing restrictions, including FBI background checks, on the access to and handling of various pathogens. The list of restricted pathogens, known as the *Select Agents List*, will be revisited in the context of the DURC discussion (Guillemin, 2011; Vogel, 2016).

The third event in 2001 is referred to as the Mousepox experiment conducted by Jackson et al. Jackson and his colleagues aimed to develop a method to induce infertility in mice as part of a pest control initiative in Australia. Essentially, Jackson et al. proposed utilizing a genetically modified variant of mousepox (a distant relative of human pathogenic smallpox) as a vector to regulate the production of interleukin-4, a hormone that modulates the immune response, thereby prompting the mouse immune system to reject its eggs and rendering the mice infertile. However, the outcomes were unforeseen, as all subjects in the experiment died. While it was understood that mousepox is lethal to mice without immunity, even those exhibiting natural immunity or having been vaccinated against the virus perished upon exposure to the genetically altered mousepox (Finkel, 2001; J. Miller et al., 2002, pp. 310–312). In 2010, the second principal investigator of the project, Ian Ramshaw, explained in an interview with Ramshaw and Jackson: "We said, 'Boy, this is scary—this is the kind of thing that science fiction is made of. This was the first example of a virus overcoming vaccination, and this was very worrying'" (quoted in: Selgelid et al., 2010, p. 19).

The Mousepox experiment was a series of investigations conducted between 1998 and 1999, and it became publicly known through publication in 2001. In the same interview, Jackson and Ramshaw elucidated that, upon observing the results, they notified the government and military authorities about their discovery, but received no response. Both researchers noted that during the early 2000s, there were no formal mechanisms in place to address dual-use concerns. In 2001, following confirmation of their findings, they elected to publish their research in the Journal of Virology, believing that the advantages of informing the scientific community and the public surpassed the risks associated with the dissemination of this information (R. J. Jackson et al., 2001; Selgelid et al., 2010).

Following the publication of their results, the Mousepox experiment garnered considerable media attention. Notably, an article was published in New Scientist early in 2001, concentrating on the dual-use potential inherent in the research project (Nowak, 2024). Jackson and Ramshaw recalled that a journalist from New Scientist had previously spoken with Jackson and his team. Subsequently, Jackson notified the research institution where he was employed regarding the forthcoming article in New Scientist, which apparently disclosed preliminary details about the Mousepox Experiment to the media. According to Jackson, media coverage of their experiment attracted notable attention in Europe and Australia but was initially largely overlooked in the United States (Selgelid et al., 2010). It was only after the events of 9/11 and the 2001 Anthrax Letters that the research conducted by Jackson et al. garnered widespread recognition within the biosecurity community. J. Miller et al. ascribe the extensive discussions prompted by Jackson's experiment to the fact that the same principle could be applied in the context of smallpox. Given the biosecurity concerns regarding the residual smallpox stockpiles from the Soviet Union, Jackson et al.'s discovery was discussed as potentially undermining vaccination initiatives initiated during the Clinton administration (J. Miller et al., 2002, pp. 310–312).

Jackson himself attributed the attention their research received to the contemporary context of 9/11, Anthrax Letters, and the New Scientist article: "If it wasn't for the New Scientist article and September 11, our mousepox research would have been a blip; no one would have paid any attention to it. The reality is that we made a recombinant virus as a research tool. It was all done with appropriate approvals in contained conditions. Probably no more than 20 or 30 mice died during the course of these studies" (Jackson quoted in: Selgelid et al., 2010, p. 21). The Mousepox Experiment is broadly regarded as the inaugural DURC experiment, or rather the catalyst that initiated the debate. Several foundational documents, primarily the Fink report, explicitly reference Jackson et al.'s experiment as it pertains directly to two fundamental aspects of the DURC discourse: the potential for misuse of the research and the deliberation over whether to publish findings that could have security implications.

2.8 Conclusion

I have included this brief discussion because it highlights the emergence of a central theme within the DURC debate: the tension between the potentially threatening and beneficial aspects of biotechnology. Within the biosecurity community, this duality is frequently observed. This is unsurprising, as DURC inherently involves dual-use considerations; however, it is particularly significant for the research project under discussion. In this context, the benefits of biotechnology and life sciences research are viewed as potential defenses against bioterrorism and the use of biological weapons. Proponents argue that research can lead to the development of new technologies, such as vaccines and detectors, which can be employed to counter bioweapons. Conversely, the capabilities proposition emphasizes that advances in the life sciences not only generate benefits but also raise concerns regarding the possible use of pathogens as weapons. During the 1980s and 1990s, this duality became increasingly apparent, and it remains a central theme throughout the subsequent analysis.

The emergence of DURC and the discourse surrounding it as a security issue did not occur suddenly. Instead, it is the result of various events, historical narratives, and contextual processes that contribute to framing DURC as a security concern. In this chapter, I primarily utilize literature from the biosecurity field to contextualize DURC within its discursive history. This approach aims not only to depict the historical background of DURC, thereby providing a static reference point for contemporary discourse, but also to demonstrate how collective memory and community knowledge influence certain understandings of the issue.

Specifically, this interpretation of history pertains to biological weapons, particularly those associated with the Soviet Union, and, to a lesser extent, the Iraqi bioweapons program. Furthermore, the rise of terrorism, regarded as a security threat, the evolving effectiveness of export controls for dual-use governance, and the (re-)emergence of infectious diseases collectively form the discursive framework within which DURC is acknowledged as a significant security concern.

The discovery and subsequent dissolution of the Soviet Union's bioweapons program represent a particularly salient issue due to concerns regarding the potential proliferation of expertise among former employees of this program to non-state actors. This concern is similarly echoed in the context of the Iraq-U.S. war in 1991, where the presupposed and later substantiated existence of an Iraqi bioweapons initiative not only led to significant investments in biosecurity programs within the U.S. but also reinforced apprehensions related to the dissemination of such knowledge. Moreover, the resurgence of infectious diseases has underscored the potentially catastrophic impact of illness, while the increase in religiously motivated terrorism has indicated to many biosecurity professionals a rise in actors who may pursue and subsequently utilize biological weapons.

These discourses intersect and influence each other, making it difficult to clearly define causal relationships or directional interactions among them. Nonetheless, they collectively contribute to a shared collective memory, with numerous members of the biosecurity community actively participating in policy discussions and publishing work that draws from this common repository of knowledge. Consequently, the historical context of biological weapons and DURC serves as an essential backdrop for the contemporary DURC discourse. Viewing the history of DURC as a collectively held stock of knowledge elucidates why certain positions are regarded as common sense within this community and provides insight into why some policy options are considered prudent while others are not.

3 Theory: Construction, Co-Production and Imaginaries of Techno-Fix and Techno-Fear

In the preceding section, I stated that my research question was: How did DURC become a security concern in Germany, and what motivated Germany's response to it? To address this inquiry, it is necessary to adopt a theoretical approach capable of interrogating the assumptions commonly accepted in discussions of DURC. Accordingly, DURC is conceptualized in this study not as an objective condition that relates to material artefacts but as an issue of knowledge and meaning. An examination of relevant publications reveals that discussions of DURC are predominantly framed through commonsense assertions, with limited elaboration on why DURC constitutes a security threat or why specific policy responses are pertinent. Furthermore, there is scant discussion regarding the application of these commonsense perspectives.

Accordingly, I have chosen a constructivist theoretical approach for this research question. Constructivist approaches are ideally suited to question the knowledge and positions that appear naturalized, highlighting the contingent nature of those claims. Drawing on literature from Critical Security Studies and Science and Technology Studies, I will use this chapter to outline the contingent nature of security and technology. Simultaneously, by using Jasanoff's concepts of co-production and socio-technical imaginaries, I will demonstrate how accounts of security and technology in DURC become entangled with one another to produce specific imaginaries about the future that must be secured (against). By highlighting risk as one of the central epistemologies employed throughout DURC, we will be able to see how future imaginaries are secured through the use of everyday practices.

When analyzing DURC and the imaginaries contained within DURC discourse, one quickly becomes aware of two competing imaginaries of a socio-technical future. One concerns technology as a potential solution to societal problems. In the case of DURC, these problems are primarily illness and insecurity through bioterrorism. Conversely, a second imaginary predominantly focuses on the destructive potential of new technologies. In this discursive strand, DURC is perceived as a source of insecurity itself due to the dual-use properties ascribed to it. I have termed these two competing imaginaries 'techno-fix' and 'techno-fear,' and will utilize them throughout this study as analytical tools through which the DURC discourse can be examined and understood.

3.1 Contingency and Future Imaginaries in Dual Use

At the core of DURC lies what the disarmament community refers to as a dual-use issue. Knowledge and technology possess the potential for various applications; what is intended for peaceful purposes may ultimately be employed for less peaceful objectives. Dual use is prevalent across many research domains, predominantly within the natural sciences and engineering, but also extends into the humanities. For example, research aimed at preventing extremist recruitment could inadvertently be repurposed to enhance such recruitment efforts. Drones utilized for surveillance after severe flooding can similarly be adapted for military operations, and 3D printing technology can produce components for water pumps as well as firearms. The life sciences, arguably more than other disciplines, face this dual-use dilemma. Nearly all research related to infectious diseases carries dual-use potential, as "[...] virtually all the research of concern is aimed at protecting humankind from disease or otherwise improving the quality of life" (Atlas & Dando, 2006, p. 282).

When discussing dual use within the domain of life sciences, there is generally a broad understanding of the concept of dual use. On one side of the duality, we find "legitimate" or even "beneficial", "civilian" research. Conversely, there exists the potential for such research to be "misused" for "offensive", "illegitimate", or "hostile" purposes, with the intent to cause widespread "harm". The terminology employed within the life science community is quite expansive, encompassing terms such as legitimate, legal, and civilian, each bearing distinct implications. The fundamental issue pertains to whether the research can be utilized to develop or enhance biological weapons agents (the payload in biological weapons). Numerous aspects of life science research may be of interest to actors seeking to acquire biological weapons. While this potential is arguably inherent in the life sciences and has always existed, the discourse regarding the dual-use potential in the life sciences has gained renewed relevance due to technological advancements achieved in this field over the past two decades.

Synthetic biology and more efficient genomic engineering methodologies have opened new possibilities within the life sciences. They have enhanced the dissemination of existing techniques by rendering them more affordable and easier to implement (Méthot, 2015, pp. 296–297). Advancements in genome editing technologies, most notably the discovery of the CRISPR-Cas9 system, have facilitated genome manipulation to become more accessible, cost-effective, and widespread than preceding methods. Synthetic biology empowers researchers to design novel genomes or reconstruct DNA sequences from extinct species, such as the 1918 H1N1 influenza strain known as the "Spanish Flu", which was responsible for the deaths of millions (Tucker, 2012, p. 5). While these emerging technologies are still in the early stages, they have already exerted a substantial influence on the field of life sciences. The availability of more affordable and user-friendly biotechnology expands access to a broader range of individuals and institutions that previously could not afford such tools. The concern, however, is that this expanded "customer base" may include "malicious actors" seeking to develop novel pathogens capable of evading detection or resisting treatment, thereby enhancing their utility for offensive applications (McLeish, 2007, p. 191).

As previously discussed in the preceding chapter, historically, the possession and development of biological weapons have been exclusively confined to nation-states due to the significant costs involved, such as the necessary equipment and specialized expertise. Nonetheless, numerous experts express concern that this barrier is diminishing. Recent technological advancements have expanded the accessibility of biotechnology to new actors, which, owing to its dual-use capabilities, raises the critical question: What are these actors employing such technology for? Progresses in life sciences—coupled with reductions in associated costs and an increased emphasis on the threat posed by non-state actors—have resulted in life sciences being increasingly regarded as a source of security concerns that warrant attention from both national governments and the international community (McLeish, 2007, pp. 190–192).

Throughout the literature on DURC policy, similar narratives to the one I have delineated above are evident. In this context, the life sciences have advanced and proliferated to such an extent that biological weapons may no longer be exclusively under the jurisdiction of nation-states. In the preceding section, we examined the historical developments and commonly cited reasons for this transformation in greater detail. Accordingly, my intention is not to reiterate this debate but to illustrate the contingency inherent in the dual-use concept. Dual use serves as a governance instrument that determines which technologies may circulate and under what circumstances, who has access to these technologies, and who is restricted. These notions are not fixed; they evolve over time and in response to shifting security environments. The technologies encompassed by the dual-use classification, the actors permitted access, and the mechanisms addressing proliferation are subject to change. While the dual-use concept is central to DURC policy, I am particularly interested in the changes, as the contingency of the idea is the theoretically interesting part. These change gives us insights into the interconnections between security, technology, and the future.

3.2 Imaginaries of Techno-Fear and Techno-Fix

Controlling technologies is as much about the future as it is about the present. Many technologies that are not widespread yet have the potential to become central in the future. The problem in the eyes of many security professionals is that once technologies have become widespread, they are challenging to regulate. In this sense, security-making vis-à-vis technologies is often associated with an anticipatory element in which various futures are imagined and acted upon in anticipation of the effects that those futures might have on the security environment (Anderson, 2010). When examining rapidly evolving technologies, it is often unclear what impacts these technologies may have. Nevertheless, proactive measures necessitate implementation now rather than postponing until these impacts materialize and become nearly impossible to alter. Numerous examples come to mind—artificial intelligence being among the most discussed today. Although there are few, if any, fully autonomous weapons currently in operation, considerable efforts are underway by states, researchers, non-governmental organizations, international bodies, and others to establish measures aimed at preventing a future in which fully autonomous weapons become a reality. This approach is understandable, as it appears likely that in a future characterized by widespread AI-controlled weaponry, their abolition would be challenging. Nonetheless, this example illustrates that security measures, such as arms control, are often driven as much by anticipation of a seemingly inevitable future as by considerations of the present.

Imagined futures concerning technologies are essential aspects of security creation. Fundamentally, our expectations regarding a specific technology in the future significantly influence our present actions towards it (Gerhold & Brandes, 2021; Jasanoff & Kim, 2015). It is important to acknowledge that the futures we envisage are not necessarily characterized by insecurity. Indeed, an examination of the relevant technologies reveals that stakeholders frequently foresee substantial benefits for both security and society. Artificial intelligence is consequently not exclusively linked to insecurity; rather, it also signifies a revolution in the economy and the potential for enhanced living standards, prosperity, and numerous other benefits. Therefore, in addition to efforts aimed at regulating artificial intelligence to mitigate insecure futures, significant research funding is being allocated to foster a positive future in which artificial intelligence realizes its promises.

In the realm of biotechnology, this duality concerning anticipated futures becomes notably evident. Biotechnologies represent significant potential for economic advancement, enhancement of public health, increased crop yields, and environmental mitigation, among other benefits. Virtually all scholarly and policy documents on the subject consistently associate these technologies with optimistic visions of the future. At the same time, those technologies are also associated with an insecure future due to various factors that will be examined shortly. This dichotomy between positive and negative, beneficial and threatening, is pervasive throughout the biosecurity discourse and in the discussion of dual-use technologies. It is essential to bear this duality in mind when analyzing the concept of dual use within the biosecurity community.

This particular linkage concerning conceptualizations of the future, wherein technology assumes a pivotal role in facilitating this future, has been designated as socio-technical imaginaries (Gerhold & Brandes, 2021; Jasanoff & Kim, 2015). Socio-technical imaginaries are: "[…] collectively imagined forms of social life and social order reflected in the design and fulfillment of nation-specific scientific and/or technological projects" (Jasanoff & Kim, 2009, p. 120).

Imaginaries are neither solely individual constructs nor unreal (as in fantasy, illusions, or imagination). Instead, they represent collectively held beliefs concerning the future and the roles of science and technology. Imaginaries influence the structuring and organization of science and technology (e.g., Knorr-Cetina, 1981, p. 68; MacKenzie, 2001) but also work on a social level where collective desirable futures are imagined in connection with technological projects and scientific undertakings (Jasanoff & Kim, 2009).

Biotechnologies deal primarily in promises (van Aken, 2006, p. 512). They promise a desirable, collective future free from illness and economically prosperous. Consequently, biotechnology holds a prominent position within the societal imagination of an improved future. Overcoming illness and resource scarcity are important issues aimed at enhancing human health, and biotechnology is often envisioned as the primary contributing factor toward realizing this future. In this sense, science itself is often regarded as essential in achieving a desirable future. This delineates a technological imaginary wherein a world continually progresses through the application of advanced biotechnology. Such imaginaries are frequently depicted within science fiction narratives, exemplified by works such as Daniel Suarez's "Change Agent" (Suarez, 2017) or Morgans's "Altered Carbon" (Morgan, 2017).

Technology is inherently ambiguous, embodying both promises and perils. This truism within Science and Technology Studies (STS) signifies that various potential futures regarding a particular technology can be envisaged by societal actors. From a desirable future perspective, Life Science pertains to a "techno-fix", a paradigm where technology is envisioned as responsible for resolving societal issues. Under the "techno-fix" framework, social challenges are redefined as technological problems. For instance, disease is no longer perceived as a societal issue rooted in stress, unsafe working conditions, or discrimination within the healthcare sector, but rather as a technological obstacle to be surmounted. A closer examination of DURC reveals aspects of a "techno-fix" embedded within DURC discourse. In this regard, DURC becomes intertwined with an imaginary of an aspirational future, with the technologies aimed at realizing this future being co-produced alongside the imaginaries of that future.

Simultaneously, competing narratives about undesirable futures can also be found in DURC. I termed these narratives "techno-fear". What I call "techno-fear" is an imaginary of insecurity, a scenario in which technology and society are co-produced, leading to a future in which technology is a source of insecurity. This situation is caused by social factors coupled with technological capabilities, and what we see here is an undesirable future of vulnerability in which constant caution must be exercised. In our case, the narrative of a global distribution of biotechnology that cannot be controlled causes the imaginary of a future where the "misuse" of that technology is almost inevitable and only a question of time. Simultaneously, the techno-fear conceptualizations lend credibility to the techno-fix conceptualizations, as biotechnology becomes something that can prevent or at least mitigate the effects of biological weapons.

In the conceptualizations of "techno-fear", biotechnology is perceived as the technology through which an undesirable future, ominously approaching, is brought to fruition. As illustrated by the broader DURC discourse, in this envisioned future, the widespread dissemination of biotechnology and its consistent progression contribute to a scenario where malicious actors have facile access to biological armaments. Biotechnology thus emerges as a source of insecurity. It appears to be ubiquitous, easily concealed, cost-effective, and capable of inflicting significant harm. For instance, during the 1990s, this "techno-fear" was expressed through various reports suggesting that biological weapons constitute a form of "poor man's nuclear bomb". Unlike nuclear weapons, which may be inaccessible due to shortages of materials, trained personnel, or prohibitive costs, biological weapons could potentially serve as an alternative in this role (e.g., Carus, 1991; North Atlantic Assembly, 1996). The destructive potential of biological terrorism, particularly its comparison to nuclear weapons, has been and remains a subject of active debate. Numerous substantial objections have been raised concerning the ease of their production and deployment; however, the security implications are still evident in the ongoing DURC discussion.

Techno-fix and Techno-fear serve as valuable archetypes frequently identified across DURC publications. These concepts exemplify two extreme conceptualizations of the nexus between technology, security, and the future. They illustrate the co-production of technology and security, which exerts tangible influence on contemporary policy-making. Accordingly, these two concepts will be employed throughout this project to describe specific discursive formations that shape the corresponding future, and they will be revisited in subsequent analysis. In the meantime, we shall examine the origins of these concepts and their establishment. To this end, we will scrutinize the construction of security and technology, subsequently applying Jasanoff's concept of co-production to demonstrate how discourses surrounding techno-fix and techno-fear are performative in shaping DURC policy.

3.3 Security and What We Make of It

Examining the evolution of dual-use conceptualizations reveals that the element of contingency within the concept is primarily linked to the futures we envision. For instance, envisioning an interstate war between two superpowers will lead to a different dual-use conceptualization and employment of policy tools compared to envisioning a future where terrorism becomes a central security concern.

Furthermore, it is advantageous to examine the very concept of security and to observe how the understanding of security evolves over time, as varying definitions of security (i.e., what objects need to be secured against what threats) are closely connected to the dual-use conceptualizations employed. Historically, and to some extent in the present, dual use is linked to national security, concerning insecurities resulting from the dissemination of technologies and the potential for adversaries to employ such technologies in military confrontations or to the detriment of the supplying state.

In general, insecurities pose threats to valued entities. Conversely, security represents the absence of such a danger (Huysmans, 2014, p. 15). Traditionally, the concept of security is rooted in the domains of international relations, military strategy, and national interests. The primary concern regarding security has been—and remains partly—focused on the (nation)state and its preservation, particularly in the context of the nuclear age. From a perspective aligned with contract theory, individuals confer authority upon states and relinquish their personal rights to engage in violence in exchange for collective security provided by the state. This conception of security delineates the enemy as external to the (state)collective; the predominant threat originates from other states and is typically countered through military force (Walt, 1991, p. 213).

This approach to security assigns minimal importance to internal state matters. Within a realist framework of security—referred to here as "traditional"—insecurity and the pursuit of security are regarded as the objective conditions that every state actor must confront. It is acknowledged that no central institution ensures the security of the state; rather, the state is solely responsible for its own security (Morgenthau et al., 2006). The initial conception of dual use epitomizes a state-centric perspective of security. Technology is deemed hazardous and necessitates restriction once it crosses borders and proliferates to the "other side". It is considered perilous only beyond the state's boundaries; within the country, it remains comparatively secure.

Constructivist scholars challenged realism's narrow focus on the interactions between states and seeming objectivism during the 1980s (A. Wendt, 1987, 1992). Accordingly, constructivism "opened up" the black box of the state and examined various state institutions and their identity as an explanation for state behavior (for a history of critical/constructivist approaches in IR see: Buzan & Hansen, 2009; C.A.S.E. Collective, 2006). Focusing on these various state agencies shifted the research agenda towards a program primarily concerned with how security is constructed. What constitutes (in)security, and for whom? Consequently, CSS scholars frequently scrutinize the very concept of security itself. Doing so can reveal significant insights into power dynamics within a society, including whose threat perceptions are accepted and who is deemed worthy of protection from certain threats. With some exaggeration, one might argue that CSS transformed security from a standalone object to be studied—aimed at predicting state behavior—into a framework through which the power relations of broader society can be critically examined.

Critical Approaches to Security

To identify the power dynamics underlying a change in security policy, it is essential to employ a theoretical framework capable of encompassing the social processes that delineate what constitutes a security threat. Such a framework must possess sufficient flexibility to accommodate the multiple interpretations of security. Security is not a singular entity but a multifaceted concept. It does not represent an objective state. Although the notion of security is dependent on its social context—thus varying according to the user—it is neither arbitrary nor solely individualistic. In practical terms, only certain phenomena can pose security threats, and generally, our understanding of security is not purely individualistic but shared.

Why is this relevant to the study of security, or, more specifically, DURC? There are several takeaways from our brief detour into epistemology and meta-theory that are pertinent to this project. To paraphrase Campbell: There are numerous dangers in the world; however, not all of them constitute security threats (Campbell, 1992, p. 2). The integration of a phenomenon into social reality as a security threat is contingent upon its recognition as such, which is ultimately a product of a social process. Through the process of objectification, entities that are physically removed can nonetheless be incorporated as security threats. Many individuals lack direct experience with biological weapons; nevertheless, biological weapons may still be regarded as hazards within our reality, even if direct exposure to them is socially distant from us, as we are typically not the individuals handling them directly.

In their seminal work, "The Social Construction of Reality", Berger and Luckmann established the foundational principles for the epistemological perspective employed in this analysis. The core premise articulated by Berger and Luckmann is readily evident within the title of their publication. Reality—understood as meaningful phenomena that happen independently of our will—is conceptualized as a social construct (Berger & Luckmann, 1990, p. Location 174).

While each individual possesses their subjective reality, the intersubjectively shared reality relies on objects that convey subjective meaning. Such subjective meaning can only be shared with others when it is objectified. The process of objectification, defined as the expression of subjective meaning in objects, is predominantly accomplished through language; however, other forms of communication are also feasible. Although I am aware that my subjective experiences and meanings may differ from those of others, I share an intersubjective reality that is generally regarded as unquestionable (Berger & Luckmann, 1990, pp. Location 466–475). This implies the following: I possess my own thoughts, which are inaccessible to you. I have the capacity to decide whether to share my thoughts, and I can do so through linguistic means. I could communicate my thoughts via speech or writing, as Berger and Luckman did, or through physical violence. The communicative tools I select carry specific, culturally accepted meanings that can evolve over time. Currently, physical violence is generally inappropriate for expressing affectionate concern for another individual, although exceptions may occur. You comprehend these modes of communication because we both understand what certain words or actions signify. Even in cases where our interpretations diverge, a mutual understanding is achieved because we can sufficiently converge on meaning. I have made my subjective reality accessible to you by translating it into objects that we both recognize.

Objectified meaning can be found in both material objects and immaterial entities such as thoughts or concepts. These objects seem independent of subjective interpretation, presenting themselves as natural and external phenomena. To date, reality appears to the individual as a collection of objects existing outside of personal subjectivity, predating the individual and likely to endure beyond them. The meaning and utilization of a can-opener or the concept of democracy are widely understood and intersubjectively shared. Both are objectified and perceived as undeniably real—though the concept of democracy is arguably less tangible than the can-opener, given its predominantly abstract nature and the ongoing debates surrounding its definition. Nonetheless, because they are objectified, such entities can be incorporated into our perceived reality. Society's members do not need to depend solely on personal experiences to comprehend their surroundings. External realities, whether spatially, temporally, or socially distant from the immediate experience of the individual, can nonetheless be integrated into that individual's reality (Berger & Luckmann, 1990, p. Location 834).

If intersubjectively shared objects are the primary means by which we can understand the world, then how do we ascertain the meaning of these objects? In essence, how are objects intersubjectively comprehensible? This inquiry leads us to the concept of knowledge. Knowledge constitutes the manner in which we comprehend objects and interpret the world. It is an objectified, intersubjectively shared meaning. As an objectified entity, it can be transported across time and space, thereby facilitating transmission between generations and social groups. This collective repository of knowledge is indispensable, as others share at least a portion of my knowledge when it bears relevance to both parties (Berger & Luckmann, 1990, pp. Location 855–856).

Constructed Security and Constructivist Security – How Does Something Become a Security Threat?

Several constructivist approaches to security more-or-less share the onto-epistemology that I have outlined above.[4] For the undertaking here, we can distinguish two different avenues of research within the literature. On the one hand, authors who focus primarily on the meaning of security. What happens if something becomes a security threat (e.g., Bengtsson et al., 2019; Huysmans, 2006, 2014)? On the other hand, we find authors who are more concerned with the making of security. How does something become a security threat (e.g., Balzacq, 2005; Buzan et al., 1998; Campbell, 1992)?

In reality, both approaches are deeply interrelated and often dependent upon one another. Something can become a security threat by being treated as one, and it can only treated like one if it can become recognized as one. Therefore, it is necessary to address both questions to some extent. However, considering two focal points of critical security research may prove beneficial to avoid becoming overwhelmed by the perpetual interconnectedness inherent in social science. What implications does this have for the project at hand? Let us begin with the initial inquiry: DURC has not inherently become a security concern due to natural circumstances. The actuality that it has emerged as a security issue stems from a social process that could have proceeded differently (this is what we refer to as the process being contingent). However, by what mechanisms does a situation transform into a security concern?

We can start with the observation that security pertains to concepts regarding the mitigation of an existential threat. Securitization theory, consistent with numerous Realist international relations scholars, asserts that a fundamental aspect of security involves emergency, survival, and the mitigation of an existential threat. Security is frequently characterized as a distinct form of politics, wherein narratives of emergency or, at minimum, urgency, are central. Existential threats must be addressed as a priority. Failure to do so renders subsequent actions by the threatened entity futile, as the entity would cease to exist. Consequently, the notion of emergency in relation to an existential threat, coupled with anticipatory measures aimed at threat mitigation, constitute the defining features of security (such an argument can be found in: Buzan et al., 1998).

> *"For example, the events of 11 September 2001 are a prototypical security event precisely because they were immediately politicized as an exceptional and global threat to the United States and the Western world more generally. They led to urgent introduction of emergency legislation that reinforced powers of the executive to the disadvantage of the legislative powers, a rhetoric of a 'war on terrorism', and to the large-scale use of military power. In that sense it confirmed what Wæver (1995) identified as the central characteristic of the national security tradition: the articulation of existential threats that are framed in the language of war and that legitimate the introduction of exceptional policies." (Huysmans, 2006, p. 5)*

However, a growing body of scholarly literature demonstrates that security cannot be conceptualized solely as associated with an existential threat. This body of work originated from the observation that security practices in Europe operate differently than those in the United States, which frequently constitutes the primary focus of security scholars. An insightful attempt to redefine security practices away from the notion of exceptionality can be found in the writings of the "Paris School“, most notably Didier Bigo. Influenced significantly by Pierre Bourdieu's writings, it is unsurprising that the Paris School posits that security is less about exceptional threats and more about the routines and mundane practices of experts. In this context, security is understood as a technique—an ability to define and organize the social world—redirecting attention to the professionals who produce security and the effects their practices have (for a good overview on Bigos contributions see: C.A.S.E. Collective, 2006, pp. 457–458).

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[4] Even if they do not necessarily share my love for Berger and Luckmann.

The Paris school contends that the analysis of security should focus on routine practices and the actors enacting those practices, rather than on external, existential threats. Security professionals are concerned with "[…] the discursive ability to produce an image of the enemy with which the audience identifies" (C.A.S.E. Collective, 2006, pp. 457–458). This shift in perspective on security indicates that security practices are not solely reactive measures aimed at addressing perceived insecurities; they are also performative. Engaging in a security practice embeds insecurities within the field and the issues it tackles, as it renders these insecurities explicit by introducing or re-articulating a security rationale. Consequently, this process stabilizes the interpretation of an issue as a security concern, since routine practices are enacted well, routinely (Huysmans, 2014, p. 17; McDonald, 2008, pp. 575–576).

When examining the routine practices of security professionals, it becomes evident that security practices have evolved since the Cold War period. They are no longer predominantly linked to a singular existential threat and address a diverse range of both existential and non-existential insecurities (Huysmans, 2014, pp. 74–90). These multiple insecurities do not necessarily reinforce each other into a single existential threat; rather, they can coexist independently. This phenomenon is evident in arguments that intertwine terrorism and migration within the context of border security practices. In most of these arguments, neither migration nor terrorism is regarded as an existential threat but rather as incremental insecurities that require mitigation. These insecurities are interconnected not through a central structure, such as an overarching existential threat, but by their association through shared security practices aimed at mitigation. In this context, border security serves as a mechanism that links migration and terrorism via the regulation of individuals at the border (Huysmans, 2014, pp. 103–109).

When security is not associated with an immediate existential threat, it ceases to be a matter of life and death for the referent object. Instead, it involves a gradual assessment of insecurity. We observe now that those issues no longer manifest as existential threats but as incremental insecurities that are not immediately life-threatening (to the body politic) but still require attention. This shift is significant for our analysis here. While narratives of apocalyptic scenarios occasionally appear, most security discussions regarding DURC do not primarily concern existential threats to the survival of a state or society. Rather, they view DURC as a potential source of risks that must be mitigated through security practices. Such practices have become routine and are not confined solely to emergencies (Huysmans, 2014, pp. 74–90). Therefore, I argue that within contemporary conceptions of security, entities are designated as security threats or insecurities through their characterization as such. Upon understanding the mechanisms by which entities are identified as security threats, the subsequent inquiry arises: What, then, is the concept of security? How can it be conceptualized, and what are the implications if an entity is deemed a security threat?

Security as an Organizing Principle

The answer I wish to present here is that security should be comprehended not as a tangible entity or a static condition but rather as an organizing principle. Security structures the manner in which activities are conducted and delineates responsibilities among various actors. Consequently, security introduces a specific rationality into the political process. When an issue is identified as a security threat, it is perceived and addressed in a manner distinct from non-security concerns, with particular emphasis and priority accorded to certain actors and their knowledge (Huysmans, 2006).

Since security is an "essentially contested concept" (Buzan, 2007) it is impossible to determine which actors are involved without examining the specific case. Who is deemed relevant depends on the construction of the threat assessment and the wider context in which such an assessment is conducted. Historically, responses to existential threats have concentrated on the executive branches of government, including policy, intelligence services, and the military, and have been linked with emergency measures that override non-security political procedures (e.g., the use of force) (Buzan et al., 1998). Here, security introduces rationales of urgency (Balzacq, 2007), risk (Hagmann & Cavelty, 2012), and secrecy (Balmer, 2006) to overcome threats. The collection of measures referenced herein are those traditionally associated with security, rather than security as a sui generis concept.

Consequently, security functions as an organizing principle that embeds specific logic into political practices.

In light of this, let us briefly revisit the inception of this chapter and the inquiry: How does an issue become characterized as a security threat? I have argued that issues attain the status of security threats when they are treated as such. This, in turn, indicates that the connection between threat description and policy is not unidirectional. An issue is not initially constructed as a security concern and subsequently addressed accordingly. Rather, the act of performing a security practice (i.e., handling an issue in accordance with a security rationale) inscribes insecurities into the domain and the issues it encompasses, as it renders them recognizable as matters of security. The integration of a security rationale into the field contributes to stabilizing the interpretation of an issue as a security concern (Huysmans, 2014).

Thus, the answer to our question is, that a matter becomes a security concern insofar as it is perceived and addressed as such (Bigo, 2002; Bigo & Tsoukala, 2008; Huysmans, 2000, 2006, 2014). For example, police officers approach social groups or places in a certain way, thus making them known as security issues (Ericson & Haggerty, 1997); EU bureaucrats observe and gather knowledge about migrants (Feldman, 2014), and immigration officials at airports are constantly engaged in sorting out who can gain access and who can not (Huysmans, 2014). Through approaching something as a security issue, be it through policing tactics, intelligence, and surveillance practices, or risk assessments that decide whether or not someone gains entry, those issues become security issues.

Likewise, it is argued here that DURC is understood as a security issue because it is approached as one. Through routine practices that assess the risk of an experiment in an everyday fashion and through extraordinary means like restricting publications, to name just two examples. The routine through which DURC is approached makes it a security issue. In this sense, DURC is not primarily about extraordinary steps that would justify extraordinary means but about routine security procedures that introduce routine security practices into the field, stabilizing its understanding as a security issue.

3.4 Security Epistemology: Moving Towards Risk

A common characteristic of non-existential security is the emergence of risk as an epidemiological instrument. Risk has become pervasive within the security domain, particularly in the decades following the Cold War. The heightened interest in the methodologies employed by security professionals has led to increased focus on risk, risk assessment, and risk management—three fundamental tools through which security practitioners interpret and understand their environment (Aradau & Van Munster, 2007, p. 90).

Until now, I have argued that nothing is in itself a security threat; rather, it becomes one. In doing so, security functions as an organizing principle that governs the approach to an issue. Risk introduces the third important aspect: knowledge about an uncertain future. Risk represents a specific epistemology frequently employed in security policymaking (e.g., Achilleos-Sarll et al., 2023; Harijanto, 2025; Nøkleberg, 2022). It markedly differs from other concepts used in security, such as dangers or threats. Risk refers to the estimated probability of a negative event occurring. In a contingent future, risk constitutes a mental model through which we can quantify and organize the radical uncertainty inherent in future contingencies. Through the concept of risk, the future becomes, to some extent, comprehensible, and actions can be undertaken to address it (Aradau et al., 2008, pp. 148–151). As such, risk makes the future not only knowable to some degree but also manageable, as we can take action in the present to mitigate risk in the future (Lakoff, 2007, p. 250). Risk introduces ways to conceptualize the future as uncertain and contingent upon actions in the present. Thus, risk introduced a particular rationale for the relationship between the present and the future and how this relationship is controlled (Kessler & Werner, 2008, pp. 292–293).

The conclusion of the Cold War diminished the efficacy of deterrence and containment as the principal security strategies, given the absence of a singular rational actor to defend against. Instead, ambiguous threats supplanted the USSR, abolishing the familiar ways of thinking and shifting the focus from who might threaten the population to how it might be threatened (Lakoff, 2007, pp. 263–264). Here we can see how risk differs significantly from dangers, as using risk bears markedly different connotations in the context of security compared to threats or dangers. Dangers are typically associated with specific actors and their agency, whereas risks emphasize the systemic features of insecurities. Risks are probabilistic and require strategic management, while dangers are existential threats that must be addressed directly. Furthermore, dangers or threats often generate enemies to be neutralized in a zero-sum manner, whereas risks pertain to objects—primarily populations—that are "at risk" from particular events (Aradau et al., 2008, pp. 148–151; Corry, 2012).

Is risk a fundamentally novel element within security policy? No. The principles of risk management and insurance have long been integral to security strategies. In a certain sense, nuclear deterrence functions as an insurance mechanism against a first strike. Consequently, a future-oriented perspective in security policy is not a recent development. What is indeed novel are the numerous practices now incorporated into the repertoire of security professionals, through which our engagement with the future is governed (Aradau & Van Munster, 2007, p. 95). What is also new is the increasing frequency of risk usage and the elevated prominence it has attained among security professionals. Risk has become widespread across Western societies. Since the conclusion of the Cold War, security professionals in Western nations have begun to describe their environment as a risk rather than a danger (Aradau et al., 2008, p. 147).

When discussing risk within the contemporary Western context, it appears pertinent to reference Ulrich Beck (1992). Becks' influential publication posited that industrialization has given rise to potentially catastrophic risks, which are conceptualized as possible futures that might materialize. Climate Change exemplifies one of these significant risks. According to Beck, risks are "out there" futures that could potentially occur with a certain likelihood. In this text, I adopt a different interpretation of risks, drawing upon Aradau's (2008) conceptual framework. For both myself and Aradau, risks are not elements that exist independently in the world; they lack an ontological status. Rather, risk constitutes a particular mode of thinking and understanding the world. It functions as an epistemological instrument that provides meaning to our perceptions of the world and, more specifically, its possible futures.

Conceptualizing risk as a knowledge technique has significant implications for its materiality. Risk is not a natural phenomenon or inherently embedded in objects. Rather, risk is a discursive practice inscribed across various fields and entities (Kessler & Werner, 2008, p. 293). Aradau and van Munster use the Foucauldian term *dispositif* to describe what a risk is. A *dispositif* is a certain way of doing things, a logic that structures the discourse[5]. In terms of security, risk becomes a rationality of government. Risks make objects knowledgeable according to an insurance logic, which considers the average damage from past events multiplied by their probability. In this way, risk functions as a *dispositif* that governs the future, making it both known and somewhat predictable. To achieve predictability, risk requires ongoing monitoring of the present to reduce potential harms or threats that might emerge (Aradau & Van Munster, 2007, pp. 97–98).

Risk also governs our relationship with the future. It incorporates contingent actions in the present. Consequently, risk provides a rationale for the connection between the present and the future, as well as the means by which this relationship is managed (Kessler & Werner, 2008, pp. 292–293). Thinking in terms of risks necessitates continuous monitoring to determine the likelihood of certain futures materializing. It pertains to a mode in which actions must be undertaken to safeguard against adverse outcomes of possible future scenarios (Aradau et al., 2008, p. 149).

Due to its foundation in statistics, risk introduces not only a specific logic into the discipline but also a distinctive "language". Risk gains significance through its reliance on numerical data and functions as an ostensibly objective metric by which various potential futures can be comparatively assessed. It incorporates scientific elements to inform decision-making concerning policy options in the face of

[5] We will talk about discourses in the Methodology section.

uncertainties (Stirling & Scoones, 2009). Through risk security, practitioners obtain the authority to classify and prioritize objects based on numerical data. The utilization of statistics enables them to delineate what constitutes security and what does not. It also clarifies what is encompassed within the "exceptional risks" of security and what falls under the scope of normal risks encountered in daily, non-security life (Bigo & Tsoukala, 2008, p. 12).[6]

So, what is my main point here? To avoid any confusion, it is important to note that I am not arguing that risk has become the only way in which security is achieved. Instead, risk is a specific epistemology within security that works alongside other modes of security. As such, risk differs from other epistemologies and modes of security. Risk has become one of the leading concepts in security, and with it, an authority of scientific, number-based expressions has gained prominence. Risk differs from danger, as dangers involve overcoming an enemy, while risks are about managing the future. We need to take action today to prevent and prepare for many potential future threats. Risk is also more about a continuum than clearly defined objects. Whereas an enemy is relatively clear-cut, almost anything can be a risk, and if its riskiness exceeds a certain threshold, it becomes an issue that must be addressed. Through the centrality of risk, security—as conceptualized here—is about managing a contingent future. The authority of numerical data and objective observations is especially relevant in the case of DURC because the object of DURC is not a potentially risky individual or a risk from environmental disasters but a human-made object rooted in science and technology. It is something we have created, something we seemingly understand, and something we can evaluate.

3.5 Security, Science and Technology

The final issue I wish to address in this chapter is the role of technologies within (Critical) Security Studies. Despite the prominence of technologies as objects or means of security practices, their role remains under-theorized in contemporary security studies. Security and technology have a longstanding interrelationship. For realist security scholars and policymakers, technology is frequently regarded as ancillary to politics, representing a tool by which states seek to gain an advantage over adversaries. In this context, advanced and improved technology equates to power (Drezner, 2019).

This relationship underwent a significant transformation as emerging technologies increasingly became vital sources of security concerns. As global dependence on technology grows, so does the apprehension that such technologies might be (mis)used for purposes often described as hostile. Adversarial states might launch "cyber-attacks" capable of damaging critical civilian and military infrastructure. New production technologies, such as 3D printing, could be exploited to access weaponry and materials; terrorist organizations might employ homemade biological weapons; and the list could extend further. Several prospective scenarios generate concern among experts, policymakers, politicians, and the engaged public, ranging from technology that could be exploited by "disgruntled individuals" and terrorist groups, to those that could lead to new dynamics on a large-scale, possibly nuclear interstate warfare (e.g.: Atlas, 1999; Atlas & Dando, 2006; Edwards, 2019; Meselson, 2000).

Technology in Critical Security

A dangerous technology can be understood as either intrinsically or extrinsically dangerous. When considering technology as intrinsically dangerous, the relevant technology is viewed as inherently dangerous regardless of the context. An extrinsic perspective on technological risks attributes such dangers to properties external to the technology itself. Most discussions concerning dual-use technology tend to adopt an extrinsic viewpoint, whereby the technology's danger manifests only when in the possession of a malicious actor capable of misuse. Conversely, it is regarded as comparatively innocuous if it remains under the control of a legitimate actor. Beyond an actor's intentions and capabilities, the potential risk posed by the technology may vary depending on the

[6] Traffic accidents for example would be a risk that is usually not governed through a security logic. The risk of nuclear war would also be discussed as a risk but most likely follow a security rational.

circumstances and the user's expertise, such that one might not know how to operate a hypersonic missile even if in possession of one (Balmer, 2006, p. 693).

Therefore, an intrinsic understanding of dangerous technology would highlight the significance of the physical or material characteristics of the technology, whereas a more external understanding would accentuate the technological regime without negating the general capacity of dangerous technology to inflict harm when placed within the appropriate (or, more accurately, the inappropriate) technological context. Internal perspectives on dangerous technologies tend to lean towards a form of technological determinism: they regard technology as an objective factor and incorporate it into the framework against which social actions occur. In this body of literature, humans engage with technology as a neutral instrument that is merely a fact of life, with its qualities being readily measurable and ascertainable (Herrera, 2003).

The critical security studies literature, and by extension, the majority of critical discourse within science, technology, and international relations (IR), adopts an approach that aligns more closely with the extrinsic perspective on technologies but is more nuanced in describing the relationship between humans, technology, and political processes. Similar to numerous other disciplines, Critical Security Studies is presently experiencing a renewed interest in the material world. The focus on the everyday practices of security professionals within CSS has highlighted the significant role that technologies play in routine security practices. Consequently, scholars within CSS have renewed their focus on topics such as materiality and methodologies derived from Science and Technology Studies (STS). This renewed interest is so pronounced that some scholars have begun discussing a "material turn" superseding the earlier linguistic turn and its associated constructivist theories (e.g., Amicelle et al., 2015; Bellanova et al., 2020). In the beginning, Critical Securities' fascination with matter and "things" often took the form of Actor-Network Theory (e.g., Best & Walters, 2013). However, by now, there is an active agenda to move away from ANT only, and a multiplicity of approaches can be found within STS attuned to CSS (Bellanova et al., 2020). STS-inspired approaches have been successfully used to analyze various security "things": car thefts (Fromm, 2023), borders (Binder, 2024; Côté-Boucher, 2002), COVID 19 apps (Markussen, 2023), drones (Brito, 2025; Walters, 2014), high-tech (Boswell & Besse, 2023; Eriksson & Giacomello, 2006; Jaffe & Pilo', 2023; Leese, 2014), low-tech (Bonelli & Ragazzi, 2014), no-tech (Nyers, 2012), and jellyfish (Rothe, 2020).

The cited papers above represent only a small selection from the expanding body of literature that examines the complex relationship between material objects, discourses, and imaginaries within the domain of security practice. This corpus of research serves as a valuable foundation for our investigation, as it emphasizes that science and technology are inherently intertwined with security affairs. They are not entirely separate entities providing an unalterable backdrop for social actions but are instead continuously produced and reproduced through a close interaction with social forces and activities. In our context, insecurity is centered around a scientific object—the high-risk experiment. Here, science and technology are regarded not merely as tools to attain security, as in through algorithms (de Goede, 2018), but DURC occupies a considerably more complex spot. It serves as the nexus connecting what must be protected with the associated threats and the methods by which security is realized, in addition to being an element that requires measurement to assess the level of risk involved. DURC is profoundly embedded within a network of biosecurity discourse and practice.

Does it Matter? Materialism in Insecure Technologies

There exists a second significant distinction between the conceptualization of DURC here and the literature focused on materiality within STS and security studies referenced earlier. For the purposes of this research, DURC is regarded as non-material. Naturally, it possesses material foundations and implications; however, the materiality of DURC is not its defining characteristic in this context. One useful starting point for contemplating technologies can be found within the theories centered on the Social Construction of Technologies (SCOT). SCOT was established in 1982 by Wiebe Bijker and Trevor Pinch (Bijker & Pinch 1987). This framework rejects the concept of technological determinism and emphasizes the plurality and ambivalence associated with technology. Relevant social groups—such as users, engineers, journalists, or politicians—who are directly involved with the technology, generate specific and often competing perspectives regarding the technology in question (S. Beck et al., 2012, pp. 132–134). Initially, the bicycle was predominantly perceived as a tool for athletic men. Nonetheless, this interpretation, although prevailing, was not exclusive. Anti-cyclists, who opposed cycling, harbored a very different perspective compared to enthusiasts involved in bicycle racing. Therefore, recognizing the pertinent social groups and their stances constitutes a fundamental aspect of the key aspects of SCOT's approach to technology (Bijker et al., 1987, pp. 27–33).

One significant shortcoming of SCOT is its focus on which social forces shape the design of a technology (for an example of how social process shape research see: Knorr-Cetina, 2003). This issue is of lesser concern in this context, as this research concentrates on the regulation of technology rather than its development. Instead, our aim is to analyze how social groups generate knowledge about technology and its security implications. For this purpose, Grint and Woolgar's post-essentialism presents a useful approach (Grint & Woolgar, 1992, 1997). Grint and Woolgar argue that, while the physical properties of a technology are not irrelevant, our understanding of those properties takes priority and is always socially constructed (Grint & Woolgar, 1992, p. 367). With reference to McKenzie's (MacKenzie, 2001) account of the invention of nuclear missile guidance, Grint and Woolgart exemplify their point with the properties of nuclear weapons:

The utilization of nuclear weapons has been envisioned in many different contexts, and our comprehension of their potential effects varies accordingly. An attack against the city center has different consequences than an underground nuclear test (Grint & Woolgar, 1992, pp. 360–361). In one example (the underground test), the nuclear weapon would probably be described as relatively safe because otherwise, the test would be abandoned. In the other (the use against a city), it would be considered a horrible weapon. Depending on the context, a technology has different capabilities, and there is not one interpretation of what a technology can do but many (Grint & Woolgar, 1992, pp. 370–371). These interpretations vary across different social groups and contexts. It is neither particularly novel or surprising to note that multiple, often contradictory claims regarding technologies and their capabilities exist, claims that cannot be resolved solely by examining the material capabilities of a technology (Wynne, 1988, p. 160). Instead, we must look at the social process that "makes" a technology.

3.6 Coproduction, Entangled Discourses, and Imaginaries

An examination of dual-use technologies in general, and DURC in particular, reveals the intrinsic connection between the development of such technologies and considerations of security. Within the biosecurity community, dual use refers to the combination of technical capabilities and the construction of insecurity. Certain technologies are ascribed capabilities that could pose security threats if acquired by adversaries. This analysis prompts critical questions regarding the directionality and causality within the social processes involved. Specifically, which phenomenon precedes the other: the emergence of hostile actors gaining access to particular technologies or the existence of dangerous technologies that necessitate safeguarding against such actors?

Dual use serves as an exemplary instance to illustrate what Sheila Jasanoff has termed co-construction, describing the mutually co-constructive relationship between technological and social orders. According to Jasanoff, co-construction is not a comprehensive theory but rather an "idiom". It elucidates how technology and scientific knowledge are embedded within and influence everyday practices, while simultaneously, social and cultural orders are constitutive of the development of technology and scientific knowledge. Neither aspect assumes precedence; rather, both are foundational to each other (Jasanoff, 2013b). Jasanoff's concept is extremely useful for comprehending the interaction between technology and security. Technology can be understood as a collection of accounts generally regarded as credible. These accounts become influential and performative in structuring social practices, while simultaneously remaining dependent on the social practices that serve as the context for their creation. In a technologically mediated society, this phenomenon occurs across nearly all domains. Therefore, Jasanoff's notion posits that technology and society are inseparably intertwined, rather than existing as distinct entities.

With regard to DURC, these social practices are, at least partly, security practices. DURC owes its legacy to the nonproliferation debate of the Cold War (Guillemin, 2005), to the bioterrorism fear of the 1990s (J. Miller et al., 2002) as well as to a general fear of the mad scientist that can be found in Poland's call to include the prohibition of biological weapons into the Geneva Protocol of 1922 (Mierzejewski, 2003). Simultaneously, numerous DURC discussions are characterized by appeals for "objective" or "science-based" risk evaluations, implying that the assessment of the technology is at least as crucial to security practices as the security practices are to the development of DURC as a technological domain (Jasanoff, 2013a).

Therefore, the argument presented herein posits that to avoid discussions about the technology's material capabilities, security and technology should be regarded as co-constructed elements. This shift directs the researcher's focus towards the social practices that generate security and technology. The intricate interweaving of distinct discourses exemplifies the manner in which I perceive the co-production of security and technology. Discourses pertaining to security and technology are profoundly interconnected; in our context, contemplating one invariably involves considering the other. Naturally, this co-production does not occur between distinctly separated security and technology discourses, but rather within arenas that influence both discourses. With the advent of risk as a pivotal security paradigm, co-production predominantly transpires in relation to the future. Risk involves extrapolating future scenarios based on past data. When technologies occupy a central role in security formation, they become intertwined with the concurrent process of "future-making", which entails shaping perceptions and projections of the future.

3.7 Conclusion: Entangled Constructions and Future Imaginaries

DURC is entangled in two competing imaginaries: "techno-fear" and "techno-fix". At the core of what has been discussed here is the question: Why can't we simply determine whether something is dangerous or not. This is because dangerous and "what something is" are no easy concepts but social constructs emerging from the current discourse. Also, both concepts are deeply related and co-produced with each other. One cannot be easily separated from the other. Technologies cannot be defined by attempts to assess their level of danger through "objective" (speak quantitative) risk assessments. Because they are not a priori to the security practice, such attempts must be treated as part of the security practice itself.

The second implication is that, any attempt to describe DURC as a separate class of experiments is necessarily intertwined with establishing a security rationale. Whether or not technologies are perceived as a risk is irrelevant to DURC—DURC is always, at least in part, approached as a risk. Social processes that endeavor to establish the experiment's capabilities also inherently construct a threat, and vice versa. Taking this dynamic seriously is a prerequisite for this project as it enables us to view arguments over whether something qualifies as DURC as security practices that reinforce threat interpretations. Simultaneously, a discussion regarding whether a particular experiment is indeed DURC already relies on security logics through which the accounts of the experiment are validated as true.

These security dynamics occur within a field where two competing conceptualizations of technologies are evident: the "techno-fix" and the "techno-fear". They serve as foundational perspectives that underpin security practices. DURC could, in theory, be addressed by aligning solely with one of these conceptual frameworks. In a "fix" narrative, it would be normatively good and not regarded as a security concern. Conversely, within a pure "fear" narrative, it would be normatively bad and likely subject to outright prohibition. Nonetheless, neither perspective is sufficiently persuasive when considered in its unadulterated form. For this study, it is essential to recognize that tension between these two conceptualizations must be negotiated. A degree of uncertainty persists regarding which of these perspectives is best suited for a particular technology, and resolving this uncertainty is necessary to enable informed action concerning the technology in question. Therefore, the central argument proposed here is that security is less about definitively categorizing certain technologies as threats and more about the practices employed to address the uncertainty associated with these technologies. These practices are performative, contributing to the co-production of technology and society.

What implications does this have for the study here? In my perspective, it presents two paramount inquiries. The first pertains to the identification of the processes of co-production: What materials are employed to demonstrate these processes in practice? The second inquiry is interconnected with the first: In what manner do these processes gain significance for political action?

4 Methodology and Methods: Engagement, Critique, Documents and Discourse

In the theory section, we have seen that the development of technology and security are profoundly entangled processes. In the context of DURC, both processes become intertwined, generating particular imaginaries concerning the future. These imaginaries subsequently serve as the focus of security policies, as advantageous futures are required to be protected through risk management.

This section, entitled *Methodology and Methods*, primarily focuses on delineating an approach to identify and examine those processes. The initial segment describes the overarching research approach adopted for this project. Accordingly, the project adheres to a critical research methodology. Its principal objective is to interrogate prevailing assumptions within the DURC community, aiming to analyze the foundational concepts underpinning these assumptions. Achieving this necessitates an engagement strategy capable of effectively interfacing with the community, given its potential inaccessibility to external observers. This strategy draws upon de Goede's conceptualization of engagement (2020) and Bellanovas' writing on "staying with the trouble" (2020); the approach I will adopt throughout this project is characterized by a close engagement with the biosecurity community's work. Collaborating with and among biosecurity professionals has facilitated my understanding of the foundational concepts employed by the community, while also integrating these insights into the research process.

The second section will introduce the methodology employed in this project. For the purpose of analysis, the social processes that construct technology and security are considered discursive processes that can be identified within DURC documents. Drawing on Jäger and Jäger's notion of discourse as the carrier of knowledge (2007), discourses as the central mechanism through which valid meanings pertaining to technology and security is produced. By employing Asdal and Reinertsen's concept of document sites (2022), documents are conceptualized as central parts of the discourse that simultaneously represent and structure the DURC discourse.

This chapter's third section outlines the specific methods I used to select and analyze the DURC document, as well as the pertinent discourse. I utilize Schreier's version of Qualitative Content Analysis (QCA) (2012, 2014), which is informed by my own experiences in the biosecurity sector. The QCA analyzes two samples of DURC documents selected via theoretical sampling methods. The first sample focuses on the early US debate regarding DURC. Correspondingly, the second sample includes pertinent DURC documents from Germany, aligned with the primary research question.

The approach outlined herein is designed to examine technical communities to which the researcher has restricted access. It is also conceived as a critical scholarly endeavor aimed at questioning the often fixed notions of security and technology prevalent within expert communities. Consequently, engagement with and within these communities constitutes a fundamental aspect of this project.

4.1 Research Approach: Access and Engagement

Accessing the DURC community is relatively challenging, as much of the knowledge relevant to the community is held tacitly and resides within biosecurity actors. Engaging with and within the community necessitates substantial prior knowledge to comprehend the ideas and concepts employed in their daily practices. These concepts are constructed upon specific narratives that are present in and well understood by the community. This shared body of knowledge among biosecurity professionals renders certain claims within the community seemingly as common sense. For instance, examining the "Rogue States -Terrorism - WMD" triangle reveals how knowledge regarding this connection develops its own influence and assimilates multiple events and processes, ultimately leading to the naturalization of the DURC issue—fostering a perception of it as common sense and tacit knowledge among the actors (Fairclough, 2013, p. 44). Through the process of naturalization, a shared security concern and associated practices become embedded in daily life, leading to a diminished tendency to question them, until they are perceived as "ends in themselves". Naturalization refers to the process by which an issue becomes regarded as inherent or natural. From a policy perspective, it signifies that a matter has become an established fact requiring attention. The DURC community, akin to any other community, comprises numerous shared common-sense concepts. These concepts are rooted in history and narratives shared among community members; however, they are not necessarily available to outsiders.

I recognized this issue during my initial attempt at conducting a preliminary analysis of the documents. In early spring 2020, shortly prior to the onset of the COVID-19 pandemic, I was seated in the library of the Otto-Suhr Institute for Political Science at Freie Universität Berlin. The space comprised a glass enclosure with workstations arranged in a U-shape along the windows, encircling a modest steel shelving unit filled with books and periodicals. I occupied my usual seat at the back, as it is the only single table available, all other tables are double, and I experienced growing frustration. My empirical data did not conform to my expectations: From a CSS perspective, the adage that "security is an essentially contested concept" is deeply ingrained in my mind. Consequently, I sought evidence of this contestation but was unable to find any. Instead, I observed extensive efforts to define the criteria under which something qualifies as DURC and significant work aimed at developing systems to assist researchers in recognizing whether something is DURC. However, I did not encounter any discussion regarding whether DURC constitutes a threat not. Upon examining the history of DURC, it becomes evident why this is the case. The matter has become naturalized in certain circles and is often accepted implicitly without question. Thus, to conduct a proper analysis of the documents, it is essential to consider the tacit knowledge possessed by the biosecurity community.

The level of specialized knowledge, encompassing both technical and historical aspects, required to comprehend DURC discussions renders them particularly challenging to analyze. For instance, Revill and Jefferson critique the biosecurity community for its considerable inaccessibility, which they attribute to the prevalent use of jargon and acronyms:

"To provide an example, experts in the CBW field may agree or disagree with the suggestion that: ... the BWC needs an OPCW style SAB supported by the ISU and the IAP to build on the new ISP’s S&T SAI discussion in the MX." (Revill & Jefferson, 2014, p. 600)[7]

Whether in agreement or not, Revill and Jefferson make an excellent observation that there are very few individuals for whom the aforementioned sentence holds significance. However, within the biosecurity community, the sentence is indeed meaningful. It is a completely valid and even common-sense standpoint, particularly among NGO and academic members of the community. Analyzing the biosecurity community presents challenges because the knowledge necessary to comprehend common-sense positions is seldom explicitly articulated. It predominantly exists as tacit knowledge and oral history. This knowledge resides with experts who dedicate the majority of their professional lives within the community. When a newcomer joins the community, they must seek out one of the "elders" in order to find out why and how certain concept became salient.

Everyday knowledge is not universal but specific to the circumstances we encounter. What is immediately intelligible to one individual may not be so to another (Berger & Luckmann, 1990). The same is true for biosecurity experts. Professional "managers of unease" (Bigo, 2002) know how to act within the worlds that constitute their everyday life. For example, policy professionals working on migration within the EU context know what certain things in their world mean (Feldman, 2014). Likewise, biosecurity professionals understand what an ISU is and how the discussion regarding a Scientific Advisory Board fits into the larger discourse within the BWC.

[7] "...the Biological Weapons Convention needs an Organization for the Prohibition of Chemical Weapons style Science Advisory Board supported by the (BWC) Implementation Support Unit and the Inter-Academy Panel to build on the new Inter-Sessional Process’s S&T Standing Agenda Item discussion in the Meeting of Experts."

When meaningful social action is only feasible against the social structures that define a particular domain, the individuals operating within this domain must possess knowledge of these structures, as effective participation in a given field necessitates relevant expertise. Without delving extensively into practice theory—which is not the primary focus here, as the objective is to demonstrate the performative effects of knowledge rather than specific examples of *in situ* meaning-making—we may reasonably presume a profound relationship between knowledge and practice.

4.2 Polymorphous Engagements in the Non-Local

Ethnographic methods provide several options for engaging with a body of tacit knowledge. The primary challenge in this context is that DURC is not confined to a single location. Participants and sites involved in DURC are geographically dispersed across the globe and are often integrated into complex networks that cannot be restricted to a single site at any given time. There is no singular location where the process of DURC creation can be directly observed. Instead, DURC is generated in numerous locations, with access to all of these locations not always available. Consequently, rather than searching for a single site conducive to observation, researchers must engage with the field where access is possible, utilizing any available methods. This approach aligns with Gusterson's concept of polymorphous engagements, which refer to engagement with a community or subject through diverse means. Such engagements emphasize reducing reliance on participant observation and include interactions through documents, newspapers, popular culture, and both formal and informal interviews, especially when access to certain communities is limited or constrained (Gusterson, 1997).

We frequently face the challenge of the absence of a singular venue "where everything is happening" within security processes, especially as they become increasingly internationalized. Non-local ethnography shifts focus from site-specific practices and participant observations to the discourses that underpin the emergence and persistence of policy regimes. The primary aim is to illustrate how discourses shape and direct a particular regime. It is not the representation of the everyday practices of a community that is sought, but rather the depiction of historically specific policy regimes. Interactions do not necessarily occur through face-to-face encounters; however, they can be observed as a "great conversation" across dispersed sites that influence certain policies while constraining others. This dialogue transpires through various channels, principally documents. Accordingly, non-local ethnography does not necessitate immersion in a particular locality but involves investigating the prevailing discourse across numerous sites (Feldman, 2011).

Ethnography has not yet established a decisive epistemological distinction between the field and participant observation as its primary methodological approach. This ambiguity arises because ethnography does not explicitly differentiate between "connections" and "relations". Connections pertain to direct contacts, even among dispersed actors, as seen in multi-sided ethnographies. They are tangible and occur at specific moments in space and time. Conversely, relations refer to broader social constellations through which actors interact—with or without direct contact. These larger constellations disrupt the link between space and time by linking disparate actors. Such actors are connected through site-specific logic and power structures that confer authority upon them. Biosecurity professionals are connected through the various institutional frameworks of the site and often documents function as the logic that integrates and unites disparate actors into a non-local yet specific local context, governed by its unique logic (Feldman, 2011, pp. 378–382).

The issue herein pertains once again to the inaccessibility of the field. Even if we attend all meetings, thoroughly review documents, and subscribe to mailing lists, our capacity to generate insights remains limited due to the discourse being largely inaccessible to us. Merely observing what we do not comprehend does not facilitate understanding. Furthermore, access presents an ongoing challenge. How does one gain entry into a community that is not confined to a specific locale? Physical presence might not always be feasible; consequently, engaging with the community's broader discourse becomes essential, which consequently exacerbates the access issue. The approach I propose has been previously alluded to. Instead of observing the field, I suggest engaging with it.

4.3 Engagement All the Way Up

The difficulty associated with ethnographic research, particularly participant observation, resides in maintaining a clear distinction between the observer and the observed, especially within highly professionalized social environments (e.g. in: Gusterson, 1997, pp. 115–116). Previous knowledge, research interests, social positioning, and the context of the research all substantially influence the research outcome. Similarly, individuals within the research field possess their own agendas. It is up to the researcher to uphold a "critical distance" from both the "research objects" and one's own socialization. How can a researcher maintain an appropriate critical distance, avoiding mere acceptance of assumptions and ensuring a fair representation of the field (see for example: Spradley, 1980, p. 53).

Lobo-Guerrero, for example, asserts that "strategic self-awareness" is essential to prevent the project from descending into the "depths of ever-seductive epiphenomena" (2012, p. 28). In practical application, however, the distinction between the subject and an "object" becomes challenging to maintain. The expertise required to manage complex objects and the extensive engagement with these objects necessary to acquire such knowledge demand comprehensive involvement in the field. While this profound engagement may impede a definitive separation between the researcher and the researched, it simultaneously offers new opportunities to analyze and critique increasingly complex entities.

Working on terror financing issues, de Goede wrote about her involvement and the potential for critique through active engagement within a specific sector. By involving stakeholders within the field, de Goede contends that critique can adopt a more strategic approach and be more sensitive to the nuanced complexities and disputes inherent in real-world contexts. An engaged critique has the capacity to bridge the divide between problem-solving research, which uncritically accepts its subject conditions, and critical research, which tends to retreat into the comfort of fundamental opposition, ostensibly detaching itself from the field of analysis. Conversely, an engaged critique depends on challenging, strategic, and tactical alliances to gain insights into the field and to influence the practices under scrutiny (de Goede, 2020).[8]

Engagement as a research strategy builds upon concepts present in both approaches but introduces a novel perspective. Rather than concentrating solely on the outcomes of our research and the critique of the surrounding world, it emphasizes the research process itself and the insights gained through active engagement with the field of interest. This approach emphasizes bodily, pre-conscious, and tacit knowledge possessed by practitioners, which is utilized through engagement rather than observation. It reinforces the notion of companionship by rejecting an elitist perspective of critical research, in which researchers are detached from the social realities they critique. Recognizing that research does not occur in isolation, it is imperative to acknowledge the numerous social relations that influence our work. Our "research subjects"—the individuals occupying the social contexts under examination—should be regarded as more than mere entities with a "false continuousness" whose truths are to be unveiled through critical inquiry (Bellanova et al., 2020).

Engagement recognizes that there is no external point outside the situations we attempt to critique from, which allows for critique (Bellanova et al., 2020; de Goede, 2020). We are always entangled in the situations in which we do our research and are always complicit in constructing the world in which we live (S. Smith, 2004). Engaging actively with the very circumstances we seek to critique and transform enables us to advocate for social change without the necessity of awaiting broader societal

[8] Working with the field instead of observing it is by no means a new method. Many researchers where dis-satisfied with taking knowledge from a community (especially from marginalized communities) and then using it to write a book (read to foster the one's own career) without giving back to that community that enabled the book in the first place (e.g., Kindon et al., 2007; Ospina et al., 2021).

alteration. This process is necessarily messy and challenging. At times, our actions may be misguided, and despite our good intentions, we might inadvertently contribute to adverse outcomes (de Goede, 2020). However, there also exists an opportunity for learning, which consequently enables the formulation of more refined and nuanced observations.

DURC practitioners are embedded in a complex web of narratives, discourses, connections, relations, and sites (de Goede, 2020). They must learn how those sites work. Thus, implicitly, they are (and, for that matter, I am) always conducting a "non-local ethnography" (Feldman, 2011), not as an observer but as a practitioner. This delineates an initial aspect of employing engagement as a research strategy. It emphasizes active involvement and participation, rather than merely commenting from the sidelines, but rather being present, collaborating with peers, and taking colleagues seriously. Furthermore, it acknowledges that critical research is indebted to those involved in the field and is also influenced by our engagement with others.

I have been privileged to have extensive engagement with the DURC community, and throughout the course of researching this project, I would have characterized myself as a member thereof. Consequently, during my doctoral studies, I participated in informal discussions, conferences, and the United Nations' annual meetings. I delivered presentations on DURC and prepared position papers for our research group, intended to serve as statements at the BWC meetings. This role often presents challenges, particularly given the frequently indistinct boundary between policymaking and research (de Goede, 2020).

In order to perform competently within the DURC environment, I must acquire extensive knowledge. This includes understanding current developments within the BWC and biosecurity sector, as well as reviewing working papers, previous statements, articles, and conference outcomes to comprehend the topics under discussion. Additionally, I need to be familiar with the rules of procedure, both formal and informal. Moreover, it is essential to master the appropriate terminology for effective communication within this field. I have had to learn all these aspects and remain engaged with the ongoing challenges (Bellanova et al., 2020; Butler, 1999) to engage in an ongoing debate and offer an (implicit) critique of rational scientific knowledge as the only valid knowledge for political decisions. I learned that by doing (and listening to others, and reading and so forth). This is what it means to engage with a community, a site, and a discourse. To learn how to act competently regarding them and, thus, how the discourse structures the field.

Simultaneously, undertaking a critical project necessitates a cautious approach towards the acceptance of knowledge claims within the field under investigation. Therefore, any understanding the "object" of one's inquiry is consistently influenced by academic training and an ongoing effort to critique the prevailing conditions (Haraway, 1988). In a methodological sense, our interaction with the field is consistently guided by our critique, and vice versa; this engagement enables us to provide a more nuanced critique that remains receptive to the contradictions and ambiguities present on the ground, rather than depending on distant generalizations (de Goede, 2020). Therefore, the inquiry primarily concerns how my initial observations are integrated into the social frameworks that influence them.

In this context, engagement necessitates a second iteration wherein we refrain from accepting our everyday knowledge of the policy process as a given or as "how the world truly is". Instead, it involves taking a step back from this perspective. This process demands profound reflection on the nature of our knowledge and actions. Specifically, it prompts us to consider the backdrop against which we are able to perform our subjectivity, as well as to question why (or perhaps, even more compellingly, why not) others recognize our performance as competent within a specific domain.

The concept of "estrangement" can help here (Bellanova et al., 2020). Making strange what is considered common sense can facilitate the attainment of a specific shift, known as displacement, which is essential in ethnographic methodology. By rendering our daily activities unfamiliar, we gain insight into the reasons and manner of our actions. One approach to detaching ourselves from our knowledge is to recount a story from an alternative perspective (Bellanova et al., 2020). The knowledge acquired through participation can be articulated in policy briefs, or it can be reinterpreted from a different perspective—one that emphasizes critical theory—thereby rendering as unfamiliar what was formerly regarded as commonplace knowledge. This approach allows us to perceive an alternative perspective, whereby discourse, narratives, structures, and power relations are prioritized over policy issues and practical solutions.

J. Miller et al. (2002) and Guillemin (2006a) have written excellent, comprehensive accounts about biosecurity and DURC. The narrative they have presented is from a perspective that emphasizes the changing security environment following the Cold War, as well as the forces of innovation and technological advancements, considering them as inevitable realities that influence biosecurity policy outcomes. Both viewpoints are highly influential within the field of biosecurity. They form a significant part of my daily understanding of biosecurity issues, and I frequently depend on both sources and their explanations when collaborating with colleagues. Nevertheless, each perspective also exhibits limitations. They tend to portray a scenario in which humans possess only limited power over technological forces, merely reacting to external influences that shape our existence. Furthermore, these perspectives often overlook the contingencies, ambiguities, and coincidences that have contributed to their formidable influence, subsequently shaping much of my own performance as a biosecurity practitioner. To some extent, I find value in retelling this narrative, yet from an alternative standpoint—one that renders what I consider common sense peculiar. This viewpoint posits that neither technology nor security are absolute facts, but rather narratives, discourses, and structures that underpin our understanding. The intention is not merely to present another perspective for its own sake, but to critically engage with existing views and, ideally, to contribute to a critique that can, at least to some degree, influence the world we collectively construct.

4.4 Methodology: Security Is What Discourses Make of It

Through engagement, we can gain insights into the social processes that co-construct technology and security within the DURC community. However, if we aim to investigate these processes, several questions arise: What are these processes? Where are they situated? How can they be analyzed? In the subsequent chapter, I will introduce discourse as the conceptual framework through which techno-security is constructed. I will also outline a methodology based on an ethnographic analysis of documents capable of capturing the process in question, followed by a detailed description of the methods I employ to enhance understanding of the phenomena occurring within DURC. I will commence with a brief recapitulation of the theoretical chapter, as it is essential to elucidate the rationale behind the forthcoming actions.

In the previous chapter, I referenced Berger and Luckmann to establish as my onto-epistemological starting point. Everything in social reality is a social construct, and we can navigate our reality through shared understandings of meaning. Our knowledge derives not solely from the objects themselves but from the social processes that shape our comprehension of these objects. Through this acquired knowledge, phenomena become intelligible and integrated into our social fabric. To facilitate discussion, we shall assign a name to the social process: Discourse. Discourse is a longstanding concept within the social sciences. Its definitions are numerous and varied; given that the number of social scientists is denoted by n, the number of definitions for discourse is at least n+2. Consequently, instead of delving into the nuanced historical development and myriad definitions of discourse, I will provide a broad overview of my understanding of the concept.

A broad overview is sufficient, as our focus is on DURC from a macro perspective rather than on detailed micro-level analyses of specific historical moments. Consequently, employing a relatively simple conceptualization of discourse and its constitutive elements is appropriate. The concept of discourse gained prominence primarily through the works of Michel Foucault (e.g., 1973), and it denotes a particular configuration of truth and power that shapes social reality. Nonetheless, these definitions do not render the concept more tangible. To attain a clearer understanding of what constitutes a discourse, it is useful to consider influences such as Stuart Hall and neo-Gramscian theory, which greatly inform my thinking. Consequently, I envisage discourse as a network of meaning

(Hall, 1997; Laclau et al., 2020). I comprehend discourse primarily as a networked framework wherein individual units of meaning are interconnected with other units, either challenging or reaffirming them. Through this mechanism, more extensive structures of meaning are maintained, and elements are linked to these structures. This network remains perpetually open to contestation and is never definitively fixed. Instead, meaning is always contested and, at best, precariously stabilized.

The "linguistic turn" in social science primarily concentrated on the role of language in constructing meaning and conceptualized discourse, predominantly as a language game. My (and most contemporary) discourse conceptualizations differ from this exclusive focus on language. While language remains significant in discourse-centric studies, this importance is primarily justified on pragmatic and methodological grounds, as written language is easy to observe and does not change when analyzed. However, a narrow definition of discourse, limited to methodological convenience, fails to encompass the complexity inherent in meaning-making processes. Security researcher Lene Hansen for example, has contended against an exclusive focus on linguistic devices and the inclusion of images within research (2011). Likewise, the "practice turn"[9] in social science emphasizes that individuals engage in actions rather than relying solely on linguistic devices, a position with which I concur. Drawing on Berger and Luckmann's framework, my understanding of discourse extends beyond mere language to encompass all meaningful facets of the social world. For instance, in professional contexts, the act of greeting someone with a handshake embodies the reproduction of its associated significance. Similarly, performing an action in a specific and meaningful manner serves to reproduce its validity. In essence, it is unnecessary to distinguish between linguistics, practice, words, or images, as all are integral to discourse insofar as they hold human significance. Moreover, these elements remain subject to contestation, resistance, and transformation (Asdal & Reinertsen, 2022, pp. 212–222).[10]

Consequently, I shall adhere to a discourse conceptualization as delineated by Jäger and Jäger. Translating their conceptual framework presents challenges, as they employ the German term "Fluss", which can denote either "flow" or "river". Let us commence with a concept that utilises the term "flow", whereby Jäger and Jäger define discourse as the "flow of knowledge through time and space" (2007, p. 15). Jäger and Jäger develop their conceptual framework of discourse based on the work of Michel Foucault. According to their perspective, similar to Berger and Luckman, reality is never directly perceived; rather, its meaning is continually interpreted. This does not imply that discourse is a secondary phenomenon. There is no separate "real reality" existing independently, with our interpretations merely overlaying what is actual. Instead, what we consider to be true and real is a direct consequence of discourse. In this context, the reality you, me, and everyone else is hold as real is discursively constructed; there exists no other reality outside of this framework (Jäger & Jäger, 2007, pp. 15–16).

In this context, reality is regarded as a social construct, and it is comprehensible solely through the knowledge we possess about it. Discourse functions as the vehicle for this knowledge. Furthermore, discourse not only transports knowledge but also serves as the forum where the definitions of proper knowledge are negotiated. This process is profoundly and inherently connected to societal power and its relations. The capacity to establish a statement as true coincides with the suppression of alternative forms of knowledge as false, and this process is influenced by power dynamics. Therefore, power influences an individual's ability to make statements that are deemed accurate, and "truth" possesses an intrinsic power (Jäger & Jäger, 2007, p. 18).

For clarity's sake, I wish to mention that establishing something as true is, in the majority of cases, an unintentional process. This situation does not resemble 1984, nor does it involve a group of individuals conspiring to determine what is true. While there may be instances where such deliberate actions

[9] For an overview of the practice turn, see, for example: Wille, 2018.

[10] There is also a reading of Foucault that argues that there is no meaningful difference between discourse and practice and I tend to agree.

occur, generally, these are unintentional and routine processes in which everyone engages daily. By performing actions "the right way", we reproduce and thereby reaffirm its status as the "right way". These effects of the discourse are not deterministic (Jäger & Jäger, 2007). Merely because a proposition is widely regarded as true does not necessarily imply that every individual perceives it as such, nor does it guarantee its permanence over time. Absent such change, the world would remain static. As evidenced during the Enlightenment period, where revolutionary thinkers contested religious dogma and the theocratic worldview was gradually replaced by scientific principles, it becomes evident that dominant discourses can be both resisted and altered.

Is there solely one discourse? This question possesses a greater degree of nuance than it initially appears. The answer is both affirmative and negative. It is negative because a specific group of individuals can maintain a discourse that differs from that of other groups. Nonetheless, these group-specific meanings are frequently considered irrelevant by political scientists. The way in which groups such as the model airplane club in Werningerode interpret the world is likely of limited interest to political scientists, as they typically lack the power—specifically in a political sense—to influence governmental decisions at the state level. Consequently, when I refer to discourse in this context, I imply a not entirely precisely defined concept of official or public discourse—something that exerts influence over all individuals connected to the pertinent field (in accordance with Berger and Luckmann’s ideas on everyday knowledge). Naturally, multiple discourses can compete over a particular topic, with numerous discourses overlapping within a single subject area. Conversely, there can be a single, relatively unchallenged discourse that structures a topic, rendering the meaning within this domain relatively uncontested (Jäger & Jäger, 2007, pp. 25–31).

Discourses may be transient, fading away after a brief period, or enduring, persisting through centuries. This leads us to the final point I wish to address—temporality and history. Discourses do not emerge ex nihilo; rather, they build upon antecedent discourses, whether by challenging previously accepted beliefs or by integrating new discursive elements, thereby altering the significance of concepts. For instance, the notion of democracy has evolved since the era of the ancient Greeks. My assertion is that these changes did not occur naturally through a process of evolution but are instead the outcome of social processes. We are able to trace these changes and examine the origins of our current understanding, the discursive strands it is founded upon, and the ones it rejects. Foucault refers to this as a genealogy, a history of the present. For me, this aligns with what Jäger and Jäger denote by "Fluss“, because, considering the history of a particular discourse, it allows us to envisage it as a curved river with tributaries and ancient, now obsolete riverbeds flooding when extraordinary circumstances arise.

Documents as Windows into the Discourse

In this project, I propose that we use documents to analyze the "official" DURC discourse. Considering insights from fields such as critical policy studies (Shore et al., 2011; Shore & Wright, 1997), and the practices surrounding (official) document-making, we see that documents are not something thrown together haphazardly. Instead, they constitute somewhat fixed moments of the discourse in question. Often, considerable discussion surrounds a document and its content. Consequently, a document offers an image of the current state of a discourse and its power structure. By outlining, for example, best practices—as is frequently done in DURC documents—we can understand the current knowledge and conventional wisdom of the document makers. Furthermore, we can comprehend the power structures within the discourse by asking why certain elements are absent. This reveals which knowledge is regarded as important and acceptable by the document creators, and which is not.

Asdal and Reinertsen (2022) use the term "document work" to describe the multitude of powerful practices that go into making a final document. This term is useful for my conceptualization of what documents are. They serve as glimpses into an otherwise free-flowing discourse, providing entry points from which we can work backward and forward by questioning why certain information was included in a document or how it gained significance within subsequent discourse.

Documents both reflect and provide structure to the DURC discourse. Documents serve not merely as representations of their creators' knowledge but also as performative entities, possessing the capacity to influence the surrounding environment. Crafted for specific purposes, they simultaneously act to shape the context in which they exist. These documents mirror particular aspects of the discourse existing at the time of their creation. Furthermore, other participants can, and in our case do, cite them. As stable reference points with some degree of authority, certain documents have the power to influence ongoing discourse. They are as integral to DURC as they are to any official discourse. The processes involved in their creation constitute a significant site for gaining insights into the perspectives and thought processes of the involved actors (Asdal & Reinertsen, 2022, p. 4).

Asdal and Reinertsen describe the documents as sites to study and analyze (2022). I will not extend my scope to include the entire process; rather, my research question pertains specifically to knowledge production, rather than the documents involved in this process. While I concur with Asdal and Reinertsen regarding the centrality of documents within such processes, I will utilize these documents as an entry point into the discourse concerning DURC, rather than as the primary object of investigation. In our context, documents exert an organizing influence on discourses. Employing the broad definition of discourse introduced earlier, discourse on a particular subject becomes difficult to delineate. The extensive volume of meaningful actions and interactions related to the topic, the geographically dispersed nature of the participants, and the predominantly informal character of most interactions make it exceedingly challenging to capture an entire discourse. Instead, it is possible to identify specific sites that allow access to observable elements. Here, documents are particularly useful. As previously discussed, documents are both representative and performative—they reflect their creators' perspectives and influence subsequent discourse. Moreover, they are readily accessible and remain unchanged when observed, rendering them ideal sites for studying the formation of DURC discourse.

Theoretical Sampling: Limiting the Field

Utilizing documents and their contextual environment enables us to obtain insights into a process that extends across multiple continents and spans approximately twenty-five years. Nonetheless, capturing the entirety of the discourse related to this matter proves impractical. Firstly, the constraints of time hinder the collection, sorting, and analysis of such extensive material; secondly, much of this material no longer exists. Spoken words and handwritten memos tend to have a limited lifespan, and obtaining a precise, word-for-word account of an informal conversation that occurred nearly twenty years prior is virtually impossible. However, we can leverage the reflective properties of documentation to identify which ideas were predominant within the discourse at a specific period. To achieve this, it is necessary to select a particular subset of documents, primarily those that are demonstrably reflective and performative—those containing knowledge that is widely accepted within the discourse. These documents may be performative due to the authority of their authors or because the knowledge they encompass aligns well with existing strands within the discourse. It should be noted that relating does not necessarily imply affirmation; such documents may either contradict or reaffirm existing knowledge, and they may expand or narrow the conceptual scope. The key criterion is that they relate to the knowledge. Documents that lack significant relation to existing knowledge are unlikely to be very performative and may, at worst, be incomprehensible. Therefore, performative documents are those that actively contribute to the discourse; they can only shape the discourse if they maintain relevance and connection to it.

Consequently, for this research project, I wish to focus on those documents most central to the discourse. I need to select from available documents, which brings us to two important concepts: Casing and case selection. Casing generally refers to a process all researchers undertake. They determine precisely what constitutes the case they wish to study. What is included in the case? What is excluded? What is the case about, and which theories are appropriate to explain the matter? All these questions significantly influence the outcomes of my research. In a sense, it is primarily the casing that brings the phenomenon I seek to explain to life. By using prior knowledge, the researcher includes what is deemed important in the case and excludes what is perceived as background noise. Through this process, a phenomenon that is often ambiguous in real life, with unclear boundaries and overlapping with other aspects, becomes a case suitable for analysis through social science research (Schwartz-Shea & Yanow, 2012).

I have elected to analyze DURC as a phenomenon characterized by the interplay between security and technology, deliberately excluding considerations such as ethics. Although one could interpret DURC as a case study concerning research ethics, I have chosen not to pursue this approach, as the co-production of security and technology appears to be more compelling and significant. Furthermore, I have decided to examine the social process from a constructivist perspective. While a materialist perspective—where biological experiments are endowed with a form of agency—was also a viable option, I have opted against this viewpoint. Consequently, this project primarily focuses on the construction of knowledge regarding DURC, rather than on the methods—mostly stemming from the natural sciences—that are employed to analyze the risks associated with experiments. Although alternative perspectives could have been equally valid, I have intentionally selected a different approach.

Let us proceed to examine in greater detail the components included in my analysis and those that are excluded. This introduces the second concept: Case Selection.[11]

Interpretative researchers select their cases based on the extent to which the analyzed documents provide explanatory power. Given the impracticality of conducting an in-depth analysis of every document ever written, I must select a subset of documents for detailed examination. This deliberate case selection raises important questions regarding the comprehensiveness and consistency of my explanations, as well as the transparency of my decision-making process for the reader. However, such a focus on interpretative analysis inherently limits the universality of my findings. Since my case selection was deliberate, there is a possibility that my results are only applicable to the particular case examined. This scenario represents the worst-case scenario. Conversely, in the best case, my findings possess significant implications that extend beyond the specific issue addressed, thereby contributing to theoretical development and broader knowledge within the subject area (Schwartz-Shea & Yanow, 2012, pp. 54–60; 91–114).

For this project, I have chosen what is called an *abductive* research design (Schwartz-Shea & Yanow, 2012, p. 26). Abduction, deduction, and induction pertain to the relationship between theory and empirical data. Typically, this relationship is unidirectional—either I seek to explain the empirical data using a theory (deduction) or to formulate a theory based on empirical observations (induction). An abductive research approach does not follow a singular direction; instead, it continuously oscillates between observed phenomena and theoretical frameworks. The abductive case design proves advantageous in this context because, thus far, there is limited established theory from which to develop comprehensive hypotheses, thereby rendering a purely deductive research approach ineffective. Nevertheless, multiple theoretical constructs provide explanatory power, obviating the need for an exclusively inductive methodology.

Based on theory and the research design, I employed what the Grounded Theory calls "theoretical sampling" (Glaser et al., 2008). Theoretical sampling constitutes a method in which researchers deliberately select materials based on their potential to contribute meaningfully to further analysis. This includes the consideration of materials that may challenge the researcher's assumptions, as neglecting such material would be deemed unethical. The process does not involve random or exhaustive selection; rather, it focuses on pertinent materials. Originally developed for theory

[11] I have chosen to distinguish between casing and case selection. As casing, I understand a meta-research process in which a phenomenon is defined as something. It becomes a case of X; thus, a rough outline is established from which a research project can be pursued. Under case selection, I understand a concept that focuses on methodological and methods questions like what material is selected for a cursory and what for an in-depth analysis. Which periods go into the study, and which do not?

formulation, this technique involves choosing the most promising materials, such as typical cases, to inform the development of theories. In this context, theoretical sampling is employed to substantiate theoretical assertions regarding the co-construction of security and technology (Glaser et al., 2008). Theoretical sampling involves selecting new material for analysis until saturation is achieved. Saturation indicates that new material no longer yields new insights, or at least none deemed significant enough for further investigation. In my particular case, saturation within the theoretical sampling process is reached with relative ease, as there is a general consensus regarding what DURC entails and its implications as a security concern. Consequently, a relatively small amount of material is required for my analysis.

Case Selection: Spaces and Times

My selection of cases was based on prior knowledge acquired through my expertise in the field during my Ph.D. studies, as well as consultations with colleagues who are specialists in biosecurity. The case selection aligns with my research question. Given that this is an interpretative research endeavor, the cases are not discrete, isolated entities. Instead, they exhibit overlaps and interconnections, akin to a river flowing through various regions. While it is possible to identify segments of the river, the activities within each segment are equally influenced by preceding segments and the surrounding environment. Nevertheless, segmenting a river into distinct sections with unique characteristics is logical, as otherwise, one would be left with an indistinct, overly vast river that is difficult to analyze. Consequently, to conduct a discourse-focused analysis of how the co-production of security and technology results in a particular configuration of biosecurity in Germany, we can separate the process into two distinct periods.

The initial emergence of DURC as a significant political concern in the United States occurred primarily around 2004 and the subsequent years. This period constitutes what I term the first phase of DURC. It transpired in the immediate aftermath of the events of 2001 and was profoundly influenced by them. This phase persisted for approximately two to four years. After roughly 2006 to 2008, there was a noticeable decline in interest regarding DURC. Therefore, the period of 2003 to 2004 marks the first recognition of DURC as a political issue. This timeframe was selected because it illustrates how DURC entered the political discourse and its subsequent legacy. Specifically, it raises questions about how it references prior discourses, which elements of earlier discourses are preserved within DURC, and which are not. In essence, this initial case provides a historical account of DURC and its emergence.

The second phase of this analysis encompasses the documents pertaining to DURC regulation in Germany. In 2012, there was a notable increase in attention directed toward DURC. Ron Fouchier's H5N1 experiment generated significant controversy within the biosecurity community. Given that this experiment was conducted in Amsterdam, the European biosecurity community also monitored it closely. Additionally, around 2012, an official discussion on DURC started in Germany. Although biosecurity professionals from Germany were engaged with DURC prior to 2012, from 2012 onward, biosecurity was officially a topic deliberated within parliamentary proceedings (Ausschuss für Bildung, Forschung und Technikfolgenabschätzung, 2012) and the state institutions. For the purpose of analysis, I have distinguished the discussions from the United States and Germany for two reasons: firstly, there exists a temporal gap between the two phases during which the topic has developed; secondly, the two phases are based on different local discourses, resulting in slightly varying arguments.

I have previously discussed the characteristics of documents as initial points of entry into a discourse. These properties may be utilized in this analysis. The initial DURC discussion, for instance, led to the development of the Fink Report and several other documents authored by the National Science Advisory Board for Biosecurity (National Research Council, 2004; NSABB, 2006, 2007). The German DURC discussion, on the other hand, is marked by the German Ethics Council report, the Leopoldina Report, and other documents that come as a by-product of parliamentary proceedings (Deutsche Forschungsgemeinschaft & Leopoldina, 2014; Deutscher Ethikrat, 2014; Max-Planck-Gesellschaft, 2010). We can use those documents to make our case selection. Doing so requires following Asdal and Reinertsen's point about document work (2022). Documents do not materialize spontaneously; they require deliberate effort. In the context of discourse analysis, this indicates that documents offer valuable and often authoritative contributions within the discourse. However, engaging with these documents requires examining the discursive formations that enabled their existence. In the approach we are utilizing, documents function as a baseline from which a more profound understanding of the surrounding discourse can be obtained by exploring how they were made possible.

US: Fink Report and the NSABB

We have already discussed the events of 2001. Jackson and Ramshaw's mousepox experiment caused a stir in the biosecurity community and can be seen as a catalyst for the following policy discussion (R. J. Jackson et al., 2001; Selgelid et al., 2010). In early April 2002, the United States National Research Council (NRC), established in 1916 and formalized through Executive Order 2859 as an advisory body in the fields of mathematics, physics, and biology, convened a meeting in Washington, DC. Members of the NRC's "Committee on Research Standards and Practices to Prevent the Destructive Application of Biotechnology" deliberated on their assigned task and authored a report addressing the management of dual-use concerns in the life sciences (National Research Council, 2004, p. 143). The process extended over five additional meetings spanning two years. In 2003, the eighteen committee members completed their tasks and produced the mandated report. "Biotechnology in the Age of Terrorism", also referred to as the "Fink Report" after the committee's chairman, can be regarded as the foundational document of DURC. Within this report, the committee delineates criteria for what they designate as "experiments of concern" and offers several recommendations regarding the management of such research. Accordingly, "Biotechnology in the Age of Terrorism" may be considered as establishing the groundwork for DURC from a political perspective. It consolidates and formalizes various discursive strands that are fundamental to the concept of DURC. Subsequent documents routinely cite the Fink Report.

The Fink Report articulated seven recommendations concerning the management of DURC, primarily emphasizing the establishment of a regulatory oversight mechanism for experiments identified as "concerning". To enhance awareness of dual-use issues within the life sciences community, educate researchers regarding potential oversight frameworks, and supervise the oversight process itself, the Fink Report proposed the creation of a permanent advisory board dedicated to security-related sciences. "Biotechnology in the Age of Terrorism" constitutes a significant and influential document, notably among the first to explicitly address DURC from a policy standpoint. Consequently, it is valuable to examine the origins of DURC, analyze the discursive elements it draws upon, and explore how it functions performatively in reinforcing the perception of life sciences as a security concern.

Following the recommendations of the Fink Reports, the establishment of the more permanent National Science Advisory Board for Biosecurity (NSABB) was announced in 2004, with its first meetings scheduled for 2005. The primary function of the NSABB, at least the one that is publicly acknowledged, is to publish reports and recommendations concerning the relationship between biotechnology and security. During regular meetings, NSABB members deliberate on specific aspects of dual-use biotechnology and optimal management strategies. The NSABB comprises 25 voting members who serve as subject-matter experts rather than representatives of their respective agencies and institutions. The NSABB operates under the auspices of the Institute of Health, and its director appoints the Designated Federal Officer, who serves as something akin to a general secretary or president of the NSABB, who calls meetings and approves agendas (Becerra, 2022).[12]

The NSABB is an important institution within the biosecurity community. Their reports are extensively read and cited by most researchers, and numerous prominent biosecurity experts have been involved

[12] For those of you interested, the NSABB is: *"Authorized by 42 U.S.C. 217a, section 222 of the Public Health Service (PHS) Act, as amended, and the Pandemic and All-Hazards and Preparedness Act, Pub. L. No. 109-417, section 205, 120 Stat. 2851 (2006) (PAHPA), codified at 42 U.S.C. 262a note. The National Science Advisory Board for Biosecurity (NSABB or Committee) is governed by the provisions of the Federal Advisory Committee Act, as amended (5 U.S.C. App. 2)."*

with or have worked in association with the NSABB. For this study, I selected two of the initial reports published by the NSABB. The *NSABB Draft Guidance Documents* (NSABB, 2006) from July 2006 and the June 2007 report entitled *Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential Misuse of Research Information* (NSABB, 2007). The two reports are very similar (up to a degree where they are identical in words) as the latter is the official version of the first report, so we can treat them essential as one paper, with *Proposed Framework for the Oversight of Dual Use Life Sciences Research* expanding on many things that where only briefly discussed in the *NSABB Draft Guidance Documents*.

The NSABB Draft Guidance Documents represent the inaugural publication issued by the NSABB; however, they are no longer accessible on the official NSABB website. This document delineates several conceptual frameworks for a proposed oversight system concerning DURC research, with particular emphasis on the criteria for identifying DURC, the protocols for communicating research findings originating from DURC experiments, and the outline of a Code of Conduct for life scientists. Originally disseminated to solicit feedback from the professional life science community and to serve as a foundational reference for discussions within the research community (NSABB, 2006). Complementary to the first report, *Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential Misuse of Research Information*, predominantly serves as a follow-up to its predecessor. It elaborates upon and clarifies several of the points already made in the previous report. The NSABB indicates that its primary purpose was not to establish an oversight framework in itself but rather to function as a "springboard" for the United States government to collaboratively develop an official oversight system alongside the life science community (NSABB, 2007).

Their reports are authoritative and serve as a frequently cited reference within the biosecurity community. For instance, the term "Dual Use Research of Concern" was initially introduced by the NSABB (where the Fink Report used the term "Experiments of Concern"), and it is now predominantly employed to refer to the entire subject matter. These reports are referenced in numerous journal articles and opinion pieces authored by life scientists during this period and subsequent to it (e.g., Holtcamp, 2012; G. L. Smith & Davison, 2010; Tucker, 2012), as well as in the German debate (Deutsche Forschungsgemeinschaft & Leopoldina, 2014; Deutscher Ethikrat, 2014).

Due to their similarity, I consider the two NSABB reports herein as a single entity. Consequently, the term "NSABB reports" that I shall employ throughout refers to both the *NSABB Draft Guidance Documents* and the *Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential Misuse of Research Information*. In their fundamental aspects, the two reports are virtually identical, with numerous phrases being identical in wording; therefore, treating them as one report to slightly augment the volume of material available for coding appears justified.

Germany: MPG, DFG/Leopoldina and the Ethics Council

To understand the German response to DURC, it is essential to analyze the nation's reaction during the second phase of DURC, which commenced around 2012. During that year, renewed interest was sparked by another controversial experiment: Ron Fouchier and Yoshihiro Kawaoka`s gain-of-function study involving H5N1. The renewed interest in DURC has prompted a discussion within the German parliament, with several prominent institutions such as the German Ethics Council and the Leopoldina, the German Academy of Sciences, generating reports on the subject. Analyzing this period and context provides valuable insights into the management of DURC in Germany and how it evolved when the concept was transferred from the United States to Germany. Consequently, the second segment of my sample comprises documents from what I have designated as the German debate.

The German debate involves three key documents. The first is *Scientific Freedom and Scientific Responsibility Recommendations for Handling Security-Relevant Research*, published in 2014 jointly by the DFG and Leopoldina. Both organizations are major players in the German research landscape. The

German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) is one of the main funding bodies for various types of research. According to the DFG itself, it has a budget of roughly 4 billion (4.000.000.000) euros, primarily funded by federal and state governments, and mainly supporting foundational research (Deutsche Forschungsgemeinschaft, 2023). The second organization mentioned in the joint statement is the German National Academy of Sciences Leopoldina, representing approximately 1600 scientists. The Leopoldina regularly provides statements and expert opinions on discussions concerning the relationship between science and society. Both organizations are central entities within Germany's research landscape; consequently, the document titled *Scientific Freedom and Scientific Responsibility* carries a significant discursive authority. This document essentially serves as an updated iteration of the 2010 *Guidelines and Rules of the Max Planck Society on a Responsible Approach to Freedom of Research and Research Risks*. The Max Planck Society (MPG), in turn, is Germany's largest research organization, conducting research across various fields, including the life sciences. Similar to the NSABB documents, the subsequent DFG/Leopoldina report quotes the Max Planck Society's guidelines nearly verbatim in large sections of its content. Accordingly, I have elected to include both documents and consider them as one position, which is discourse. Minor differences exist between the documents, primarily regarding the introduction of new oversight boards; however, the principal points of interest for this project are markedly similar.

The third significant document concerning the German debate was authored by the German Ethics Council (Ethikrat). The Ethics Council serves as a high-level advisory body to the German Parliament. Comprising 26 members drawn from diverse fields, it was established in the early 2000s. In response to the rapidly advancing technological developments, particularly in medicine and the life sciences, the establishment of an advisory council was deemed necessary. Concurrently, the Ethics Council aims to enhance transparency within the policy advisory process. Accordingly, the Ethics Council publishes its recommendations and conducts open meetings that allow public participation (Fischer & Bauer, 2022).

In 2012, the Ethics Council was assigned the responsibility by members of the federal government, specifically the Minister of Education Anette Schavan and the Minister of Justice Bahr, to deliberate on the issue of DURC research (Schavan & Bahr, 2012). Following its two-year deliberations, the Ethics Council published its findings in a comprehensive approximately 200-page opinion. Unlike the reports by MPG/DFG/Leopoldina, the Ethics Council's document is more detailed. Moreover, the Ethics Council entertains the possibility of enacting new legislation to regulate DURC experiments, whereas the MPG/DFG/Leopoldina reports explicitly oppose this measure. Consequently, the MPG/DFG/Leopoldina reports and the Ethics Council's report are sometimes viewed as presenting contrasting approaches to the regulation of DURC.

The Ethics Council report was published approximately three weeks prior to the DFG/Leopoldina report. Entitled *Biosecurity – Freedom and Responsibility of Research*, it encapsulates the findings of the Ethics Council's deliberations on the subject. Structurally, the Ethics Council report bears resemblance to the Fink Report. Spanning nearly 300 pages, it significantly exceeds the length of the 18-page DFG/Leopoldina report. Its approach is notably more deliberative, as it examines the history of biological weapons and dual-use biotechnology, while also reviewing selected reports and guidelines pertinent to DURC oversight. Moreover, it diverges considerably from the DFG/Leopoldina and NSABB reports, as it is not primarily a report delineating an oversight system, but rather an Ethics Council document intended to provide policymakers with ethical and moral guidelines on specific issues. Consequently, the report predominantly addresses the moral justification of an oversight system and explores the ethical features such a system should possess.

The report by the Ethics Council is particularly noteworthy within this analysis as it offers a contrasting document. The Ethics Council represents an outlier in this selection for two primary reasons. Firstly, it provides significantly more detail than the NSABB or the MPG/DFG/Leopoldina reports. Similar to the Fink Report, the Ethics Council dedicates considerable space to delineating its reasoning. Secondly, in several notable instances, the Ethics Council draws upon different elements and configurations. Consequently, the Ethics Council offers a perspective akin to "a road not taken". Ultimately, the conceptualization of life sciences, DURC, and the policy recommendations proposed by the Ethics Council did not attain hegemonic status. This outcome aligns with expectations, as the Ethics Council incorporates elements that are generally not employed within the hegemonic discourse on DURC.

Sample

The documents discussed above are authoritative within their respective jurisdictions. The Fink Report and the NSABB documents serve as foundational texts. The German discourse has significantly fewer associated documents. Although the MPG and the DFG/Leopoldina reports have been revised in recent years, these revisions have not entailed substantial modifications. The selected documents for this sample embody the temporal and spatial specificities of the debate, indicating that DURC has evolved over time and is discussed with slight variations across different regions.

The selected documents also contain sufficient material to achieve saturation. Most other documents refer to the selected ones and only address minor points or discuss specific issues highlighted within the documents. For instance, in the discussion concerning the United States, we find several additional documents that elaborate on the methodology of conducting risk analyses. However, these do not deviate from the use of risk as an epistemological instrument for establishing security (e.g., Tucker, 2012). Likewise, we find additional documents in the German debate, such as in-house guidelines for research institutions (e.g., Robert-Koch Institut, 2013) and conference reports (Interacademy Parterschip, 2017) that discuss over-the-horizon threats but do not change the fundamental understanding of DURC. Thus, the selected documents will provide enough material to answer the research question.

Document	Year	Pages	Coded Segments
National Research Council. (2004). Biotechnology Research in an Age of Terrorism.	2004	147	174
NSABB. (2006). NSABB Draft Guidance Documents.	2006	24	44
NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential Misuse of Research Information.	2007	59	249
Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	2010	12	89
Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung.	2014	18	253
Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	2014	299	133

4.5 Methods and Operationalization

In the final section of this chapter, I wish to discuss the methods used for my analysis and how my research strategy informs those methods and their operationalization. I also intend to address the specific sample that was subjected to analysis. The insights derived from engaging with the biosecurity community inform the content analysis and connect it to the field-specific discourse of the biosecurity community, thereby rendering the content analysis a means through which the non-local discourse of DURC can be observed.

Content Analysis

Generally speaking, content analysis is a method used to examine the content of material consisting of language. Typically, it is applied to written materials, although spoken language or other forms of language are also possible. There are two types of content analysis, with some overlap: quantitative and qualitative. Quantitative analysis involves the use of word frequencies and can handle large volumes of material if a computer assists the researcher. Qualitative is the variety we are working with here. While most qualitative content analysis incorporates the frequency of words or codes to some extent, its primary concern is with the material not based on the frequency of words and phrases. In this context, qualitative content analysis is a method for understanding the significance of a text (Schreier, 2014).

There are many varieties of qualitative content analysis (QCA). German social science has developed numerous variants, with Mayring's methods probably being the best known (2022). Other authors, among them Udo Kuckartz (e.g., Kuckartz & Rädiker, 2022) or Glaser and Strauss (2008), developed specific methodological approaches centered around QCA as well. For this project, I will follow a relatively pragmatic, synthesized approach laid out by Schreier, who conceptualizes QCA as a toolbox.

QCA analyzes texts in a structured manner. Structured here means the analysis is systematic, rule-based, valid and reliable (Schreier, 2014). The initial two characteristics, namely being systematic and rule-based, primarily pertain to the process within a QCA and refer to the core element of every QCA- its category system. To interpret the material, the researcher constructs categories and allocates the relevant and meaningful statements within the material to these categories. Categories may either be formulated deductively, indicating they are derived from existing theory, or inductively, meaning they emerge from the material itself. The abductive research orientation previously introduced represents a third approach, involving a continuous interplay between the material and theoretical frameworks. Category systems can be as comprehensive or as detailed as necessary for the specific research; however, they must also be valid, signifying their suitability for the data under examination. Practically, this entails that a minimum of some categories within the coding system should be developed inductively, directly originating from the material rather than from abstract theoretical constructs (Schreier, 2014).

The category system must be subjectively comprehensible, indicating that an individual who is not the researcher should be able to understand the rationale behind categorizing a statement in a particular manner rather than another. Inter-subjective reliability necessitates that the process of assigning codes to statements is rule-based, supported by explicit guidelines delineating the scope of each code. Only through such clear guidelines can other researchers accurately interpret which statements correspond to which codes. Attaining genuine intersubjective reliability is notably challenging and generally requires multiple coders to evaluate the category system through extensive testing. Typically, the category system undergoes numerous iterations before reaching full reliability. Consequently, smaller-scale research projects, such as this one, must accept the inherent limitations of their coding system's reliability. Rather than striving for complete reliability, this research emphasizes transparency. The category system should be designed to be as transparent as possible, enabling other researchers to comprehend and critique it without necessitating a level of reliability where numerous coders assign identical codes to the same statements. This inevitably shifts the focus away from inter-subjectivity toward individual researcher judgment, a compromise deemed acceptable within this context (Schreier, 2014).

Schreier describes the coding scheme as the main tool through which we reduce and interpret the material at hand (Schreier, 2012, p. 58). Through a QCA, we are able to distill the material to what is pertinent to our analysis and to a manageable amount suitable for subsequent examination. Additionally, we can identify similarities and differences within the material that pertain to various (or identical) discursive strands.

Sensitizing Concepts: Limiting the Material

The primary challenge associated with qualitative research pertains to the enormous volume of material that researchers are required to manage. Several documents incorporated into this analysis exceed 100 pages in length. Even if data saturation is achieved relatively early in this project, multiple documents must nonetheless be examined to ensure a comprehensive sample. This results in a rather unwieldy collection of material, many of which is irrelevant to the research question. For instance, numerous document-sections review other sources and include a "state-of-the-art" overview at the beginning of their discussion. However, this review of existing literature is only partially pertinent to the focus of my analysis. My primary interest lies in understanding how actors, through the use of statements, "make DURC" within their documents.

The volume of information within this sample must be filtered and reduced through the coding scheme. Coding schemes are complex to develop as they must be valid and provide a strong foundation for our analysis. This means that building a useful coding scheme is a reflexive process refined through many iterations. Starting with a relatively broad coding scheme that limits the amount of material that goes into the analysis, it is consecutively refined into categories that can capture the nuances of the material. Likewise, several documents also include sections about biosafety, the physical security of research material, the background of the documents as in what is the scope of the documents or the working group that wrote them, and detailed explanations of what an oversight system would look like. Those sections were excluded from the coding as they are not relevant to the research question we are looking at.

My previous exposure to the field assists me in assessing which passages are pertinent and relate to various sections of the discourse. It offers a set of "sensitizing concepts", providing a general understanding of what is relevant and what is not. Unlike specific concepts that are clearly delineated, sensitizing concepts are abstract, preliminary, and tailored to the field. They encompass the researcher's prior knowledge and research interests, serving as a broad guideline (Blumer, 1954, pp. 7–8; for an overview in the context of theory generation, see also: Bowen, 2006, pp. 13–15). Engaging in the biosecurity field and acquiring an understanding of its operational mechanisms provided me with a certain perspective on how concepts interconnect, the historical evolution of these concepts, and their relevance within specific contexts.

In the context of the example provided above, for instance, the arguments presented by the actors themselves are systematically coded and examined in detail. The reviews of existing material were coded in a broad manner and incorporated into the analysis only where deemed appropriate to illustrate the progression of the DURC discourse. This approach largely excludes, for example, detailed legal discussions concerning export control laws and legal requirements for laboratory security, as well as comprehensive histories of pathogen usage as weapons, given that such specifics are not pertinent to the overarching research question. Consequently, we are left with document passages relevant to the project, primarily those in which the document authors develop and articulate their arguments. This encompasses their recommendations and, most critically, the justifications provided for them. These justifications often contain the core narratives underpinning biosecurity. Due to the particular nature of the material, especially the common-sense style of argumentation,

4.6 Phase 1: Initial Coding

The initial stage of coding was conducted using an abductive approach. During the initial iteration of coding, relevant segments were assigned codes based on the content of the passages. This involved abstracting and summarizing the content. For instance, passages describing the rapid advancement of life sciences in the past year were assigned the code "Fast Progress".

Beginning the summarization of material via codes diverges from Schreier's methodology. Schreier adopts a deductive approach, initially constructing a "coding frame" based on the research interest and theoretical framework. This coding frame includes the "main categories" or "dimensions".[13] These dimensions serve as axes along which the researcher navigates through the material, identifying pertinent passages for coding accordingly (Schreier, 2012, pp. 58–62). The rationale for deviating from Schreier's methodology concerning QCA is twofold. Firstly, my pre-existing familiarity with the subject matter and its associated discourse. Through my engagement with biosecurity, I possess substantial prior knowledge of the field. This expertise is employed to pinpoint pertinent sections within the documents. Consequently, constructing a coding frame is not inherently essential, as I approach the material with prior understanding of its content and relevance to this project.

The second reason for deviating from Schreier's process is related to the specific characteristics of the material. The pertinent passages are highly dense and primarily comprise a very technical discussion of particular aspects of DURC. At first glance, the material does not necessarily resemble the theoretical discourse, which was discussed when I expressed my dissatisfaction with the lack of conflict within the material. These properties of the material, as well as the field in general, necessitate a shift from Schreier's deductive approach towards an abductive methodology that oscillates between prior knowledge, theory, and the material itself. Nevertheless, it is important to emphasize that this constitutes a minor alteration in the sequence of steps within the QCA process, rather than a fundamental deviation from the overarching methodology.

Following the initial phase of coding, we are left with several individual, grounded codes. Presently, these codes are organized on a site-by-site basis without a specific hierarchy. Moreover, they frequently encode the same meaning. Since the codes are grounded and developed directly within the material, subtle semantic differences may result in distinct codes, even if they convey the same argument. Therefore, at this stage of the process, the codes are not mutually exclusive, and the final step in Phase 1 involves aggregating codes that pertain to the same meaning. This consolidation results in codes that encompass a greater number of passages related to the same issue and also reduces the total number of codes as they are combined. Upon completing Phase 1, most relevant passages have been coded, and subsequent work primarily involved refining the coding scheme.

4.7 Phase 2: Category-Driven Dimensions and the Coding Frames

In Phase 2, the aggregated codes from Phase 1 were systematically organized into a comprehensive coding framework. This framework introduces various dimensions and conceptual categories, established through an abductive process that integrates the material with theoretical constructs. These dimensions serve to operationalize the relationships between different aspects of the theory and the material under study. Additionally, they provide a pragmatic function by organizing the coding scheme, grouping similar codes accordingly. Typically, coding frameworks may exhibit varying degrees of complexity, often combining multiple dimensions and hierarchical levels of hierarchy as well (Schreier, 2012, p. 63). For instance, the code "public health" encompasses two sub-codes that delineate the various threats to public health. One is for threats from naturally occurring diseases such as HIV/AIDS, while the other addresses threats resulting from the deliberate release of pathogens. Both sub-codes pertain to a specific concept of public health; however, they are associated with distinct strains within the discourse. Conversely, the code "public health" is categorized within the "Beneficial Biotechnology" dimension, as it includes a passage asserting that life science research can enhance public health. Other codes are grouped within different dimensions.

The coding scheme I employ here consists of four distinct categories. Three of these are relatively straightforward, each comprising two levels of depth. Codes and sub-codes within these categories capture specific details of the coding process. The fourth dimension, "Responses“, is somewhat more complex, as it includes additional levels of depth and conceptual categories beyond grounded codes. All dimensions pertain to different aspects of the theory; consequently, they serve as the central framework through which the theory is operationalized. In the subsequent section, I will elaborate on

[13] I will use the term dimensions throughout this project.

the main dimensions in greater detail, while a comprehensive list of all codes and their descriptions can be found in the Annex.

Dimension 1: Threatening Biotechnology

The first dimension encompasses codes associated with the formulation of threats. In the chapter on theory, it has been demonstrated that security concerns do not inherently occur, but something becomes a security threat through a social process. These processes are evidenced in the material. By aggregating codes that represent threat-making instances within the material, it becomes possible to trace these processes, observe their evolution over time, and discern subtleties related to various aspects of biosecurity discourse. Accordingly, "Threatening Biotechnology" constitutes a significant category that operationalizes threat construction. This category is derived abductively through an iterative process that involves revisiting the material and the threat construction instances identified in Phase 1, alongside the theoretical frameworks that elucidate these processes.

"Threatening Biotechnology" constitutes a relatively straightforward dimension, comprising two abstract categories that organize nine grounded codes. The included codes within "Threatening Biotechnology" illuminate aspects concerning the construction of insecurity emerging from the material. This dimension delineates the discursive formation of the threat contained within the data, thereby linking critical security studies to empirical evidence. It is evident that "Threatening Biotechnology" is not an overly complex dimension. Throughout the analysis, it is apparent that much of the "insecurity-making" within the DURC discourse occurs within other segments of the material, particularly those that formulate responses to the security concerns.

Dimension 2: Beneficial Biotechnology

The second dimension in the coding framework is designated as "Beneficial Biotechnology", which encompasses codes that capture segments describing the advantages of biotechnology and its associated potential. This classification was derived from the material, meaning that in Phase 1, significant portions pertaining to the benefits of biotechnology and life sciences research were identified. Upon further reflection, this outcome is expected. As discussed in the theoretical framework, technology is inherently ambiguous. Therefore, it is not surprising that technology can be regarded as both dangerous and beneficial. The identification of passages related to beneficial biotechnology directly reflects the inherent ambiguity of technology (Grint & Woolgar, 1992). It also relates to a circulation-centric concept of security. If security is about controlling the circulation of people and goods (Huysmans, 2014), there must be some benefits to the circulation. Otherwise, we would expect to see a mode of security that relies on the exceptional, outright banning the circulation of something and not trying to regulate it.

On a formal level, the dimension "Beneficial Biotechnology" is relatively straightforward. It encompasses eight codes, one of which extends into two levels. The codes primarily pertain to the benefits of biotechnology across various sectors of society. The benefits represented by these codes exhibit differing levels of abstraction. Nonetheless, the codes within this dimension are notably abundant in the material. "Beneficial Biotechnology" operationalizes ambiguity as a theoretical construct, in conjunction with the first dimension, "Threatening Biotechnology". Through the analysis of both dimensions, the normative ambiguity inherent in the life sciences becomes evident within the material. Incorporating technological ambiguity into the coding framework is essential, as throughout the analysis, it will be observed that technological ambiguity plays a central role in the regulation of DURC experiments.

Dimension 3: The Making of Life Science

The third dimension incorporated within the coding framework is "Life Science". This dimension consolidates codes encompassing passages that delineate the manner in which life sciences are conducted. These codes pertain to the social framework within which scientific activities occur and the processes through which they are carried out. It is a reasonably simple dimension, containing three codes and only going down one level. The code was developed through abductive reasoning, becoming incorporated into the coding scheme both by its presence in the material and through expectations derived from the theory. Science does not occur in isolation. Based on theoretical considerations, I anticipated identifying sections that address the questions regarding the methodology of conducting experiments and the conditions under which they are performed. Concurrently, the material includes several segments pertaining to the practice of science. From an analytical perspective, this dimension holds significance as it pertains to the construction of security within the material. Insecurity and the processes of security-making are profoundly interconnected with broader societal structures. When science becomes a focus of security frameworks, the larger societal structures in which scientific activity takes place become significant factors influencing how science and technology are framed as objects of security.

Dimension 4: Responses

The final dimension incorporated in this project is titled "Responses", encompassing all codes associated with the management of DURC and the policy responses to the challenges posed by advanced dual-use biotechnology. In alignment with the constructivist approach to security articulated earlier, security responses are not a direct consequence of the threat; rather, they are the products of social processes. Consequently, dimension 4 encapsulates the outcomes of these processes. The principle of unilateral dimension stipulates that two dimensions should not pertain to the same conceptual structures. As a result, dimension 4 is comparatively extensive and intricate, encompassing several diverse abstract codes along with numerous grounded codes. All these codes pertain to security measures to be implemented in response to DURC; however, they address different facets of these measures. These codes relate to the same substantive material, thereby reducing redundancy and facilitating analysis. Within this dimension, segments are captured that discuss specific issues, regardless of whether or not they present arguments in favor of them.

The first category of codes pertains to evaluating hazards and the essential attributes required for such assessments concerning DURC. In the majority of discussions regarding the appropriate procedures for securing DURC, hazard assessment is considered a preliminary step. This hazard is typically balanced against the advantages of performing DURC experiments. Consequently, this first category encompasses all codes associated with this evaluative process.

The second category within this dimension addresses the measures implemented to secure hazardous biotechnology. In contrast to the initial formation, which primarily focused on identifying dangers, this formation pertains to the security instruments utilized in relation to DURC. It comprises six codes that discuss the various tools available to enhance security. These codes encompass both tangible recommendations and more conceptual discussions regarding security policies applied to DURC.

The third category, Formal Regulation, encompasses codes associated with more formal oversight measures. Within this classification, we observe codes that address oversight measures of varying degrees of formality concerning DURC experiments. This includes informal self-governance as an oversight approach, up to proposals for the enactment of DURC-specific legislation. Formal Regulation integrates those components that pertain to the mode of oversight rather than specific security protocols, thereby primarily concerning questions of authority in security governance rather than its substantive content.

The fourth category encompasses codes pertaining to the responsibilities assigned within the material. This includes the obligations towards various actors, such as scientists, institutions, and others, as designated by the material. Unlike the previous sections, which delineated modes and measures of security implementation, this category is primarily focused on the rationale underlying those measures. The central inquiry here is: Why must the threat be addressed? Consequently, numerous codes relating to ethical responsibilities are incorporated within this category.

The final category within this dimension pertains to the actors. It encapsulates codes that specify who is responsible for executing certain actions. To whom do the responsibilities outlined prior relate? Accordingly, there exists a significant overlap with the preceding category, and frequently, identical material is documented with codes from both categories. Nevertheless, it approaches the material from two distinct perspectives: the codes in this category assign responsibilities to specific actors, rather than indicating what is ascribed to them.

4.8 Conclusion: Approaching the DURC Discourse

Throughout this chapter, I have outlined my primary approach for this project. Concentrating on the knowledge and practices pertinent to rendering DURC a security concern within Germany requires a research approach that captures the development of knowledge regarding DURC. Due to the specificities of DURC, notably the extent of prior knowledge necessary to evaluate the discourse, I have contended that engaging with the DURC community constitutes a valuable strategy for acquiring pertinent insights. Furthermore, it provides a distinctive opportunity to formulate a nuanced critique of the current state and thereby introduce a novel perspective on the intersection of technology and security. Throughout this chapter, I have conceptualized discourse as the fundamental site of meaning-making. Consequently, engaging with the community necessarily entails engaging with the specific discourse predominant within that community and the knowledge conveyed through it.

Through the utilization of documents, we acquire material that offers several advantages, as it is relatively stable, reflects the underlying knowledge, and is performative in structuring the discourse. The selection of two sets of documents, one from the United States and the other from Germany, enables us to observe changes within the DURC concept over time. Simultaneously, this approach allows us to account for local particularities in the discourse that may differ elsewhere. By adopting this methodology, we can analyze the development of a hegemonic discourse within DURC, identifying which aspects are transferred from one locale to another across different time periods.

Once again, the specific characteristics of the material, its intuitive style of argumentation, and its density present significant challenges for analysis. Codifying frameworks that are overly detailed risk generating an unmanageable number of codes without providing substantial insight. Conversely, schemes lacking sufficient nuance may fail to identify intuitive positions that appear natural within the material, thereby overlooking crucial aspects of the discourse that contribute to the construction of technology and security. Employing an abductive approach to qualitative content analysis enables continuous oscillation between theory, prior knowledge, and the material. Consequently, this approach affords the flexibility to discern the relevant meaning structures within the material while maintaining a manageable scope.

Integrating existing knowledge regarding the broader discourse context of the selected documents with the structured analysis provided by QCA allows us to trace the development of pertinent meanings. Accordingly, the purpose of the subsequent study is to utilize these documents as exemplifications of the knowledge inherent within the wider DURC discourse. Such an approach enables us to expose the contingent aspects of DURC as a security concern and to offer a critique that introduces an alternative perspective, thereby rendering seemingly natural developments as subject to scrutiny.

5 The Fink Report: The Beginning of DURC

The initial document I wish to examine in greater detail here is *Biotechnology Research in an Age of Terrorism*, also known as the Fink Report (National Research Council, 2004). The Fink report is among the earliest official documents concerning DURC. Concurrently, it holds considerable influence, with subsequent documents frequently citing it. It serves as a foundational reference for both the United States and German debates, aiding our understanding of how DURC emerged as a policy issue.

At the outset of this dissertation, it has been established how the Fink Report references a specific historical background of DURC. The Fink Report situates DURC predominantly within the historical frameworks of military strategy, such as the Cold War, proliferation control, and the broader shift towards terrorism as a principal security concern at the conclusion of the Cold War. Consequently, *Biotechnology Research in the Age of Terrorism* cites several preceding documents in this domain and devotes substantial attention to delineating a history of DURC that closely aligns with the synthesis presented in the initial chapters of this thesis. In this account, the Cold War-era logic of proliferation control and its efficacy within a security environment centered on terrorism are examined in detail. Throughout this analysis, we will observe how the Fink Report articulates a specific historical context for DURC that diverges from subsequent documents. This particular historical narrative of DURC engenders a certain tension within the report, as it simultaneously portrays DURC as something good and something bad.

The primary point I wish to articulate in this chapter pertains to the construction of DURC as both a security concern and a solution to these security issues concurrently. Consequently, the Fink Report presents an almost circular framework of techno-fix and techno-fear. As will be demonstrated, the report conceptualizes DURC as a source of insecurity as well as a remedy for the dangers associated with dual-use biotechnologies. Advanced biotechnology is not merely a cause of concern but also possesses the potential to "resolve" these concerns. Within this framework, biotechnology—particularly DURC—addresses security issues and is regarded as essential for achieving a more secure future. The Fink Report serves as an ideal site to observe the concurrent occurrence of techno-fix and techno-fear within the DURC discourse. This tension has engendered significant debate concerning DURC, constraining policy options and reallocating responsibility and authority from the state to scientists.

5.1 The Dispersion of Dual-Use Biotechnology

"Biotechnology represents a 'dual use' dilemma in which the same technologies can be used legitimately for human betterment and misused for bioterrorism." (National Research Council, 2004, p. 1, C1)

I commence this chapter by scrutinizing the construct of insecurity as articulated in *Biotechnology Research in the Age of Terrorism*. The insecurity frameworks delineated in the Fink Report are comparatively straightforward. Biotechnology is attributed an inherent, comprehensive dual-use potential. According to the Fink Report, all life-science research and biotechnology possess the capacity for malicious exploitation, at least to some extent. Within this framework, the primary concern of the Fink Report pertains to the production and dissemination of biological weapons via advanced biotechnological techniques, identified as the principal insecurity requiring mitigation (National Research Council, 2004, p. 1, C1).

The report addresses the security concerns associated with biotechnology, primarily focusing on the global dissemination of biotechnological equipment and expertise. In doing so, the Fink Report reiterates the fundamental dual-use dilemma inherent in biotechnology, whereby nearly all experiments possess dual-use potential to varying extents (National Research Council, 2004, p. vii, C2). According to the Fink Reports, biotechnology constitutes a fundamental dual-use problem that cannot be easily resolved (e.g., National Research Council, 2004, p. viii, C3, p. 25, C4). Regarding biotechnology and life sciences research, the authors of the report contend that there exists no functional differentiation between permitted and prohibited experiments. Consequently, all research in life sciences could be exploited to create and develop novel biological warfare agents (National Research Council, 2004, p. 19, C5). Here, the Fink Report draws a comparison to nuclear science during the 1930s. However, the report contends that, unlike nuclear research, it is impossible to establish a definitive a priori distinction between research that is dangerous and research that is not (National Research Council, 2004, p. 23, C6).

According to the authors of the Fink Report, the global dissemination of biotechnology constitutes the principal source of insecurity. The report asserts that this proliferation facilitates greater access, thereby amplifying the risk that the dual-use potential of biotechnology may be exploited by malevolent actors. Furthermore, biotechnological research is no longer confined to wealthy G8 nations such as the United States, the United Kingdom, Germany, Israel, or Japan; it has become widespread across the globe, with numerous sources of material and equipment now accessible (National Research Council, 2004, p. 17, C7). This, in conjunction with the increasing digitalization of research, renders the equipment and expertise necessary for the development of biological weapons accessible to nearly every actor who seeks to do so (National Research Council, 2004, p. 23). Here, the Fink Report argues that, due to its global dispersion, conventional security measures based on export controls are no longer effective. Given its widespread distribution, the future proliferation of equipment and knowledge to both state and non-state actors is regarded as "inevitable" (National Research Council, 2004, p. 31, C9).

Referring to a speech delivered by the then-President of the United States, Mr. Bush, the Fink Report asserts that "states, groups, and individuals" are actively seeking the capability to develop biological weapons. Considering the proliferation of biotechnology, the authors contend that the resources and methods for constructing biological weapons are broadly accessible (National Research Council, 2004, p. 16, C12). Although the development of advanced bioweapons remains associated with technical challenges, initiating a weapons program does no longer necessitate a substantial investment of resources. Thus, according to the Fink Report, the capability to cause harm and disruption is "[…] within the capability of many laboratories" (National Research Council, 2004, p. 84, C11). Here, progress in the life sciences has led to a global distribution of know-how and material. Given the inherent dual-use potential of life sciences, the increased number of possible hostile actors is the primary source of insecurity for the Fink Report (National Research Council, 2004, p. 2, C10).

Analysis

The discourse on insecurity presented in the Fink Report appears to be somewhat superficial and straightforward. It includes assertions regarding the intrinsic dual-use potential of biotechnology, the global dissemination of materials, knowledge, and equipment necessary for the development of bioweapons, as well as claims concerning malicious actors interested in acquiring such knowledge and materials. While these assertions are made without further elaboration, they are grounded in longstanding, common-sense perspectives held within segments of the biosecurity community. The notion that the threat is inherent to biotechnology due to its dual-use nature, immateriality, and global dissemination is a widely accepted premise within this community. Here, we observe a "[...] deterministic belief that possession of technologies will lead to the realization of the misuse potential" (McLeish, 2007, p. 194). According to this reasoning, when a technology disseminates and becomes available to new participants, it is inevitable that one of these individuals may emerge as a "malicious actor", exploiting the technology for "nefarious" purposes.

Throughout the reports, advanced biotechnology is attributed this inherent dual-use potential. The prevailing view that all life science possesses dual-use capabilities to some extent is a recurring theme in nearly every DURC discussion. Virtually all knowledge concerning methods to contain disease transmission can, in theory, be exploited to accelerate the dissemination of disease, reflecting the conventional wisdom within the biosecurity community. This perspective is cited in the preface of the Fink Report (National Research Council, 2004, p. vii, C2). The underlying rationale is that biotechnology is inherently dangerous as "[...] the same techniques used to gain insight and understanding regarding the fundamental life processes for the benefit of human health and welfare may also be used to create a new generation of biological weapon agents by hostile governments and individuals" (National Research Council, 2004, p. 19, C2).

Certainly, the realization of this abstract risk relies on an actor willing to undertake such actions, as technologies are incapable of acting autonomously (McLeish, 2007). Instead, the biosecurity discourse is mainly comprised of a discussion about the possible dangers associated with the proliferation of dual-use biotechnology. Various reports and journal articles that appeared in the wake of Ron Jackson's Mouse-pox experiment describe the possible proliferation problem seen in advanced biotechnology.

Here, the Fink Report draws on an established discourse in biosecurity circles about bioterrorism that has existed at least since the 1990s. What we see throughout the 1990s and reencounter in the Fink Report is what I have called before a techno-fear. Technology itself has become a source of concern, as its use as a weapon is inevitable. Biotechnology is globally available and within the reach of almost all actors. This makes a "misuse" of the technology for offensive applications almost inevitable. On the one hand, this conceptualization has implications for regulating DURC. If it is already globally dispersed, placing access restrictions on it is futile.

Traditionally, the circulation of sensitive knowledge and material was restricted by making it secret or at least controlling their export through other means (Holtcamp, 2012; McLeish, 2007). This was the case with many technologies with military relevance, first and foremost nuclear technology that could be weaponized, but other technologies such as cryptology (both mentioned explicitly in the Fink Report) as well. Within the logic of the DURC, simply restricting their circulation is no longer possible, as there are too many sources from which material, personal, and knowledge could stem. Additionally, in the eyes of the Fink Report, restrictions on biotechnology constitute a security problem in itself.

5.2 Dual-Use Biodefense – Biotechnology for Public Health

"The great achievements of molecular biology and genetics over the last 50 years have produced advances in agriculture and industrial processes and have revolutionized the practice of medicine." (National Research Council, 2004, p. 15, C1)

Throughout the Fink Report, life science is portrayed not solely as something dangerous but predominantly as a valuable asset. It is depicted as possessing multiple capabilities, rendering it an indispensable technology that enhances human existence. The Fink Report delineates biotechnology as a pivotal driving force across diverse domains. Notably, the report references food supply—discussed in terms of agriculture, animal health, food security, industrial production, and economic growth—as well as human health.

These advantages constitute the "other side" of dual use. Biotechnology is regarded throughout the report as equally advantageous. The authors of the report contend that nearly all research in the life sciences is undertaken to enhance human health against naturally occurring diseases. Concurrently, this research also offers protection against potential biological warfare agents, thereby contributing to security (National Research Council, 2004, p. vii, C2). The characterization of life science as beneficial can be found in various segments, for example, when security measures are proposed with the caveat that those measures should not "hinder" the progress of biotechnology. Within the report, scientific Progress in the life sciences and the development of new biotechnologies are seen as essential for the health and security of the United States (e.g., National Research Council, 2004, p. vii, C13). Life sciences are attributed in the report to enhancing public health and human life generally, as well as playing a vital role in defending against "biological threats". Accordingly, the report advises caution in implementing policy measures that could hinder these functions (National Research Council, 2004, pp. 13–14, C14).

The advantages ascribed to biotechnology become particularly evident when examining Public Health, a category frequently referenced throughout the Fink Report. Within this context, it is evident that life science research has been designated a crucial role in safeguarding human health from disease. In its most general form, this is articulated in the analyzed text as the statement that biotechnology is "[...] essential for the health of the nation" (National Research Council, 2004, p. vii, C13). The Fink Report consistently emphasizes the correlation between the advancement of biotechnology and public health. The significance of life science research and biotechnological progress for public health is highlighted in the report's opening sentence.

The term "public health", as used in the Fink Report, encompasses two distinct themes that appear to be disjointed. Within the report's argumentation, public health is perceived to be threatened by two sources of insecurity: naturally occurring illnesses and deliberate releases of pathogens. Although it may seem unexpected that both are categorized under the "Public Health" designation, they share a common historical context in the 1990s that links both issues to the domain of public health (see: Chapter 2.6).

The Fink Report states that developing vaccines against viral diseases is one of the core contributions of life science research to public health (National Research Council, 2004, p. 19, C15). Life science research is characterized as essential for identifying defenses against naturally occurring diseases and other health conditions. Explicitly listed among these are influenza, HIV/AIDS, as well as additional illnesses such as Alzheimer's disease, cancer, diabetes, and stroke (National Research Council, 2004, p. 19, C16), as well as hepatitis B, arthritis, multiple sclerosis, cystic fibrosis, heart attacks, hemophilia, and sepsis (National Research Council, 2004, p. 17, C17). Furthermore, *Biotechnology Research in an Age of Terrorism* highlights the historical accomplishments of the life sciences in producing scientific breakthroughs such as DNA and gene splicing (National Research Council, 2004, p. 16, C18), or the contributions of biology in identifying novel diseases such as Severe Acute Respiratory Syndrome (SARS), a coronavirus that caused a pandemic in 2002/2003 (National Research Council, 2004, p. 17, C19).

The second sub-theme of "Public Health" concerns the threats to public health posed by intentional outbreaks; in contrast to naturally occurring incidents or accidents, the term "intentional" refers to scenarios where "malicious actors" deliberately release pathogens with the intent to cause harm. Biotechnology research is recognized as a critical component in safeguarding the United States against bioweapon threats (National Research Council, 2004, pp. 2–3, C20). The reports identify "health promotion" and "national defense" as the two primary advantages of biotechnology, both mentioned within the same sentence (National Research Council, 2004, p. 23, C4). If we examine a statement within the Fink Report on a subsequent page, we observe that naturally occurring diseases and those resulting from the deliberate release of pathogens are regarded as two aspects of the same issue. The so-called "health of the nation" is threatened by two distinct sources: firstly, by natural causes, and secondly, by terrorists. Nevertheless, in the Fink Report, the measures to counter these two threats are largely analogous. What is required is the "[...] development of effective vaccines, diagnostics, therapeutics, and detection systems, along with a responsive public health system, will play in protecting against bioterrorism—and other serious health threats [...]" (National Research Council, 2004, p. 68, C21).

Analysis

Throughout the "beneficial biotechnology" section, we observe the extrapolation of historical developments into a contingent future. The overarching argument posits that because biotechnology has been advantageous in the past, it is likely to yield similar benefits in the future. Promises constitute a significant aspect of the life sciences. The anticipated benefits include the potential to cure previously incurable diseases in humans and animals, develop drought-resistant crops, combat plant pathogens and pests, enhance crop yields, detect emerging infectious diseases well before they pose public health threats, and harness microorganisms for material production. Jan van Aken criticizes the tendency of the biosecurity community to attribute some benefit—regardless of how remote—to nearly all experiments within the life sciences.

The concept of "beneficial life science" constitutes a fundamental principle within every biosecurity discourse. It is evident from numerous examples that the notion of inherently beneficial life science research is widely endorsed across the biosecurity community. Nearly every report or statement begins by highlighting the significant contributions of life science research to economic development, human health and safety, and national security. For instance, the highly influential 1982 report *Scientific Communication and National Security* ascribes the economic and military strength of the United States to its advanced research endeavors (National Academy of Engineering, 1982, p. 18). In 2003, the editors of prominent life science journals issued a statement outlining their approach to handling submissions with security implications. Within their statement, they prominently emphasized the significant benefits of life science, including: "[...] protecting public health, multiplying agricultural yields, fostering technological development and economic growth, and enhancing global stability and security" (Journal Editors and Authors Group, 2003).

Life science, as depicted in the Fink Report, is primarily an endeavor aimed at identifying the fundamental causes of naturally occurring illnesses and developing corresponding countermeasures. This encompasses infectious diseases such as SARS or HIV/AIDS, as well as non-infectious conditions (e.g., MS, stroke, heart attack, or cancer), irrespective of whether these illnesses are caused by naturally occurring pathogens or by intentionally released agents. At first glance, this may appear banal: biotechnology is advantageous for disease treatment. However, this notion is fundamentally significant as it directly influences the regulation of DURC. DURC is contextualized within a security framework once again, this time not as a threat to security but as a technological solution to security challenges. The Fink Report itself makes limited reference to this overarching security framework. It posits that biotechnology is beneficial for curing diseases, thereby defending the nation against threats from nature and terrorism as a common-sense stance. Common-sense positions are considered self-evident and do not require extensive explanation. Nevertheless, they are by no means inherently obvious; they depend on prior discourses that establish certain ideas as common sense.

The entanglement of bioterrorism and public health that occurred at the end of the 1990s and the early 2000s provides the backdrop against which the Fink Report was written. The Fink Report illustrates a specific variant of the dual-use biodefense argument. Biotechnology is responsible for offering technological solutions to prevent the spread of diseases, regardless of their origin. Protection against biological warfare agents is no longer solely intended for soldiers to safeguard them from bioweapons in the battlefield. Instead, through biotechnological innovation, the general population is also safeguarded against biological weapons. In this framework, biological weapons are no longer perceived as a threat only to soldiers on the battlefield, a group that can be vaccinated with relative ease due to their relative homogeneity (i.e., healthy individuals between the ages of 18 and 40), but also pose a threat to the civilian population at large, which has markedly different health characteristics (Institute of Medicine, 2002, p. 23). Over a century after their "invention", bioweapons have completed a full circle: Reflecting on the origins of biological and chemical weapons, their emergence coincides with the advent of the airplane as a strategic military asset. Bioweapons were predominantly conceived for use against civilian infrastructure situated behind enemy frontlines (Guillemin, 2005). Setting aside the irony of history, biological terrorism and natural diseases create insecurities that must be addressed. To resolve these issues, research and development in security technologies are deemed necessary.

The ongoing research and development of advanced biotechnologies are seen as essential to safeguarding against the security challenges posed by bioterrorism and infectious diseases. The Fink Report attributes the capacity of biotechnology to address both of these issues. Biotechnology is positioned not only as a security concern but also a solution to insecurity. The Fink Report offers limited reference to the discursive background underlying its conceptualization of biotechnology. Nonetheless, this background is crucial for comprehending the policy challenges involved. The discursive background influences perceptions of objective conditions that the biosecurity community must navigate and highlights the ambiguous nature of technology—viewed both as a threat and as a means of preparedness.

5.3 Fast Progressing Life Science

"In short, a dynamic national and international research enterprise has evolved, with an extraordinary record of achievement at multiple centers of excellence." (National Research Council, 2004, p. 18, C22)

Science and technology are always constructed within a social process that determines how they operate and what their properties are. Accordingly, the third coding dimension that I wish to discuss here is the "Making of Life Science". Life science research is primarily understood as progressing rapidly, as noted in the Fink Report. Biotechnology is characterized as an evolving entity that advances at an increasingly rapid pace. The report outlines progress within the life sciences, primarily referencing past achievements that are causative for newly emerging security concerns. Biotechnology and life science research are seen as having steadily advanced from their inception at the end of the 19th century to their current state. In this context, they have contributed to a desirable future by providing "[...] myriad applications in industry, agriculture, and medicine" (National Research Council, 2004, p. 16, C23). According to the Fink Report, life sciences are characterized as an "ever-expanding" field with "ever-shorter" intervals between discovery and its application in biotechnology (National Research Council, 2004, p. 17, C24).

Regarding the Fink Report, the advancement of life sciences, particularly the remarkable expansion following the discovery of DNA, is associated with the benefits conferred by (National Research Council, 2004, p. 22, C25). Additionally, the report associates rapid advancements in the life sciences with numerous public health and other benefits outlined in the preceding section (National Research Council, 2004, p. 17, C17).

Nonetheless, the Fink Report indicates that the swift advancements within the life sciences sector also accentuate the possible risks associated with biotechnology, particularly through the worldwide dissemination of expertise and equipment previously discussed. According to the authors of the Fink report, the involvement of an increased number of actors in the research process is anticipated to result in a corresponding rise in the number of dual-use experiments (National Research Council, 2004, p. 109, C26) as well as an increased availability of sources for dual-use material and knowledge (National Research Council, 2004, pp. vii–viii, C27), making the "[...] acquisition of biotechnology and biological weapons capability is considerably easier than was the case in the 1940s and 1950s [...]" (National Research Council, 2004, p. 22, C25).

Analysis

The "Fast Progress" code integrates a future-oriented vision into the Fink Report and its conceptualization of biotechnology. Future narratives hold significant importance; they mobilize substantial resources in the present, thereby fostering not only a futurization of the current moment but also a presentification of the future, as the future begins in the present (Lafontaine et al., 2021). A similar mechanism can be observed here: the past is utilized to construct future expectations. The past is neither entirely objective nor fully established; rather, it is always crafted in the present for a particular purpose (Assmann, 2008). We observe here the mobilization of the past as a historical context in which biotechnology offers substantial benefits to individuals, projected into the future as anticipations of forthcoming developments.

The observations derived from these two examples highlight the concept of a dynamic, continuously evolving, and steadily advancing life sciences sector. This concept is widely recognized within the biosecurity community. In the Fink Report, the historical account of biotechnology primarily serves to bolster arguments regarding the sector's benefits. The core assertion is that history demonstrates that the life sciences have advanced significantly from their origins in Paris and Berlin, marked by the use of anthrax and microscopes. In doing so, they have markedly enhanced the quality of life for many individuals and have developed into an increasingly expansive and vibrant industry. Concurrently, the rapid progress in this field introduces new insecurities. Within this context, the particular framing of biotechnology reinforces and facilitates the imaginaries of techno-fear and techno-fix.

Society and science are co-constructed (Jasanoff, 2013b). In our context, this indicates that the modes through which scientific knowledge is produced and ordered are intricately linked to the processes through which societal knowledge is produced and structured. Science is not an isolated entity functioning as a black box separate from the socio-political environment; rather, broader societal modes of knowledge production are profoundly interconnected with scientific modes of understanding. This underscores the importance of considering perceptions regarding the functioning of science, and it is pertinent to examine these perspectives (Nowotny, 2014). Accordingly, when we examine the characteristics attributed to biotechnology by the Fink Report, we observe the profound interconnectedness between modes of scientific knowledge production and the construction of insecurity. The sections of the report that depict biotechnology as rapidly advancing with a growing number of actors involved internationally suggest a future characterized by insecurity. The advancement of biotechnology has enhanced its accessibility; this increased accessibility results in proliferation, thereby elevating the risk of malicious actors potentially misusing biotechnology in the future.

While the Fink Report introduces certain imaginaries concerning the future, it also dismisses speculative projections. When delineating the scope of the report, the authors explicitly state their intention to concentrate on plausible scenarios and to avoid excessive speculation regarding future developments. Furthermore, they caution against compiling a definitive list of potentially hazardous experiments, contending that the fast-paced progress within the life sciences renders any such list obsolete in a short period. Consequently, a flexible and adaptive response is deemed necessary (National Research Council, 2004, p. 6, C28). This introduces a third theme within the "Fast Progress" category: the policy problem. While we will examine this argument in greater detail at a later stage, I believe it warrants preliminary mention here. For the present, let us focus on the two primary themes in the narrative: the potential for a positive or negative future.

5.4 Policy Problems and Overregulation

"The charge to our Committee was to consider ways to minimize threats from biological warfare and bioterrorism without hindering the progress of biotechnology, which is essential for the health of the nation." (National Research Council, 2004, p. vii, C30)

Initially, the Fink Report identifies the proliferation of biotechnology as the primary policy challenge it seeks to address. The report contends that insecurity is heightened due to the global distribution of biotechnology. Simultaneously, the authors oppose restrictive measures that could impede the dissemination of knowledge within the life sciences. On multiple occasions, the Fink Report emphasizes the fundamental dilemma between "[...] the spread of technologies that protect us and the spread of technologies that threaten [...]" (National Research Council, 2004, p. vii, C29).

The authors of the Fink Report state that their primary objective is to establish a balance that hinders the proliferation of dual-use items while enabling advantageous developments in biotechnology (National Research Council, 2004, p. viii, C3). Here, life science research is associated with benefits for "human health and welfare and national security" (National Research Council, 2004, p. viii, C3). Consequently, such research is regarded as "critical" by the authors and should "proceed" without impediment (National Research Council, 2004, p. 19, C31). Throughout the report, various instances are identified where the tension between restrictions on research itself or the dissemination of research outcomes and the imperative to conduct research for its benefits is discussed.

When outlining a proposed oversight system, the code "Overregulation" slightly shifts from characterizing the tension between free research and the necessity for regulation towards the imperative to identify which experiments pose the greatest threat, thereby focusing regulatory efforts accordingly. The issue of regulation and restrictions is now reframed as "[...] assessing whether the risk(s) associated with the benefits of fundamental research outweigh the potential for misuse" (National Research Council, 2004, p. 31, C32). The Fink Reports notes that there is currently no international governing body capable of making such a decision (National Research Council, 2004, p.

107, C34). Instead, the authors propose that Institutional Biosafety Committees could serve as a governing body responsible for evaluating the benefits versus the risks and making determinations based on these outcomes (National Research Council, 2004, p. 7, C33).

Analysis

The Fink Report principally aims to propose an oversight system capable of alleviating the potentially threatening aspects associated with biotechnology. Nonetheless, it approaches this objective in a specific manner, as overregulation constitutes one of the primary concerns articulated within the Fink Report and the broader biosecurity community. The document contains significantly more segments addressing the issue of overregulation than, for instance, those discussing public health. The concept of overregulation, or rather the avoidance thereof, is of such importance that it is mentioned in the report's opening sentence. A central issue within the biosecurity community is the apprehension that regulations designed to address security concerns related to biotechnology may impede the advancement of biotechnology. This perspective, which views life sciences as inherently dynamic and in need of maximal freedom to generate results, is prevalent within the biosecurity community and is subsequently reiterated in later reports. Accordingly, we shall revisit this point in greater detail later.

Throughout the Fink Report, it becomes apparent that the authors attributed significant benefits to the conduct of life science research. This implies that such research cannot simply be prohibited due to the hazardous properties attributed to it. The primary policy issue identified by the Fink Report has been characterized as a problem in the "organization of circulation" by Dagmar Rychnovská elsewhere (2016b, p. 314). This conceptualization is pertinent in this context, as it directs our focus toward the ambiguous nature attributed not only to biotechnology—considered both threatening and beneficial—but also to the uncertainties associated with potential interventions, which may enhance security yet impede the progress of security technologies.

On the one hand, this makes DURC regulation a circulation problem, as described by Dagmar Rychnovská (2016b). However, it also renders DURC regulation a matter of problem identification. Considering Huysmans' characterization of contemporary security, discerning which entities can pass through and which are restrained constitutes an essential modus of daily security procedures.

Classifying insecurity issues signifies a shift in the approach to security from an exceptional politics framework to a risk-based conceptualization. This method necessitates identifying the most problematic entities to prevent, while permitting the continuation of others (Huysmans, 2014). In the Fink Report, we observe the initial stages of the discourse on identification and (over)regulation, as the report discusses pinpointing the most problematic experiments and balancing regulation with the conduct of dual-use experiments.

5.5 Conclusion: Competing Imaginaries of the Future

The Fink Report serves as a significant document not only for its standalone analytical value but also for providing an overview of some of the primary discursive themes that will be encountered in subsequent reports. It occupies a position between traditional reports on dual-use issues, which emphasize military strategies of proliferation control, and the initial stages of what will evolve into DURC. Consequently, it draws upon established security concepts while simultaneously beginning to introduce novel ideas.

The initial fundamental discourse pertains to the ambiguity inherent in biotechnology and the implications arising from its advancement and global dissemination. On one side, biotechnology is regarded as a potential source of insecurity or as something that may soon become so. Conversely, biotechnology also serves as a means to mitigate the insecurities it may engender. Through these two constructs of (in)security, the Fink Report delineates two competing visions for the future. One vision is inherently desirable, while the other is not. These two visions are inextricably interconnected, with biotechnology acting both as a harbinger and as an obstacle to a desirable future.

There are several noteworthy aspects of this particular discourse on future insecurities, including Ulrich Beck's writings on the risk society (1992) or the role of technology and nature in the Anthropocene (Fagan, 2017). However, I would like to stay with in-securities performative power as an organizational principle. The discourse about an ambiguous future that we see in the Fink Report is something that we will encounter in other reports as well, and it is highly relevant to how security policies are organized around the subject.

The Fink Report delineates two competing visions regarding the same category of technologies. One resembles a techno-fear, whereby the progression and global dissemination of biotechnology evoke apprehensions. This perspective fosters an imaginary in which malicious actors might access these technologies, thereby escalating insecurity, as it suggests that the deliberate release of pathogens could occur at any moment. Conversely, the same technologies also envisage a future wherein there is liberation from illness, whether naturally occurring or intentionally induced. Throughout the report, it is evident how these two opposing visions influence policy formulation. Due to their inherent ambiguity, neither perspective predominates. Biotechnology cannot be categorically regarded solely as a security issue that necessitates security-based measures, nor can it be viewed exclusively as a matter of research funding and regulation, as exemplified by the Manhattan Project, where certain technologies were prioritized for development. Rather, it embodies both dimensions concurrently. Each extreme should inform specific policies—either restricting or fostering research.

Nevertheless, upon examining the Fink Report, it becomes evident that the specific policy issue concerning DURC stems from the ambiguity of technology, in which both interpretations are valid. Consequently, the Fink Report characterizes the primary challenge faced by DURC as "finding an appropriate balance" between restriction and facilitation. Furthermore, the report articulates a fundamental conceptualization within the biosecurity community—that biosecurity pertains to matters of risk and degree. It emphasizes that the focus is not solely on identifying sources of insecurity but rather on quantifying the level of insecurity and determining whether it surpasses a particular threshold. Throughout this analysis, the recurring theme of "risk-benefit" or "matters of degree" will be apparent in every report examined. It is essential to comprehend how the regulation of DURC is conceptualized.

6 The NSABB Reports: Civilian Imaginaries and Open Communication

The second document(s) pertinent to this analysis are the NSABB reports. The NSABB, established in response to one of the recommendations of the Fink Reports, issued two comparable reports in 2006 and 2007, respectively. Continuing with the overarching theme of ambiguous biotechnology, which has been evident throughout the Fink Report, the NSABB reports introduce some variation to the techno-fear and techno-fix conceptualizations identified earlier. Within these reports, there is a discernible transition from the Fink Report's predominant emphasis on state-centric security paradigms towards a more civilian-oriented, multi-hazard, and risk-based security framework.

A considerable portion of the NSABB reports is devoted to the formulation of a Code of Conduct (CoC) for life scientists, thereby assigning them the ethical obligation to mitigate potential risks associated with disseminating their research findings. This "ethicalization" of security and the consequent shift in responsibility—where the individual researcher now bears the responsibility for addressing associated insecurities—is noteworthy; however, it has been addressed in other discussions (Rychnovská, 2016a; 2016b). I will largely disregard the CoC discussion here and concentrate on two distinct themes: the transition toward research outcomes and the identification of DURC. Throughout the NSABB reports, it becomes evident that the locus of insecurity shifts from the conduct of hazardous experiments to the communication and potential misuse of research findings. Consequently, a primary issue highlighted in the NSABB reports, which will be examined herein, is the necessity for risk mitigation via the identification of communication methods susceptible to misapplication and the determination of what can be safely published. This transition necessitates the deployment of new, biotechnical knowledge and expertise, positioning the researcher at the core of managing insecurity.

6.1 Beneficial Biotechnology: NSABB – Doubling Down on Desirable Futures

"Life sciences research is a critically important endeavor that has benefited society by advancing our understanding of living systems." (NSABB, 2007, p. 51, C35)

The NSABB reports persistently conceptualizes biotechnology as beneficial. However, in contrast to the Fink Report, there is less emphasis on the national security aspect of biotechnology and a broader array of benefits. National security is regarded as merely one advantage among others, with public health, agriculture, and the economy generally enumerated collectively (e.g., NSABB, 2007, p. 1, C36).

Once again, public health is portrayed as one of the primary sectors that has benefited from advancements in biotechnology. As noted in the NSABB reports, public health is frequently associated with "[...] new pharmaceuticals, diagnostic procedures, preventive strategies, treatments, and cures for myriad acute and chronic diseases and conditions and for emerging and reemerging infectious diseases that affect humans and exact a heavy toll in terms of quality of life, medical costs, and productivity" (NSABB, 2007, p. 1, C37). Comparable examples are also present elsewhere in the report, describing the advantages derived from the progression of biotechnology and life science research. This list encompasses pharmaceuticals, diagnostic procedures, preventive strategies, treatments, and cures (NSABB, 2007, p. iii, C38). Life science research is attributed a fundamental role in understanding pathogens and their modes of transmission. For the NSABB, this knowledge can be utilized to develop novel treatments for diseases and innovative preventive strategies (NSABB, 2007, p. 1, C39).

Within the "Beneficial Biotechnology" dimension, the codes "National Security" and "Public Health" occupy a central position. Nonetheless, "Food Supply", "Agriculture", and "Economy" are frequently referenced among the advantages offered by biotechnology, although they are seldom elaborated upon. Several instances demonstrate the assertion that "[...] a strong and safe food supply, a healthy environment, and a vigorous economy" (see e.g., NSABB, 2007, p. 24, C40) are areas in which biotechnology contributes, but they are not discussed in more detail.

The NSABB reports contend that utilizing biotechnology to enhance food safety and security constitutes a global endeavour. Around the world, researchers employ biotechnology to increase agricultural crop yields and to bioengineer plants for the production of valuable products, including medical treatments for various illnesses (NSABB, 2007, p. 1, C41). In addition to the direct benefits attributed to biotechnology by the authors concerning the food supply, they also contend that research in the life sciences offers advantages for the environment, as it will contribute to "the quality of our environment" (NSABB, 2007, p. 1, C41).

The NSABB reports also reference economic advantages. These benefits seem to be connected either to national security or to a civilian perspective of economic growth and environmental sustainability. In several sections, economic stability and growth are discussed in conjunction with national security. In this context, biotechnology offers advantages not only for public health and the food supply but also for "[...] other relevant sectors and makes a substantial contribution to a robust national security and economy" (NSABB, 2007, p. 7, C42). In another instance, the reports argue that biotechnological advancement is necessary for "[...] maintaining and strengthening our national security and economy" (NSABB, 2007, p. 1, C36).[14]

In the second iteration, economic benefits are more directly associated with the civilian domain. At this stage, such benefits are not explicitly correlated with national security but are instead connected to the concept of economic growth. There are several instances in the reports where biotechnology is described as generating positive impacts across "numerous" commercial sectors or broadly contributing to a "vigorous economy". Throughout the report, there are also passages indicating that biotechnology connects economic growth with environmental health. Here, biotechnology appears to serve as a factor in balancing economic prosperity with environmental sustainability, thereby offering a solution to the exploitation of nature in the pursuit of economic wealth. In another example, the life sciences contribute positively to society by "[...] developing environmental remediation technologies and creating new materials and even energy sources" (NSABB, 2007, p. 1, C43).

Analysis

Analysis of the NSABB reports reveals a recurring central theme evident also in the Fink Report: the socio-technical imaginary of a desirable future facilitated by biotechnology. Similar to the Fink Report, public health is prominently positioned within the "Beneficial Biotechnology" dimension. Additionally, the NSABB reports demonstrate that the emphasis on "Public Health" somewhat diminishes the military legacy that persisted in the Fink Report. The reports primarily address "Public Health" concerning naturally occurring diseases, rather than as a means of defending against the deployment of biological weapons by state actors or terrorist organizations.

Within the NSABB reports, biotechnology research is regarded as possessing significant benefits for society. Conversely, the Fink Reports contains multiple lists delineating research advancements in areas pertinent to national security, such as diagnostics, detection, prevention, and treatment. The socio-technical imaginary conveyed through the NSABB reports, however, is somewhat less explicitly defined. The NSABB places less emphasis on technological solutions to bioterrorism and bioweapons and instead envisions a future that is not only secure but also free from want and economically prosperous. This vision encompasses nearly all facets of life. The aspirational vision of a future enabled by biotechnology gradually diminishes its strong association with a military logic of proliferation and

[14] The linking of economic productivity and national security is not new. For example, the influential and often referred to 1982 Report *Scientific Communication and National Security* (National Academy of Engineering, 1982) argues in the first paragraph: "Advances in science and technology have traditionally thrived in an atmosphere of open communication; openness has contributed to American military and economic strength and has been a tenet of American culture and higher education" (National Academy of Engineering, 1982, p. v).

asymmetric warfare—as seen in the Fink Report—and becomes more closely aligned with the civilian sphere.

The NSABB reports propose a redefined notion of benefit, emphasizing the risks faced by individuals within contemporary society. The concepts of health, employment, and a sustainable planet are increasingly associated with biotechnology and its advantages. In this context, biotechnology gains legitimacy through the direct benefits it affords to individuals. Furthermore, the reports exhibit a global perspective. They illustrate an evolution of biotechnology from a primarily national focus, such as national security, to a broad-based technology that offers advantages universally. Consequently, the techno-fix imagery present in the NSABB reports reflects a vision of a future characterized by global prosperity and the eradication of deprivation.

According to the NSABB reports, public health has become associated with the civilian sector, and a civilian conception of public health primarily concerned with naturally occurring illnesses. The NSABB's account of biotechnology and life sciences is legitimized by its reference to national security and the potential impacts on public health resulting from the use of biological weapons. Additionally, it is justified through the advancement of medical applications that directly influence the "quality of life" of individuals, their productivity, and the public expenditure on healthcare. This rationale was evident in the Fink Report, but it was later augmented by proliferation and terrorism concerns. While public health appeared as a supplementary aspect in the Fink Report, it emerged as a central issue in the NSABB Reports. Emphasizing the individual as the primary beneficiary of these technological advancements enhances political legitimacy for future life science research (Nowotny, 2014, p. 18).

The desirable future, as depicted in the Fink Report, evolves into a concept that encompasses many aspects of life. It extends beyond merely health and security concerns to include other risks prevalent in contemporary Western society, such as unemployment and economic decline. Concurrently, it aligns with a global initiative aimed at delivering benefits to communities adversely affected by food shortages and incorporates references to the environment, which is depicted as deriving advantages from advancements in life science research. In this context, the imaginaries of techno-fixes begin to transcend biotechnology as a solution solely for existential insecurities related to the potential deployment of biological weapons. Instead, biotechnology is envisioned as a potential remedy for a multitude of societal insecurities.

6.2 Ambiguous Biotechnology: Threats and Benefits to National Security

"The concern regarding dual use research is that the information, technologies, or products developed from it could be misused to threaten national security. The NSABB found that there are many different understandings of the term "national security", so it identified the relevant aspects and used the collective terms. Thus, the criterion refers to the potential for threats to public health and safety, agricultural crops and other plants, animals, the environment, and/or materiel. This would include threats to farming, livestock, aquaculture, terrestrial and marine wildlife, companion animals, domestic and wild plants and trees, ecological systems, and other natural resources, as well as manmade resources." (NSABB, 2007, p. 17, C44)

Initially, the term "National Security" appears among a comprehensive list of potential benefits; however, it holds limited significance within the scope of this analysis. In this context, national security is frequently cited as a benefit but remains an abstract concept. Nonetheless, a notable conceptualization of national security can be observed within the NSABB reports. At a subsequent point, the NSABB defines what it understands as national security. For the NSABB, national security constitutes a very broad concept, as evidenced by the preceding quote, encompassing numerous different areas that substantially overlap with domains in which biotechnology is presumed to provide benefits (NSABB, 2007, p. 17, C44).

Despite the expansive definition of national security outlined above, the concept remains predominantly focused on the state within the NSABB reports. Nevertheless, the report posits that such threats may originate across various domains, thereby expanding the security agenda. Although its definition is somewhat vague, the NSABB does not suggest that every danger constitutes a threat to national security. Instead, the reports establish a quasi-quantitative threshold for national security, wherein only threats with "broad potential consequences" are considered relevant—implying that only threats impacting the general population, rather than individuals, should meet this criterion (NSABB, 2007, p. 16, C45).

Although there is a movement towards a more civilian-oriented perspective in its security conceptualization, national security remains a significant concern in the reports. The NSABB reports regards biotechnology and life sciences research as ambiguous in relation to security implications. While advances in biotechnology emphasize the importance of national security, the potential for misuse poses a threat to it. Consistent with other benefits, the NSABB reports consider biotechnology essential for maintaining and enhancing national security. Furthermore, the reports argue that biotechnology offers substantial benefits to national security. Additionally, there are sections indicating that research outcomes could be misappropriated to the detriment of "public health and safety" (NSABB, 2007, p. 7, C46). This general ambiguity of technology sets the task for the NSABB as: "[i]n acknowledgment that the threat of the misuse of research information is important and real, the U.S. Government agreed that new biosecurity measures were warranted to minimize the risk that information from life sciences research might be misused to threaten public health and safety and other aspects of national security" (NSABB, 2007, p. 3, C47).

An interesting observation to highlight is that the NSABB reports contend that the information derived from life science research, rather than the research itself, is considered "vital" to national security. Similarly, there is an emerging shift from emphasizing the material outputs of research towards acknowledging the intangible outcomes of experiments as the principal source of insecurity (NSABB, 2007, p. 1, C36). Biotechnology is not dangerous by itself, but the "[…] deliberate and malevolent misuse of dual-use research findings […]" (NSABB, 2006, p. 9, C48) might pose national security threats. Throughout the NSABB reports, it is the "[…] misapplication of information, technologies, or biological agents resulting from legitimate dual-use research, not the conduct of the research itself [...]" (NSABB, 2007, p. 16, C49) that causes threats. Throughout the NSABB reports, numerous other passages reinforce the notion that the misuse, not the experiment, is the problem here.

Analysis

The definition of National Security utilized in the NSABB reports is exceedingly broad. Threats are no longer confined solely to the deployment of bioweapons in warfare or public health risks resulting from bioterrorism; rather, they encompass a multitude of domains. I wish to highlight two points in relation to this definition: Firstly, the re-emergence of the concept of intentional release. While the term "Public Health" primarily pertains to the benefits of curing and preventing naturally occurring diseases, the concern regarding intentional release is revisited within the NSABB reports through its reference to "National Security".

The Fink Report primarily interprets intentional release as a significant threat to public health, to the extent that it could cause the failure of state and societal functions. Consequently, biotechnology is justified through its application as a technological remedy to counteract the public health consequences of an intentional release. Conversely, the NSABB reports expand their conceptualization of national security to encompass a broader range of issues. This expansion of the security agenda is the second point I wish to highlight. The NSABB reports conceptualize national security in a manner more aligned with an "all-hazards" approach, as opposed to the Fink Report's logic of "territory, population, and monopoly of violence".

Similar to the Fink Report, the NSABB reports recognize that national security can be jeopardized by advanced biotechnology. Utilizing the broad interpretation of national security discussed previously, DURC remains an ambiguous technology that, while beneficial to national security, can also pose a threat to it. However, the NSABB reports employ a slightly different nuance in how they conceptualize national security as being vulnerable to biotechnology. The Fink Report primarily focused on DURC experiments and their potential implications for the creation of biological weapons. This perspective shifts in the NSABB reports, which are more focused on the "misuse" or "misapplication" of DURC experiments rather than on the intrinsic dangers of those experiments. Consequently, this modifies the dual-use paradigm from one where the threat originates directly from biotechnology to one where the danger arises from its use (or rather "misuse") (McLeish, 2007).

The NSABB reports distinguish clearly between "misuse" and "misapplication" as areas of concern, rather than focusing on the research itself. Although this distinction may appear subtle, it represents a significant departure from the perspective presented in the Fink Report. In the Fink Report, DURC experiments are characterized as a "necessary evil"; inherently hazardous due to the potential for proliferation, yet deemed essential for a desirable future. Conversely, the NSABB reports emphasize that the dual-use dilemma in biotechnology is not intrinsic to the technological development itself but arises solely from its misapplication. Consequently, the experiments and their conduct are considered to be unproblematic and non-threatening, no longer inherently dangerous. Therefore, the central issue in biotechnology shifts from whether such experiments should receive funding or be executed to safeguarding the information they generate from potential misuse by malicious actors.

The Fink Report also includes sections addressing misuse; however, such sections are less frequently observed compared to the NSABB reports. Instead, there are passages in which the authors of the "Fink Report" appear to express greater concern regarding advanced biotechnology. For instance, they anticipated "[…] significant increases in funding that will be going to biodefense—precisely the sort of research likely to pose the most severe dual use dilemmas […]" (National Research Council, 2004, p. 108).

The NSABB reports do not constitute a wholly novel chapter in the discourse of biodefense. Instead, it signifies a gradual shift in tone. The socio-technical imaginaries associated with biotechnology increasingly extend beyond concerns of national security and functioning of the state, and dual-use biotechnology starts to become normatively good if not for the possibility of someone misusing it for malicious purposes. The subsequent chapter will examine a third notable transition—from material to immaterial, from tangible products to intangible information—which is essential for comprehending the regulatory landscape of biotechnology.

6.3 Making Life Science: Fast Progress Needs Openness

The conceptualization of life sciences within the NSABB reports begins largely similar to the depiction found in the Fink report. Life sciences and biotechnology are regarded as progressing swiftly, giving rise to new risks and advantages. In the NSABB reports, life sciences and biotechnology are depicted as a global endeavor, with researchers worldwide striving to develop novel treatments for diseases (NSABB, 2007, p. 1, C39). Life science is regarded as an ongoing "quest" to attain a more profound understanding of health and disease in humans, animals, and plants (NSABB, 2007, p. 1, C50).

The authors of the NSABB reports emphasize this depiction of a vibrant research initiative by highlighting the complexity and unpredictability inherent in research. According to the NSABB, research comprises "complex, iterative processes" (NSABB, 2007, p. 52, C51). Concerning its dual-use potential, the reports contend that biotechnologies’ dual-use potential may be realized at various "junctures" within the research process and through other activities (NSABB, 2007, p. 52, C51). Life sciences, according to the NSABB reports, are highly complex and may yield unforeseen results (NSABB, 2007, p. 8, C52). In another instance, life science is regarded as a dynamic and interdisciplinary field, which renders the formulation of concrete security policies challenging (NSABB, 2007, p. 17, C53). We have seen such a conceptualization of life science as constantly evolving in the Fink Report. Being inherently "extraordinarily dynamic" presents a policy challenge, as security measures may quickly become obsolete. In this context, the NSABB advocates for "[…] guidelines rather than regulations so that course corrections can be made more easily and new technological advances can be addressed as needed with relative ease" (NSABB, 2007, p. 5, C54). Accordingly, anyone involved in biosecurity must "[…] periodically review if their research might have security implications" (NSABB, 2007, p. 17, C53).

In addition to "Fast Progress", the NSABB reports contain a second theme in conceptualizing science. Science, as the authors of the report contend, relies on open communication. This conceptualization was implicitly present in the Fink Report but was not as pronounced there. On the contrary, it is of paramount importance in the NSABB reports. The NSABB asserts that the "open and unfettered" communication within the scientific community, including the exchange of information and technology among scientists, is the driving force behind advancements in the life sciences and consequently, their benefits (NSABB, 2006, p. 9, C55). Through transparent communication, progress in biotechnology becomes attainable. Consequently, the transparent dissemination of research findings is instrumental in attaining a desirable future, given the advances in life sciences: "[...] underpin public health and safety, a strong and safe food supply, and a healthy environment" (NSABB, 2006, p. 9, C55; NSABB, 2007, p. 24, C40).

The NSABB sees progress in the life sciences depending upon the unrestricted exchange of information, as research outcomes must undergo validation by other scholars to be valuable for future investigations (NSABB, 2006, p. 9, C56; NSABB, 2007, p. 24, C57). Consequently, open communication becomes essential for the effective conduct of scientific research. According to the NSABB reports, "[l]ife sciences research should be communicated to the fullest extent possible to ensure the continued advancement of human, animal, plant, and environmental health" (NSABB, 2007, p. 24, C58).

This emphasis on the importance of open communication and the dissemination of research findings has implications for the security policies proposed by the NSABBS. According to the NSABB reports, "[...] any restriction of scientific communication should be the rare exception rather than the rule" (NSABB, 2007, p. 24, C58) with unfettered access to information being the "default position". The Fink Report has previously addressed the issue of "unintended consequences" for a desirable future, should the conduct of DURC be subject to restrictions or if access to information is limited. The NSABB's primary concern revolves around access to information. As discussed above, the NSABB reports suggest that the experiments themselves are generally unproblematic, and security measures should focus on their outcomes rather than the experiments. Consequently, the "Open Science" code reflects the NSABB''s discussion regarding whether access to research information can be subject to restrictions and whether such restrictions should be imposed on the dissemination of research findings.

The NSABB reports contend that it is necessary to establish security policies that guarantee "responsible" dissemination of research findings, thereby balancing biosecurity requirements with the research community's need for transparent communication (NSABB, 2007, p. 23, C59). However, as in the understanding of the NSABB, scientific progress relies on access to information: "[a]ny decision to do otherwise should be undertaken very carefully" (NSABB, 2007, p. 7, C60). With open science being the "default position" (NSABB, 2007, p. 7, C60), "[…] life sciences research should be communicated to the fullest extent possible" (NSABB, 2006, p. 24, C61) and restrictions should be: "[…] the rare exception rather than the rule" (NSABB, 2006, p. 24, C61).

Analysis

As in the Fink Report, the term "Fast Progress" serves as a pivotal code within the NSABB's framework for conceptualizing life sciences. This field is characterized by rapid advancement, marked by continual scientific discoveries and technological developments. The "Fast Progress" code is relatively small and reiterates themes previously identified in the Fink Report. The passages associated with this code predominantly emphasize the necessity for a flexible oversight system, given that the pace of life science research often surpasses the efficacy of traditional, list-based regulatory approaches. The second code in this domain is "Open Science", which encompasses passages from the NSABB reports advocating for transparent communication as essential for scientific progress. According to these reports, open communication and uninhibited information exchange are fundamental attributes of a scientific culture of discovery and are implicitly required to realize a desirable future. Both codes conceptualize life science research in a specific manner, thereby shaping the nature of political intervention and influencing what solutions to security concerns are deemed appropriate. Moreover, these two codes, along with others previously mentioned, form the foundational groundwork for a paradigm shift in security policy—moving away from a focus on state and export controls toward a more nuanced, incremental, and risk-based strategy.

The "Fast Progress" framework incorporates both temporal and spatial dimensions within which security measures are implemented. The prevailing beliefs in the biosecurity community are that "life science happens globally" and "life science changes extremely fast". These positions are embedded within a discursive structure that limits the political sector’s capacity to regulate DURC effectively. Common objections to political oversight include assertions that: politics is too slow and every measure will be outdated by the time politicians and bureaucrats have agreed on it, as well as that: life science happens across the globe, and politics can only address one country at a time. The dynamic and global conceptualization of life science research exerts a significant influence, dictating which security measures are feasible and which are not. Furthermore, it initiates a shift in responsibility for implementing security measures. If traditional, state-centric security measures prove ineffective due to their limited spatial reach and temporal immediacy, the pertinent question becomes: who is capable of instituting effective security measures?

The NSABB reports fundamentally conceptualize biotechnology as a domain that advances at a velocity exceeding the capacity of traditional security bureaucracies to effectively manage. According to the NSABB reports, life sciences are highly intricate, and security issues can manifest rapidly. This renders traditional security measures—such as government committees, hearings, and definitive lists like the Select Agents list in the United States, which classify experiments as either permissible or prohibited—insufficiently agile to respond to the rapid progression of scientific research. Concurrently, there is an argument emphasizing the necessity of scientific progress, as it is believed to contribute to a desirable future within this framework. Herein, we observe the onset of a shift in responsibility, as the authority and efficacy of conventional "managers of unease" become questionable in their capability to address security threats that arise from DURC.

Simultaneously, the NSABB emphasizes the necessity for transparency within the Life Sciences. The NSABB argues that scientific progress depends on the open dissemination of research findings. Therefore, any limitations on the publication of research outcomes should be considered a "rare exception". According to the NSABB reports, advancements in the life sciences—and indeed in any scientific discipline—are achieved incrementally through continual refinement of existing knowledge. Researchers build upon previous experiments, rectifying errors made by their intellectual predecessors or validating previous findings. The NSABB reports conceptualize science as a steady progression that incrementally enhances prior knowledge.

The NSABB reports conceptualize science as a rational process of knowledge production. Within this framework, scientists are regarded as the primary actors who generate assertions about the world, which are subsequently validated or falsified by their peers. Consequently, scientists accumulate knowledge that is regarded as true through a process of validation. Concurrently, uncertainties regarding natural phenomena are reduced by continuously expanding the body of accepted knowledge through the formulation of revisable statements about the subject, which are then subjected to either falsification or validation by other researchers. This model heavily relies on the free dissemination of research findings and the institutions that facilitate such openness, as its core logic involves critically examining statements made by others through rigorous scrutiny (Callon, 1995). The free exchange of research findings into a worldwide, logical procedure of validation or refutation is a defining characteristic of such a Popperian scientific paradigm. By entrusting scientists with the authority to determine what constitutes true knowledge, this model further accentuates the significance of scientists within the process of knowledge creation. It positions researchers at the forefront and vested with the authority to decide which knowledge is regarded as true and which is dismissed.

The NSABB reports indicate that the communication of scientific information is a pivotal aspect of its conceptualization of DURC. There are two overarching frameworks within bio(in)security: the first pertains to the security of materials such as laboratory equipment, pathogens, and other tangible artifacts. The second concerns the knowledge acquired through conducting experiments and disseminating their results, which could potentially enable an actor to develop a biological weapon (Atlas, 2008; Atlas & Dando, 2006; Atlas & Reppy, 2005; Vogel, 2008). The Fink Report primarily addresses the logic of proliferation and export controls concerning tangible artifacts. It only takes initial steps toward addressing immaterial aspects, specifically tacit knowledge. In contrast, the NSABB reports predominantly emphasize the second biosecurity framing, concentrating mainly on communication and information sharing, which are regarded as vital activities for ensuring ongoing progress within the life sciences.

6.4 Public Trust and Responsible Communication

"Because of the potential for misuse of dual use research results, concerns on the part of the public, including members of the scientific community, about the sharing of such information can be anticipated. In addition, the public is increasingly sensitive to issues pertaining to research involving dangerous microbes and the risk of accidental or intentional release of such agents. A lack of public understanding and appreciation for the reason for conducting and communicating dual use research, sensationalism of dual use research findings, and concerns about public safety and national security all serve to undermine public trust in the life sciences research enterprise. Therefore, it is the responsibility of the scientific community to ensure that dual use research results and technologies are communicated responsibly." (NSABB, 2007, p. 26, C62)

The perceived need for ongoing advancements within the life sciences, as articulated in the NSABB reports, results in the implementation of a second-tier security framework within these documents. In this context, the discipline of life science itself must be safeguarded from public scrutiny. The authors of the NSABB reports assert that the public is prone to "misunderstanding and sensationalism" and could be alarmed by biosecurity concerns raised over an experiment (NSABB, 2006, p. 10, C63). In turn, there is the danger that the public could lose its trust in the scientist (NSABB, 2006, p. 10, C64). On the other hand, public trust and support are portrayed as vital for continued progress in the life sciences (NSABB, 2006, p. 10, C64). In another instance, the NSABB report states, "[…] the future of scientific progress and freedom is the preservation of public trust and support, which scientists have earned through their attention to responsible research practice" (NSABB, 2007, p. 51, C65).

The NSABB reports assign to the public an "increasing sensitivity" for accidents involving research materials and the potential for bioterrorism (NSABB, 2007, p. 26, C62). Simultaneously, the reports claim the existence of a knowledge deficiency among the public concerning DURC experiments and their significance or necessity. The reports indicate that the public lacks "understanding" and "appreciation" for conducting DURC experiments and for openly communicating research findings (NSABB, 2006, p. 13, C66). Disseminating research findings transparently presents a challenge, as there exists a significant risk of "public misunderstanding" (NSABB, 2006, p. 10, C64). The Authors attribute this potential for misunderstanding not only to the lack of information and knowledge but also to a certain tendency for "sensationalism" on behalf of the public (e.g., NSABB, 2007, p. 25, C67).

In light of the perceived challenges associated with sustaining public trust, the NSABB reports emphasize that the "responsible communication" of research findings is essential to uphold the public’s confidence in the scientific community (NSABB, 2007, p. 8, C68). Responsible communication pertaining to public trust mainly consists of "[…] the need for the inclusion of contextual and explanatory information that might minimize [the public’s] concerns and misunderstanding" (NSABB, 2006, p. 10, C63). This form of responsible communication takes the form of due diligence within reports. Researchers are encouraged to participate in outreach initiatives throughout the research process to enhance awareness of the significance of DURC experiments and to reassure the public that the research is conducted and communicated responsibly" (NSABB, 2006, p. 10, C64).

The term "responsible communication" acquires a secondary connotation within the report. In its initial context, it serves as a means to preserve public trust. Here, it is regarded as a security measure pertaining to the potential misuse of DURC itself. The authors of the NSABB reports describe developing strategies for communicating research outcomes that balance biosecurity requirements with the necessity for open communication as one of the primary responsibilities of the board (NSABB, 2006, p. 8, C69). When examining the misuse aspect of "responsible" communication, the tension between open communication and the necessity for confidentiality becomes apparent once more. Negotiating this tension is central to the NSABB and the broader biosecurity community. In the preceding chapter, it was observed that restrictions on disseminating research findings are viewed as the exception rather than the norm (NSABB, 2006, p. 9, C61). Nevertheless, the NSABB contends that restricting the dissemination of research may be justified when security concerns necessitate such measures. In such instances, withholding specific information that could potentially jeopardize national security might be deemed appropriate (NSABB, 2006, p. 9, C70).

The NSABB reports describe a variety of strategies for disseminating research findings, encompassing immediate and comprehensive disclosure, delayed and/or modified disclosure, as well as withholding communication entirely. The selection of an appropriate strategy, as outlined in the reports, must be determined on an individual basis, contingent upon the specific risks associated with the publication (NSABB, 2006, p. 9, C71). A further option is to "[l]imit access to selected individuals on a 'need to know' basis" (NSABB, 2006, p. 13, C72). In accordance with the NSABB's conceptual framework of the research process, information pertaining to research is disseminated at numerous stages, necessitating continuous vigilance on the part of researchers.

The NSABB reports herein do not specify precise criteria defining dual-use potential or national security concerns. Instead, it allocates the responsibility for identifying potential risks to the local level, including higher authorities when necessary. According to the NSABB reports, conducting reviews at the local level ensures that individuals with "[...] appropriate expertise and the best understanding of local personnel, facilities, and ethos" are assessing research for dual-use potential (NSABB, 2007, p. 9, C73).

In the NSABB reports, dual-use "[…] research that, based on current understanding, can be reasonably anticipated to provide knowledge, products, or technologies that could be directly misapplied by others to pose a threat to public health and safety, agricultural crops and other plants, animals, the environment, or materiel" (NSABB, 2007, p. iv, C74). Research falling into this category may present security concerns; consequently, communication might be restricted. However, this process is by no means simple. The NSABB reports contend that labeling research as dual use "should not be viewed pejoratively" and does not automatically imply that restrictions should be imposed on the conduct of experiments or the dissemination of research findings (NSABB, 2007, p. 16, C75).

Analysis

Considering the security narratives previously examined and the emphasis on research outcomes in the NSABB reports, the documents dedicate significant attention to the manner in which research findings should be communicated "responsibly". The term "responsibly" here encompasses two distinct aspects. The first pertains to addressing the issue of "misuse", which involves constraining or restricting the dissemination of research results. The second relates to maintaining public trust and resembles a due diligence process through which the trustworthiness of life science research should be demonstrated to the public. Dagmar Rychnovska has previously noted that both aspects fall within the same category of "responsibility" via an ethicalization of security, whereby individual researchers are ethically accountable for communicating their research findings (2016).

I wish to underscore two key aspects. The first pertains to the NSABB report's conceptualization of the public and its relationship with science. Within the NSABB reports, the public is regarded as lacking sufficient knowledge and information to comprehend the rationale behind conducting high-risk experiments for their own benefit (as in a desirable future) (see also: Marris, 2015). The public is primarily perceived as sensationalist and lacking in understanding, thereby rendering them unable to appreciate life science research. Simultaneously, they are envisaged as possessing significant power, and public trust is considered "[c]ritical to the future of scientific progress and freedom [...]" (NSABB, 2007, p. 51, C65).

However, I wish to highlight a different aspect present within these passages—the necessity of exhibiting responsible behavior concerning potential misuse. This conflict between scientists and the public can be exemplified by the interview conducted by Ronald Jackson and Ian Ramshaw regarding the mousepox controversy, wherein they address the media's role in scrutinizing their research and the politicization related to security measures (Selgelid et al., 2010). Here, the public not only serves as a central point of legitimization through a desirable future, but also becomes a concern, as the public is perceived to be unaware of the benefits that biotechnology can offer them and their future. This conceptualization is evident multiple times throughout the NSABB reports.

The second point I wish to emphasize is the conflation of misuse and public trust through the term "responsible communication". By demonstrating an awareness of the security implications of DURC and the appropriate management of these challenges, public confidence is similarly maintained. Throughout the biosecurity discourse, there are comparable concerns that the public may pressure policymakers to implement biosecurity measures that could adversely impact the life sciences industry. "Of even greater concern are potential constraints on the flow of scientific information stemming from fundamental research on dangerous pathogens. In a world concerned with the threat of terrorism, it is understandable that politicians and their constituents might feel safer if pathogens were locked up, tight regulations imposed on research, and strict controls placed on the dissemination of research results" (Relman et al., 2006).

Here, maintaining public trust becomes an additional reason to communicate responsibly, or more precisely, to demonstrate that research is communicated responsibly and that "[...] the careful consideration given to biosecurity concerns in the decision to publish" (NSABB, 2007, p. 27, C76). In this context, trust, security, and the pursuit of desirable futures become intricately interconnected. Security measures serve to establish public confidence, while, conversely, public confidence facilitates the advancement of life sciences towards a more desirable future, unhindered by excessive security restrictions. Paradoxically, demonstrating adequate security measures helps to prevent the implementation of unnecessarily restrictive security protocols.

The transition of the security object, from the experiment to the outcomes observed in the previous section, also emphasizes the importance of the information obtained through DURC experiments and their handling. Advancements in biotechnology are closely linked with visions of a beneficial future. Through this linkage, the tension between secrecy and transparency emerges as a central issue, as transparency is regarded as essential for scientific progress and fulfilling its promise of a desirable future. Although the Fink Report briefly addressed this matter, it is more prominently highlighted in the NSABB reports. The two conflicting priorities—preventing misuse and disseminating research findings—are a primary concern within these reports. I would like to underscore four key points within this discussion that elucidate the development of current DURC regulations: a concern about overregulation, significant mistrust of political and public institutions, the perceived necessity for vigilance and responsible communication of research, and the pursuit of a "rational" system capable of distinguishing between beneficial and hazardous communication.

The NSABB delineates an oversight process whereby the initial step involves assessing whether specific research presents a security concern. Nevertheless, the identification of a potential threat does not inherently necessitate the implementation of security measures. Instead, additional review is required to determine appropriate actions, considering the conflicting priorities associated with the research in question. The proposal to restrict communication in certain manner remains in tension with the imperative of maintaining open access to information. Several passages emphasize the "[...] need for reasonable balance in decisions about the communication of research with dual use potential" (NSABB, 2006, p. 9 C70; NSABB, 2007, p. 23, C77). The apparent necessity to establish an appropriate equilibrium is linked to the apprehension of excessive regulation previously identified in both the Fink report and the NSABB reports. For the NSABB, the resolution of this dilemma involves performing a risk-benefit assessment to determine the most suitable course of action.

6.5 Evaluating Risks and Benefits – Who's knowledge?

"NSABB members agreed that the principal investigator, using the criterion set forth above, should conduct the initial evaluation of his or her research for its potential as dual use research of concern. Those projects initially identified as dual use research of concern—and NSABB members anticipate that there will be very few projects that are truly dual use of concern—would undergo additional institutional review that involves interactive discussion among reviewers to assess the potential for and the ways in which information, technologies, or biological agents from the research could be misused to pose a threat; the likelihood that the information might be misused; the potential impacts of misuse; and the strategies for mitigating the risks that information from the research could be misused."
(NSABB, 2007, p. iv, C78)

In the preceding section, we discussed the dual necessity of responsible conduct, which involves considering the risks associated with dual-use experiments, originating from public perception (the public) as well as from the security concerns themselves (national security). The NSABB reports propose a twofold process to address the conflict between the need for open communication and the potential requirement for secrecy or restricted communication to meet security obligations. The initial step is to evaluate whether the disclosure of research information presents security implications. If it does, the subsequent step is to assess the extent of these security implications and the potential benefits derived from communicating the research findings. Therefore, "[i]f the communication of dual use research does pose potential security risks, the logical next step is a risk-benefit analysis of communicating the information" (NSABB, 2006, p. 9 C70).

The NSABB criterion for dual-use research is: "[…] research that, based on current understanding, can be reasonably anticipated to provide knowledge, products, or technologies that could be directly misapplied by others to pose a threat to public health and safety, agricultural crops and other plants, animals, the environment, or materiel" (NSABB, 2007, p. iv, C74). Two qualifiers restrict this broad criterion. The first is a temporal restriction: "based on current understanding" confines the scope to what is presently known. The second pertains to the conceptualization of science: "reasonably anticipated" limits which futures should be taken into account. To perform the initial dual use review and subsequent risk-benefit analysis, the NSABB reports advocate for an oversight system based on self-regulation, akin to the one employed for governing DNA research in the United States, precisely because it is not embedded in regulation. The authors of the NSABB reports contend that such an oversight system offers greater flexibility and adaptability to the evolving nature of scientific inquiry (NSABB, 2007, p. 5, C79).

The NSABB reports argue that dual-use reviews: "[…] should be done at the inception of any research and periodically throughout the research process" (NSABB, 2007, p. 15, C80). This periodic review is necessary because "[…] research findings are communicated at many points along the research continuum, e.g., during project concept and design, in funding applications, in seminars, and in publication of manuscripts […]" (NSABB, 2006, p. 8, C81).

Following this diffuse and rapidly evolving conceptualization of dual use, the NSABB reports prioritize the expertise of scientists regarding their research in order to anticipate future issues. Throughout various sections of the NSABB reports, researchers are depicted as the primary actors responsible for dual-use evaluations. Researchers, or more specifically, principal investigators, are designated as the responsible individuals who "[…] should conduct the initial evaluation of his or her research for its potential as dual use research of concern, using the criterion set forth above as guidance for decision-making" (NSABB, 2007, p. 22, C83, see also e.g., 2007, p. 51, C84).

Placing the researcher at the forefront is justified in the NSABB reports due to the expertise they can contribute. The researcher's role is delineated as pivotal within the oversight process, as they possess the most comprehensive understanding of the potential dual-use implications of their research (NSABB, 2007, p. 11, C82). Principle investigators, "after appropriate training" (NSABB, 2007, p. 9, C73), also become the principal authority on the dual use of a research project. However, higher-level institutions and peer-review mechanisms are also mentioned to "[…] ensure an unbiased and comprehensive evaluation and application of the criteria for identifying dual use research of concern" (NSABB, 2007, p. 9, C73). Despite this, local knowledge remains central and becomes authoritative in deciding whether something is dual use or not. As for the NSABB, any dual-use review requires "[…] scientific expertise and logical, sound judgment about the probability or foreseeability that others could misapply/misuse research results" (NSABB, 2007, p. 17, C85).

For the authors of the NSABB reports, conducting a risk-benefit analysis constitutes a logical subsequent step. Following the identification of potential dual-use experiments, it is imperative to evaluate the associated risks and benefits of disseminating the results of such experiments. The risk assessment proposed by the NSABB reports predominantly concentrates on the dual-use criterion employed. Researchers are advised to estimate whether it can be reasonably anticipated that their research might be directly misapplied and to consider the timeframe within which this could occur. Furthermore, the NSABB reports recommend incorporating the potential for "public misunderstanding and sensationalism" into the risk analysis. Parallel to this, a benefit assessment should be performed by examining whether the publication of research findings may serve to beneficially impact public health, safety, or the life sciences community, as well as the timeframe for such benefits. Ultimately, researchers are seen as responsible for balancing the potential risks against the expected benefits (NSABB, 2006, p. 11–12, C86). After weighing the risks against the benefits, the NSABB reports note that a corresponding publication strategy should be employed, ranging from full to no publication (NSABB, 2006, p. 9, C87).

Analysis

Within the NSABB definition of dual use, we observe the security conceptualization previously discussed. Security encompasses a broad scope and is not confined to the state; rather, it includes numerous facets of civilian life. Although the criterion that potential damage must be significant—stated elsewhere in the NSABB reports—limits its scope, it still potentially covers a broad range. Nevertheless, we identify two limitations within this criterion that substantially diminish the scope of research deemed dual use. These limitations have two implications for the dual-use review. First, they decrease the number of experiments that are considered dual use by the NSABB:

"The NSABB gave a great deal of thought to the issue of how much life sciences research might reasonably be considered dual use research of concern. Although it was not possible to quantify the exact amount of dual use research of concern that is generated in the U.S. or elsewhere in a given period such as a year, preliminary analyses suggested that the number of cases of true dual use research of concern will be quite small." (NSABB, 2007, p. 2, C88)

The NSABB acknowledges the potential for "misuse". However, due to limitations imposed by "based on current knowledge" and "reasonably anticipated", the number of future scenarios—and consequently, the number of experiments—that are considered diminishes significantly. Discourse in this domain focuses predominantly on questions of plausibility rather than possibility. In a certain sense, this represents an extrapolation of past conditions into future projections. The core issue revolves around what can be reasonably anticipated in the future, often grounded in historical experience. Consequently, these discussions frequently dismiss futures perceived as implausible or speculative.

A second challenge pertains to this issue: "directly misapplied". The research involved must be directly applicable to a "malicious" project. Interestingly, this appears somewhat contradictory to the importance of open communication, where transparency is crucial because every exchange of information can lead to new developments for other researchers. In the NSABB's perspective of the scientific process, open and unrestricted access to information is fundamental because science progresses incrementally. Researchers depend on this information to shape their investigations and to acquire new insights into the natural world, thereby contributing to progress towards a brighter future. Conversely, information that could potentially cause harm is excluded from this principle. Instead, dual-use information must be "directly" applicable to be regarded as risky, thereby limiting the range of scenarios classified as dual use. Within the biosecurity community, these two considerations frequently emerge in debates concerning whether certain activities qualify as dual use, with discussions typically centered on what is reasonable to anticipate and what is not.

The limitations associated with future scenarios that warrant consideration are somewhat inconsistent with the previously discussed conceptualization of science as a rapidly advancing field. Due to the swift progress characteristic of the life sciences, the implementation of a formal oversight system founded on strict regulations is deemed inappropriate here, as it lacks the flexibility necessary to adapt to the continually evolving scientific landscape. This causes a degree of tension: on one side, science is perceived as advancing at a pace that exceeds the capacity of formal regulations; on the other hand, potential threats are somewhat anchored in the present moment. There is a necessity for a "reasonable anticipation" whereby, "based on current understanding", information could be "directly" misapplied to inflict harm" (NSABB, 2007, p. iv, C74). In the reports by the NSABB, the future appears somewhat paradoxical, with hazards rooted in a linear interpretation of the present and opportunities envisaged within an increasingly rapid future.

According to the NSABB's conceptual framework for the review process, dual-use concerns may emerge at various stages throughout the research trajectory. The review of dual-use considerations thus becomes a complex issue, as potential problems can arise at virtually any point. An extensive knowledge of the research project and its contextual environment is essential for adequately identifying possible dual-use implications. Consequently, the level of familiarity necessary underscores the importance of the expertise possessed by the principal investigators, who have the most comprehensive understanding of their respective research efforts, shifting the responsibility for security measures towards the researchers.

At the outset of this chapter, we see that the NSABB reports articulate the concept of an informal and expeditious review process that is sufficiently adaptable to respond to the dynamic pace of scientific developments. This concept mobilizes researchers and their embodied knowledge in new ways. Researchers are positioned as individuals endowed with "scientific expertise" and a requisite familiarity with their research to identify dual-use implications and assess their significance within their own work. In this context, researchers function as a form of tripwire against undesirable futures, tasked with raising alarms should their research possess the potential to contribute to such outcomes. In accordance with Jasanoff's notion of socio-technical imaginaries, this reinforces the perspective that the future remains intricately intertwined with scientific endeavors, as reflected in the NSABB reports, where scientists, in contrast to a democratic public, are regarded as the primary custodians of desirable futures.

6.6 Conclusion: Immaterial Threats in a Civilian World

The NSABB reports expand upon the foundations established in *Biotechnology Research in the Age of Terrorism* and continue the dual imaginaries of techno-fix and techno-fear. However, both imaginaries have transitioned from their Cold War, state-centric legacy to be rooted in a civilian, all-hazards framework that emphasizes individual risks. Regarding the techno-fear perspective, the NSABB considers a wider array of domains that advanced biotechnology might potentially threaten. The focus has shifted from the state being the exclusive object of techno-fear to including sectors such as agriculture, public health, and the environment. This transition can be likened to the broader movement away from traditional security paradigms, which concentrated on existential threats, toward conceptualizations encompassing various non-existential hazards that necessitate attention.

In the techno-fix imaginary, a comparable phenomenon is observable within the NSABB reports. The Fink Report primarily focused on biotechnology as a potential solution to mitigate the impacts of biological weapons. Conversely, the NSABB reports develop an imagination in which biotechnology serves as a potential remedy for several potential risks. A desirable future is envisioned not merely as one in which the effects of biological weapons are mitigated but also as a future devoid of illness, characterized by economic prosperity and a healthy environment. Similar to techno-fear, the imaginary in which biotechnology becomes intertwined extends over a much wider area. Likewise, biotechnology is no longer legitimized by the state but is also justified by its prospective benefits to individuals on a global scale. Therefore, the first conclusion we can derive from the comparison of the two reports is that techno-fix and techno-fear have transitioned into civilian spheres. They are no longer confined to state-centric security imaginaries but now encompass societal imaginaries as a whole.

The second significant distinction pertains to the NSABB's transition from emphasizing materials to emphasizing knowledge. Consistent with its historical focus, the Fink Report primarily addressed the production of biological weapons and the potential contribution of DURC to bioweapons proliferation. In subsequent NSABB reports, a notable shift is observed away from concentrating on material aspects, as the knowledge generated (and later disseminated) in DURC experiments emerges as the primary conduit through which technology may become hazardous. These reports express a greater concern with the dissemination of knowledge than with the proliferation of physical materials. This represents a fundamental divergence, as technology is now regarded less as a tangible substance subject to physical safety protocols, and more as an immaterial entity, where physical safety measures such as export controls assume only a minor role.

Simultaneously, the NSABB reports are less concerned with the existence of DURC experiments and more with their potential misuse. Shifting attention towards the immaterial aspects contributes to a conceptualization of insecurity, in which the causes of insecurity stem primarily from the application of that technology, not the technology itself, leading to policy choices that focus mainly on governing the circulation of knowledge. We have already discussed the tension between this and the need for open communication as a critical element for the progress of science. However, I would like to revisit this point as it marks a significant distinction between the Fink Report and subsequent documents. The Fink Report primarily focused on conducting experiments. In contrast, later reports are less concerned with the experiments themselves and more with resolving the tension between open communication and insecurities arising from the circulation of knowledge.

Throughout the NSABB reports, a particular conceptualization of science emerges, wherein traditional security measures are deemed insufficient to resolve the inherent tension. Science is characterized as advancing at a pace that outstrips governmental interventions such as legislation and hearings. Consequently, self-governance frameworks are proposed as sufficiently adaptable to accommodate the rapidly evolving nature of scientific progress. This approach also facilitates the engagement of new actors as "managers of unease". In this context, scientists themselves are entrusted with the responsibility of safeguarding research endeavors and, by extension, a desirable future. In the subsequent chapter, this issue will be examined more detail. Additionally, we will examine more closely the role of risk and risk-benefit assessments in addressing the tension between techno-fix and techno-fear—particularly as it pertains to DURC—will be scrutinized more closely.

7 The German Discourse: Risk, Responsibility and Roads not Taken

The third analytical chapter provides a more detailed examination of the German discourse. The sample comprises three documents that were analyzed extensively. The first document is the DFG/Leopoldina report. As previously discussed, *Scientific Freedom and Scientific Responsibility* closely parallels an earlier MPG report, and, as outlined in the methodology section, these two reports will be treated as a single entity. The second document is the Ethics Council's report on *Biosecurity—Freedom and Responsibility of Research*. This chapter serves two primary objectives: firstly, to analyze several key themes in the framing of DURC as a security threat; and secondly, to explore the role of risk in balancing insecurity with the necessity for transparency, along with the interplay between science and society. Both thematic strands enhance our understanding of how DURC has been conceptualized as a security concern and its broader implications.

Conversely, this chapter offers an opportunity to examine the development of a hegemonic discourse within DURC. While the MPG/DFG/Leopoldina report supplements the discourse previously presented in the Fink Report and the NSABB reports, the Ethics Council adopts a different discourse in several key instances. By analyzing the two reports together, it becomes evident how they diverge, drawing on distinct discursive strands. Consequently, both reports are discussed concurrently in this chapter and are not separated, as is the case with the US sample. Comparing the MPG/DFG/Leopoldina reports with the Ethics Council's report provides insights into why Germany selected the approach outlined in the MPG/DFG/Leopoldina report as its model for DURC governance. The MPG/DFG/Leopoldina report reflects a hegemonic, global conceptualization of DURC as a security concern. In contrast, the Ethics Council report challenges this hegemony and attempts to establish an alternative conceptual framework. I wish to start the discussion of the reports by concentrating on the techno-fear and techno-fix imaginaries contained therein. Both continue a discourse that has been previously observed in earlier documents; however, they also present certain local variations.

7.1 Dangerous if Misapplied in the Future

Regarding the construction of insecurity, the MPG/DFG/Leopoldina reports remain relatively silent. As we have seen in the NSABB reports, biotechnology-related insecurities are almost common sense. Biotechnology and life science research become dangerous when misapplied by somebody. The MPF/DFG/Leopoldina reports explicitly mention that dangerous research is not limited to the life sciences but can rise in every discipline. The MGD/DFG/Leopoldina reports emphasize that insecurities from the misuse of science can arise in "[…] most areas of research" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 9, C89).

Similar to the NSABB reports, we observe a conceptualization of danger that primarily resides outside the scope of life science experiments. The experiments themselves are regarded as less problematic; they become hazardous only if they are misused or misapplied. The MPG/DFG/Leopoldina reports share a comparable understanding of life science and researchers' actions. Accordingly, it is stated: "[Biosecurity] risks do not necessarily result from negligence or deliberate misconduct by scientists. In all areas of science, there is also the danger that findings—which are neutral or useful per se—may be misused by third parties for harmful purposes" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 9, C90).

Similar to the NSABB reports, the MPG/DFG/Leopoldina reports consistently emphasize that scientists must be conscious of the potential for their research to be misused. They are advised to: "[…] take account of the consequences and opportunities for application and misuse of their work [...]" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 12, C91). In addition, the MPG/DFG/Leopoldina reports reaffirm their view of research as inherently beneficial, while also highlighting that researchers should be aware of the: "[…] possibility that useful research findings could be misused for harmful purposes by third parties" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 12, C91). We have previously observed the crucial importance attributed to awareness and education in handling DURC in the NSABB reports, and this emphasis will persist in subsequent analyses of the German sample. Nonetheless, the two selected instances are noteworthy as they underscore the normative value of research itself, suggesting that it is inherently beneficial and only becomes problematic through misuse or misapplication.

A second point of interest arises here. While the English versions of the MPG/DFG/Leopoldina report predominantly address a general risk of research being misused to cause harm, the German version of the MPG report delineates specific areas where DURC research could pose threats. For instance, the MPG report indicates that DURC could potentially threaten the "protection of human rights", "international humanitarian law", the "law of armed conflict", "prohibitions on torture and violence", or the "Biodiversity Convention", along with more abstract concerns related to human dignity, life, health, the environment, or other "important areas protected by the basic law", which are also referenced in the English version of the text (Max-Planck-Gesellschaft, 2010, p. 7, C92).

The Ethics Council articulates a shared apprehension of technological risks, aligning with the perspectives presented in the MPG/DFG/Leopoldina reports. It emphasizes that biotechnology possesses the potential for misuse, which can result in harm. Furthermore, the Ethics Council contends that dual-use issues inherently associate the risk of misuse with the research process itself, thereby presenting ethical challenges for researchers, research institutions, funding agencies, and governments (Deutscher Ethikrat, 2014, p. 55, C93). The Ethics Council shares the general conceptualization of insecurity with the MPG/DFG/Leopoldina reports. They too see biosecurity as "[…] scenarios in which harm to humans, the environment or other legal interests is caused intentionally" (Deutscher Ethikrat, 2014, p. 169, C94). DURC is designated as possessing at least the abstract potential for misuse, and the outcomes of DURC experiments could be utilized in the development of Weapons of Mass Destruction (Deutscher Ethikrat, 2014, p. 187, C95). For example, the Ethics Council highlights the concern that, with increasing understanding of pathogens and genetic engineering, there is a rising potential for "malicious actors" to employ entirely new pathogeneses for their "nefarious purposes" (Deutscher Ethikrat, 2014, p. 21, C96). Similarly, the Ethics Council highlights the concern that states may employ advanced biotechnology to develop a new generation of biological weapons (Deutscher Ethikrat, 2014, p. 45, C97).

Interestingly, the Ethics Council contends that DURC is mainly an on-the-horizon threat. It argues that, pathogens are difficult to acquire, particularly for non-state actors (Deutscher Ethikrat, 2014, p. 45, C97), and biotechnical methods are complicated to implement for actors without the backing of large institutions and with limited financial resources and personnel. Given that bioengineering pathogens are highly complex and necessitate skilled personnel with extensive expertise, non-state actors may encounter difficulties in utilizing DURC experiments to inflict harm (Deutscher Ethikrat, 2014, p. 46, C98). The report states that, particularly in instances where the researcher is not concurrently the perpetrator, the challenges, the risks posed to the (mis-)user's health, and the time required in practice to execute biotechnological procedures are frequently underestimated (Deutscher Ethikrat, 2014, p. 45, C97).

According to the Ethics Council, the development of biological weapons, particularly sophisticated ones such as those utilizing bioengineered pathogens, typically necessitates the resources possessed by a sovereign state entity (Deutscher Ethikrat, 2014, p. 187, C99). While the Ethics Council does not rule out the potential for any group to utilize DURC experiments for the development of biological weapons (Deutscher Ethikrat, 2014, p. 187, C99), they place the misuses of biotechnology instead in the realm of medium to long-term threats (Deutscher Ethikrat, 2014, p. 45, C100), where de-skilling may facilitate increased utilization of biotechnology by a broader range of actors, the Ethics Council emphasizes the considerable challenges associated with evaluating this potential (Deutscher Ethikrat, 2014, p. 53, C101).

Analysis

While all documents share a certain conceptualization of techno-fear, two key differences are evident in this section. The MPG/DFG/Leopoldina report conceptualizes science as being inherently good and views misuse as occurring outside of the experiments themselves or science in general. The insecurities associated with advanced biotechnology and life sciences do not originate from the research itself, as the research remains at least neutral. Furthermore, these insecurities do not arise from the conduct of the scientists. Instead, the cause of these insecurities is attributed to the actions of external third parties who misuse scientific work for "harmful purposes". This externalization shifts the perceived source of insecurity away from the scientific community toward potentially malicious actors. Implicitly, this framing suggests that life science research is inherently good or beneficial, and that misuse is external to its normative value.

This externalization of danger to a realm outside of the scientific process cannot be found in the Ethics Council report. On the contrary, the Ethics Council at least entertains the notion that scientists could themselves be the perpetrators of misuse. As we can see later in the analysis, the Ethics Council is also much more hesitant to understand science as normatively good, and different conceptualizations about science can be found throughout the report. The second key difference that I like to point out is the temporal construction of danger. The Ethics Council repeatedly states that misusing advanced biotechnology is not easy, and specialized knowledge is needed. As such, the reports see the dangers associated with DURC as on-the-horizon threats that depend on several context variables (e.g., de-skilling) to materialize. These limitations cannot be found in the MPG/DFG/Leopoldina reports. Instead, the MPG/DFG/Leopoldina reports are almost silent on the contextual factors that could lead to misuse.

7.2 Zero Sums and Unequal Distributions

Both the Ethics Council and the MPG/DFG/Leopoldina reports assign several benefits to life sciences and biotechnology. Biotechnology is regarded as essential for the "progress of humanity" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 9, C102). One of the primary areas of advantage is public health and the acquisition of knowledge about various diseases (Deutscher Ethikrat, 2014, p. 64 C104; see also: p. 176, C103). Another commonly listed area is the environment (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 9, C102; Deutscher Ethikrat, 2014, p. 64, C104). Furthermore, the MPG/DFG/Leopoldina reports, along with the Ethics Council, refer to a broad concept of human progress when discussing the potential benefits of research and science. They also highlight various categories in which biotechnology could serve society: "[...] the extension of the boundaries of knowledge and enhances the welfare, prosperity, and security of mankind and the protection of the environment" (Max-Planck-Gesellschaft, 2010, p. 4, C105; see also: Deutscher Ethikrat, 2014, p. 187, C106).

Rather than focusing on the national security advantages prominently highlighted in the United States reports, the MPG/DFG/Leopoldina appears to possess a broader, more global conception of security, characterized as "security of mankind" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 9, C102). Similarly, the Ethics Council contends that life science research represents an important avenue through which humans and the environment are safeguarded against potential hazards (Deutscher Ethikrat, 2014, p. 64, C104). This may represent a subtle variation in emphasis, or it may stem from a slightly different interpretation of the term ‘security’ within the German language. Nonetheless, as with preceding reports, biotechnology and life sciences are conceptualized as serving the overall benefit of society. Concurrently, the reports consistently associate research with a forward-looking perspective. For instance, the Ethics Council asserts that life science research is essential: "[...] to achieve and maintain certain standards of living and to provide for future generations" (Deutscher Ethikrat, 2014, p. 175, C107).

The documents allocate comparable advantages to the conduct of DURC experiments. However, the Ethics Council and the MPG/DFG/Leopoldina reports exhibit considerable divergence in their conceptualization of the relationship between science and society. The interpretation of life since research, as outlined in the MPG/DFG/Leopoldina reports, views science as directly contributing to societal benefit (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 12, C108). Consequently, the reports assign a responsibility to scientists for ensuring the security of the research. As researchers undertake studies that directly benefit society, they are also obligated to "[…] prevent or minimize direct or indirect harm to humans and the environment as far as possible" (Max-Planck-Gesellschaft, 2010, p. 7, C109).

Furthermore, the DFG/MPG/Leopoldina report's conceptualization of science asserts that abstaining from a research project constitutes a risk in its own right. The reports from MPG/DFG/Leopoldina contend that refraining from engaging in a DURC research project could inherently pose a risk, particularly in circumstances such as when the project aims to develop a vaccine for an imminent epidemic (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 9, C206). Thus, in assessing the risks of a particular research project, both types must be considered as researchers must: "[…] take account of the consequences and opportunities for application and misuse of their work and its controllability. In doing so, they should also consider the risks of not conducting the research in question" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 12, C110).

Free research is emphasized as a top priority in the reports by MPG, DFG, and Leopoldina, highlighting the direct connection between society and science. The reports assert that "Freedom of Research" ensures societal progress and prosperity (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 6, C111). Through a rare notion of national security, this has immediate implications for the potential regulation of DURC research, as restrictions on science or the publication of scientific findings become significantly challenging due to the following consideration: "[…] suppression of research results may prevent effective protection against their misuse by totalitarian regimes, terrorist groups, organized criminal groups or individual criminals" (Max-Planck-Gesellschaft, 2010, p. 9, C112; see also: Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 14, C113).

While the Ethics Council report acknowledges a notion of science that is normatively good (Deutscher Ethikrat, 2014, p. 172 C114), it argues that the concept of linear scientific progress is fundamentally flawed. Particularly in the domain of basic research, the benefits of science cannot be readily predicted or systematically planned (Deutscher Ethikrat, 2014, p. 173, C115). In contrast to the MPG/DFG/Leopoldina reports, the Ethics Council contends that uncertainty and inequality characterize contemporary research. The advantages of research cannot be predicted with certainty, as they rely on numerous intermittent steps (Deutscher Ethikrat, 2014, p. 66, C116). The report also notes that research does not benefit society equally, as the advantages derived from science are not distributed uniformly across society, while many of the risks associated with DURC are (Deutscher Ethikrat, 2014, p. 67, C117).

Analysis

All reports encompass a techno-fix narrative. Nevertheless, the techno-fix within the German sample diverges from that of the United States, as it predominantly pertains not to a national security logic but to a wider array of societal concerns. Notably, the Fink Report and, to a lesser extent, the NSABB reports discuss benefits pertinent to national security and include a catalog of areas where biotechnology might be advantageous. Conversely, the German reports place less emphasis on the national security aspect of biotechnology and emphasize a more abstract conception of societal benefits and knowledge production. In this context, the Ethics Council, along with the MPG/DFG/Leopoldina reports, engage with socio-technical imaginaries concerning a desirable future and portray a notion of science that is considered morally desirable. However, the imaginary depicted in the German sample appears to be less definitive.

While the MPG/DFG/Leopoldina reports assign an almost linear progression to science that benefits society through its advancements, the Ethics Council employs a divergent conception of science wherein the benefits are neither directly nor equally applied to society. Within the MPG/DFG/Leopoldina reports, abstaining from research constitutes a risk in itself that must be weighed against the risks associated with potential misuse of technology. Within the Ethics Council report, we see similar arguments; however, it posits that the benefits of science are neither certain nor equitably distributed. This conceptual shift regarding science influences the Ethics Council's perspective on how to regulate DURC research. In the MPG/DFG/Leopoldina reports, there is an almost zero-sum logic suggesting that every restriction on research could pose a danger to society. In contrast, the Ethics Council contends that the relationship between science and society is more complex and nuanced.

7.3 Making Life Science: Laws, Progress, and Society

In the preceding sections, we have already examined the conceptualization of science as free and open and its association with an aspirational future. The reports from MPG/DFG/Leopoldina reports, we find two lines of reasoning supporting this conceptualization of science. The first is derived from references to Article 5 of the Basic Law of Germany, which ensures the freedom of scientific inquiry (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 6, C118). Within the report, references to Article 5 restrict what measures can be implemented to secure DURC, as all measures must be "[...] compatible with researchers' scientific freedom" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 16, C119). This constrains legal regulations concerning DURC that, as the MPG/DFG/Leopoldina reports contend, "[...] would conflict with the freedom of research enshrined in the constitution" (Max-Planck-Gesellschaft, 2010, p. 5, C120).

The conceptualization of science as open is not solely associated with legal guarantees but also with the notion of a desirable future. Analogous to the perspectives presented in the NSABB reports, the MPG/DFG/Leopoldina reports contend that scientific endeavors must be open to ensure their efficacy: "The freedom of research [...] is the main requirement for [the benefits provided by life science research]" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 9, C121; see also: Max-Planck-Gesellschaft, 2010, p. 4, C122). The reports by MPG, DFG, and Leopoldina characterize science as a discipline that necessitates unrestricted communication in order to be successful (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 9, C123; Max-Planck-Gesellschaft, 2010, p. 4, C124), as scientific process is conceptualized as an iterative process in which scientists test and verify previous results (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 13, C125; Max-Planck-Gesellschaft, 2010, p. 9, C126).

In the Ethics Council Report, a comparable line of reasoning is observed; however, it is more closely associated with the ethical dilemma between risk mitigation and scientific freedom. The conflict between potential risks and benefits arising from research presents an ethical challenge intrinsically linked to the relationship between science and society. For the Ethics Council, this tension is evident in areas such as security-relevant research, biosafety concerns, and other fields with security implications (Deutscher Ethikrat, 2014, p. 57, C127). For the Ethics Council, establishing an appropriate balance between the opportunities and risks associated with research is "[...] first and foremost the issue of the relationship between science and society" (Deutscher Ethikrat, 2014, p. 56, C128).

The relationship between science and society is one of the core discussions in the Ethics Council report, with society being perceived as a major stakeholder in science (Deutscher Ethikrat, 2014, p. 175, C129). According to the Ethics Council report, science directly benefits society (Deutscher Ethikrat, 2014, p. 175, C129), but it can also pose a danger to society (Deutscher Ethikrat, 2014, p. 66, C130).

The Ethics Council's report contends that biotechnology has advanced significantly over the past decades, resulting in increased availability of knowledge in the public domain. This encompasses, for instance, the genome of *Yersinia pestis*, the microorganism responsible for the plague, as well as the genome of the smallpox virus (Deutscher Ethikrat, 2014, p. 24, C131). Additionally, biotechnological methods have advanced. As with the Fink and NSABB reports, the Ethics Council highlights de-skilling as a key concern. Automation and de-skilling could enable individuals with limited training and experience to effectively carry out sophisticated bioengineering techniques. The Ethics Council also identifies increased knowledge and greater accessibility as factors that may elevate the risk of misuse. Nonetheless, the Reports of the Ethics Council contend that predicting these developments is challenging, and substantial uncertainty remains regarding the timing and how the progress of science would significantly impact the risk of misuse (Deutscher Ethikrat, 2014, p. 47, C132).

For the Ethics Council, the progress in science does not only impact security concerns related to scientific research. It also transforms the relationship between science and society. The Ethics Council states that, especially in the life sciences, there has been a blurring of the boundary between foundational research and its application, as research methods have evolved from observation to intervention. Advances in the life sciences have significantly expanded the scope of this research domain, rendering a clear demarcation between knowledge acquisition and its application increasingly challenging (Deutscher Ethikrat, 2014, p. 56, C133) to the extend where such a distinction can no longer be maintained (Deutscher Ethikrat, 2014, p. 60, C206). Conversely, the Ethics Council contends that science cannot be regarded as isolated from society. Given that the distinction between research and duplication has become unsustainable, science is no longer separable from societal influences. It must be evaluated not solely on the basis of the knowledge generated but also in accordance with broader social criteria (Deutscher Ethikrat, 2014, p. 59, C134).

Analysis

Implicitly, in the cases of the MPG/DFG/Leopoldina reports and explicitly within the Ethics Council report, the German debate predominantly concerns the role of science in society. Throughout various sections of the reports, the relationship between science, scientists, and the public is examined. The reports emphasize the responsibilities that derive from science being an integral part of broader societal frameworks. In these documents, such responsibilities are primarily interpreted as fostering benefits for society. Science is perceived as a technological solution for a prosperous future. Consequently, scientists are primarily tasked with safeguarding science and, consequently, ensuring a desirable future. In contrast, the Ethics Council report presents a more complex view of the relationship between science and society.

The MPG/DFG/Leopoldina reports consider science and society as relatively separate entities. The relationship between these two spheres is already codified through legislative documents. The discussion herein demonstrates the deployment of various discursive artifacts to uphold the established relationship between science and society. A similar pattern has previously been observed in the US reports, where references to the National Security Decision Directive 189 of 1985 are made. NSDD 189 ensures the uninhibited transfer of primary research findings. In a manner analogous to Article 5, the reference to the two elements herein functions to delimit the range of potential policy determinations. The discussion presented in the MPG/DFG/Leopoldina reports confines legal regulations as a policy measure for the management of DURC. Within this framework, advancements in science should not be hindered, as such progress is intrinsically linked to societal benefits.

In contrast, the Ethics Council report emphasizes the evolving nature of science. Science is perceived as advancing rapidly. However, the Ethics Council considers that this has implications not only for potential security concerns but also for the relationship between science and society. The Ethics Council presents a perspective that science and society are becoming increasingly interconnected as a result of scientific progress. In this logical framework, advancements in scientific research do not inherently constitute benefits to society; rather, they can engender developments that are incompatible with societal values. Consequently, research is no longer regarded as intrinsically normatively positive, with the primary concern shifting to the potential misapplication of research outcomes, which may produce results that contravene societal values during the process. Additionally, the Ethics Council introduces an element of uncertainty into its narrative regarding scientific progress. As previously discussed, the Ethics Council perceives DURC mainly as an on-the-horizon/over-the-horizon threat, something that may materialize in the coming years. Similarly, this element of uncertainty influences the anticipated benefits derived from scientific endeavors. The Ethics Council contends that scientific benefits are distributed unevenly across society, thereby complicating the relationship between science, societal risk, and chance, rendering it less straightforward than depicted in the MPG/DFG/Leopoldina reports. These contrasting conceptualizations of the relationship between science and society affect the report's perspective on potential policies aimed at regulating DURC.

7.4 MPG/DFG/Leopoldina – Self-Governance, Knowledge, and Risk

In the previous section, we saw how different conceptualizations of the relationship between science and society lead to different outlooks on the governance and regulations of DURC. Here, the two reports diverge greatly from one another. In order to better trace the discussions in the respective reports, I have decided to separate them at this point and discuss them individually.

I begin with the DFG/MPG/Leopoldina report, which puts forward a conceptualization of science as relatively separate from society and as a techno-fix for a number of nonspecific risks and concerns. Drawing on a discursive tradition in which science and society are separate entities leads to skepticism over society's capability to effectively regulate DURC in the MPG/DFG/Leopoldina reports. Thus, the socio-technical imaginary constructed in the reports has significant impacts on which security measures are understood as effective and justified.

Legal Regulations and Privileged Knowledge

"[F]ree research is also associated with risks. These risks result primarily from the danger of useful research findings being misused (known as the dual use dilemma). Legal regulations can only cover these risks to a limited extent." (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 8, C135)

In the MPG/DFG/Leopoldina reports, the relationship between science, security, and the regulatory legal framework in which they are embedded is not as straightforward as the apparent simplicity suggested by the previous emphasis on openness and transparency. The reports consistently include segments advocating for a sense of responsibility among scientists that extends beyond merely adhering to legal stipulations. Furthermore, legal regulations are characterized within the reports as the predominant authority governing scientific activity. What science can do is: "[…], in the first instance, determined by legal provisions" (Max-Planck-Gesellschaft, 2010, p. 5, C136). Legal regulations provide a framework for research activities, and the reports emphasize the importance of researchers complying with applicable legal constraints for research, not least because violating laws would lead to adverse conditions for the conduct of science ("sanctions", "lengthy procedure") and potentially damage the reputation of institutions such as the MPG, DFG, and Leopoldina (Max-Planck-Gesellschaft, 2010, p. 5, C137). On the one hand, as indicated by the initial quote, legal regulations are depicted as ineffective within a rapidly evolving research environment (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 8, C135).

Similar to the NSABB reports, research is perceived to be advancing at a pace that outstrips the ability of legislation to adapt to the continuously evolving scientific environment. Thus, legal measures: "[...] would not sufficiently take account of the differentiated and rapidly changing global issues of area-specific risks and would conflict with the freedom of research enshrined in the constitution" (Max-Planck-Gesellschaft, 2010, p. 5, C138). In the reports, laws are generally perceived as somewhat ineffective in regulating research activities. Rather than relying solely on formal legal regulations, the reports from MPG, DFG, and Leopoldina advocate for a self-governance framework that would be better equipped to: "[…] stay abreast of the continually changing research landscape, account for difficult dual-use risk estimates, and make the difficult value judgments that follow – especially in cooperation with specialized committees" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 11, C139).

The MPF/DFG/Leopoldina argue that scientists have the highest familiarity with the research. The reports consistently equate knowledge with the flexibility required in a swiftly evolving research environment. Conversely, a self-governance structure becomes a principal instrument of DURC governance, as it is: "[…] founded on a high level of familiarity with the subject and can react flexibly"

(Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 8, C140). The reports conclude that the acceleration of scientific progress outpaces the governance process, rendering scientific knowledge essential for navigating dual-use concerns. Through scientific expertise, scientists are able to "[…] stay abreast of the continually changing research landscape […]" and "[…] account for difficult dual-use risk estimates and make the difficult value judgments that follow […]" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 11, C141).

Scientific Responsibility

The capacity for self-governance inherently entails a corresponding duty to do so. Throughout the MPG/DFG/Leopoldina reports, there are segments asserting that scientists' familiarity with their subjects leads the public to anticipate responsible and ethical conduct. Conversely, the MPG/DFG/Leopoldina reports maintain that such expectations originate from the public's belief that scientists adhere to "ethical principles" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 6, C143). Conversely, scientists are regarded as possessing an inherent responsibility, adhering to legal regulations due to their knowledge, experience, and the freedoms granted to them (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 8, C142).

Accordingly, researchers are regarded as experts in the reports and serve as the primary actors in DURC governance. The MPG/DFG/Leopoldina report notes that, ultimately, the individual researcher (supported by their respective organization) must determine the security implications of their research. As the primary security actors, the researcher: "[…] must therefore use their knowledge, experience and skills to recognize, estimate and assess relevant risks. In critical cases, these individuals must make a personal decision about the constraints on their work, and take responsibility for that decision within the scope of their freedom of research. In some cases, the result may be that some projects – even those that are not prohibited by law – must be carried out in a different form or not at all" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, pp. 10–11, C144).

This passage illustrates a certain individualization of security, whereby scientists assume responsibility for adhering to "subject-specific" regulations concerning risk mitigation and for enhancing awareness (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 15, C207). Scientists are assigned the responsibility to minimize the risks involved in their work (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 13, C208) and, in the master-apprentice model of training younger scientists, they are entrusted with the responsibility of communicating risks and exemplifying proper conduct (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 15, C145).

As the primary actors: "[e]valuating whether research complies with legal provisions, self-regulatory measures and ethical principles is, in the first instance, the task of the scientists responsible for the project. In addition, the scientists' superiors bear responsibility, in particular within the scope of their legally required duty of supervision" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 15, C146). Notwithstanding this individualization, the MPG/DFG/Leopoldina reports delegate the responsibility to research institutions to assist scientists in their risk assessments. These institutions are mandated to increase awareness and communicate the legal requirements that researchers must adhere to (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 16, C147). In addition increasing awareness and participating in a self-governance framework, research institutions are also required to establish internal regulations for managing research with security considerations. The report by MPG/DFG/Leopoldina emphasizes that research institutions should not merely adhere to legal obligations but mitigate risks as far as possible (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 8, C148).

Risk, Risk Mitigation, Risk-Benefit

"The primary goal of risk analysis is to carry out and communicate research in a responsible way." (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 14, C209; see also: Max-Planck-Gesellschaft, 2010, p. 9, C149)

Risk is prominently featured within the self-governance frameworks outlined in the MPG/DFG/Leopoldina reports. These reports conceptualize risk as a critical factor that researchers must be cognizant of to effectively prevent or mitigate associated issues (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 12, C150). If any potential risks are identified, the reports assert that a comprehensive risk analysis must be conducted. For subsequent risk assessments, the MPG/DFG/Leopoldina reports propose considering a broad spectrum of factors deemed significant. These include: "[…] the extent of possible damages, the probability of damage risk, [wether] the research results could be used directly for harmful purposes, or whether complex implementation processes are required, and whether the use of the results could be controlled" (Max-Planck-Gesellschaft, 2010, p. 9, C151). The reports contend that these risks are not solely attributable to the conduct of the researcher. Researchers undertake their work for "neutral or useful purposes"; however, their findings may be exploited for malevolent objectives or "misused by third parties" (Max-Planck-Gesellschaft, 2010, p. 8, C152).

In another instance, the MPG/DFG/Leopoldina reports note that: "[…] following factors should be considered: the probability that damages will occur, the extent of possible damages, the extent to which the research results could be used for harmful purposes with or without complex implementation processes. Finally, consideration should be given to whether misuse can be prevented and the extent to which the consequences can be controlled. Other decisive factors include the identity of the cooperation partners, customers, users and funders of the research" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 14, C153). Risk assessment in this instance also includes: "[…] consider[ing] the risks of not conducting the research in question" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 12, C110).

The second step in managing the dangers associated with DURC is to translate the risk analysis into a risk-benefit assessment. In this context, the reports emphasize that researchers must evaluate the benefits of their research against the associated risks (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 8, C210). Risk assessment and risk-benefit analysis are conducted in conjunction with risk mitigation measures, as researchers are tasked with minimizing the risks associated with their research projects (Max-Planck-Gesellschaft, 2010, p. 7, C211), before and during their research (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 13, C212). For the MPG/DFG/Leopoldina reports, risk mitigation is of significant importance, as risk-benefit analyses should account for whether the anticipated advantages of a research project outweigh the possible damages subsequent to the application of risk mitigation measures (Max-Planck-Gesellschaft, 2010, p. 9, C213).

Similar to the NSABB reports, the risk mitigation strategies proposed by the MPG/DFG/Leopoldina reports primarily concern the communication of research findings. The MPG/DFG/Leopoldina recognize the tension between security concerns and the desire to publish results (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 13, C154). However, the reports argue that full publishing of research results can be postponed or restricted if research is considered DURC and can be directly misapplied to cause significant damage (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 13, C155). Alternatively: "[…] researchers may only share specific results of their work with certain persons" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 14, C157; see also:, p. 13, C156).

Simultaneously, the MPG/DFG/Leopoldina reports contend that imposing restrictions on the dissemination of research findings presents its own set of risks, as it could adversely affect the development of defenses against bioweapons utilized by both state and non-state actors (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 14, C158). As in prior reports, the MPG/DFG/Leopoldina report emphasizes that the open dissemination of research findings is a fundamental element for scientific advancement and its capacity to generate protective strategies against various threats. Consequently, abstaining from full publication should be regarded as a measure of last resort (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 14, C158).

In accordance with the comprehensive understanding of research risks previously discussed in this analysis, access restrictions are considered to address both accidental incidents and hazards stemming from the misuse of research products. In this understanding, minimizing risk includes the adoption of measures to prevent the release or theft of pathogens, as well as measures to safeguard the confidentiality of research findings (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 13, C156). While research "[…] which from the outset is subject to comprehensive confidentiality for an unforeseeable period of time is incongruous with the self-conception of the Max Planck Society […]" (Max-Planck-Gesellschaft, 2010, p. 9, C159), access restriction might be put in place as risk mitigation techniques.

Therefore, the accessibility of research outputs becomes a significant consideration within the risk analysis presented in the MPG/DFG/Leopoldina reports, and researchers should take into account who their collaboration partners, users, and funding agencies are and whether or not they adhere to sufficient security standards (Max-Planck-Gesellschaft, 2010, p. 10, C160). Reminiscent of the personalization of security decisions, insecurity also becomes somewhat personalized. In this understanding, insecurity arises from malicious actors gaining access to the relevant research projects. Accordingly, the reports contend that employees and cooperation partners must be selected judiciously based on their "reliability" and "sense of responsibility" (Max-Planck-Gesellschaft, 2010, p. 8, C161).

Similar to the reports by the NSABB, the MPG/DFG/Leopoldina reports advocate for the establishment of specialized oversight boards to assist researchers in their risk evaluation processes. These oversight boards, called KEF, an acronym for "commissions for ethics in research"[15], should be implemented at the institutional level, and: "[e]ach institution should set up a special committee on research ethics to implement these rules and to advise scientists" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 8, C162). These Commissions are intended to be "[…] special research ethics committee to advise on issues arising from the implementation of ethics rules. This committee should provide researchers with support on issues of research ethics, mediate in differences of opinion between researchers on relevant matters, and issue recommendations on the implementation of research projects. The committee's powers and actions must be compatible with researchers' scientific freedom. This is particularly true when committee decisions are set to be compulsorily enforced or reinforced with sanctions" (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 15, C163).

As a final measure, the MPG/DFG/Leopoldina reports mention the complete restriction of research activities. If mitigation measures are deemed unfeasible, high-risk research should only proceed subsequent to a moratorium or be entirely avoided (Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 8, C164). However, this is primarily an afterthought as the "[…] primary goal of risk analysis is to carry out and communicate research in a responsible way" (Max-Planck-Gesellschaft, 2010, p. 9, C166; see also: Deutsche Forschungsgemeinschaft & Leopoldina, 2014, p. 14, C165)

Analysis

Throughout this section, three fundamental logics are identified. The first emphasizes privileging scientific knowledge over laws or other governance mechanisms. The MPG/DFG/Leopoldina reports present a temporal construction of science that advances at a pace surpassing that observed in the NSABB reports. In light of the rapid developments in life sciences, the familiarity of scientists with their subject matter becomes a crucial element in anticipating future hazards. Laws are viewed critically as being ineffective or unable to keep pace with scientific progress, thereby assigning them limited legitimacy. In the absence of legislation that explicitly guides behavior, scientists are accorded an ethical obligation to conduct research safely. This obligation includes safeguarding research from potential misuse. Guidelines and self-regulation systems serve not only to mitigate risks of misuse but also to shield researchers from allegations of unethical conduct, which could impede scientific

[15] "Kommissionen für Ethik in der Forschung" in the German original.

advancement. To some extent, this perspective incorporates elements of ethnicization and individualization, whereby scientists are positioned as primary actors responsible for making value judgments regarding the associated risks and benefits.

The second element we encounter once again is the centrality of risk assessments. As demonstrated herein, risk analysis encompasses a broad scope. When addressed with due diligence, the researcher responsible would not only need to possess substantial technical expertise but also be capable of assessing the likelihood and outcomes of misuse, at least in the near term. Achieving this is notably challenging, as technological development inherently involves uncertainties, even in the short-term. Interestingly, in the preceding section, technologies are presented as certain concerning the benefits of a specific research undertaking. Research appears to yield almost assured benefits. Otherwise, it would be challenging to compare the risks associated with undertaking a project to those of not pursuing it. Similarly, the risk analysis appears to presuppose that research projects are subject to nearly certain dangers that can be integrated into the quantitative framework of risk assessment. From this section, we can deduce that the specialized knowledge employed by scientists seems to primarily address certainties rather than uncertainties. The uncertainty inherent in discovery—which leads to increased knowledge—becomes intertwined with the retrospective, numerical logic of risk assessments, which are designed to accommodate the apparent certainty of past events and project them into the future.

In this context, risk assessments serve as techniques to identify dangers and implement mitigation measures within a research project. Following the implementation of mitigation strategies, a risk-benefit analysis must be conducted to evaluate the research project in question. DURC oversight or regulation of DURC, in this scenario, involves a case-by-case evaluation of associated risks and the corresponding mitigation measures designed to reduce these risks. This process demonstrates the normalization of dual-use concerns, which are integrated into risk assessments alongside other potential dangers, such as the accidental release of pathogens. Consequently, all potential hazards are encompassed under the category of "ethical research", necessitating their addressing through various mitigation strategies. The report additionally considers a research ban—either temporary or permanent—as a last-resort measure for risk mitigation. Nevertheless, as reflected in previous reports, risk predominantly assumes an enabling role within the MPG/DFG/Leopoldina reports. Risk analysis and mitigation serve to ethically justify research and facilitate its continuation, with restrictions justified only under exceptional circumstances.

The third essential element pertains to the externalization of hazards associated with scientific endeavors. Previously, the emphasis was placed on output-oriented concerns, notably framing publication as the principal source of risk. In this conceptualization, dangers are externalized from the research process itself, positing that knowledge output from a research project becomes perilous should it fall into malicious hands. Consequently, dual-use concerns are further externalized and, to some extent, individualized within this discourse. The risk here is attributed not to the research activity itself but to external entities that could access the research findings. This perspective is reminiscent of Cold War-era export controls, wherein technology is deemed hazardous only when crossing national borders and accessed by adversaries. As a result, hazards are perceived as external to the technology or scientific experiments, rendering the research itself relatively unproblematic, as it is not inherently dangerous. Concurrently, restricting access serves to reinforce the normative perception that life science research is ethically sound. In this context, the researcher assumes the role of an ethical intermediary; those identified as hostile actors are classified not as researchers but as outsiders who must be identified during risk assessment and mitigation processes.

7.5 Ethics Council: Science, Society and the Limits of Risk

Contrary to the MPG/DFG/Leopoldina reports, the Ethics Council report presents an alternative perspective regarding the applicability of risk and the relationship between science and society. In the subsequent section, I will examine these points in greater detail, beginning with risk. The Ethics

Council's skepticism concerning the utility of risk analysis in ensuring DURC results in a different outlook on the implementation of security policies. While the MPG/DFG/Leopoldina report advocates for self-governance founded on scientific knowledge and risk assessments, the Ethics Council places greater emphasis on the role of political institutions and the oversight process.

Risk Mitigation

The proposals for risk mitigation outlined by the Ethics Council closely resemble the measures proposed in other reports. Primarily, there are discussions concerning restrictions on the publication of research results. Typically, research outcomes should be accessible to the public (Deutscher Ethikrat, 2014, p. 193, C167), but they could be restricted (Deutscher Ethikrat, 2014, p. 181, C207) in special circumstances. We find the physical security of pathogens and laboratory equipment as a critical factor in risk mitigation (Deutscher Ethikrat, 2014, p. 169, C168). Additionally, we find discussions regarding the role of research funding in DURC and the potential withholding of funding for specific experiments due to the associated risks they may present (Deutscher Ethikrat, 2014, p. 179, C169).

Oversight boards are also referenced, with various models being examined. One option identified in the report proposes an oversight board that primarily serves an advisory role. This board would support scientists in addressing potential biosecurity implications associated with their research. Notably, the ethics council explicitly advocates for the formation of an interdisciplinary advisory board comprising experts from civil society (Deutscher Ethikrat, 2014, p. 185, C170). The alternative course of action, proposed in the report, would involve establishing an oversight board that operates as a regulatory agency, responsible for rendering legally binding decisions on research projects (Deutscher Ethikrat, 2014, p. 184, C171).

The Ethics Council report includes more extensive sections discussing the justification of measures that restrict research freedom and the conditions under which such measures would be warranted. The report from the Ethics Council contends that security measures related to DURC are primarily aimed at an abstract threat, thereby making broad restrictions on the freedom of research difficult (Deutscher Ethikrat, 2014, p. 172, C171). Nonetheless, the Ethics Council notes that arguments advocating for more substantial restrictions, grounded in the potentially devastating consequences of misusing DURC, may also be valid (Deutscher Ethikrat, 2014, p. 172, C172). Generally, we identify multiple sections that call for a proportionate response to the potential hazards arising from the misuse of DURC experiments. Correspondingly, there are sections that assign responsibility to scientists to evaluate their research and implement appropriate security measures (Deutscher Ethikrat, 2014, pp. 193–194, C173). In its recommendations, the Ethics Council adopts a risk-benefit approach when determining appropriate security measures and whether a research project should be pursued at all (Deutscher Ethikrat, 2014, p. 193, C174). Deviating from the other reports, which argue that everything could be DURC and nothing is DURC per-se: "Some members of the Ethics Council are, in addition, of the opinion that the potential damage can be presumed to outweigh the potential benefits in the case of research programmes in which the virulence of a micro-organism in respect of its pathogenic effects for humans or animals would be strengthened to such an extent, or such strengthening is to be anticipated, that its dissemination outside the laboratory is likely to produce a serious epidemic amongst humans. Such programmes should not be carried out unless a direct, concrete and preponderant benefit in terms of diminishing hazards for human life and health is probable" (Deutscher Ethikrat, 2014, p. 193, C174).

Although the possible governance instruments discussed for managing DURC experiments are very similar to those encountered in other reports, the Ethics Council report originates from a different discursive framework than, for instance, the MPG/DFG/Leopoldina reports. While the MPG/DFG/Leopoldina reports regard security measures primarily as risk-mitigation techniques influencing risk-benefit assessments, the Ethics Council report conceptualizes security measures more as prerequisites for scientific activity and as a means of balancing competing needs on behalf of scientists and the general public.

"The question as to what constitutes 'appropriate' handling of biosecurity risks in research needs to be addressed by the scientific community generally, specifically by individual life scientists, by the state, by security experts and indeed by society as a whole. A suitable answer can only be found on the basis of cooperation between all the persons and bodies concerned in the search for the best risk provisioning strategy, i.e. one that takes account of all the various interests and clarifies the apportionment of responsibility […]." (Deutscher Ethikrat, 2014, pp. 85–86, C175).

Risk Is not Enough

What is the origin of this discrepancy? The Ethics Council exhibits a notably greater skepticism regarding the utility of risk as an epistemological framework in governing DURC. The Ethics Council contends that, as an initial approximation, risk logics already familiar to life scientists through biosafety inquiries may prove beneficial in evaluating the danger associated with a research project (Deutscher Ethikrat, 2014, p. 67, C176). Nevertheless, regarding biosecurity questions, risk is perceived as linked to substantial uncertainty, to such an extent that the Ethics Council contends that conventional risk-assessment methods may possess limited utility in the context of DURC (Deutscher Ethikrat, 2014, p. 56 C177).

The Ethics Council asserts that, unlike biosafety, biosecurity does not involve a question of risk versus benefits. Biosecurity concerns pertain to events instigated intentionally, and the likelihood of such deliberate acts cannot be accurately predicted through statistical means because: "[…] such acts are either irrational, so a probability estimate cannot be reliably grounded in previous experience or profiling techniques, or they are carried out with a degree of forethought that also obviates any benefits of past knowledge" (Deutscher Ethikrat, 2014, p. 169, C178). For the Ethics Council, this constrains the usefulness of conventional risk estimates in DURC evaluations (Deutscher Ethikrat, 2014, p. 68, C208). Although the damage potential of pathogens can be assessed, as there is no distinction between deliberate and accidental releases of pathogens (Deutscher Ethikrat, 2014, pp. 168–169, C179), the likelihood of a deliberate release cannot be expressed numerically, which limits the usefulness of risk assessment (Deutscher Ethikrat, 2014, p. 69, C180). The probability of a bioterrorist attack can solely be approximated through proxies such as the accessibility of a pathogen, the presence and efficacy of countermeasures, and the requisite expertise to bioengineer a pathogen (Deutscher Ethikrat, 2014, pp. 48–49, C182). However, national and international conditions and developments also influence the situation (Deutscher Ethikrat, 2014, p. 84, C181).

Throughout its reports, the Ethics Council expresses skepticism regarding the utilization of risk as a governing factor for DURC, owing to the substantial uncertainty surrounding the likelihood of such Dual Use Research of Concern. The Ethics Council perceives this as creating a moral and operational dilemma for researchers. There exists uncertainty not only concerning the conduct of specific research projects but also regarding the potential damages associated with abstaining from particular research activities, such as the development of a vaccine. Nonetheless, the potential benefits remain inherently uncertain. Consequently, the report argues that this results in a scenario where it is impossible to make a definitive decision for either option based solely on a risk-benefit analysis (Deutscher Ethikrat, 2014, p. 188, C183). Given that risk assessments and risk-benefit calculations are inadequate for informed decision-making, the Ethics Council recommends employing the precautionary principle as a normative framework for biosecurity decisions in situations of uncertainty (Deutscher Ethikrat, 2014, p. 169, C210; see also: pp. 75–76, C184).

According to the Ethics Council, the precautionary principle: "[…] states that, under certain circumstances, (massively) restrictive measures may be justified where a given technology or some course of action threatens to cause serious and irreversible damage to humans or the environment, even if no reliable scientific risk analysis is available" (Deutscher Ethikrat, 2014, p. 78, C185). The Ethics Council notes that the precautionary principle is a legal doctrine derived from environmental policy. It differentiates between a strong variant in which risk-associated actions should not be undertaken until scientific evidence confirms they do not cause harm, and a less stringent version, wherein potentially harmful actions must be accompanied by precautionary measures to mitigate associated risks, without constituting a blanket prohibition on executing specific action (Deutscher Ethikrat, 2014, pp. 78–79, C185).

The Ethics Council delineates four "postulates" for implementing harm reduction or preventative measures in DURC. The first is a "burden of argument", which stipulates that research may only be restricted if plausible grounds exist to assume that it could cause harm (Deutscher Ethikrat, 2014, pp. 80-81, C186). The second is a "responsibility to conduct research" into the risks associated with emerging biotechnologies. The aim here is to provide a scientific basis for future risk assessments (Deutscher Ethikrat, 2014, p. 81, C214). The third postulate articulated is "risk provisioning". While research projects should not be discontinued solely due to the absence of definitive evidence indicating they will not cause harm, the involved parties are nonetheless obligated to implement appropriate measures. This includes the potential prohibition of a research project if deemed necessary, in order to mitigate foreseeable risks (Deutscher Ethikrat, 2014, pp. 81–82, C186).

While the initial three postulates resemble those previously outlined in the MPG/DFG/Leopoldina reports—namely, a responsibility to prevent society from being exposed to undue dangers, a commitment to conducting risk analyses, and the obligation to implement risk mitigation measures where appropriate—the fourth postulate diverges from the logical framework established in the MPG/DFG/Leopoldina reports. The fourth postulate is titled "Public Dialogue". Although it advocates for science-based risk analysis and concurrently expresses skepticism regarding the applicability of risk to DURC, the Ethics Council emphasizes that: "[…] where uncertainty prevails, there is also a need to ensure that the discussion becomes part of a public dialogue to establish a social framework for responsible dealings with new areas of research and innovation" (Deutscher Ethikrat, 2014, pp. 82–83, C187).

Non-privileged Knowledge

For the Ethics Council, identifying appropriate measures for risk mitigation is not solely a scientific endeavour but also involves negotiation with the broader public. While the MPG/DFG/Leopoldina reports view science as an activity conducted on behalf of society yet ultimately distinct from it, the Ethics Council contends that: "[…] society itself is a stakeholder, for instance in that it is dependent on research to achieve and maintain certain standards of living and to provide for future generations" (Deutscher Ethikrat, 2014, p. 175, C129). Since contemporary science produces applications that directly affect society, it is no longer regarded as a separate entity but rather as an integral component of society that must be evaluated according to societal parameters (Deutscher Ethikrat, 2014, p. 59, C188).

For the Ethics Council, science and society are interrelated. Accordingly, which dangers are acceptable in research becomes a critical question. The Ethics Council conceptualizes this as a negotiation process between scientific advancement and societal values (Deutscher Ethikrat, 2014, p. 55, C190), where scientific research operates within an overarching context of social norms and may be constrained by them (Deutscher Ethikrat, 2014, p. 64, C189).

The greater role society in the conduct of science leads the Ethics Council to assign a more prominent role to the public in assessing acceptable risks. Unlike the privileged knowledge of scientists as outlined in the MPG/DFG/Leopoldina reports, the Ethics Council emphasizes a greater involvement of the public. The Ethic Council asserts the necessity of incorporating public participation in decision-making processes and addressing public "unease" regarding certain research initiatives (Deutscher Ethikrat, 2014, p. 68, C191). Based on the reports from the Ethics Council, the integration of the public should extend beyond merely addressing knowledge gaps for laypersons, a practice frequently observed in the reports of the NSABB, among others. Instead, it should aim to harmonize differing perceptions of risk. This is particularly crucial because internal scientific mechanisms may deem a particular issue as safe, while public perceptions may differ (Deutscher Ethikrat, 2014, p. 175, C192). Here, the Ethics Council differs strongly from the MPG/DFG/Leopoldina reports when it states: "It is not appropriate simply to brush off such differences by claiming that lay persons' lack of knowledge renders them less able to form competent judgements" (Deutscher Ethikrat, 2014, p. 175, C193). According to the Ethics Council report, the scientist's knowledge does not attain the same level of privileging as in the MPG/DFG/Leopoldina publications. Instead, the Ethics Council contends that divergent risk perceptions must be harmonized through dialogue with the public and cannot be resolved solely through scientific mechanisms on behalf of the public (Deutscher Ethikrat, 2014, p. 88–89, C187).

Codes of Conduct and New Laws

According to the Ethics Council, appropriate security measures for high-risk research should be negotiated through a transparent public process. Nevertheless, the primary responsibility for ensuring the security of research projects rests with the scientist. The Ethics Council asserts that a scientific ethos, which encompasses the obligation to maintain research safety and security, is fundamental to fostering public trust in science (Deutscher Ethikrat, 2014, p. 58, C194). The Ethics Council observes that this ethic is increasingly being codified in codes of conduct (Deutscher Ethikrat, 2014, p. 58, C195). The Ethics Council contends that Codes of Conduct, to a certain extent, guide the conduct of researchers. To achieve this, it is essential for Codes of Conduct to possess a high degree of binding authority within the scientific community (Deutscher Ethikrat, 2014, p. 178, C196).

The Ethics Council report also contains several sections on awareness raising, wherein it argues that it is essential for scientists to be cognizant of the dual-use implications associated with specific research projects in order for Codes of Conduct to be truly effective (Deutscher Ethikrat, 2014, pp. 178–179, C197). Accordingly, the Ethics Council advocates for enhanced awareness initiatives and educational programs targeted at scientists, including during their university studies, training sessions, and periodically throughout their employment (Deutscher Ethikrat, 2014, pp. 181–182, C198; p. 192, C199). Codes of Conduct are effective only if scientists and laboratory personnel are aware of the hazards and demonstrate interest in reviewing the pertinent Codes of Conduct (Deutscher Ethikrat, 2014, p. 165, C200).

The Ethics Council refers here to biosecurity experts, stating that awareness raising is generally seen as key for biosecurity governance and the effectiveness of Codes of Conduct (Deutscher Ethikrat, 2014, p. 165, C200). Additionally, it is argued that Codes of Conduct must incorporate the participation of all stakeholders involved in the research process, as well as a mechanism that "[...] more clearly formulates the material stipulations for responsible action and, thirdly, whose institutional adoption and implementation is guaranteed" (Deutscher Ethikrat, 2014, p. 189, C201).

The Ethics Council explicitly references the MPG's code of conduct when questioning whether the sensitizing and behavior-steering function of Codes of Conduct is sufficient to meet the security requirements of DURC experiments (Deutscher Ethikrat, 2014, p. 189, C203). The Ethics Council states that Codes of Conduct can establish explicit standards for research conduct. However, these Codes are generally not legally binding documents. They may possess some legally enforceable authority for employees, but do not constitute direct legislation (Deutscher Ethikrat, 2014, pp. 182–183, C204). The Ethics Council concludes that awareness-raising initiatives and Codes of Conduct may not be adequate to fully satisfy the precautionary principle, which serves as the normative standard for the security of DURC research (Deutscher Ethikrat, 2014, pp. 189–190, C202). In its conclusion, the Ethics Council states: "In order to provide a suitable strategy for dealing with biosecurity risks that is properly grounded in the precautionary principle, the German Ethics Council considers it to be necessary to complement measures designed to promote people's own sense of responsibility by legislative ones. Such measures should allow for the implementation of a transparent process for the assessment of research projects lying within the scope of DURC" (Deutscher Ethikrat, 2014, pp. 189–190, C202).

Those new legal regulations proposed by the Ethics Council encompass the establishment of a legally binding definition of DURC. This includes the formation of a DURC commission and mandates that scientists seek biosecurity consultation from said commission. Additionally, it involves the evaluation of the consultation process and assigns new responsibilities to biosafety officers concerning DURC. Furthermore, some members of the Ethics Council advocate for the implementation of a general licensing authority responsible for issuing permits for DURC experiments (Deutscher Ethikrat, 2014, pp. 194–195, C205). The Ethics Council argues that legally binding measures would ensure effective navigation of the conflicting priorities between freedom of research and the state's responsibility to safeguard its citizens. Additionally, such measures would promote uniformity and transparency of standards throughout the nation (Deutscher Ethikrat, 2014, pp. 182–183, C204).

Analysis

Although their governance measures exhibit similarities, the logical frameworks adopted by the Ethics Council diverge considerably from those presented in the MPG/DFG/Leopoldina report. Two principal points merit attention. The first pertains to the prominence of risk. The Ethics Council exhibits a markedly more skeptical stance regarding the applicability of risk to DURC. It does not assert that risk lacks significance for DURC; rather, it considers risk to be of limited utility and associated with substantial uncertainty. The Ethics Council advocates for a precautionary principle that permits research contingent upon the implementation of appropriate security measures. The determination of what constitutes appropriate security measures is subject to negotiation between scientists and society at large.

This leads us to the second critical point identifiable within this context. If risk and self-governance mechanisms founded on risk assessments lack a legitimizing function, then research itself must be justified through alternative means. The Ethics Council contends that scientific endeavors require societal validation when they pose potential dangers. Here, a distinct conception of the relationship between science and society emerges. Whereas reports by MPG, DFG, and Leopoldina regard risk analysis based on privileged knowledge as a legitimizing factor for science, the Ethics Council advocates for a societal framework that must be negotiated among the involved stakeholders. Such a framework either enables or constrains high-risk research initiatives. Within this paradigm, science is perceived as an activity that occurs within society and is inherently connected to societal values and perceptions.

A particular emphasis is placed on the role of the state, which is the institution responsible for formalizing societal values through legislation. Consequently, the state possesses considerable authority in the regulation of science and bears both a duty to safeguard its citizens from harm and a responsibility to facilitate the freedom of research. To address these dual imperatives transparently, the Ethics Council considers new legislation justified and advocates for the standardization of procedures related to DURC experiments.

7.6 Conclusion – Uncertainty and the Public

The MPG/DFG/Leopoldina reports and the Ethics Council report offer comparable techno-fix and techno-fear imaginaries that are prevalent throughout the biosecurity discourse. Both sources depict biotechnology and life sciences research as potential solutions to various societal risks. These concerns are depicted more prominently than in the NSABB reports, particularly within the civilian sphere. Although the threat of biological weapons is briefly addressed in the MPG/DFG/Leopoldina reports, the primary focus of these documents remains on public and individual health, economic stability, and environmental protection. Similarly, the threat constructions outlined in these reports mirror the techno-fear imaginaries previously identified in the NSABB reports and the Fink report. Within these imaginaries, advancements in biotechnology have resulted in increased access to these technologies by a broader range of actors, thereby amplifying the potential for misuse.

The first central distinction I wish to emphasize pertains to the degree of certainty conveyed in the presentation of these imaginaries. Similar to the US sample, the MPG/DFG/Leopoldina report depicted techno-fix and techno-fear imaginaries as relatively certain constructs. Notably, in the context of techno-fix, life sciences are portrayed as offering nearly certain benefits. On the techno-fear site, threats are presented with a degree of certainty as well. In contrast, the Ethics Council's report emphasizes the substantial complexities involved in the potential misuse of advanced biotechnologies, thereby rendering techno-fear imaginaries a future that is on the horizon. Likewise, the benefits derived from life sciences research are not regarded as guaranteed. Instead, the report underscores the inherent uncertainties associated with the benefits of such research. Although the concept of techno-fix remains a possible imaginary within the reports, its certainty diminishes when considering future implications.

The second fundamental distinction pertains to the role of risk. Continuing the discursive trajectory, we can observe in the United States documents, the MPG/DFG/Leopoldina reports strongly highlight the significance of risk in facilitating research activities. Initially, life sciences research and biotechnology are concurrently intertwined with notions of techno-fear and techno-fix imaginaries. These can lead to either a desirable or undesirable future. Risk assessment and the corresponding mitigation measures are presented as primary mechanisms through which undesirable futures can be avoided, at least to an acceptable extent. Preventing an undesirable future allows the techno-fix imaginaries to become the relevant future, as threatening futures are mitigated or minimized to a satisfactory level. Therefore, risk analysis, in this context, functions both as a tool to regulate DURC and as a means to facilitate its conduct by constraining the range of possible futures, thus legitimizing research. This shift occurs as the connection to techno-fear diminishes, leaving only the association with techno-fix. Nevertheless, a certain degree of certainty regarding the probability of events is required to undertake risk analysis.

Risk analysis becomes less applicable if techno-fix and techno-fear imaginaries are not regarded as certain futures, as noted in the Ethics Council report. Consequently, risk analysis and risk mitigation techniques lose their validation function, and both imaginaries—techno-fix and techno-fear—remain potential futures. This highlights a third fundamental distinction between the reports. While the MPG/DFG/Leopoldina reports continue the NSABB's emphasis on scientists and their knowledge in assessing risks, the Ethics Council adopts a different discourse. For the Ethics Council, legitimacy cannot be established through risk-centric methods, as the high degree of uncertainty renders risk unsuitable as an epistemological instrument.

Instead, legitimacy for the DURC must be achieved through a political process. This alters the role of the public in DURC. While the Fink report, as well as the NSABB and the MPG/DFG/Leopoldina reports, propose a conception of science conducted on behalf of the public yet ultimately separate from it, the Ethics Council assigns a role for the public as a stakeholder in the research process. Here, research must be legitimized via a public process. As imaginaries of techno-fear can no longer be dismissed through risk, techno-fix and techno-fear remain viable imaginaries, necessitating a political decision regarding their acceptability to legitimize DURC experiments.

8 Conclusion: Securing a Risky Future and the Emergence of a Global Biosecurity Discourse

I began this project with the question of the rationale behind the allocation of research funding for my position. Specifically, what motivated Germany to invest in the advancement of biosecurity related to DURC? Drawing from my expertise in Critical Security research, this inquiry naturally extended to: Why does DURC constitute a security concern? Preliminary investigations into the matter quickly indicated that Germany favored a self-governance model for overseeing DURC activities. Pertaining to policy options, Germany had two principal strategies: self-governance, as outlined by the MPG/DFG/Leopoldina reports, and a dialogue/law-centric approach advocated by the Ethics Council. Ultimately, Germany adopted the former strategy. Consequently, the secondary research question I posed initially is: Why did Germany opt for a self-governance framework? Let us begin with a review of the research methodology before proceeding to discuss the principal findings and deriving conclusions regarding the initial research question.

8.1 Recap – Co-Construction, Discourse and Engagement

The first part of my research question relates to the construction of (in)security. The subsequent aspect concerns security as an organizing principle that confers priority upon specific actors and measures. Drawing upon literature from critical security studies as well as constructivist STS, I have posited that technology and (in)security are social constructs. Nothing is inherently a security threat; rather, items are recognized as (in)security issues through being conceptualized as such. Similarly, policy measures implemented to address (in-)security issues are founded on the same social process that constructs security concerns. Threats and corresponding measures are shaped by interdependent processes.

Similar to the processes that facilitate the recognition of an issue and its classification as a security concern, technology is fundamentally constructed through discourse. For this project, technology does not refer to material artifacts; rather, it pertains to the knowledge and understanding of technology. Consequently, in our context, DURC, is not a static backdrop against which security measures are constructed. Instead, the processes that designate technology as a security issue and those that assign threatening properties to it are mutually constitutive. Therefore, technology and (in)security are jointly co-constructed.

In the case of DURC, the construction of technology and (in)security is related to ideas about the future. Reading through the existing DURC literature and documents, it becomes apparent that two archetypical imaginaries about the future can be found in the material: Techno-fix, an imaginary in which the properties of a technology provide a fix for various (in)securities, and techno-fear, where the properties of a technology cause (in)securities. Of course, the empirical reality is often fuzzier than these two archetypes suggest, but they provide something akin to an idiom through which we can examine the DURC discourse.

In the methods chapter, I introduced discourse as the central instance through which knowledge is produced, reproduced, and travels through new locales. I suggested that documents provide a site for researchers to examine the DURC discourse, as documents often reflect the knowledge of their time. Simultaneously, important documents offer reference points for the ongoing discourse. Because documents are representative as well as performative in the production of knowledge, they are useful instances through which we can access the discourse. I also spoke about the difficulties of accessing the discourse of a small community of technical and subject-matter experts and the prior knowledge needed to make sense of the discourse. Here, I outlined an approach in which engagement with the community in question can not only put forward a more nuanced critique of the status quo but also gain much-needed knowledge. Throughout the analysis, my engagement with the biosecurity community has helped me immensely to select documents, make sense of the discourse, and link the often common-sense positions found in the documents to a broader discursive field.

Utilizing the described methodology, I conducted an analysis of six pivotal DURC documents to exemplify the broader discourse surrounding DURC. These documents reflect common-sense positions commonly observed within the community. The examination of this discourse yielded interesting results for the research question as well as for the theoretical discussion on the interplay between (in)security and technology within the framework of Critical Security Studies. Moreover, the findings carry significant implications for the ongoing debate concerning dual-use research and technologies, thereby offering insights that extend beyond the domain of biotechnology.

8.2 Main Findings – Imaginaries of Security and Technology

Let us initially focus on the first aspect of the research question. How did DURC evolve into a security threat? Based on the analysis, I wish to emphasize three principal findings: the co-creation of (in)security and technology, the influence of risk in determining among uncertain futures, and the mobilization of scientists in place of the political.

In the context of DURC, security and technology are co-constructed to form the concept of DURC. Throughout the discourse surrounding DURC, science and technology are ascribed certain attributes. Embedded within previous discourse formations, biotechnology and life cycle research are conceptualized as advancing at an ever-increasing pace. This notion of progress encompasses the global proliferation of equipment and expertise, decreasing costs, and the trend toward de-skilling. Simultaneously, biotechnology becomes seemingly more dangerous, as genome editing could lead to the synthesis of novel pathogens. Considering the theoretical foundations of this project, accelerated progress is not an intrinsic characteristic of science. It does not stem from a fundamentally altered material basis; rather, knowing that biotechnology is advancing more rapidly results from a social process.

Simultaneously, the DURC discourse draws on a shift in the security agenda. Traditional state-centric interpretations of (in)security transitioned to all-hazard approaches following the Cold War era. Terrorism has emerged as one of the principal security concerns. Similarly, the incorporation of non-exceptional instances of (in)security, such as economic recession, public health issues, and environmental degradation, into a security agenda has expanded the scope of issues that can be approached as security concerns. In cases involving non-exceptional security making, we often observe a change in the referent object of security as well. While approaches centered on inter-state conflict typically identify the state as the referent object, non-exceptional security perspectives often designate the individual as the primary object requiring protection. Collectively, these developments are of significant importance to the formation of DURC.

This leads us to a conceptualization of DURC in which DURC is a fuzzy threat that could potentially emerge in any location. In this conceptualization, increased access to biotechnology by various actors is associated with capabilities that may be perceived as threatening across multiple domains. This threat is not confined to a single entity; it does not originate solely from a particular state actor, nor does it necessarily hold the state as its primary object of concern. Instead, biotechnology has the potential to pose risks to individuals or large groups of individuals in numerous undefined areas. The uncertainty surrounding the possible applications of biotechnology also leads to uncertainty regarding the security risks it entails. Considering the future orientation of technology and security, this fosters an image of an undesirable future, often characterized by what I have termed techno-fear, and constitutes the primary conceptualization of threat within DURC.

In a second instance, conceptualizations of (in)security and technology interact within the DURC discourse to generate an opposite imaginary. In these interactions, referent objects are already confronted with insecurity across various domains. Biotechnology has already proliferated and could be used as a weapon. Simultaneously, individuals face insecurities in numerous areas, including environmental degradation, unemployment, and naturally occurring illnesses. Within this context, DURC is attributed capabilities that could potentially mitigate some of the risks faced by these referent object faces. From countermeasures to the large or small-scale deployment of biological weapons, as documented in the Fink Report, to the development of cures for illnesses, as detailed in other documents. Biotechnology is thus ascribed significant benefits in overcoming existing insecurities. In this envisioned future, DURC experiments progress towards becoming a techno-fix for various insecurities. Ironically, the concepts of techno-fix and techno-fear are mutually dependent; the broader the scope of potential applications assigned to DURC research, the greater the emergence of potential threats. Conversely, when benefits are less certain—as observed in foundational research where benefits are assigned to the conduct of experiments without clear application yet, threats become fuzzy as well.

In the DURC discourse, we see the interaction of technology constructions with constructions of security to produce future imaginaries, both for desirable and undesirable futures. The emergence of DURC as a security concern is largely attributable to the fact that these future imaginaries fundamentally underpin the concept of DURC itself. Essentially, DURC constitutes a conceptual categorization for a specific class of experiments; these experiments are classified within this category because they are intricately linked with techno-fix and techno-fear.

The second key finding I would like to highlight is the role of risk as an epistemological tool to decide between two futures. Throughout the main DURC discourse, we find that risk analysis is suggested as a tool to secure DURC. At the outset, techno-fix and techno-fear stand as potential futures that are both possible in DURC. Through the use of risk analysis and risk-mitigation measures, these changes have been made. If we look at the analyzed documents, risk analysis takes on the role of enabling research to go forward despite techno-fear being a possible future.

Initially, employing risk as an epistemological instrument transforms DURC from an unclear threat to a quantifiable and recognizable entity. Given the techno-fear imaginary, numerous insecurities stemming from DURC can be analyzed. Here, risk analysis delineates the parameters regarding which aspects of DURC should be encompassed and which may be safely disregarded. This includes temporal constraints concerning the emergence of a threat, as DURC must, in most definitions, be directly applicable, as well as scope limitations, considering only specific areas or casualty figures. The ambiguous perception of an undesirable future risk renders DURC into an object with distinct boundaries that are measurable. Consequently, debates among DURC experts frequently center on whether a particular experiment meets certain criteria, rather than on the utility of the threat construct itself. In this context, risk shifts the discourse from the construction of DURC as a threat to a technical discussion about the precise capabilities biotechnology must possess to pose a threat. The techno-fear imaginary becomes conventional knowledge as DURC increasingly pertains to technical limits and technological capabilities.

In the second instance, it becomes apparent that risk serves a legitimizing function. Through the techno-fear imaginary, biotechnology is associated with potentially catastrophic outcomes. Simultaneously, techno-fix imaginaries ascribe significant benefits to DURC experiments. This ambivalence between a future that is desirable and one that must be avoided presents a challenge, as the possibility of endangering substantial segments of the population could likely undermine the legitimacy of a research project, even if it holds the potential to deliver benefits. Together with the ethicalization of security (Rychnovská, 2016b), risk provides a potential way out of this paralysis. By conducting risk analysis, actors can demonstrate their "responsible" behavior. As risk analysis has made the insecurities caused by DURC known, they can now be mitigated. Consequently, due diligence is undertaken to prevent an undesirable future. In this context, risk contributes to the de-politicalization of security within DURC, as the legitimacy of DURC experiences is not derived from a political process but rather from a combination of techno-fix narratives that underpin DURC and the application of risk management techniques designed to mitigate insecurities. Through the lens of risk, techno-fix solutions and techno-fear are no longer equally feasible; instead, techno-fear has become recognized, constrained, and addressed. Conversely, the potential benefits associated with a techno-fix imaginary remain limitless.

The third significant finding I wish to address pertains to the measures that can be implemented to mitigate DURC as a security concern. Previously, we discussed how security measures are developed within the same framework that defines a security issue. In the context of DURC, the interplay between the development of technological capabilities and perceptions of security or insecurity results in a limitation of feasible policy options. Due to the specific construction of DURC, certain measures are deemed appropriate while others are not. The co-construction of fast progress and a terrorism-centric understanding of security issues leads to the diminished importance of traditional export-control regulations. Given that DURC is perceived as a fluid threat evolving rapidly, list-based approaches such as the United States' Select Agents list or export control lists are considered ineffective. DURC is viewed as a threat that advances too swiftly for conventional political processes to manage. Consequently, risk-based self-regulation approaches emerge as preferable policy options. Alongside the techno-fix narrative, which grants legitimacy to DURC by emphasizing its conduct in the interest of individuals, these policies maintain the privileged role of scientific knowledge within DURC governance.

The security measures implemented for DURC experiments have primarily become technical, necessitating a significant degree of familiarity and specialized knowledge. The privatization of scientific knowledge represents a logical subsequent step following these measures. As the discourse surrounding DURC transitions from concerns about threats to considerations of technical limitations, the locus of responsibility for security also shifts. It is no longer attributed to political process but to the scientists themselves, who possess the requisite expertise. In this context, the interaction between technological developments and (in)security constraints influences the feasibility of certain policy measures, rendering others more plausible by framing them as "sensible".

So, how did DURC come to be regarded as a security issue? It became one by the specific interactions between technology construction and constructions of (in)security that are evident in the pertinent discourse. Simultaneously, competing imaginaries about the future interact and produce a threat conception that is fuzzy and de-limited, thus reinforcing each other. Additionally, risk-related techniques limit the scope of DURC as a security threat and shift the political debate into a technical domain. Simultaneously, the co-construction of technology and (in)security that we see in DURC discursively constrains the applicability of certain security measures while giving primacy to others.

8.3 Outlook: The Emergence of a Global Biosecurity Discourse and Its Implications

The third key finding already provides insights into the second research question posed at the outset. Why did Germany opt for a self-governance approach? Because it appears to be a prudent, even commonsensical solution to the security issue. However, upon close examination of the documents, a second factor emerges that contributed to Germany's decision to reject the Ethics Council's position and instead adopt the stance proposed in the MPG, DFG, and Leopoldina reports: the rise of a global DURC discourse. When comparing the Fink reports with those from the NSABB and the MPG/DFG/Leopoldina reports, it becomes evident that these documents rely on very similar discursive frameworks.

In contrast, the Ethics Council report references a different discourse. The preliminary argument presented herein suggests that DURC has achieved global recognition as an object with a hegemonic discourse built around it. Conversely, documents that do not engage with this established discourse will have difficulties constructing the object differently. In our analysis, the primary differences involve the certainty attributed to techno-fix arguments, the applicability of risk assessments, the role of the public, and consequently, the role of legislation. The Fink report, alongside reports from NSABB and MPG/DFG/Leopoldina, align with the understanding I have outlined above in the main findings. The Ethics Council offers a distinct conceptualization. Consequently, one response to the inquiry is that the

Ethics Council is unlikely to attain hegemonic status in its co-construction of technology and security, thereby explaining why Germany is unlikely to adopt such an approach. In the context of a globally prevailing biosecurity discourse, the participation of the public remains constrained. This situation bears significant implications for security as a political practice, and further research is urgently required.

I accomplished three objectives during this project: Empirically, this project has contributed to research concerning the interactions between biotechnology and security. Despite the significance of advanced biotechnologies in contemporary society and the future importance attributed to them through discourse, the field remains under-explored. The majority of research approaches biotechnology from a public health perspective, thereby neglecting the implications of DURC for conducting research in other disciplines.

Theoretically, this project could advance our understanding of the interactions between the social construction of technology and the social construction of (in)security. Technology is not merely a backdrop against which security-making and shaping occur; rather, as demonstrated throughout this project, the processes that generate technology and security are profoundly interconnected. In the contemporary world, where numerous social interactions are mediated through technology, acknowledging the role of technology is a crucial endeavor that can deepen our understanding of, at the very least, the social world. Employing a strict constructivist perspective in this study has enabled me to maintain a coherent epistemology; however, it has also required some simplification. Therefore, the contributions of scholars with diverse ontological and epistemological perspectives will be paramount in advancing research that considers the productive role of technology across a wide array of interactions.

From a methodological perspective, I was able to outline a potential approach for examining technical communities that are inaccessible due to the specialized knowledge required for meaningful engagement with community members or their products. By actively engaging with these communities and attaining a certain level of expertise, while maintaining a commitment to a critical research agenda, social scientists can explore topics that often lie outside the scope of everyday knowledge. Considering the significance of technical issues in social processes, pursuing such an approach appears to be worthwhile. However, due to COVID-19 restrictions, I was unable to fully demonstrate the utility of this methodology. For instance, the interactions among members of the biosecurity community could not be thoroughly investigated. Ethnographic research that addresses technical issues remains essential in this context, as does further research highlighting the role of institutions within biosecurity and related fields.

Notwithstanding these limitations, the research project here still yields some important findings that warrant further investigation. The ongoing developments within DURC hold substantial implications for other disciplines and for society at large. In numerous instances, DURC serves as a paradigm for other technological sectors with security considerations. Simultaneously, there exists a discourse that depoliticizes security issues within DURC, thereby confining the role of the public to that of passive observers. Research is conducted and risks are assumed on their behalf without engaging in political debate regarding those risks. It is the role of critical scholars to demonstrate that the prevalence of technical rather than political discourse is not an inherent or natural phenomenon. In pursuit of this objective, critical scholars must resist being deterred by technical challenges. Instead, they should actively engage with pertinent communities and work to reframe transfer risks from an ostensibly apolitical, technical domain into issues that are validated through a political process.

9 Literature

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Annex

Table 1 – Coding Scheme

Note: Biotechnology here includes life science research. Additionally, no distinctions have been made whether, for example, benefits are placed in the past, present or future ore whether or not they are direct or indirect.

Name of Code	Definition		Frequency
Dimension 1: Threatening Biotechnology	Sections that argue biotechnology can be a source of threats		0
1.1 Proliferation Problem	Sections that argue that threats stem form proliferation of knowledge and/or equipment		0
1.1.1 Available Equipment	Sections that argue that threats stem form proliferation of equipment	The information to conduct genetic engineering research is easily accessible on the Internet. Moreover, the equipment and expertise to use this information to create novel agents are available globally. The international diffusion of knowledge and capabilities in biotechnology means that the capacity to carry out beneficial as well as harmful research activities is widely accessible, both to nations and to terrorist groups.	3
1.1.2 Dispersion of Knowledge	Sections that argue that threats stem form proliferation of knowledge	The information to conduct genetic engineering research is easily accessible on the Internet. Moreover, the equipment and expertise to use this information to create novel agents are available globally. The international diffusion of knowledge and capabilities in biotechnology means that the capacity to carry out beneficial as well as	16

		harmful research activities is widely accessible, both to nations and to terrorist groups.	
1.1.3 Cheap Weapon	Sections that argue that biotechnology enable the production of cheap WMDs	Research in biology lies between these two extremes. Traditionally, biology has been considered a small-scale science. Although work in genomics, proteomics, and bionanotechnology is overturning this paradigm, the research and development associated with biological weapons programs do not necessarily require large-scale investment or specialized, dedicated facilities. Creating pathogen weapons poses certain technical challenges, but the ability to produce enough material to cause morbidity, mortality, public panic, and economic costs is within the capability of many laboratories.	1
1.2 Offensive Applications	Sections that describe potential offensive applications of biotechnology	However, life sciences research has the potential to produce information or technology that can be misused to pose a threat to public health and safety, and therefore it is appropriate to have in place a framework and tools for the responsible oversight, conduct, and communication of such research.	21
1.2.1 Proliferation to malicious actors	Sections that argue that proliferation a potential threat stemming from biotechnology	As a result, questions have been asked by the scientists themselves and by some political leaders about the possibility that new information published in research journals might give aid to those with malevolent ends.	13
1.2.2 Building Weapons	Sections that argue biotechnology can be used to build weapons	Useful distinctions between permitted and prohibited activities at the level of basic research are difficult to make because biotechnology presents a classic example of the dual use dilemma. In the life sciences, for example, the	5

			same techniques used to gain insight and understanding regarding the fundamental life processes for the benefit of human health and welfare may also be used to create a new generation of BW agents by hostile governments and individuals.	
	1.2.3 National Security Threat	Sections that argue biotechnology can be a source of national security concerns	U.S. Government Response. In acknowledgment that the threat of the misuse of research information is important and real, the U.S. Government agreed that new biosecurity measures were warranted to minimize the risk that information from life sciences research might be misused to threaten public health and safety and other aspects of national security.	19
	1.2.5 Misuse/Misapplied	Sections that argue biotechnology can be misapplied	Any area of research could yield knowledge, products, or technologies that can be directly misapplied to pose a threat to public health, agriculture, plants, animals, the environment, and/or materiel. Therefore, all life sciences research should be assessed for dual use potential.	30
Dimension 2: Beneficial Biotechnology		Sections that argue biotechnology has benefits	last 50 years have produced advances in agriculture and industrial processes and have revolutionized the practice of medicine. The very technologies that fueled these benefits to society, however, pose a potential risk as well—the possibility that these technologies could also be used to create the next generation of biological weapons. Biotechnology represents a "dual use" dilemma in which the same technologies can be used legitimately for human betterment and misused for bioterrorism	7

Table 1 – Coding Scheme

2.1 Risks from Not Doing Research	Sections that argue there are risks from not engaging in research	In contrast, suppression of research results may prevent effective protection against their misuse by totalitarian regimes, terrorist groups, organized criminal groups or individual criminals.	5
2.2 Progress	Sections that argue biotechnology is providing a benefit for human progress	The NSABB's tasks include proposing an oversight framework for the identification, review, conduct, and communication of life sciences research with dual use potential in consideration of protecting both national security concerns and the progress of the life sciences.	6
2.3 National Security Benefit	Sections that argue biotechnology provides a national security benefit	The Dual Use Research Issue. Information from life sciences research is clearly vital to improving public health, agriculture, and the environment and maintaining and strengthening our national security and economy.	17
2.4 Public Health	Sections that argue biotechnology provides a benefit to public health	All of these developments have prompted the current report. The goal of this report is to make recommendations that achieve an appropriate balance between the pursuit of scientific advances to improve human health and welfare and national security.	9
2.4.1 Natural Occurrence	Sections that argue biotechnology provides a benefit to public health in case of natural outbreaks	Life sciences research has a critical role in understanding life at the ecosystem, organism, biological system, organ, cellular, and molecular levels. Advances in the life sciences have led to new pharmaceuticals, diagnostic procedures, preventive strategies, treatments, and cures for myriad acute and chronic diseases and conditions and has contributed to improvements in animal and plant health and the food supply.	17

Table 1 – Coding Scheme

2.4.2 Intentional Release	Sections that argue biotechnology provides a benefit to public health in case of bioterrorist/weapons use	These research activities also include an intense effort to discover vaccines, antibiotics, and detection systems that would provide the defense against each of the select agents. But many of the same methods for developing attenuated live vaccines against viral diseases can have offensive applications as well.	9
2.5 Understanding Nature	Sections that argue biotechnology provides a benefit to scientific knowledge	Life sciences research is a critically important endeavor that has benefited society by advancing our understanding of living systems.	9
2.6 Agriculture/Food Supply	Sections that argue biotechnology provides a benefit to agriculture production and food security	Plant biologists are utilizing similar approaches to enhance crop yield and nutritional content and explore the potential for using plants to manufacture products such as vaccines, antibodies, and other biological products. Similar efforts are underway in the field of animal husbandry in an effort to produce animals for human consumption that are heartier and better sources of nutrition.	8
2.7 Economic Benefits	Sections that argue biotechnology provides economic benefits	Life sciences research underpins advances in public health, agriculture, the environment, and other pertinent areas and contributes significantly to a strong national security and economy.	11
2.8 Other Benefits	Collection category for sections that argue biotechnology provides a benefit to areas not already listed (e.g., environmental protection)	In other arenas, life scientists are developing environmental remediation technologies and creating new materials and even energy sources.	11

Table 1 – Coding Scheme

Dimension 3: Making of Life Science	Sections that describe the conditions/environment of biotechnology		0
3.1 Fast Progress	Sections that argue biotechnology is progressing fast	In short, a dynamic national and international research enterprise has evolved, with an extraordinary record of achievement at multiple centers of excellence.	28
3.2 Freedom of Science	Sections that mention freedom of research in connection with biotechnology	The freedom of research, which is enshrined in the Basic Law and may only be restricted to protect other significant constitutionally protected values, is a fundamental requirement in this respect.	13
3.3 Open Science	Sections that mention science needs to have open communication	The free and open conduct and communication of life sciences research is vital to a robust scientific enterprise; thus the "default" position should be the unfettered progress and communication of science. Any decision to do otherwise should be undertaken very carefully.	31
3.4 The Public	Sections that speculate/make statements about the public perception of an issue related to DURC	In addition, the public is increasingly sensitized to issues pertaining to research involving dangerous pathogens and the risk of accidental or intentional release of such agents. A lack of public understanding and appreciation for the reason for conducting and communicating dual use research, sensationalism of dual use research findings, and concerns about public safety and national security all serve to undermine public trust in the life sciences research enterprise.	35

Table 1 – Coding Scheme

Dimension 4: Responses	Sections that discuss potential responses to DURC		0
4.1 Assessing Dangers	Sections that discuss how dangers stemming from biotechnology are assessed		0
4.1.1 Risk Assessment	Sections that discuss risk assessment	Assess their own research efforts for dual use potential and report as appropriate	60
4.1.2 Awareness/Education	Sections that discuss awareness raising or educational measures	The NSABB strongly promotes the free and open exchange of information in the life sciences to the maximum extent possible and believes that the best way to address concerns regarding dual use research is to raise awareness of the issue and strengthen the culture of understanding and responsibility within the scientific community and the public as well as instituting new oversight procedures to minimize the risk of misuse of research information.	44
4.1.3 Risk-Benefit	Sections that discuss risk-benefit calculations	The distinction between the great opportunities and great dangers of biotechnology turns on assessing whether the risk(s) associated with the benefits of fundamental research outweigh the potential for misuse. The challenge to the scientific community, therefore, is to develop formal and informal pro-cesses and procedures to mitigate or minimize the destructive applications of advanced biotechnology without unduly restricting legitimate biotechnology research activities	33

	4.1.4 Uncertainty/Non-Knowledge	Sections that discuss the role of non-knowledge or uncertainty	The current inability to quantify dual use research of concern and the risk of misuse of research information raises challenges for proposing an oversight framework.	26
	4.1.5 Relevant Knowledge	Sections that discuss the role of specialized knowledge need for assessing dangers	Local Evaluation and Review of Research for Dual Use Potential. The initial evaluation of the dual use potential of life sciences research should be conducted by the investigator, after appropriate training. Additional review by others at the research institution may also be appropriate to ensure an unbiased and comprehensive evaluation and application of the criteria for identifying dual use research of concern. Local evaluation and review ensure that those with the appropriate expertise and the best understanding of local personnel, facilities, and ethos are assessing research for dual use potential.	20
	4.1.6 Criteria/Qualities for Identification	Sections that list qualities that make something DURC or passages that refer to such qualities e.g., lists or general references such as causing "broad threats" makes something DURC	One of the fundamental tasks of the NSABB was to develop criteria for identifying dual use research of concern. The proposed criterion is "research that, based on current understanding, can be reasonably anticipated to provide knowledge, products, or technologies that could be directly misapplied by others to pose a threat to public health and safety, agricultural crops and other plants, animals, the environment, or materiel." As guidance for those assessing research for its dual use potential, the NSABB identified seven broad categories of information that might be generated by life sciences research that has a high potential for being dual use of concern.	11

Table 1 – Coding Scheme

	4.1.7 All Life Science is Dual Use	Sections that argue all biotechnology is dual use	This dual use quality is inherent in a significant portion of life sciences research. In fact, it can be argued that virtually all life sciences research has dual use potential.	3
	4.1.8 Few Experiments are DURC	Sections that argue very few biotechnology is DURC	Although it was not possible to quantify the exact amount of dual use research of concern that is generated in the U.S. or elsewhere in a given period such as a year, preliminary analyses suggested that the number of cases of true dual use research of concern will be quite small. Similarly, it was not possible to quantify the risk of misuse of information from that research, but there was a consensus among NSABB members that there is indeed the potential for misuse with severe consequences to public health and safety and other areas presented herein. Misuse of dual use research of concern is therefore a low-probability but potentially high-consequence event, and this is a significant factor in the NSABB's formulation of oversight recommendations.	5
4.2 Handling the dangers		Sections that describe/propose/oppose measure to mitigate potential threats		0
	4.2.1 Overregulation/ Propionate Regulation	Sections that discuss potential effects from overregulation	Risk Assessment and Risk Management. The degree of oversight should be commensurate with the degree of risk and the potential impact of any misuse of research information. Risk assessment and management should be the foundation for local oversight of dual use research of concern. This will help minimize the potential for misuse of dual use research information while minimizing any	38

Table 1 – Coding Scheme

			negative impact on the conduct of science and will facilitate the responsible conduct of life sciences research.	
	4.2.2 Limit Communication/Publication/etc.	Sections suggesting limited circulation of knowledge	Limit access to selected individuals on a "need to know" basis. It will be necessary to identify categories of individuals who should have access and under what circumstances. iii) Recommend that the product not be published or otherwise made accessible to the public.	34
	4.2.3 Risk mitigation	Sections discussing risk mitigation	Considering options for communication that may reduce or eliminate risks when communicating information with dual use potential is clearly warranted by its benefits. Examples of mitigating strategies may include a delay in releasing the information, the addition of appropriate contextual information, or communicating the information to a more limited audience.	32
	4.2.4 Precaution	Sections discussing precaution	In view of this, ethical analysis leads to the conclusion that scientific responsibility in the area of biosecurity is mainly to be governed by the precautionary principle.	15
	4.2.5 Restricted Access/Cooperation	Sections discussing restricting access to knowledge/materials	It may be necessary for researchers to find out about the context of the research project, the nature of a customer or cooperation partner or about their customers.	14
	4.2.6 Restrict Research	Sections discussing the potential to restrict conducting certain research	The main aim of the risk analysis is responsible implementation and communication of the research. However, responsible decision-making by researchers may, in individual cases, result as ultima ratio in specific research projects, where risk potential is disproportionate	12

Table 1 – Coding Scheme

		or cannot be restricted, not being carried out, even if this is not prohibited by law.	
4.3 Formal Regulation	Sections that discuss formal (incl. voluntary) oversight mechanisms		0
4.3.1 Legislation/Legal Obligations	Sections that describe legal obligations on behalf of scientists	Even highly detailed legal regulations would not sufficiently take account of the differentiated and rapidly changing global issues of area-specific risks and, moreover, would conflict with the freedom of research enshrined in the constitution.	27
4.3.2Code of Conduct	Sections that discuss the role of a code of conduct	In fulfilment of one of its specific charges, the NSABB also provides recommendations on the development of a code of conduct for scientists and all laboratory personnel that could be adopted by professional organizations and institutions engaged in the performance of life sciences research. These are articulated in "Considerations in Developing a Code of Conduct for Dual Use Research in the Life Sciences“, which provides a conceptual foundation for understanding the dual use issue, describes the nature and utility of codes of conduct, articulates the fundamental principles of responsible conduct with regard to dual use research, and provides guidance on addressing the dual use issue in specific phases of the research process.	16
4.3.3 Self Governance	Sections that discuss self-governance by scientists	These rules aim to prevent misuse of research and avoid risks through self-regulation based on ethical principles.	15

4.3.4 Oversight Institution/Procedures	Sections that discuss the implementation of formal oversight mechanisms	For areas considered to constitute DURC (see Recommendation 4.1), an interdisciplinary commission should be set up on the basis of appropriate legislation.	16
4.4 Responsibility	Sections that discuss responsibilities for securing DURC		0
4.4.1 Ethic/Moral Obligations	Sections that discuss ethical responsibilities for securing DURC. In contrast to "4.4.2 Secure Research", this code only includes sections in which a explicit moral obligation is mentioned and not limited to security related obligations.	Substantive knowledge of the potential risks is not sufficient, however. The Committee believes that biological scientists have an affirmative moral duty to avoid contributing to the advancement of biowarfare or bioterrorism. Individuals are never morally obligated to do the impossible, and so scientists cannot be expected to ensure that the knowledge they generate will never assist in advancing biowarfare or bioterrorism.	20
4.4.2 Secure Research	Sections that discuss a responsibility to keep research secure	It is therefore the responsibility of the scientific community to ensure that dual use research results and technologies are communicated responsibly.	18
4.4.3 Culture of Responsibility	Sections that discuss a culture of responsibility	The NSABB has observed that there is a need not only to raise life scientists' awareness of the dual use potential of their research but also to provide and promote principles of research conduct that will sustain a culture of responsibility within the scientific community.	6

Table 1 – Coding Scheme

4.5 Actors	Sections that discuss the which actors are involved in securing DURC incl. traits attributed to the actors		0
4.5.1 Scientists	Sections that discuss the role of scientists incl. traits attributed to the actors		0
4.5.1.1 Aware of Dangers	Sections that argue scientists are aware of the dangers	As the preceding examples make abundantly clear, there is an increasing awareness within and outside the scientific community of the dangers posed by the proliferation of biological weapons capabilities. This heightened awareness has also increased the collective concerns of this Commit-tee and the scientific community about preventing the destructive applications of biotechnology research.	3
4.5.1.2 Knowing the Dangers	Sections that argue scientists need to know the potential dangers	Researchers thus have a professional responsibility to be aware of dual use research issues and concerns, to be aware of the implications of their work and the various ways in which information from their work could be misused, and to take steps to minimize misuse of their work. This includes being knowledgeable about and complying with all local and federal policies for oversight of dual use research, ensuring that their own dual use research training and that of their staff is current, assessing their own work and that of their research personnel for dual use potential on an ongoing basis, and communicating dual use research in a responsible manner	12

	4.5.1.3 DURC Assessment	Sections that discuss the role of scientists in DURC assessments incl. risk assessments	The NSABB members agreed that the PI should conduct the initial evaluation of his or her research for its potential as dual use research of concern, using the criterion set forth above as guidance for decision-making.	14
	4.5.1.4 Improving Oversight	Sections that discuss the role of scientists in improving oversights	Participating in the development of those measures is an opportunity to ensure that the open process of scientific discovery that has been so critical to the progress and achievements in life sciences research remains open. Life scientists have been and must continue to be fully committed to the free flow of scientific inquiry. It is in the life sciences community's interest to engage and demonstrate to the public and policymakers that life scientists are taking responsibility for the implications of their work.	2
	4.5.1.5 Responsible Research	Sections that argue scientists have a duty to conduct research responsibly	Scientists bear the primary responsibility for the integrity of their own research. By their actions and explicit guidance, they can foster a sense of ethical responsibility in the research team and an awareness of applicable laws and guidelines. This document may aid in increasing their awareness of their responsibilities in the area of dual use research of concern and help them mentor students, trainees, and technical staff. Mentors are encouraged to involve these individuals in laboratory discussions of dual use research of concern, the ethical responsibilities that are outlined in this document, and the relevance of these responsibilities to their work.	17

Table 1 – Coding Scheme

4.5.2 Research Institutions	Sections that discuss the role of research institutions	Effective oversight will help maintain public trust in the life sciences research enterprise by demonstrating that the scientific community recognizes the implications of dual use research and is acting responsibly to protect public welfare and security. The federal agencies that fund life sciences research, the institutions that are the recipients of those public funds, and the individuals who conduct this research share this oversight responsibility.	14
4.5.3 Others	Sections that discuss the role of other actors (e.g., Journals, Funding Agencies)	Funding agencies/institutions. Institutions and agencies that fund research establish the framework for decisions about the research considered eligible for funding and provide oversight to ensure responsible stewardship of funds. In order to avoid endangering public health, agriculture, plants, animals, the environment, or materiel, they are responsible for ensuring that projects that could be considered dual use research of concern are identified prior to funding. When a project meets the criteria for this type of research, the funders should ensure that a process is in place to manage risks through a thoughtful and informed consideration of options that could mitigate or manage them.	19
9. Discourse and Genealogy	Internal code that marks section that discuss the history of DURC and biosecurity	One example is the very short time it took the scientific community to identify the coronavirus as the causal agent of the newly emerging human disease, severe acute respiratory syndrome (SARS).	

Table 2 – List of Used Codes

ID	Dokumentname	Code	Segment
C1	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 1: Threatening Biotechnology > Offensive Applications > Building Weapons Dimension 3: Making of Life Science > Fast Progress Dimension 2: Beneficial Biotechnology	The great achievements of molecular biology and genetics over the last 50 years have produced advances in agriculture and industrial processes and have revolutionized the practice of medicine. The very technologies that fueled these benefits to society, however, pose a potential risk as well—the possibility that these technologies could also be used to create the next generation of biological weapons. Biotechnology represents a "dual use" dilemma in which the same technologies can be used legitimately for human betterment and misused for bioterrorism.
C2	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 1: Threatening Biotechnology > Proliferation Problem > Dispersion of Knowledge Dimension 1: Threatening Biotechnology > Offensive Applications > Misuse/Misapplied Dimension 2: Beneficial Biotechnology > National Security Benefit	This task is complicated because almost all biotechnology in service of human health can be subverted for misuse by hostile individuals or nations. The major vehicles of bioterrorism, at least in the near term, are likely to be based on materials and techniques that are available throughout the world and are easily acquired. Most importantly, a critical element of our defense against bioterrorism is the accelerated development of biotechnology to advance our ability to detect and cure disease. Since the development of biotechnology is facilitated by the sharing of ideas and materials, open communication offers the best security against bioterrorism. The tension between the spread of technologies that protect us and the spread of technologies that threaten us is the crux of the dilemma.
C3	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 1: Threatening Biotechnology > Offensive Applications > National Security Threat Dimension 4: Responses > Handling the dangers > Overregulation/ Propionate Regulation	All of these developments have prompted the current report. The goal of this report to make recommendations that achieve an appropriate balance between the pursuit of scientific advances to improve human health and welfare and national security.
C4	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 1: Threatening Biotechnology > Proliferation Problem > Dispersion of Knowledge	These dangers cannot be eliminated entirely since the fundamental knowledge from which they emerge is available around the world and the potential benefits of biotechnology for health promotion and national

			defense are too great to contemplate efforts to prohibit or reverse such research.
C5	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 1: Threatening Biotechnology > Offensive Applications > Building Weapons	Useful distinctions between permitted and prohibited activities at the level of basic re-search are difficult to make because biotechnology presents a classic example of the dual use dilemma. In the life sciences, for example, the same techniques used to gain insight and understanding regarding the fundamental life processes for the benefit of human health and welfare may also be used to create a new generation of BW agents by hostile governments and individuals.
C6	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 1: Threatening Biotechnology > Proliferation Problem > Available Equipment	In this situation it is futile to imagine that access to dangerous pathogens and destructive biotechnologies can be physically restricted, as is the case for nuclear weapons and fissionable materials.34 The nature of the biotechnology problem—indeed the nature of the biological research enterprise—is vastly different from that of theoretical and applied nuclear physics in the late 1930s. The contrast between what is a legitimate, per-haps compelling subject for research and what might justifiably be prohibited or tightly controlled cannot be made a priori, stated in categorical terms, nor confirmed by remote observation.
C7	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 1: Threatening Biotechnology > Proliferation Problem > Dispersion of Knowledge	Biotechnology research is now a truly global enterprise. While industrialized countries such as the United States, the United Kingdom, Germany, Israel, and Japan may be the first to develop advanced research and technologies, other countries have a skill base that will enable broad domestic utilization of biological technologies.
C8	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 1: Threatening Biotechnology > Proliferation Problem > Available Equipment Dimension 1: Threatening Biotechnology > Proliferation Problem > Dispersion of Knowledge	The information to conduct genetic engineering research is easily accessible on the Internet. Moreover, the equipment and expertise to use this information to create novel agents are available globally. The international diffusion of knowledge and capabilities in biotechnology means that the capacity to carry out beneficial as well as harmful research activities is widely accessible, both to nations and to terrorist groups.

C9	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 1: Threatening Biotechnology > Proliferation Problem > Dispersion of Knowledge	The most elaborate treaty-based inspection procedures could not achieve effective restrictions at the level of basic research without severely restricting research in general. The inevitable diffusion of knowledge and capabilities has already demonstrated that the capacity to do harm is be-coming globally available, both to state and nonstate actors.
C10	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 1: Threatening Biotechnology > Proliferation Problem > Dispersion of Knowledge	The techniques, reagents, and information that could be used for offensive purposes are readily available and accessible. Moreover, the expertise and know-how to use or misuse them is distributed across the globe.
C11	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 1: Threatening Biotechnology > Proliferation Problem > Cheap Weapon	Research in biology lies between these two extremes. Traditionally, biology has been considered a small-scale science. Although work in genomics, proteomics, and bionanotechnology is overturning this paradigm, the research and development associated with biological weapons programs do not necessarily require large-scale investment or specialized, dedicated facilities. Creating pathogen weapons poses certain technical challenges, but the ability to produce enough material to cause morbidity, mortality, public panic, and economic costs is within the capability of many laboratories.
C12	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 1: Threatening Biotechnology > Proliferation Problem > Dispersion of Knowledge	States, groups, and individuals are pursuing a biological weapons capability—and the means for them to do so are widely available
C13	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 2: Beneficial Biotechnology > Public Health > Natural Occurrence	The charge to our Committee was to consider ways to minimize threats from biological warfare and bioterrorism without hindering the progress of biotechnology, which is essential for the health of the nation
C14	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 2: Beneficial Biotechnology	Throughout the Committee's deliberations there was a concern that policies to counter biological threats should not be so broad as to impinge upon the ability of the life sciences community to continue its role of con-tributing to the betterment of life and improving defenses against biological threats. Caution must be exercised in adopting policy measures to respond to this threat so that the intended ends will be achieved without creating "unintended consequences." On the other hand, the potential threat from the misuse of current and future biological research

			is a challenge to which policymakers and the scientific community must respond.
C15	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 2: Beneficial Biotechnology > Public Health > Intentional Release	These research activities also include an intense effort to discover vaccines, antibiotics, and detection systems that would provide the defense against each of the select agents. But many of the same methods for developing attenuated live vaccines against viral diseases can have offensive applications as well.
C16	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 2: Beneficial Biotechnology > Public Health > Natural Occurrence	Current research programs in universities, government laboratories, and pharmaceutical companies include experiments directed toward such goals as discovering vaccines for major diseases such as influenza, AIDS, and cancer; new antibiotics for both bacterial and fungal diseases; new sources of genes to protect crops against pests and diseases; and treatments for diabetes, stroke, and Alzheimer’s disease. These research activities also include an intense effort to discover vaccines, antibiotics, and detection systems that would provide the defense against each of the select agents.
C17	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 2: Beneficial Biotechnology > Public Health > Natural Occurrence Dimension 3: Making of Life Science > Fast Progress	This ever-expanding research activity has resulted in numerous new biopharmaceutical products that are transforming medicine. Examples include human recombinant insulin for the treatment of diabetes, a vaccine against hepatitis B, and medicines for diabetes, cancer therapy, arthritis, multiple sclerosis, cystic fibrosis, heart attacks, hemophilia, and sepsis. As knowledge of the human genome increases, it may even be-come possible to tailor pharmaceutical products not only to specific diseases but also to specific individuals. Throughout this process, the time between new discoveries and their applications has grown ever shorter.
C18	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Discourse and Genealogy	The biological sciences have experienced enormous growth over the last century, fueled by a stream of discoveries—such as the principles of genetics, the structure of DNA, and the discovery of gene-splicing technologies. These have opened new fields of inquiry and provided the basis for myriad applications in industry, agriculture, and medicine. Among the technological breakthroughs in the life sciences, genetic engineering plays a particularly significant role

Table 2 – List of Used Codes

C19	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Discourse and Genealogy > Illness > SARS	One example is the very short time it took the scientific community to identify the coronavirus as the causal agent of the newly emerging human disease, severe acute respiratory syndrome (SARS).
C20	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 2: Beneficial Biotechnology > National Security Benefit Dimension 2: Beneficial Biotechnology > Public Health > Natural Occurrence Dimension 2: Beneficial Biotechnology > Public Health > Intentional Release	The Committee stresses that implementation of current legislation must not be overly restrictive given the critical role that the development of effective vaccines, diagnostics, therapeutics, and detection systems, along with a responsive public health system, will play in providing protection against bioterrorism—and other serious health threats. Otherwise these legislative solutions may unintentionally limit the research on dangerous pathogens by legitimate laboratories and investigators. To be effective, a harmonized international system for the regulatory oversight of the possession of dangerous pathogens and toxins, comparable to the one being put in place in the United States, is needed.
C21	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 2: Beneficial Biotechnology > National Security Benefit Dimension 2: Beneficial Biotechnology > Public Health > Natural Occurrence Dimension 2: Beneficial Biotechnology > Public Health > Intentional Release	The Committee stresses that implementation of current legislation must not be overly restrictive given the critical role that the development of effective vaccines, diagnostics, therapeutics, and detection systems, along with a responsive public health system, will play in providing protection against bioterrorism—and other serious health threats. Other-wise these legislative solutions may unintentionally limit the research on dangerous pathogens by legitimate laboratories and investigators.
C22	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 3: Making of Life Science > Fast Progress	In short, a dynamic national and international research enterprise has evolved, with an extraordinary record of achievement at multiple centers of excellence
C23	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 3: Making of Life Science > Fast Progress	The biological sciences have experienced enormous growth over the last century, fueled by a stream of discoveries—such as the principles of genetics, the structure of DNA, and the discovery of gene-splicing technologies. These have opened new fields of inquiry and provided the basis for myriad applications in industry, agriculture, and medicine. Among the technological breakthroughs in the life sciences, genetic engineering plays a particularly significant role.

C24	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Handling the dangers > Risk mitigation	Hierzu gehört zunächst der einzelne Wissenschaftler, der im Sinne des Ethos epistemischer Rationalität seine Forschung nicht nur gegenüber den Wissenschaftler-Kollegen im Hinblick auf die Einhaltung der Regeln guter wissenschaftlicher Praxis, sondern darüber hinaus auch im Hinblick auf Sicherheitsgewährleistung und Risikominimierung zu verantworten hat. Diese Verantwortung des Wissenschaftlers besitzt eine gesamtgesellschaftliche Dimension
C25	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 3: Making of Life Science > Fast Progress	The acquisition of biotechnology and biological weapons capability is considerably easier than was the case in the 1940s and 1950s. The explosion in biotechnologies and genetic engineering technologies—all of which have legitimate civilian applications—could empower a hostile agent.
C26	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 3: Making of Life Science > Fast Progress	Many more experiments will explore the virulence factors of bacteria and viruses.
C27	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 3: Making of Life Science > Fast Progress	Since that report, much has happened to justify an examination of the life sciences in this context—the discovery of nations with clandestine research programs dedicated to the creation of biological weapons, the anthrax attacks of 2001, the rapid pace of progress in biotechnology, and the accessibility of these new technologies via the Internet.
C28	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 3: Making of Life Science > Fast Progress	Moreover, all of these areas are changing rapidly. The great diversity as well as the pace of change make it imprudent to project the potential both for good and ill too broadly and too far into the future. Therefore, the Committee has initially limited its concerns to cover those possibilities that represent a plausible danger and has tried to avoid im-probable scenarios. Over time, however, the Committee believes it will be necessary to expand the experiments of concern to cover a significantly wider range of potential threats.
C29	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 3: Making of Life Science > Open Science	This task is complicated because almost all biotechnology in service of human health can be subverted for misuse by hostile individuals or nations. The major vehicles of bioterrorism, at least in the near term, are likely to be based on materials and techniques that are available throughout the world and are easily acquired. Most importantly, a critical

			element of our defense against bioterrorism is the accelerated development of biotechnology to advance our ability to detect and cure disease. Since the development of biotechnology is facilitated by the sharing of ideas and materials, open communication offers the best security against bioterrorism. The tension between the spread of technologies that protect us and the spread of technologies that threaten us is the crux of the dilemma.
C30	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 4: Responses > Handling the dangers > Overregulation/Propionate Regulation	The charge to our Committee was to consider ways to minimize threats from biological warfare and bioterrorism without hindering the progress of biotechnology, which is essential for the health of the nation.
C31	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 4: Responses > Handling the dangers > Overregulation/Propionate Regulation	The key issue is whether the risks associated with misuse can be reduced while still enabling critical research to go forward.
C32	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 4: Responses > Assessing Dangers > Risk-Benefit Dimension 4: Responses > Handling the dangers > Overregulation/Propionate Regulation	The distinction be-tween the great opportunities and great dangers of biotechnology turns on assessing whether the risk(s) associated with the benefits of fundamental research outweigh the potential for misuse. The challenge to the scientific community, therefore, is to develop formal and informal processes and procedures to mitigate or minimize the destructive applications of advanced biotechnology without unduly restricting legitimate biotechnology research activities
C33	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk-Benefit	The IBC would then review that issue along with the other aspects of the project that it is evaluating, carefully weighing potential benefits versus potential danger. Occasionally, the IBC may discover that what is proposed is forbidden under current guidelines and would not approve the research. In most cases, however, it would designate the project either as acceptable to move forward or as raising concerns that need further consideration at a higher level.
C34	National Research Council. (2004). Biotechnology Research in an Age of Terrorism. National Academies Press.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk-Benefit	In addition, no national or international review body currently has the legal authority or self-governance responsibility to evaluate a proposed research activity prior to its conduct to determine whether the risks associated with the proposed research, and its potential for misuse, outweigh its potential benefits.

C35	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 2: Beneficial Biotechnology	Life sciences research is a critically important endeavor that has benefited society by advancing our understanding of living systems.
C36	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 2: Beneficial Biotechnology > Public Health > Natural Occurrence Dimension 2: Beneficial Biotechnology > National Security Benefit Dimension 2: Beneficial Biotechnology > Economic Benefits Dimension 2: Beneficial Biotechnology > Agriculture/Food Supply	The Dual Use Research Issue. Information from life sciences research is clearly vital to improving public health, agriculture, and the environment and maintaining and strengthening our national security and economy.
C37	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 2: Beneficial Biotechnology > Public Health > Natural Occurrence	Advances in the life sciences have led to new pharmaceuticals, diagnostic procedures, preventive strategies, treatments, and cures for myriad acute and chronic diseases and conditions and for emerging and reemerging infectious diseases that affect humans and exact a heavy toll in terms of quality of life, medical costs, and productivity.
C38	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 2: Beneficial Biotechnology > Public Health > Natural Occurrence Dimension 2: Beneficial Biotechnology > Agriculture/Food Supply Dimension 2: Beneficial Biotechnology > Understanding Nature	Life sciences research has a critical role in understanding life at the ecosystem, organism, biological system, organ, cellular, and molecular levels. Advances in the life sciences have led to new pharmaceuticals, diagnostic procedures, preventive strategies, treatments, and cures for myriad acute and chronic diseases and conditions and has contributed to improvements in animal and plant health and the food supply.
C39	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 2: Beneficial Biotechnology > Public Health > Natural Occurrence	Across the globe, researchers are manipulating microorganisms to gain a deeper understanding of how they cause disease to identify new targets for the development of novel and improved treatments for the diseases these microbes cause, identify new strategies for the control of microorganisms, and develop measures to prevent infection with or illness caused by microorganisms.

Table 2 – List of Used Codes

C40	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 2: Beneficial Biotechnology > Public Health > Natural Occurrence Dimension 3: Making of Life Science > Open Science Dimension 2: Beneficial Biotechnology > Other Benefits Dimension 2: Beneficial Biotechnology > Economic Benefits Dimension 2: Beneficial Biotechnology > Agriculture/Food Supply Dimension 2: Beneficial Biotechnology > Understanding Nature	The open and unfettered sharing of information and technologies has been a hallmark of the life sciences and has fostered a steady stream of scientific advances that underpin public health and safety, a strong and safe food supply, a healthy environment, and a vigorous economy.
C41	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 2: Beneficial Biotechnology > Agriculture/Food Supply	Plant biologists are utilizing similar approaches to enhance crop yield and nutritional content and explore the potential for using plants to manufacture products such as vaccines, antibodies, and other biological products. Similar efforts are underway in the field of animal husbandry in an effort to produce animals for human consumption that are heartier and better sources of nutrition.
C42	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 2: Beneficial Biotechnology > National Security Benefit Dimension 2: Beneficial Biotechnology > Other Benefits Dimension 2: Beneficial Biotechnology > Economic Benefits Dimension 2: Beneficial Biotechnology > Public Health > Natural Occurrence	Life sciences research underpins advances in public health, agriculture, the environment, and other pertinent areas and contributes significantly to a strong national security and economy.
C43	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 2: Beneficial Biotechnology > Other Benefits	In other arenas, life scientists are developing environmental remediation technologies and creating new materials and even energy sources.

C44	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 1: Threatening Biotechnology > Offensive Applications > National Security Threat	The concern regarding dual use research is that the information, technologies, or products developed from it could be misused to threaten national security. The NSABB found that there are many different understandings of the term "national security," so it identified the relevant aspects and used the collective terms. Thus, the criterion refers to the potential for threats to public health and safety, agricultural crops and other plants, animals, the environment, and/or materiel. This would include threats to farming, livestock, aquaculture, terrestrial and marine wildlife, companion animals, domestic and wild plants and trees, ecological systems, and other natural resources, as well as manmade resources.
C45	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 1: Threatening Biotechnology > Offensive Applications > National Security Threat Dimension 4: Responses > Assessing Dangers (Abstract Code) > Criteria/Qualities for Identification	In addition, the NSABB focused on the scope of a potential threat as a key consideration in evaluating research for dual use potential. Thus, the criterion captures threats with broad potential consequences to public health or other aspects of national security (e.g., that threaten populations rather than individuals).
C46	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 1: Threatening Biotechnology > Offensive Applications	However, life sciences research has the potential to produce information or technology that can be misused to pose a threat to public health and safety, and therefore it is appropriate to have in place a framework and tools for the responsible oversight, conduct, and communication of such research.
C47	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 1: Threatening Biotechnology > Offensive Applications > National Security Threat	U.S. Government Response. In acknowledgment that the threat of the misuse of research information is important and real, the U.S. Government agreed that new biosecurity measures were warranted to minimize the risk that information from life sciences research might be misused to threaten public health and safety and other aspects of national security.

C48	NSABB. (2006). NSABB Draft Guidance Documents.	Dimension 1: Threatening Biotechnology > Offensive Applications > National Security Threat	4. There is a need for reasonable balance in decisions about the communication of research with dual use potential. It is important to recognize the potential for deliberate and malevolent misuse of dual use research findings and to consider whether the disclosure of certain information might reasonably pose a threat to national security (i.e., public health, agriculture, plants, animals, the environment, or materiel). If the communication of dual use research does pose potential security risks, the logical next step is a risk-benefit analysis of communicating the information.
C49	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 1: Threatening Biotechnology > Offensive Applications > National Security Threat	The biosecurity concerns that the NSABB is tasked with addressing pertain to the misapplication of information, technologies, or biological agents resulting from legitimate dual use research, not the conduct of the research itself. The goal of identifying dual use research of concern is to initiate a process aimed at reducing the potential that knowledge, products, or technology derived from certain life sciences research could be misapplied to threaten public health and safety or other aspects of national security.
C50	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 3: Making of Life Science > Fast Progress	Advances in molecular and cell biology, genetics, microbiology, and other life sciences disciplines have made it possible to routinely manipulate aspects of biological systems as part of an ongoing quest to better understand the health and disease states and the life cycles of humans, animals, plants, insects and microorganisms.
C51	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 3: Making of Life Science > Fast Progress	Research is a complex, iterative process, and the potential for dual use may be recognized at many junctures and through different activities.
C52	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 3: Making of Life Science > Fast Progress	Life sciences research is by nature dynamic and can produce unanticipated results and therefore must be periodically evaluated for dual use potential.

C53	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 3: Making of Life Science > Fast Progress	Life sciences research is an extraordinarily dynamic field that encompasses many diverse disciplines; therefore, it will be important to periodically review the criterion and modify it as necessary to ensure its relevance in the face of new advances and technologies.
C54	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 3: Making of Life Science > Fast Progress	The NSABB has drawn from the recombinant DNA research oversight system in proposing oversight measures for dual use research of concern. The current proposals are for guidelines rather than regulations so that course corrections can be made more easily and new technological advances can be addressed as needed with relative ease.
C55	NSABB. (2006). NSABB Draft Guidance Documents.	Dimension 3: Making of Life Science > Open Science	The open and unfettered sharing of information and technologies has been a hallmark of the life sciences and has fostered a steady stream of scientific advances that underpin public health and safety, a strong and safe food supply, and a healthy environment.
C56	NSABB. (2006). NSABB Draft Guidance Documents.	Dimension 3: Making of Life Science > Open Science	Progress in the life sciences relies heavily upon the communication of research findings, so that they can be both validated, and built upon.
C57	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 3: Making of Life Science > Open Science	Progress in the life sciences relies heavily on the communication of research findings so that the findings can be both validated and used for further research.
C58	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 3: Making of Life Science > Open Science	Life sciences research should be communicated to the fullest extent possible to ensure the continued advancement of human, animal, plant, and environmental health. Consequently, any restriction of scientific communication should be the rare exception rather than the rule.
C59	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 3: Making of Life Science > Open Science	One of the major charges to the NSABB is to recommend strategies to help ensure that research information with dual use potential is communicated responsibly, in a manner that addresses both biosecurity concerns and the need for open sharing of research results and technologies so that the research can be validated and used for further research. Toward this end, the NSABB developed a set of tools to facilitate consistent decision making about the responsible communication of research information with dual use potential.

C60	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 3: Making of Life Science > Open Science	The free and open conduct and communication of life sciences research is vital to a robust scientific enterprise; thus the "default" position should be the unfettered progress and communication of science. Any decision to do otherwise should be undertaken very carefully.
C61	NSABB. (2006). NSABB Draft Guidance Documents.	Dimension 3: Making of Life Science > Open Science	3. To ensure the continued advancement of human, animal, plant, and environmental health, life sciences research should be communicated to the fullest extent possible. Consequently, any restriction of scientific communication should be the rare exception rather than the rule.
C62	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 3: Making of Life Science > The Public	Because of the potential for misuse of dual use research results, concerns on the part of the public, including members of the scientific community, about the sharing of such information can be anticipated. In addition, the public is increasingly sensitive to issues pertaining to research involving dangerous microbes and the risk of accidental or intentional release of such agents. A lack of public understanding and appreciation for the reason for conducting and communicating dual use research, sensationalism of dual use research findings, and concerns about public safety and national security all serve to undermine public trust in the life sciences research enterprise. Therefore, it is the responsibility of the scientific community to ensure that dual use research results and technologies are communicated responsibly.
C63	NSABB. (2006). NSABB Draft Guidance Documents.	Dimension 3: Making of Life Science > The Public	It is important to consider not only what is communicated, but also the way in which it is communicated. Investigators and sponsors of research with dual use potential should recognize that the communication of certain dual use information is likely to raise biosecurity concerns, not only within the scientific community, but also within the general public. Consideration should be given to the potential for public concern and misunderstanding and for sensationalism. Thought should be given to the need for the inclusion of contextual and explanatory information that might minimize such concerns and misunderstanding.
C64	NSABB. (2006). NSABB Draft Guidance Documents.	Dimension 3: Making of Life Science > The Public	Public trust is essential to the vitality of the life sciences research enterprise. It has always been important for life scientists to participate in activities that enhance public understanding of their research. However, because of the potential for public misunderstanding of, and concerns

			about dual use research, it is especially important that life scientists conducting research with dual use potential engage in outreach on a regular basis to raise awareness of the importance of the research and to reassure the public that the research is being conducted and communicated responsibly.
C65	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 3: Making of Life Science > The Public	Critical to the future of scientific progress and freedom is the preservation of public trust and support, which scientists have earned through their attention to responsible research practice.
C66	NSABB. (2006). NSABB Draft Guidance Documents.	Dimension 3: Making of Life Science > The Public	In addition, the public is increasingly sensitized to issues pertaining to research involving dangerous pathogens and the risk of accidental or intentional release of such agents. A lack of public understanding and appreciation for the reason for conducting and communicating dual use research, sensationalism of dual use research findings, and concerns about public safety and national security all serve to undermine public trust in the life sciences research enterprise.
C67	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 3: Making of Life Science > The Public	It is important to consider not only what is communicated but also the way in which it is communicated. Investigators and sponsors of research with dual use potential should recognize that the communication of certain dual use information is likely to raise biosecurity concerns, not only within the scientific community but also within the general public. Consideration should be given to the potential for public concern and misunderstanding and for sensationalism. Thought should be given to the need for the inclusion of contextual and explanatory information that might minimize such concerns and misunderstanding. 8. Public trust is essential to the vitality of the life sciences research enterprise. It has always been important for life scientists to participate in activities that enhance public understanding of their research. However, because of the potential for public misunderstanding of and concerns about dual use research, it is especially important that life scientists conducting research with dual use potential engage in outreach on a regular basis to increase awareness of the importance of the research and

			to reassure the public that the research is being conducted and communicated responsibly.
C68	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 4: Responses > Handling the Dangers > Limit Communication/Publication/etc.	Responsible communication of research with dual use potential. This should be done throughout the research process.
C69	NSABB. (2006). NSABB Draft Guidance Documents.	Dimension 4: Responses > Handling the Dangers > Limit Communication/Publication/etc.	One of the major charges to the National Science Advisory Board for Biosecurity (NSABB) is to recommend strategies to help ensure that research information with dual use potential is communicated responsibly, in a manner that addresses both biosecurity concerns and the need for open sharing of research results and technologies. Towards this end, the NSABB has developed a set of tools to facilitate consistent decision making about the communication of research information with dual use potential. These tools currently consist of: • A set of principles for the responsible communication of research with dual use potential; • Points to consider (i.e., a framework) for identifying and assessing the risks and benefits of communicating research information with dual use potential, including options for the communication of such research information; and • Considerations for the development of a communication plan for research with dual use potential. The NSABB anticipates that these communication tools will become an integral component of the dual use research oversight system that is currently being developed by the Board. It is important to note that it is not the intent of the NSABB that every potential communication of research—be it an abstract, poster, seminar, or manuscript—be assessed using the communication tools. Rather, the tools might be utilized for the subset of life sciences research or research information determined to have dual use potential.
C70	NSABB. (2006). NSABB Draft Guidance Documents.	Dimension 4: Responses > Handling the Dangers > Limit Communication/Publication/etc.	There is a need for reasonable balance in decisions about the communication of research with dual use potential. It is important to recognize the potential for deliberate and malevolent misuse of dual use research findings and to consider whether the disclosure of certain information might reasonably pose a threat to national security (i.e.,

			public health, agriculture, plants, animals, the environment, or materiel). If the communication of dual use research does pose potential security risks, the logical next step is a risk-benefit analysis of communicating the information.
C71	NSABB. (2006). NSABB Draft Guidance Documents.	Dimension 4: Responses > Handling the dangers > Limit Communication/Publication/etc.	After weighing the risks and benefits of communicating dual use research, the decision regarding communication is not necessarily a binary (yes/no) one. Rather, a range of options for communication should be identified and considered. The options available will depend on the research setting (e.g., academia, federal, private). They could range from full and immediate communication, to delayed and/or modified communication, to restricted/no communication, and could be recommended singly or in appropriate combinations on a case-by-case basis, depending on the nature of the dual use finding and the potential risks associated with its communication.
C72	NSABB. (2006). NSABB Draft Guidance Documents.	Dimension 4: Responses > Handling the Dangers > Limit Communication/Publication/etc. Dimension 4: Responses > Handling the Dangers > Restricted Access/Cooperation	ii) Limit access to selected individuals on a "need to know" basis. It will be necessary to identify categories of individuals who should have access and under what circumstances. iii) Recommend that the product not be published or otherwise made accessible to the public.
C73	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment Dimension 4: Responses > Actors > Others > Institutional review Dimension 4: Responses > Actors > Scientists > DURC Assessment Dimension 4: Responses > Assessing Dangers (Abstract Code) > Relevant Knowledge	Local Evaluation and Review of Research for Dual Use Potential. The initial evaluation of the dual use potential of life sciences research should be conducted by the investigator, after appropriate training. Additional review by others at the research institution may also be appropriate to ensure an unbiased and comprehensive evaluation and application of the criteria for identifying dual use research of concern. Local evaluation and review ensure that those with the appropriate expertise and the best understanding of local personnel, facilities, and ethos are assessing research for dual use potential.

C74	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment Dimension 4: Responses > Assessing Dangers (Abstract Code) > Criteria/Qualities for Identification	One of the fundamental tasks of the NSABB was to develop criteria for identifying dual use research of concern. The proposed criterion is "research that, based on current understanding, can be reasonably anticipated to provide knowledge, products, or technologies that could be directly misapplied by others to pose a threat to public health and safety, agricultural crops and other plants, animals, the environment, or materiel." As guidance for those assessing research for its dual use potential, the NSABB identified seven broad categories of information that might be generated by life sciences research that has a high potential for being dual use of concern.
C75	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 4: Responses > Handling the Dangers > Limit Communication/Publication/etc.	It cannot be overemphasized that characterization of research as dual use research of concern should not be viewed pejoratively. Such a characterization does not automatically mean that this type of research should not be conducted or communicated, rather that the conduct and communication of that research should be carefully considered from the outset and throughout the research process. The oversight process is about the responsible conduct and communication of research, not the restriction of research.
C76	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 3: Making of Life Science > The Public	Depending on the nature of the dual use research result/technology being communicated and the potential impact of communicating the information, it may be prudent to consider steps to maximize public understanding of, and appreciation for, the research effort and the decision to communicate the information. This can be achieved through the development of a plan for the responsible communication of dual use research information. For example, it may be important to address the following issues, both in the content of the work product and in the activities associated with dissemination of the work product: • The significance of the research findings for public health and/or safety, agriculture, the environment, or materiel • How the new information or technology will be useful to the scientific community • The biosafety measures in place during the conduct of the research

			• The dual use aspects of the information and the careful consideration given to biosecurity concerns in the decision to publish
C77	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 1: Threatening Biotechnology > Offensive Applications > National Security Threat Dimension 4: Responses > Handling the Dangers > Limit Communication/Publication/etc. Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk-Benefit Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment Dimension 1: Threatening Biotechnology > Offensive Applications > Misuse/Misapplied	There is a need for reasonable balance in decisions about the communication of research with dual use potential. It is important to recognize the potential for the deliberate and malevolent misuse of dual use research findings and to consider whether the disclosure of certain information might reasonably pose a threat to national security (i.e., public health and safety, agricultural crops and other plants, animals, the environment, or materiel). If the communication of dual use research does pose potential security risks, the logical next step is a risk-benefit analysis of communicating the information.
C78	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Criteria/Qualities for Identification > Few Experiments are DURC Dimension 4: Responses > Actors > Others > Institutional review Dimension 4: Responses > Actors > Scientists > DURC Assessment Dimension 4: Responses > Handling the Dangers > Risk mitigation	NSABB members agreed that the principal investigator, using the criterion set forth above, should conduct the initial evaluation of his or her research for its potential as dual use research of concern. Those projects initially identified as dual use research of concern—and NSABB members anticipate that there will be very few projects that are truly dual use of concern—would undergo additional institutional review that involves interactive discussion among reviewers to assess the potential for and the ways in which information, technologies, or biological agents from the research could be misused to pose a threat; the likelihood that the information might be misused; the potential impacts of misuse; and the strategies for mitigating the risks that information from the research could be misused.

C79	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment Dimension 4: Responses > Assessing Dangers (Abstract Code) > Criteria/Qualities for Identification > Few Experiments are DURC Dimension 4: Responses > Assessing Dangers (Abstract Code) > Uncertainty/Non-Knowledge	The current inability to quantify dual use research of concern and the risk of misuse of research information raises challenges for proposing an oversight framework. The NSABB recognized some parallels with recombinant deoxyribonucleic acid (DNA) research, which provides an important historical precedent for managing risk when its magnitude is unknown. The system of oversight for recombinant DNA has stood the test of time in part because it is capable of evolving with technological developments and new scientific understanding. Oversight of recombinant DNA research is not imbedded in regulation; this provides greater facility to adapt to advancing science while nonetheless establishing a standard of practice that is embraced by public and private sectors.
C80	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Evaluation of life sciences research for its dual use potential. This should be done at the inception of any research and periodically throughout the research process.
C81	NSABB. (2006). NSABB Draft Guidance Documents.	Dimension 4: Responses > Handling the Dangers > Limit Communication/Publication/etc.	Because research findings are communicated at many points along the research continuum, e.g., during project concept and design, in funding applications, in seminars, and in publication of manuscripts, it is important to be aware of the potential for misuse of information. The communication tools are designed to help individuals identify and assess the risks and benefits of communicating information with dual use potential.
C82	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment Dimension 4: Responses > Actors > Scientists > DURC Assessment	Researchers. Researchers are the most critical element in the oversight of dual use life sciences research. They know the work best and are in the best position to anticipate the types of knowledge, products, or technologies that might be generated, the potential for misuse, and the degree of immediacy of that threat. However, to fulfill this responsibility, the principal investigator (PI) must be cognizant of the concept of dual use research of concern and aware of the risk that technologies or information produced by life sciences research may be misused.

C83	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment Dimension 4: Responses > Actors > Scientists > DURC Assessment	The NSABB members agreed that the PI should conduct the initial evaluation of his or her research for its potential as dual use research of concern, using the criterion set forth above as guidance for decision-making.
C84	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment Dimension 4: Responses > Actors > Scientists > DURC Assessment	Assess their own research efforts for dual use potential and report as appropriate
C85	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Criteria/Qualities for Identification	An evaluation of research for its dual use potential will require scientific expertise and logical, sound judgment about the probability or foreseeability that others could misapply/misuse research results. It is important to acknowledge, however, that any such evaluation is subjective and will be influenced by the individual's knowledge, experience, and judgment.
C86	NSABB. (2006). NSABB Draft Guidance Documents.	Dimension 1: Threatening Biotechnology > Offensive Applications > Misuse/Misapplied Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment Dimension 3: Making of Life Science > The Public	2) Risk Analysis a) Are there reasonably anticipated risks to public health from direct misapplication of this information? i) e.g., is novel scientific information provided that could be intentionally misused to threaten public health? ii) e.g., does the information point out a vulnerability in public health preparedness? b) Is it reasonably anticipated that this information could be directly misused to pose a threat to agriculture, plants, animals, the environment, or materiel? i) e.g., does the information point out a vulnerability with respect to agriculture, plants, animals, the environment, or materiel? c) If a risk has been identified, in what time frame (e.g., immediate, near future, years from now) might this information be used to pose a threat to public health, agriculture, plants, animals, the environment, or materiel? d) If the information were to be broadly communicated "as is," what is the potential for: i) Public misunderstanding (1) What might be the implications of such misunderstandings, e.g., psychological, social, health/dietary decisions, economic, commercial etc.? ii) Sensationalism (1) In what way might it result in widespread concern or even panic about public health or other safety/security issues?

C87	NSABB. (2006). NSABB Draft Guidance Documents.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk-Benefit	After weighing the risks and benefits of communicating dual use research, the decision regarding communication is not necessarily a binary (yes/no) one. Rather, a range of options for communication should be identified and considered. The options available will depend on the research setting (e.g., academia, federal, private). They could range from full and immediate communication, to delayed and/or modified communication, to restricted/no communication, and could be recommended singly or in appropriate combinations on a case-by-case basis, depending on the nature of the dual use finding and the potential risks associated with its communication.
C88	NSABB. (2007). Proposed Framework for the Oversight of Dual Use Life Sciences Research: Strategies for Minimizing the Potential	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment Dimension 4: Responses > Assessing Dangers (Abstract Code) > Uncertainty/Non-Knowledge	The NSABB gave a great deal of thought to the issue of how much life sciences research might reasonably be considered dual use research of concern. Although it was not possible to quantify the exact amount of dual use research of concern that is generated in the U.S. or elsewhere in a given period such as a year, preliminary analyses suggested that the number of cases of true dual use research of concern will be quite small. Similarly, it was not possible to quantify the risk of misuse of information from that research, but there was a consensus among NSABB members that there is indeed the potential for misuse with severe consequences to public health and safety and other areas presented herein. Misuse of dual use research of concern is therefore a low-probability but potentially high-consequence event, and this is a significant factor in the NSABB's formulation of oversight recommendations.
C89	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 1: Threatening Biotechnology > Offensive Applications > Misuse/Misapplied	Missbrauchsrisiken bestehen daher in den meisten Wissenschaftsbereichen. Gleichzeitig kann aber auch die Unterlassung von Forschung bedeutsame Risiken nach sich ziehen, etwa wenn ein Impfstoff gegen eine drohende Epidemie gefunden werden muss.

C90	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 1: Threatening Biotechnology > Offensive Applications > Misuse/Misapplied	Diese resultieren nicht nur unmittelbar aus eigenem fahrlässigem oder vorsätzlichem Fehlverhalten von Wissenschaftlern. Daneben besteht in allen Wissenschaftsbereichen die Gefahr, dass – für sich genommen neutrale oder nützliche – Ergebnisse durch andere Personen zu schädlichen Zwecken missbraucht werden:
C91	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 1: Threatening Biotechnology > Offensive Applications > Misuse/Misapplied	Das Erkennen von Forschungsrisiken betrifft nicht nur das eigene Verhalten. Der Forscher soll darüber hinaus bei missbrauchsgefährdeten Arbeiten auch die Folgen seiner Forschung berücksichtigen, deren nützliche Ergebnisse von anderen Personen zu schädlichen Zwecken missbraucht werden können.
C92	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 1: Threatening Biotechnology > Offensive Applications > Misuse/Misapplied	Die Kenntnis der möglichen Risiken ist die Voraussetzung dafür, dass Forschung verantwortlich erfolgen kann. Eine zentrale Voraussetzung für die Vermeidung oder zumindest die Kontrolle von 6 Z.B. Schutz der Menschenrechte, humanitäres Völkerrecht, Kriegsvölkerrecht, Folter- und Gewaltverbot, Biodiversitäts-Konvention. Forschungsrisiken ist daher – sowohl in der grundlagenorientierten als auch in der angewandten Forschung – die Bewusstmachung der einschlägigen Gefahren. Der Forscher soll deswegen so weit wie möglich die Folgen sowie die Einsatz- und Missbrauchsmöglichkeiten seiner Arbeiten und deren Beherrschbarkeit mitbedenken. Potentiell risikobehafteten Forschungsvorhaben soll daher eine Prüfung der mit ihnen verbundenen Risiken für die Menschenwürde, für Leben oder Gesundheit von Menschen, für die Umwelt und für andere wichtige verfassungsrechtlich geschützte Güter vorausgehen.
C93	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 1: Threatening Biotechnology > Offensive Applications	Die Möglichkeit einer missbräuchlichen Anwendung biologischer Forschungsergebnisse stellt ein ethisches Dilemma dar, da vielversprechende und hilfreiche Aspekte untrennbar mit bedrohlichen und besorgniserregenden Aspekten verbunden sind. Von diesem Dilemma ist nicht nur der Forscher selbst, sondern sind auch die Forschungseinrichtung, die forschungsfinanzierende Institution und häufig der Staat betroffen.

C94	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 1: Threatening Biotechnology > Offensive Applications	Biosecurity bezieht sich auf eine Schädigung von Menschen, Umwelt oder anderen Rechtsgütern, die vom Verursacher als solche intendiert ist.
C95	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 1: Threatening Biotechnology > Offensive Applications	Für Forschungsarbeiten, deren Missbrauch die öffentliche Gesundheit oder die nationale Sicherheit bedrohen könnte, hat sich international der englische Begriff Dual Use Research of Concern, kurz DURC, durchgesetzt. Solche besorgniserregende Biosecurity-relevante Forschung umfasst Arbeiten, bei denen anzunehmen ist, dass sie Wissen, Produkte oder Technologien hervorbringen, die direkt von Dritten missbraucht werden könnten, um das Leben oder die Gesundheit von Menschen, die Umwelt oder andere Rechtsgüter zu schädigen. Bei ihren auch als biologische Agenzien bezeichneten Forschungsobjekten handelt es sich um Mikroorganismen, Toxine und andere biologische Stoffe, die lebenswichtige physiologische Funktionen schädigen können. Biologische Agenzien in diesem Sinne haben grundsätzlich das Potenzial, als Massenvernichtungswaffen eingesetzt zu werden, und können sich zum Teil auch durch Infektion weltweit verbreiten, selbst wenn die Freisetzung örtlich begrenzt erfolgt.
C96	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 1: Threatening Biotechnology > Offensive Applications > Misuse/Misapplied	Heute ermöglichen es Entwicklungen im Bereich der Molekularbiologie und Genetik, die Mechanismen krank machen-der Prozesse durch infektiöse Mikroorganismen immer gezielter und präziser zu entschlüsseln. Die Entwicklung dieses Wissenschaftsfeldes gibt jedoch auch Anlass zur Sorge, dass vollkommen neue, für Terroranschläge besser geeignete Arten von gentechnisch modifizierten Agenzien hergestellt und an-gewendet werden könnten, auch wenn dies bisher noch nicht der Fall war.
C97	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 1: Threatening Biotechnology > Proliferation Problem > Dispersion of Knowledge	Zur Frage der Bedrohungssituation im Rahmen der Biosecurity-relevanten Forschung ist aus naturwissenschaftlicher Sicht festzustellen, dass die neuen Entwicklungen im Bereich der Lebenswissenschaften, insbesondere die anspruchsvolleren Technologien, eher für die nähere und weitere Zukunft eine mögliche Gefährdung der Sicherheit der Bevölkerung durch Missbrauch von Forschungsergebnissen darzustellen scheinen als für die Gegenwart. Zum Teil wird zwar die Befürchtung

			geäußert, dass Terroristen oder Staaten ohne Weiteres die neuen Entwicklungen in der Biotechnologie verwenden können, um B-Waffen zu produzieren. Dabei werden jedoch oft, jedenfalls wenn nicht der Forscher selbst zum Täter wird, die Schwierigkeiten, die Gefahren für die eigene Gesundheit und der in der Praxis notwendige Zeitaufwand für biotechnologische Verfahren unterschätzt.
C98	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 1: Threatening Biotechnology > Proliferation Problem > Dispersion of Knowledge	Anspruchsvolle biotechnologische Methoden sind in der Praxis nicht leicht anzuwenden. Zur Umsetzung sind langjährige Expertise, speziell ausgestattete Laboratorien bzw. Produktionseinrichtungen und erhebliche finanzielle Mittel erforderlich. Technisch ausgefeilte Technologien sind daher eher von Forschern selbst oder sonstigen Akteuren einzusetzen, die von großen Institutionen unterstützt werden und langjährige praktische Erfahrung besitzen. Wie die wenigen gut dokumentierten terroristischen Anschläge mit B-Waffen bisher gezeigt haben, werden Terroristen, sofern sie nicht selbst an dieser Forschung beteiligt sind, nach gegenwärtiger Einschätzung eher auf natürliche Agenzien und traditionelle B- oder C-Waffen zurückgreifen.
C99	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 1: Threatening Biotechnology > Offensive Applications > Misuse/Misapplied	Die tatsächliche Höhe des Missbrauchsrisikos lässt sich jedoch oft nur schwer einschätzen, da sie außer von den Eigenschaften der biologischen Agenzien selbst auch von mitunter schwer fassbaren weiteren kontextbedingten Faktoren abhängt. Für die Verwendbarkeit eines biologischen Agens als Biowaffe können zum Beispiel seine Handhabbarkeit und Verbreitungsfähigkeit von ebenso entscheidender Bedeutung sein wie die für einen Missbrauch benötigte Expertise und die Wahrscheinlichkeit, diese bei Terroristen anzutreffen. Zudem hängt die Wahrscheinlichkeit von terroristischen Anschlägen stark von innerstaatlichen und staatsübergreifenden Strukturen und Entwicklungen ab. Klar ist jedenfalls, dass ein Missbrauch auch in Laboren mit höchster Sicherheitsstufe nicht völlig ausgeschlossen werden kann.

Table 2 – List of Used Codes

C100	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 1: Threatening Biotechnology > Offensive Applications > Misuse/Misapplied	Zur Frage der Bedrohungssituation im Rahmen der Biosecurity-relevanten Forschung ist aus naturwissenschaftlicher Sicht festzustellen, dass die neuen Entwicklungen im Bereich der Lebenswissenschaften, insbesondere die anspruchsvolleren Technologien, eher für die nähere und weitere Zukunft eine mögliche Gefährdung der Sicherheit der Bevölkerung durch Missbrauch von Forschungsergebnissen darzustellen scheinen als für die Gegenwart
C101	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 1: Threatening Biotechnology > Proliferation Problem > Dispersion of Knowledge	Die Fachexpertise und das Tacit-Wissen, aber auch der Stand des schwierig einzuschätzenden De-Skilling-Prozesses spielen hierbei eine große Rolle.
C102	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 2: Beneficial Biotechnology > Progress Dimension 2: Beneficial Biotechnology > Public Health	Forschung ist eine wesentliche Grundlage für den Fortschritt der Menschheit. Sie dient der Wissensvermehrung und fördert Gesundheit, Wohlstand und Sicherheit der Menschen sowie den Schutz der Umwelt
C103	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 2: Beneficial Biotechnology > Public Health	Abzuwägen sind dabei insbesondere die Freiheit der Forschung einerseits und der Schutz des Lebens und der körperlichen Unversehrtheit sowie der andererseits. Erstere kann durch eine Einschränkung von Forschung verletzt, Letztere durch eine risikoreiche Forschung gefährdet werden. Eine solche mögliche Gefährdung kann durch die angestrebten Forschungsziele (z. B. Herstellung oder Veränderung biologischer Agenzien) oder die für die Forschung einzusetzenden Mittel erfolgen, sodass beide einer Beurteilung im Hinblick auf die mit ihnen verbundenen Missbrauchsrisiken unterzogen werden müssen. In die Beurteilung einzubeziehen sind auch die mit den Forschungszielen verbundenen Chancen eines Erkenntnisgewinns oder anderen Nutzens, zum Beispiel für Leben und Gesundheit von Menschen
C104	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 2: Beneficial Biotechnology > Public Health	Diese Entwicklung in der Laborsicherheit zeigt, wie erst auf der Basis einer wechselseitigen Verantwortung von Wissenschaft und Gesellschaft ein Umgang mit schädlichen und möglicherweise schädlichen biologischen Agenzien ethisch zu rechtfertigen ist. Dabei geht es nicht um die Gewährung einer Erlaubnis für die Forschung selbst, sondern um die

			Festlegung von Anforderungen und Bedingungen für deren Durchführung zum Schutz von Menschen und Umwelt. Der Staat hat die Pflicht, die Forschungsfreiheit zu gewährleisten und Forschung, die dem Wohl und Nutzen der Gesellschaft dient, zu fördern. Dazu gehört auch, die Weiterentwicklung des Wissens und der Techniken zur Abwehr erkannter Gefahren und Risiken für Menschen und Umwelt zu fördern. Biologische Forschung ist unerlässlich zur Weiterentwicklung der Prävention und Behandlung von Krankheiten. Dabei sind die Hoffnungen auf Erkenntnisse und die Chancen, die mit der Forschung verbunden sind, aber stets auch abzuwägen mit den möglichen Risiken.
C105	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 2: Beneficial Biotechnology > Public Health	Forschung ist eine der wesentlichen Grundlagen für die Fortschritte der Menschheit. Sie dient der Wissensvermehrung und fördert Gesundheit, Wohlstand und Sicherheit der Menschen sowie den Schutz der Umwelt.
C106	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 2: Beneficial Biotechnology	Forschungsergebnisse in den Lebenswissenschaften können nicht nur zum Nutzen des Einzelnen und der Gesellschaft angewandt, sondern auch in Schädigungsabsicht missbraucht werden.
C107	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 2: Beneficial Biotechnology > Economic Benefits	Schließlich stellt die Gesellschaft selbst einen Akteur dar, insofern sie zur Sicherung ihres Wohlstandes und ihrer Zukunftsfähigkeit auf Forschung angewiesen ist.
C108	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 2: Beneficial Biotechnology > Other Benefits	Forschung dient der Wissensvermehrung und ist dem Wohl der Menschen sowie dem Schutz der Umwelt und anderer – vor allem verfassungsrechtlich geschützter – Güter verpflichtet.
C109	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 2: Beneficial Biotechnology > Understanding Nature	Die Forschung in der Max-Planck-Gesellschaft dient der Wissensvermehrung und ist dem Wohl der Menschheit und dem Schutz der Umwelt verpflichtet. Der Wissenschaftler hat deswegen eine – unmittelbare und mittelbare – Schädigung von Mensch und Umwelt so weit wie möglich zu vermeiden oder zu vermindern.

C110	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 2: Beneficial Biotechnology > Risks from Not Doing Research	Dabei sind auch die Risiken zu berücksichtigen, die durch ein Unterlassen von Forschung entstehen.
C111	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 2: Beneficial Biotechnology > Economic Benefits	Der Freiheit der Forschung ist ein hoher Stellenwert beizumessen, denn sie ist eine wesentliche Grundlage für Fortschritt und Wohlstand der Gesellschaft.
C112	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 2: Beneficial Biotechnology > Risks from Not Doing Research	In vielen Risikobereichen ermöglicht die Offenlegung von Ergebnissen auch die Entwicklung von Schutzmaßnahmen (z.B. Impfstoffe im Gesundheitswesen oder Antivirenprogramme in der Informatik). Eine Unterdrückung von Forschungsergebnissen kann demgegenüber dazu führen, dass ein wirksamer Schutz gegen ihre missbräuchliche Anwendung durch totalitäre Regime, terroristische Gruppen, organisierte Straftäter oder Einzeltäter nicht möglich ist.
C113	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 2: Beneficial Biotechnology > Risks from Not Doing Research	Eine Unterdrückung von Forschungsergebnissen kann dazu führen, dass ein wirksamer Schutz gegen ihre missbräuchliche Anwendung durch totalitäre Regime, terroristische Gruppen, organisierte Straftäter oder Einzeltäter nicht möglich ist.
C114	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 2: Beneficial Biotechnology > Understanding Nature	Ein Einwand gegen einschränkende Maßnahmen aufgrund des Vorsorgeprinzips resultiert aus ethischer Perspektive aus der Verpflichtung des Wissenschaftlers auf Wahrheit und Erkenntnisgewinn. Mit dieser Verpflichtung ist eine Beschränkung der Wissenschaftsfreiheit nur dann zu vereinbaren, wenn sie dem Schutz von gewichtigen Rechtsgütern vor erheblichen und hinreichend konkreten Gefahren dient.

C115	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 2: Beneficial Biotechnology > National Security Benefit	Mit einem Einwand, der insbesondere gegen die starke Variante des Vorsorgeprinzips gerichtet ist, wird geltend gemacht, dass mit einer Unterlassung oder Einschränkung von Forschung auch eine Erhöhung von Risiken verbunden sein könne, insofern hierdurch Defizite bzw. ein Rückstand in Wissen und Technologie verursacht werden können, die die Entwicklung angemessener Instrumente der Risikovorsorge, wie zum Beispiel die Möglichkeit der schnellen Identifizierung eines Biosecurity-Notfalls oder das Spektrum angemessener dekontaminativer und therapeutischer Reaktionsmöglichkeiten einschränken könnten. Dem wird entgegengehalten, dass dies nur der Fall sei, wenn ein Forschungsvorhaben das Spektrum der Reaktionsmöglichkeiten tatsächlich konkret erhöhen könne, was insbesondere im Bereich der Grundlagenforschung in der Regel kaum vorhersehbar und planbar sei.
C116	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 1: Threatening Biotechnology > Offensive Applications	Zum einen trägt sie dem Umstand Rechnung, dass viele Mittel ihren Zweck nur noch mit einer gewissen Wahrscheinlichkeit zu realisieren erlauben. Zwischen Ausgangssituation und Endzweck können nämlich sehr viele in ihrer Wirkung schwer zu kalkulierende Vermittlungsstufen liegen. Zudem kann technisches Handeln oft andere als die beabsichtigten Folgen zeitigen. Diese Folgen betreffen das individuelle Wohlergehen der Menschen, ihre sozialen und institutionellen Bindungen, sowie die Umwelt.
C117	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 1: Threatening Biotechnology > Offensive Applications	Unsicherheit und Ungleichheit sind somit Merkmale der modernen Forschung und Technik, die spezifische moralische Probleme aufwerfen. Dabei stellen sich beispielsweise Fragen wie die, ob man eine Gefahr angesichts eines nicht sicher zu erreichenden Zwecks in jedem Falle auf sich nehmen (individuelle Risiken) oder sogar anderen zumuten darf (übertragene Risiken), oder ob man Menschen Risiken zumuten darf, die sie nicht frei gewählt haben und von deren Zweck sie nicht oder nicht mit Sicherheit profitieren.
C118	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung	Dimension 3: Making of Life Science > Freedom of Science	Die Wissenschaftsfreiheit wird durch Artikel 5 des Grundgesetzes geschützt.

	Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung		
C119	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 3: Making of Life Science > Freedom of Science	Zur Beratung von Angelegenheiten, die sich aus der Umsetzung der Ethikregeln ergeben, soll bei der jeweiligen Forschungsinstitution eine spezielle Kommission für Ethik der Forschung gebildet werden. Diese soll allen Forschern bei Fragen der Forschungsethik zur Verfügung stehen, bei einschlägigen Meinungsverschiedenheiten zwischen Forschern vermitteln und Empfehlungen zur Durchführung von Forschungsprojekten geben können. Die Befugnisse und Handlungen der Kommission müssen mit der Wissenschaftsfreiheit der Forscher vereinbar sein. Dies gilt insbesondere, wenn Entscheidungen der Kommission zwangsweise durchgesetzt oder mit Sanktionen bewehrt werden sollen.
C120	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 3: Making of Life Science > Freedom of Science	Selbst detaillierte gesetzliche Regelungen würden den differenzierten und sich rasch ändernden globalen Problemen von gebiets-spezifischen Risiken nicht ausreichend Rechnung tragen und darüber hinaus leicht in Konflikt mit der verfassungsrechtlich garantierten Forschungsfreiheit geraten.
C121	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 3: Making of Life Science > Freedom of Science	Zentrale Voraussetzung hierfür ist vor allem die Freiheit der Forschung, die durch Artikel 5 Absatz 3 des Grundgesetzes besonders geschützt ist und die nur zum Schutz anderer wichtiger verfassungsrechtlich geschützter Güter gesetzlich begrenzt werden kann.
C122	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 3: Making of Life Science > Freedom of Science	Zentrale Voraussetzung hierfür ist vor allem die Freiheit der Forschung, die durch das Grundgesetz besonders geschützt ist und die nur zum Schutz anderer wichtiger verfassungsrechtlich geschützter Werte begrenzt werden kann.
C123	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 3: Making of Life Science > Open Science	Eine wissenschaftlich erfolgreiche Forschung erfordert weiter Transparenz, vor allem durch einen freien Informationsaustausch und die Veröffentlichung von Forschungsergebnissen.

C124	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 3: Making of Life Science > Open Science	Eine erfolgreiche Grundlagenforschung erfordert weiter die Transparenz, den freien Informationsaustausch sowie die Veröffentlichung von Forschungsergebnissen.
C125	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 3: Making of Life Science > Open Science	Insbesondere in der staatlich finanzierten und der erkenntnisorientierten Forschung sind der freie Informationsaustausch und besonders die Veröffentlichung von Ergebnissen wichtige Faktoren für die wissenschaftliche Erkenntnis und den Fortschritt der Forschung. Sie dienen auch der Transparenz, der Reproduzierbarkeit, der Kontrolle und damit der Qualitäts-sicherung des Forschungsprozesses. Die Offenlegung von Ergebnissen kann darüber hinaus die Entwicklung von Schutzmaßnahmen (z. B. Impfstoffe im Gesundheitswesen oder Antivirenprogramme in der Informatik) fördern.
C126	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 3: Making of Life Science > Open Science	In diesen Fällen kollidieren Sicherheitsinteressen mit den in der Max-Planck-Gesellschaft gelten-den Grundsätzen der Transparenz, des freien Informationsaustauschs sowie insbesondere der Veröffentlichung von Forschungsergebnissen. Die vorgenannten Grundsätze gelten auch, wenn Angehörige der Max-Planck-Gesellschaft als Her-ausgeber von Zeitschriften oder Büchern tätig sind. Mitarbeiter in derartigen Positionen sollen in entsprechenden Risikobereichen darauf hinwirken, dass die Publikation von Forschungsergebnissen sowie die Politik der von ihnen unterstützten Verlage und anderen Institutionen mit den hier genannten Grundsätzen vereinbar ist. Deren Austausch und deren Veröffentlichung sind wichtige Faktoren für den wissenschaftlichen Fortschritt. In vielen Risikobereichen ermöglicht die Offenlegung von Ergebnissen auch die Entwicklung von Schutzmaßnahmen (z.B. Impfstoffe im Gesundheitswesen oder Antivirenprogramme in der Informatik). Eine Unterdrückung von Forschungsergebnissen kann demgegenüber dazu führen, dass ein wirksamer Schutz gegen ihre missbräuchliche Anwendung durch totalitäre Regime, terroristische Gruppen, organisierte Straftäter oder Einzeltäter nicht möglich ist.

C127	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 3: Making of Life Science > Freedom of Science	Entsprechend wird die internationale Diskussion vorrangig von Fragen bestimmt, die bereits der traditionellen Wissenschaftsethik zuzuordnen sind (beispielsweise die Ab-wägung von Forschungsbeschränkungen, Publikationsverboten u. Ä. mit der Forschungsfreiheit).
C128	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 3: Making of Life Science > Freedom of Science	Im Bereich der Biosecurity geht es dabei um grundsätzliche ethische Abwägungen, etwa von Freiheit und Sicherheit, von Chancen und Risiken, um die Frage nach einer angemessenen Risikovorsorge, zunächst aber auch um die Frage nach dem Verhältnis von Wissenschaft und Gesellschaft.
C129	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 3: Making of Life Science > The Public	Schließlich stellt die Gesellschaft selbst einen Akteur dar, insofern sie zur Sicherung ihres Wohlstandes und ihrer Zukunftsfähigkeit auf Forschung angewiesen ist
C130	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Responsibility > Ethic/Moral Obligations	Aufgrund der wechselseitigen Durchdringung von lebenswissenschaftlichem Erkenntnisgewinn und technischer Anwendung werden die ethischen Fragen moderner Technik unmittelbar für die lebenswissenschaftliche Forschung relevant. Die moderne Einstellung zu Forschung und Technik ist durch zwei ethisch relevante Gesichtspunkte geprägt:
C131	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 3: Making of Life Science > Fast Progress	Das Biosecurity-Problem im Zusammenhang mit diesen Arbeiten bestand darin, dass neben dem möglichen medizinischen Nutzen ein Bauplan für die Konstruktion eines für Menschen hochgefährlichen Mikroorganismus erstellt wurde. Inzwischen wurden bereits weitere Gensequenzen von gefährlichen Agenzien veröffentlicht: Seit 2010 steht die Gensequenz des Pockenvirus öffentlich zur Verfügung und seit 2011 die Gensequenz des Pest-Erregers Yersinia pestis.

C132	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 3: Making of Life Science > Fast Progress	Täter ohne Fachwissen würden vermutlich eher auf natürliche Agenzien zurückgreifen, als zu versuchen, gefährliche Agenzien gentechnisch zu verändern. Eine Anwendung anspruchs-voller Technologien durch Bioterroristen oder sonstige Täter ist wesentlich von der Expertise bzw. dem Tacit-Wissen, das heißt der langjährigen, praktischen Erfahrung der Täter sowie dem Stand des De-Skilling-Prozesses abhängig. Dies schließt selbstverständlich nicht aus, dass Experten ihr Wissen in terroristischer Absicht einsetzen oder Terroristen sich unerkannt gezielt über längere Zeiträume in den relevanten Techniken und Verfahren ausbilden lassen. Es ist äußerst schwierig einzuschätzen, ab welchem Punkt ein de-skilling und die allgemeine Verfügbarkeit von Wissen einen Stand erreicht haben, der das Gefährdungspotenzial stark ansteigen lässt.
C133	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 3: Making of Life Science > Fast Progress	Mit fortschreitendem wissenschaftlichen Erkenntnisgewinn in den Lebenswissenschaften haben die Möglichkeiten der Anwendung dieses Wissens mit ihren spezifischen Chancen und Risiken in den letzten Jahrzehnten dramatisch zugenommen. Wie im Folgenden dargestellt wird, hat sich im Zuge dieser Entwicklung das traditionelle wissenschaftsinterne Wissenschaftsethos zu einer grundsätzlichen Verantwortung der Wissenschaften gegenüber der Gesellschaft weiterentwickelt. Dabei sind Erkenntnisgewinn und technische Anwendung gerade in den Lebenswissenschaften oft nicht mehr scharf voneinander zu trennen (vgl. Abschnitt 4.1).
C134	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 3: Making of Life Science > Fast Progress	Wissenschaft bringt allerdings zunehmend praktische Folgen und Anwendungen hervor, die nicht nur mit Fort-schritten, sondern auch mit Gefahren im Sinne negativer gesamtgesellschaftlicher Konsequenzen verbunden sein können. Dies trägt dazu bei, Wissenschaft nicht nur als internen Prozess einer Wissenschaftler-Gemeinschaft, sondern darüber hinaus als in allgemeine gesellschaftliche Zusammenhänge eingebettet zu verstehen. Wissenschaft wird insoweit nicht nur am Erkenntnisgewinn als solchem oder an seiner unmittelbar technischen Umsetzbarkeit gemessen, sondern allgemeinen gesellschaftlichen Bewertungen unterzogen

C135	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Formal Regulation > Legislation/Legal Obligations	Diese Risiken sind durch rechtliche Regelungen nur begrenzt erfassbar.
C136	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 4: Responses > Formal Regulation > Legislation/Legal Obligations	Die Grenzen der Forschung werden zunächst durch rechtliche Normen bestimmt. Diese können zum Schutz wichtiger verfassungsrechtlich geschützter Güter die Forschungsfreiheit begrenzen, wenn dies verhältnismäßig ist. Die einschlägigen Bestimmungen haben dabei unterschiedliche Ziel-setzungen und Ansatzpunkte: Sie können Forschungsziele ausschließen (z.B. die Entwicklung von Atom- und Biowaffen), Methoden reglementieren (z.B. für bestimmte Experimente am Menschen) oder den Export von Wissen, Dienstleistungen und Produkten in bestimmte Länder untersagen (z.B. im Rahmen des deutschen Außenwirtschaftsrechts oder der EG-Verordnung für die Ausfuhr-kontrolle von Gütern und Technologien mit doppeltem Verwendungszweck). Diese Regelungen sind in der Max-Planck-Gesellschaft strikt einzuhalten. Verstöße gegen sie können zu erheblichen Sanktionen, langwierigen Verfahren sowie einem Reputationsverlust des Wissenschaftlers, seines Instituts und der Max-Planck-Gesellschaft führen.

C137	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 3: Making of Life Science > The Public	Die Grenzen der Forschung werden zunächst durch rechtliche Normen bestimmt. Diese können zum Schutz wichtiger verfassungsrechtlich geschützter Güter die Forschungsfreiheit begrenzen, wenn dies verhältnismäßig ist. Die einschlägigen Bestimmungen haben dabei unterschiedliche Ziel-setzungen und Ansatzpunkte: Sie können Forschungsziele ausschließen (z.B. die Entwicklung von Atom- und Biowaffen), Methoden reglementieren (z.B. für bestimmte Experimente am Menschen) oder den Export von Wissen, Dienstleistungen und Produkten in bestimmte Länder untersagen (z.B. im Rahmen des deutschen Außenwirtschaftsrechts oder der EG-Verordnung für die Ausfuhr-kontrolle von Gütern und Technologien mit doppeltem Verwendungszweck). Diese Regelungen sind in der Max-Planck-Gesellschaft strikt einzuhalten. Verstöße gegen sie können zu erheblichen Sanktionen, langwierigen Verfahren sowie einem Reputationsverlust des Wissenschaftlers, seines Instituts und der Max-Planck-Gesellschaft führen.
C138	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 4: Responses > Formal Regulation > Legislation/Legal Obligations	Selbst detaillierte gesetzliche Re-gelungen würden den differenzierten und sich rasch ändernden globalen Problemen von gebiets-spezifischen Risiken nicht ausreichend Rechnung tragen und darüber hinaus leicht in Konflikt mit der verfassungsrechtlich garantierten Forschungsfreiheit geraten.
C139	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Formal Regulation > Legislation/Legal Obligations	Sie können dabei – insbesondere mit speziellen Kommissionen – der sich rasch verändernden Forschung, den schwierigen Risikoabschätzungen im Dual-Use-Bereich und den entsprechenden schwierigen Wertungsentscheidungen oft besser Rechnung tragen als gesetzliche Regelungen.
C140	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Formal Regulation > Self Governance	Große Bedeutung haben dabei die Instrumente der Selbstregulierung der Wissenschaft. Sie basieren auf besonderer Sachnähe und können flexibel reagieren.

C141	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Formal Regulation > Self Governance	Neben dem staatlich gesetzten Recht ist damit auch die Selbstregulierung der Wissenschaft von besonderer Bedeutung. Die Instrumente der Selbstregulierung basieren auf besonderer Sachnähe und Kompetenz, können eine Vorwarnfunktion im Hinblick auf neue Problemstellungen übernehmen, rasch und flexibel reagieren sowie mit sicherheitsrelevanter Forschung verbundene Probleme autonom lösen. Sie können dabei – insbesondere mit speziellen Kommissionen – der sich rasch verändernden Forschung, den schwierigen Risikoabschätzungen im Dual-Use-Bereich und den entsprechenden schwierigen Wertungsentscheidungen oft besser Rechnung tragen als gesetzliche Regelungen
C142	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Formal Regulation > Legislation/Legal Obligations	Die Deutsche Forschungsgemeinschaft (DFG) und die Nationale Akademie der Wissenschaften Leopoldina appellieren an die Wissenschaftler, sich nicht mit der Einhaltung der gesetzlichen Regelungen zu begnügen. Denn Forscher haben aufgrund ihres Wissens, ihrer Erfahrung und ihrer Freiheit eine besondere ethische Verantwortung, die über die rechtliche Verpflichtung hinausgeht.
C143	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 3: Making of Life Science > The Public	In der öffentlichen Diskussion darüber wird die Erwartung formuliert, dass die Wissenschaftler selbst ethische Prinzipien und Mechanismen zum verantwortungsvollen Umgang mit Forschungsfreiheit und Forschungsrisiken entwickeln.
C144	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Actors > Scientists > Responsible Research	Daher muss er sein Wissen, seine Erfahrung und seine Fähigkeiten einsetzen, um die einschlägigen Risiken zu erkennen, abzuschätzen und zu bewerten. In kritischen Fällen muss er eine persönliche Entscheidung über die Grenzen seiner Arbeit treffen, die er im Rahmen seiner Forschungsfreiheit selbst verantwortet. Dies kann dazu führen, dass – auch gesetzlich nicht unter-sagte – Vorhaben im Einzelfall nur in modifizierter Form oder überhaupt nicht durchgeführt werden.

C145	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Awareness/Education	Die Wissenschaftler sollen in der universitären Lehre und bei der Schulung des wissenschaftlichen Nachwuchses die Grundsätze eines verantwortungsvollen Umgangs mit Forschungs-risiken vermitteln und vorleben. Dabei muss auch auf die fachspezifischen Regeln zur Risikominimierung im jeweiligen Forschungsgebiet eingegangen werden. Auch bei der Durchführung ihrer Projekte sollen die Forscher dazu beitragen, das Bewusstsein für diese Fragen zu wecken und zu schärfen (vgl. dazu auch unten II.B.3).
C146	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Actors > Scientists > DURC Assessment	Die Prüfung einer Vereinbarkeit der Forschung mit rechtlichen Vorschriften, Maßnahmen der Selbstregulierung und ethischen Grundsätzen obliegt zunächst den für das Projekt zuständigen Wissenschaftlern. Weiter sind – insbesondere im Rahmen der rechtlich gebotenen Aufsichtspflicht – die Vorgesetzten des Wissenschaftlers verantwortlich.
C147	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Awareness/Education	Forschungsinstitutionen sollen ihren Mitarbeitern das Problembewusstsein und die notwendigen Kenntnisse über die rechtlichen Grenzen der Forschung in ihrem Tätigkeitsbereich vermitteln.
C148	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Actors > Research Institutions	Der zweite Teil der Empfehlungen wendet sich an die Forschungsinstitutionen. Diese sollen ihren Mitarbeitern das Problembewusstsein und die notwendigen Kenntnisse über die rechtlichen Grenzen der Forschung vermitteln und entsprechende Schulungsmaßnahmen der Wissenschaftler unterstützen. Forschungsinstitutionen sollen über die Einhaltung gesetzlicher Re-gelungen hinaus Ethikregeln für den Umgang mit sicherheitsrelevanter Forschung entwickeln.

C149	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Primäres Ziel der Risikoanalyse ist eine verantwortliche Durchführung und Kommunikation der Forschung. Im Einzelfall kann die verantwortliche Entscheidung des Forschers allerdings als ultima ratio zur Folge haben, dass eine bestimmte Forschung mit einem nicht zu begrenzenden und unverhältnismäßigen Risikopotential nicht durchgeführt wird, selbst wenn ihr kein gesetzliches Verbot entgegensteht.
C150	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Die Kenntnis der möglichen Risiken ist die Voraussetzung dafür, dass Forschung verantwortlich erfolgen kann. Eine zentrale Voraussetzung für die Vermeidung oder zumindest die Kontrolle von Forschungsrisiken ist daher die Bewusstmachung der einschlägigen Gefahren. Der Forscher muss daher die Folgen sowie die Einsatz- und Missbrauchsmöglichkeiten seiner Arbeiten und deren Beherrschbarkeit mitbedenken.
C151	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Bei dieser Abwägung sind sowohl die Höhe des möglichen Schadens als auch das Risiko des Schadenseintritts zu berücksichtigen. In Fällen mit drohenden Gefahren sollte abgeschätzt werden, wie hoch ein eventueller Schaden wäre, wie wahrscheinlich das Schadensrisiko ist, ob die Forschungsergebnisse unmittelbar für schädliche Zwecke einsetzbar sind oder ob schwierige Umsetzungsprozesse erforderlich sind, und ob die Verwendung der Ergebnisse beherrschbar ist.
C152	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Das Erkennen von Forschungsrisiken betrifft nicht nur die Risiken des eigenen Verhaltens. Der Forscher soll darüber hinaus bei missbrauchsgefährdeten Arbeiten auch die Folgen seiner Forschung berücksichtigen, die er zu neutralen oder nützlichen Zwecken durchführt, deren Ergebnisse dann jedoch von anderen Personen zu schädlichen Zwecken eingesetzt oder missbraucht werden können.

C153	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk-Benefit	Bei dieser Abwägung sind einerseits die Wissenschaftsfreiheit und der Nutzen der Forschung, andererseits aber auch das Schadensrisiko zu berücksichtigen. Dabei sollte abgeschätzt werden, wie wahrscheinlich der Schadenseintritt ist, wie hoch ein eventueller Schaden wäre und inwieweit die Forschungsergebnisse unmittelbar oder nur mit schwierigen Umsetzungsprozessen für schädliche Zwecke einsetzbar sind. Weiter sollte berücksichtigt werden, ob ein Missbrauch zu verhindern ist und inwieweit seine Folgen beherrschbar sind. Entscheidungserheblich kann auch sein, wer Kooperationspartner, Auftraggeber, Nutzer oder Finanzier der Forschung ist.
C154	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Handling the Dangers > Limit Communication/Publication/etc.	In diesen Fällen kollidieren Sicherheitsinteressen mit dem Interesse an einer Veröffentlichung von Forschungsergebnissen.
C155	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Handling the Dangers > Limit Communication/Publication/etc.	In Bereichen risikoreicher Forschung sollen – auch bereits vor Projektbeginn – die möglichen Folgen einer Veröffentlichung der Ergebnisse geprüft werden. Dies gilt besonders dann, wenn Forschungsergebnisse ohne zusätzliches Wissen und ohne aufwendige Umsetzungs- und Anwendungsprozesse zu spezifischen Gefahren oder großen Schäden führen können (Dual Use Research of Concern).

C156	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Handling the Dangers > Restricted Access/Cooperation	Dies kann dazu führen, dass Sicherheitsmaßnahmen (z. B. gegen die Freisetzung oder den Diebstahl von gefährlichen Stoffen aus Laboren) durchgeführt werden oder dass die Vertraulichkeit der Forschungsergebnisse durch physische, organisatorische und informationstechnische Maßnahmen (z. B. Verschlüsselung der gespeicherten und übermittelten Daten) besonders gesichert wird. Das Transparenzgebot steht derartigen Sicherungen und Zugriffsbeschränkungen nicht entgegen, da es nicht verlangt, dass Forschungsergebnisse jederzeit und jedem zugänglich sind (vgl. auch II.A.4). Bei missbrauchsgefährdeter Forschung sind die Mitarbeiter und Kooperationspartner sorgfältig und unter Berücksichtigung ihrer Verlässlichkeit und ihres Verantwortungsbewusstseins auszuwählen. Bei besonderen Risiken der Verbreitung von sicherheitsrelevanten Forschungsergebnissen (etwa im Zusammenhang mit Massenvernichtungsmitteln oder Exportbeschränkungen) kommt eine Zusammenarbeit mit speziellen Beratungsstellen, Rechtsabteilungen der Forschungsorganisationen oder mit staatlichen Sicherheitsstellen in Betracht.6 Maßnahmen zur Risikominimierung können auch darin bestehen, dass einzelne Forschungen nur für oder nur mit bestimmte(n) Kooperationspartner(n) durchgeführt werden. Internationale Kooperation ist zwar ein Grundprinzip erfolgreicher Forschung, im Einzelfall kann sich unter dem Aspekt der Risikominimierung gleichwohl eine Einschränkung der Zusammenarbeit oder ein Verzicht auf Partner oder Mitarbeiter aus bestimmten Staaten empfehlen. Anhaltspunkte für Staaten, in denen ein Missbrauch bestimmter Forschungsergebnisse zu befürchten ist, können sich aus den nationalen und internationalen Vorschriften und Listen über Ausfuhrbeschränkungen ergeben.

C157	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Handling the Dangers > Limit Communication/Publication/etc.	Die Gebote der Transparenz und der Kommunikation schließen jedoch nicht aus, dass der Wissenschaftler bestimmte Risiken seiner Forschung minimiert, indem er die Ergebnisse seiner Arbeiten nicht sofort, sondern zeitlich verzögert publiziert. Bei Forschungsergebnissen mit einem hohen Missbrauchspotenzial können in speziellen Fällen die für einen Missbrauch besonders relevanten Teilergebnisse von der Publikation – in kenntlich gemachter Weise – ausgenommen oder verkürzt dargestellt werden. Der Forscher kann einzelne Ergebnisse seiner Arbeiten in besonderen Fällen auch nur mit bestimmten Personen teilen.
C158	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Handling the Dangers > Limit Communication/Publication/etc.	Eine Unterdrückung von Forschungsergebnissen kann dazu führen, dass ein wirksamer Schutz gegen ihre missbräuchliche Anwendung durch totalitäre Regime, terroristische Gruppen, organisierte Straftäter oder Einzeltäter nicht möglich ist.
C158	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Handling the Dangers > Limit Communication/Publication/etc.	Ein völliger Verzicht auf Kommunikation und Veröffentlichung der Forschungsergebnisse kommt nur in Betracht, wenn andere Maßnahmen zur Verhinderung von Gefahren nicht möglich sind. Dies ist aber nur in speziellen Fällen gerechtfertigt.
C159	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 4: Responses > Handling the Dangers > Restricted Access/Cooperation	Der Forscher kann einzelne Ergebnisse seiner Arbeiten in besonderen Fällen auch nur mit bestimmten Personen teilen. Ein völliger Verzicht auf Kommunikation und Veröffentlichung der Forschungsergebnisse kommt als ultima ratio in Betracht. Er ist nur in speziellen Einzelfällen – eventuell auf bestimmte Zeit – gerechtfertigt. Forschung, die von Anfang an unter dem Siegel gegenständlich umfassender und zeitlich unabsehbarer Geheimhaltung steht, ist mit dem Selbstverständnis der Max-Planck-Gesellschaft unvereinbar.

C160	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 4: Responses > Handling the Dangers > Restricted Access/Cooperation	Entscheidungserheblich kann auch sein, wer Kooperationspartner, Auftraggeber, Nutzer oder Finanzier der Forschung ist. Muss davon ausgegangen werden, dass bestimmte missbrauchsgefährdete Forschungsvorhaben von anderen Stellen ohne entsprechende Sicherheitsstandards oder zu missbräuchlichen Zwecken durchgeführt werden, kann Forschung mit dem Ziel der Abwehr solcher Gefahren bzw. der Minimierung von daraus drohenden Schäden akzeptabel sein.
C161	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 4: Responses > Handling the Dangers > Restricted Access/Cooperation	Bei missbrauchsgefährdeter Forschung sind die Mitarbeiter und Kooperationspartner sorgfältig und auch unter Berücksichtigung ihrer Verlässlichkeit und ihres Verantwortungsbewusstseins auszuwählen. Soweit staatliche Stellen Aufgaben der Sicherheitsüberprüfung erfüllen, bietet sich etwa bei Risiken einer Proliferation von sicherheitsrelevanten Forschungsergebnissen eine entsprechen-de Zusammenarbeit an.
C162	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Formal Regulation > Oversight Institution/Procedures	Zur Umsetzung dieser Regeln und zur Beratung der Wissenschaftler sollen sie jeweils eine spezielle Kommission für Ethik der Forschung (KEF) einrichten.
C163	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Formal Regulation > Oversight Institution/Procedures	Zur Beratung von Angelegenheiten, die sich aus der Umsetzung der Ethikregeln ergeben, soll bei der jeweiligen Forschungsinstitution eine spezielle Kommission für Ethik der Forschung gebildet werden. Diese soll allen Forschern bei Fragen der Forschungsethik zur Verfügung stehen, bei einschlägigen Meinungsverschiedenheiten zwischen Forschern vermitteln und Empfehlungen zur Durchführung von Forschungsprojekten geben können. Die Befugnisse und Hand-lungen der Kommission müssen mit der Wissenschaftsfreiheit der Forscher vereinbar sein. Dies gilt insbesondere, wenn Entscheidungen der Kommission zwangsweise durchgesetzt oder mit Sanktionen bewehrt werden sollen.

C164	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Handling the Dangers > Restrict Research	Im Einzelfall kann eine verantwortungsbewusste Entscheidung des Forschers sogar bedeuten, dass ein hochrisikoreiches Projekt nur nach einem Forschungsmoratorium oder gar nicht durchgeführt wird.
C165	Deutsche Forschungsgemeinschaft, & Leopoldina. (2014). Wissenschaftsfreiheit und Wissenschaftsverantwortung Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung	Dimension 4: Responses > Handling the Dangers > Restrict Research	Im Einzelfall kann die verantwortliche Entscheidung des Forschers allerdings zur Folge haben, dass – falls keine anderen Schutzmechanismen bestehen – ein hochrisikoreiches Projekt erst nach einem Forschungsmoratorium zu einem späteren Zeitpunkt oder auch gar nicht durchgeführt wird, selbst wenn ihm kein gesetzliches Verbot entgegensteht.
C166	Max-Plank-Gesellschaft. (2010). Hinweise und Regeln der Max-Planck-Gesellschaft.	Dimension 4: Responses > Handling the Dangers > Restrict Research	Primäres Ziel der Risikoanalyse ist eine verantwortliche Durchführung und Kommunikation der Forschung. Im Einzelfall kann die verantwortliche Entscheidung des Forschers allerdings als ultima ratio zur Folge haben, dass eine bestimmte Forschung mit einem nicht zu begrenzenden und unverhältnismäßigen Risikopotential nicht durchgeführt wird, selbst wenn ihr kein gesetzliches Verbot entgegensteht.
C167	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Actors > Scientists > DURC Assessment	e) Grundsätzlich sind Ergebnisse Biosecurity-relevanter Forschung zu publizieren. Forschende sollen jedoch prüfen, ob Forschungsergebnisse so erhebliche Missbrauchsmöglichkeiten eröffnen, dass die Weitergabe oder Veröffentlichung von Forschungsergebnissen ausnahmsweise eingeschränkt oder unterlassen werden soll. Dies gilt auch für das Eingehen und die Durchführung von Forschungskooperationen. Ebenso sollten Forschende bei einer Tätigkeit als Gutachter oder Redakteure im wissenschaftlichen Publikationsprozess die oben genannten Grundsätze berücksichtigen.

C168	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Handling the Dangers > Restricted Access/Cooperation	Gleichwohl weist der Umgang mit Biosecurity- und Biosafety-Fragen Gemeinsamkeiten zumindest in den Fällen auf, in denen ein Bioterrorist darauf abzielt oder angewiesen ist, sich zur Vorbereitung oder Ausübung eines Anschlags eines Labors zu bedienen. Auch im Kontext von Biosafety können Intentionen eine Rolle spielen, etwa wenn etablierte Sicherheitsregeln durch Bequemlichkeit des Forschers (z. B. fehlen-de Dokumentation) oder durch das Erstreben von zeitlichen oder materiellen Vorteilen (z. B. Auslassen von Prüfschritten, Diebstahl von Materialien) bewusst umgangen werden. Die hiergegen zu treffenden Maßnahmen der Laborsicherheit, etwa Zugangskontrollen, können unter Umständen in einem weiten Bereich auch vor ähnlichen, jedoch bioterroristisch in-tendierten Handlungsweisen schützen.
C169	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Actors > Others > Multi Stakeholder Problem	Auflagen bei der Forschungsförderung oder Nichtförderung: Als Maßnahmen der internen und externen Risikovorsorge können bestimmte Grenzen der Forschungsförderung, das heißt die Erteilung von Auflagen oder die Nichtförderung, ein-gesetzt werden. Forschungsvorhaben in den Biowissenschaften sind in der Regel auf eine Finanzierung durch öffentliche oder private Geldgeber angewiesen, für die eine Biosecurity-spezifische Risikovorsorge auch im eigenen Interesse liegen. Zu diesen Faktoren gehören unter anderem: Faktoren, die die Eintrittswahrscheinlichkeit des Missbrauchs bestimmen (Verfügbarkeit des Agens, Stand der Entwicklung der Technologie, Verfüg-barkeit der Technologie, Verfügbarkeit der Expertise, Gegebenheiten der Einrichtung, Verfügbarkeit der Therapiemöglichkeiten); der quantitative und der qualitative Ausmaß der potenziellen Schäden; die sozialen und politischen Kontexte der Forschung; die Rolle, die internationale Aspekte spielen sollte. Die Nichtförderung von bestimmten Forschungsvorhaben stellt prinzipiell keinen Eingriff in die Forschungsfreiheit dar und muss daher nicht an der Wissenschaftsfreiheit gemessen werden; allerdings ist der Gleichbehandlungsgrundsatz zu wahren.

C170	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Formal Regulation > Oversight Institution/Procedures	Wissenschaftliche Expertenkommission: Die für die Beurteilung von DURC notwendige interdisziplinäre Expertise könnte gewährleistet werden, indem in Deutschland eine wissenschaftliche Expertenkommission als Zentrale DURC-Kommission eingerichtet wird, die DURC-Forschungsvorhaben auf ihre Vertretbarkeit im Hinblick auf die mit dem Vorhaben verbundenen Chancen und das Missbrauchsrisiko überprüft. Für die Erfüllung dieser Aufgabe erscheint es erforderlich, dass die DURC-Kommission sowohl aus Experten der Lebenswissenschaften und der Sicherheit (Biosecurity) besteht, als auch zivilgesellschaftliche Biosecurity-Expertise einbezieht und unabhängig arbeitet. Nach den Vorgaben des Demokratie- und Rechtsstaatsprinzips des Grundgesetzes ist für die Arbeit einer solchen Kommission eine gesetzliche Grundlage erforderlich, in der hinreichende Vorgaben für den Bereich der relevanten Forschung gemacht werden, zudem auch für die Berufung und die Zahl der Mitglieder, die Erfordernisse der multidisziplinären Zusammensetzung, die Arbeitsweise der Kommission und den Modus der Beschlussfassung.
C171	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Auch wenn durch Missbrauch bestimmter Ergebnisse biosicherheitsrelevanter Forschung in terroristischer Absicht im Prinzip katastrophale Schadensszenarien herbeigeführt werden können, besteht dieser Auffassung zufolge das Ziel einer Normierung im Bereich der Biosecurity angesichts der geringen Eintrittswahrscheinlichkeit und der diesbezüglichen Ungewissheit über das Risiko nicht in der Abwehr einer konkreten, sondern allenfalls in der Prävention einer abstrakten Gefahr, die solche weitreichenden Eingriffe in die Wissenschaftsfreiheit nicht oder nur sehr begrenzt rechtfertige.
C171	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Formal Regulation > Oversight Institution/Procedures	Genehmigungsbehörde: Ein mögliches Instrument zur Prüfung und Kontrolle von Biosecurity-relevanter Forschung besteht in der Übertragung der Entscheidungskompetenz an eine Bundesbehörde, die für besorgniserregende Biosecurity-relevante Forschungsvorhaben (DURC) nach Konsultation eines wissenschaftlichen Expertengremiums Genehmigungen erteilen kann. Durch die Übertragung dieser Aufgabe an eine Bundesbehörde kann auch eine gerichtliche Überprüfung der Entscheidung ermöglicht werden. Denkbar ist auch, die Funktion der

			Genehmigungsbehörde auf die DURC-Kommission (siehe unten) zu übertragen.
C172	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Dem wird allerdings von anderer Seite entgegengehalten, dass einer Einschränkung der Forschungsfreiheit zwar insoweit hohe Hürden gesetzt sind, als dass sie nur mit dem Schutz verfassungsrechtlicher Güter gerechtfertigt werden kann. Genau um solche besonders bedeutsamen Rechtsgüter (Leben und Gesundheit einer Vielzahl von Menschen, Umwelt, Frieden) gehe es aber gerade bei der Regulierung im Bereich der Biosecurity, da die Bedrohung dieser Rechtsgüter durch bioterroristische Anschläge real und damit hinreichend konkret sei.
C173	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Handling the Dangers > Limit Communication/Publication/etc.	e) Grundsätzlich sind Ergebnisse Biosecurity-relevanter Forschung zu publizieren. Forschende sollen jedoch prüfen, ob Forschungsergebnisse so erhebliche Missbrauchsmöglichkeiten eröffnen, dass die Weitergabe oder Veröffentlichung von Forschungsergebnissen ausnahmsweise ein-geschränkt oder unterlassen werden soll. Dies gilt auch für das Eingehen und die Durchführung von Forschungs-kooperationen. Ebenso sollten Forschende bei einer Tätigkeit als Gutachter oder Redakteure im wissenschaftlichen Publikationsprozess die oben genannten Grundsätze berücksichtigen.

C174	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk-Benefit	(iv) Forschungsvorhaben sollen daraufhin geprüft wer-den, ob die Risiken im Verhältnis zu den Chancen verantwortbar sind. Dabei ist insbesondere zu prüfen, ob mit dem Forschungsvorhaben unverhältnismäßige Risiken für geschützte Güter wie das Leben und die Gesundheit von Menschen oder die Umwelt eingegangen werden. Kommt die Prüfung zu dem Ergebnis, dass die Risiken nicht verantwortbar sind, sollte das Forschungsvorhaben unterlassen werden. Ein Teil der Mitglieder des Ethikrates vertritt darüber hinaus die Auffassung, dass bei Forschungsvorhaben, die zum Gegenstand haben oder bei denen abzusehen ist, dass damit die für Menschen oder Tiere pathogene Wirkung eines Mikroorganismus so verstärkt wird, dass im Falle seiner Verbreitung außerhalb des Labors die Gefahr der Epidemie einer schwerwiegenden Erkrankung bei Menschen gegeben ist, davon auszugehen ist, dass der potenzielle Schaden den potenziellen Nutzen des Vorhabens übersteigt. Diese Vorhaben sollten nicht durchgeführt werden, es sei denn, es ist eine direkter, konkreter und überwiegender Nutzen für die Abwehr von Gefahren für das Leben oder die Gesundheit von Menschen wahrscheinlich.
C175	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Handling the Dangers > Precaution	Die Frage eines angemessenen Umgangs mit Biosecurity-Risiken in der Forschung stellt sich für die Wissenschafts-gemeinschaft und die in den Lebenswissenschaften tätigen Wissenschaftler, für den Staat und die Sicherheitsexperten sowie für die Gesellschaft. Beantwortet werden kann sie nur mithilfe einer Verständigung zwischen diesen Akteuren über eine angemessene Strategie der Risikovorsorge, die die unterschiedlichen Interessen und Voraussetzungen für die Übernahme von Verantwortung berücksichtigt (vgl. Abschnitt 10).
C176	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Der Begriff des Risikos ist ein bewährtes Instrument, um Gefahrensituationen wahrzunehmen und zu beschreiben, sie auf dieser Grundlage zu beurteilen und, davon ausgehend, auch möglichst angemessen zu bewältigen.

C177	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Bei der Beurteilung der Risiken der Biosecurity-relevanten Forschung kann sich die ethische Reflexion zunächst auf die bewährten Instrumente der Risikoabwägung für den Bereich der Biosafety stützen (vgl. Abschnitt 4.2). Die Risikoszenarien der Biosafety und der Biosecurity überlappen sich allerdings nur teilweise, und es verbleiben im Bereich der Biosecurity erhebliche Unsicherheiten, die mit dem klassischen Instrumentarium der Risikoabwägung gegenwärtig nicht bzw. nicht hinreichend zu beurteilen sind.
C178	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Jedoch ist die Schadenseintrittswahrscheinlichkeit mit Blick auf Biosecurity kaum hinreichend zu bestimmen, da mit dem intentionalen Moment des Bioterroristen entweder irrationale Elemente in die Beurteilung einbezogen werden müssten, die einen Rück-griff auf vorgängige Ereignisse und Verhaltensmuster kaum erlauben, oder auch bewusste Handlungen berücksichtigt werden müssten, deren Ratio gerade darin besteht, solche Rück-griffe sinnlos zu machen
C179	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Zwar ist das Schadensausmaß biosicherheitsrelevanter Forschung mit Blick auf Biosecurity häufig ebenfalls hinreichend bestimmbar, da kein Unterschied besteht, ob biologische Agenzien etwa durch Unachtsamkeit eines Forschers oder in schädigender Absicht durch einen Bio-terroristen aus einem Labor freigesetzt werden.
C180	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Jedes Instrument der rationalen Orientierung hat implizite Grenzen, die durch die Reichweite der Kriterien vorgegeben sind. Im Falle des bereits oben genannten Begriffs des Risi-kos als Produkt aus numerisch ausgedrücktem Schaden und numerisch ausgedrückter Eintrittswahrscheinlichkeit sind diese Grenzen durch die Anforderungen der Verteilbarkeit und der Vergleichbarkeit vorgegeben. Diese Grenzen sind bestimmt durch die Gewichtung der Parameter, das heißt deren numerische Ausdrückbarkeit sowohl hinsichtlich der Größen der Eintrittswahrscheinlichkeit als auch des Schadens. Gerade bei bioterroristischem Handeln ist die Eintrittswahrscheinlichkeit angesichts der bislang geringen Fallzahlen nicht numerisch ausdrückbar. Allerdings ist oftmals quantifizierbar, welche Schäden entstehen, wenn ein missbräuchlicher Einsatz eines Agens erfolgt.

C181	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Im Unterschied zur Situation auf dem Gebiet der Biosafety ergeben sich bei der Risikobeurteilung und Risikovorsorge im Bereich von Biosecurity zusätzliche Herausforderungen. Das Gefahrenpotenzial eines biologischen Agens kann nicht allein aus seinen toxischen oder pathogenen Eigenschaften abgeleitet werden. Ausschlaggebend ist seine Verwendbarkeit als Biowaffe, wobei seine Handhabbarkeit und Verbreitungsfähigkeit von entscheidender Bedeutung ist. Zudem hängt die Wahrscheinlichkeit von terroristischen Anschlägen stark von innerstaatlichen und staatsübergreifenden Strukturen und Entwicklungen ab.
C182	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Eine gewisse Einschätzung der Wahrscheinlichkeit bioterroristischer Gefährdung lässt sich anhand von Zielszenarien vornehmen. Hauptkriterien für eine Einschätzung der Eintrittswahrscheinlichkeit des Missbrauchs sind: >> Verfügbarkeit des Agens: Grad der Schwierigkeit bei der Beschaffung und gegebenenfalls Produktion dieser Agenzien in größeren Mengen; >> Therapiemöglichkeiten: Verfügbarkeit von effektiven Impfstoffen, Antibiotika, antiviralen Therapeutika, Antiseren; >> Verfügbarkeit der Technologie: Komplexität einer Technologie im Hinblick auf den De-Skilling-Prozess; >> Verfügbarkeit der Expertise: Verfügbarkeit des Fachwissens, des Tacit-Wissens; >> Gegebenheiten einer geeigneten Einrichtung: Ausstattung des Labors, Sicherheitsmerkmale des Labors; >> Verfügbarkeit von finanziellen Mitteln für Infrastruktur und Personal der Organisation. Weitere Faktoren der Risikoeinschätzung umfassen das quantitative und qualitative Ausmaß der potenziellen Schäden, die Rolle, die internationale Aspekte spielen, sowie den sozialen und politischen Kontext der Forschung.

C183	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk-Benefit	Mit Blick auf diese fundamentale Unsicherheit zeigt die ethische Analyse, dass im Gegensatz zum Bereich der Biosafety eine Risikovorsorgestrategie, die, ausgehend von den Eigenschaften eines biologischen Agens und der gegen seine unbeabsichtigte Freisetzung getroffenen Sicherheitsmaßnahmen, den Begriff des Risikos als Schadenswert mal Eintrittswahrscheinlichkeit fasst, zu kurz greift. Hinzu kommt gerade für den Bereich von DURC das Dilemma, dass sowohl die Forschung als auch das Unter-lassen von Forschung im Biosecurity-relevanten Bereich nach-teilige Folgen für Leben und Gesundheit aller Menschen haben kann. Darüber hinaus sind neben dem aktuellen und künftigen Missbrauchsrisiko von Biosecurity-relevanter Forschung – auf-grund des grundsätzlichen ergebnisoffenen Charakters von Forschung – auch die Chancen solcher Vorhaben oft schwierig einzuschätzen, insbesondere, wenn es neben reinem Erkenntnisgewinn um Ziele wie zum Beispiel den Lebensschutz bzw. die Verbesserung der Gesundheit der Bevölkerung geht.
C184	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Risk Assessment	Verfahren der Risiko-Chancen-Abwägung, die mit den entsprechenden Instrumenten arbeitenden Risiko-Risiko-Vergleiche und in Abhängigkeit von diesen formulierte Sicherheitsstandards hängen grundsätzlich von der Verfügbarkeit von Informationen über Eintrittswahrscheinlichkeiten und Schadensszenarien ab. Diese Verfügbarkeit ist aber nicht immer gegeben, beispielsweise auf neuen Forschungs- und Innovationsfeldern. Bei einer Handlung unter Ungewissheit ist zu bedenken, dass es zur Ausführung oder aber Unterlassung der Handlung keine dritte Möglichkeit gibt. In diesen Fällen ist der Mensch gewissermaßen zur Entscheidung zwischen Ausführung oder Unterlassung der Handlung verurteilt. In solchen Fällen ist es daher keine per se vorzugswürdige Option, nur wegen der Ungewissheit hinsichtlich der Eintrittswahrscheinlichkeit von Handlungsfolgen den Modus der Unterlassung der Handlung zu wählen. Unterlassungshandlungen können in vergleich-barem Ausmaß von Ungewissheit über die Folgen geprägt sein wie die korrelativen Ausführungshandlungen. Im Fall Biosecurity-relevanter Forschung liegen statistisch belastbare Informationen weder

			über die Eintrittswahrscheinlichkeit von negativen Biosecurity-relevanten Ereignissen (beispielsweise bioterroristischen Anschlägen) noch über die negativen Folgen einer Unterlassung entsprechender Forschung vor (beispielsweise durch das unter Umständen folgenreiche Unterlassen der Forschung zur Behandlung oder Vorbeugung einer bestimmten schweren Infektionskrankheit). Angesichts solcher Ungewissheiten sind in der ethischen Reflexion auf das Handeln unter Risiko-Bedingungen Ansätze entwickelt worden, Kriterien für gerechtfertigte Handlungs-empfehlungen zu formulieren. Die im Folgenden vorgenommene Analyse zeigt jedoch, dass diese bis auf das – allerdings in geeigneter Weise zu interpretierende – Vorsorgeprinzip für die Herausforderungen, die sich im Bereich der Biosecurity stellen, nicht oder allenfalls beschränkt als Instrumente der Risikobeurteilung einsetzbar sind.
C185	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Handling the Dangers > Precaution	Vorsorgeprinzip Das Vorsorgeprinzip (precautionary principle) besagt, dass unter Umständen auch massiv einschränkende Maßnahmen gerechtfertigt sind, wenn durch Technologien oder sonstige Handlungen Menschen oder Umwelt schwerwiegende und irreversible Schäden drohen, selbst dann, wenn noch keine fundierte wissenschaftliche Risikoanalyse vorliegt. Im Unterschied zu den zuvor genannten Ansätzen ist das Vorsorgeprinzip zunächst als ein Prinzip der rechtspolitischen Gestaltung wirksam geworden. So hat es vor allem Eingang in das nationale und internationale Umweltrecht gefunden. Das Vorsorgeprinzip stellt heute jedoch darüber hinaus im Falle wissenschaftlicher Unsicherheit ein international etabliertes ethisches Entscheidungskriterium dar. Obwohl das Vorsorgeprinzip in verschiedenen Varianten vertreten wird, hat – auch unter Bezugnahme auf das "Prinzip Verantwortung" von Hans Jonas – die oben genannte prononciert risikoaverse Interpretation des Vorsorgeprinzips besondere Beachtung gefunden. Dabei wird vor allem auf die Verletzbarkeit von Natur, Umwelt und Menschheit durch die neue Qualität technologischer Interventionen des Menschen mit irreversiblen Folgen abgehoben. Ferner wird eine Kluft zwischen den technischen Fähigkeiten des Menschen und seiner moralischen Kompetenz

			angenommen. Den ethischen Gehalt des Vorsorgeprinzips hat Hans Jonas wie folgt akzentuiert: Handle so, dass Du den Fortbestand der Menschheit nicht gefährdest, vermeide den größtmöglichen Schaden, den man sich vorstellen kann, und versuche nicht, das gegenüber an-deren Vorteilen abzuwägen. Dieses Prinzip bedeutet für den hier behandelten Biosecurity-Kontext, dass Forschung und die Verwendung ihrer Ergebnisse nicht erst dann eingeschränkt werden, wenn eindeutige wissenschaftliche Belege für die Verursachung von Schäden durch diese Handlungen vorliegen. Umstritten ist dabei jedoch, wann genau das Vorsorgeprinzip ein solches Unterlassen von bestimmten risikoreichen Handlungen fordert; hier wird das Vorsorgeprinzip in einer starken und einer schwachen Variante vertreten: Die starke Variante des Vorsorgeprinzip stützt sich auf eine Umkehrung der Beweislast: Es soll eine risikoreiche Handlung so lange unterlassen und auch verboten werden, bis nachgewiesen ist, dass ein bestimmtes Niveau an gesellschaftlicher Sicherheit gewährleistet ist. Ein Problem dieser Variante besteht darin, dass die Umkehrung der Beweislast unter Umständen zu weitreichenden Beschränkungen von Forschung und innovativen Techniken führen würde, obwohl der Nachweis der Schädlichkeit gerade nicht erbracht ist. Gegen zu weit gehende Unterlassungspflichten in Situationen der Unsicherheit wenden sich die Vertreter der schwachen Variante des Vorsorgeprinzips. Sie stützen sich auf den Grundsatz, dass in Situationen der Ungewissheit zwar Maßnahmen der Schadensabwehr geboten sind, wenn schwerwiegende negative Folgen für hochrangige Güter wie Menschenleben oder die Umwelt durch risikoreiche Handlungen drohen, darüber hinaus jedoch nicht per se eine Pflicht zum Unterlassen der Handlung abgeleitet werden kann.

C186	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 3: Making of Life Science > Freedom of Science	(a) Argumentationslast Gemäß der Grundregel der neuzeitlichen Philosophie "im Zweifel für die Freiheit" darf der Staat nicht allein wegen Unsicherheit aufgrund von fehlendem Wissen, sondern erst dann regulierend (mit Verboten) eingreifen, wenn es gute Gründe zur Annahme des Schadenspotenzials einer Technologie oder eines Produktes gibt. Das Fehlen eines wissenschaftlichen Nachweises für die Schadensverursachung kann allerdings per se keine Rechtfertigung für das Unterlassen von staatlichen Maßnahmen der Risikominimierung darstellen. Bestehen daher plausible Gründe für die Annahme einer möglichen schwerwiegenden Schadensverursachung, können sie verhältnismäßige Einschränkungen der Handlungsfreiheiten zur Minimierung möglicher Risiken rechtfertigen.
C186	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Handling the Dangers > Restrict Research	(c) Risikovorsorge Wie oben dargestellt, darf eine Technologie nicht schon allein deswegen untersagt werden, weil der wissenschaftliche Beweis ihrer Ungefährlichkeit noch aussteht. Allerdings haben sowohl der Staat als auch die Wissenschaftsgemeinschaft die Pflicht zur Risikovorsorge. Dies kann Maßnahmen der Risikoreduzierung umfassen und im Einzelfall sogar ein Forschungsverbot rechtfertigen. Das Postulat der Risikovorsorge beinhaltet zudem, Forschung durch Monitoring zu begleiten und zu überprüfen.

C187	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 3: Making of Life Science > The Public	(d) Öffentlicher Diskurs Neben dem wissenschaftsinternen Prozess der Risikobeurteilung, erfordert die Situation der Ungewissheit die Einbettung der Debatte in einen gesellschaftlichen Diskurs mit dem Ziel, gesellschaftliche Grundlagen für einen verantwortlichen Um-gang mit neuen Forschungsbereichen und Innovationen zu schaffen. Bürgerbeteiligung im Rahmen von wissenschaftspolitischen Entscheidungen ist aus unterschiedlichen Gründen gefordert. Sie kompensiert die eher technikinduzierte Sichtweise der Experten durch alltagspraktische Überlegungen. Partizipation fördert die Offenlegung von Wertkonflikten sowie Konsens- und Dissensbereichen, ermöglicht diskursethische Modelle der Normenbegründung und fördert die informierte Zustimmung der im weiteren Sinne (potenziell) Betroffenen. Partizipation in diesem Sinne kann bedeuten, dass Betroffene Informationen in den Prozess einbringen, an Beurteilungsprozessen teilnehmen und selbst von den Ergebnissen dieser Prozesse, die somit öffentlich zugänglich sind, profitieren. Wenn Bürger am Informationsprozess teilnehmen, können emotionale, pragmatische, aber vor allem auch kulturelle Einschätzungen stärker erfasst werden. Solche Aspekte könnten im Rahmen diskursiver Verfahren "aufgespürt" und gegebenenfalls auch hinterfragt werden, sodass sie für den akademisch-wissenschaftlichen Diskurs nachvollziehbar werden. Diese Verfahren sind nicht ergebnisorientiert (z. B. indem sie ein Wissensdefizit ausgleichen oder Konsense aushandeln), sondern entsprechen Reflexionsdiskursen. Damit kommt der Bürgerbeteiligung eine ergänzende beratende Funktion zu bereits vorfindlichen Diskursen mit Experten und gesellschaftlichen Gruppen zu.
C188	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 3: Making of Life Science > The Public	Wissenschaft bringt allerdings zunehmend praktische Folgen und Anwendungen hervor, die nicht nur mit Fort-schritten, sondern auch mit Gefahren im Sinne negativer gesamtgesellschaftlicher Konsequenzen verbunden sein können. Dies trägt dazu bei, Wissenschaft nicht nur als internen Prozess einer Wissenschaftler-Gemeinschaft, sondern darüber hinaus als in allgemeine gesellschaftliche Zusammenhänge eingebettet zu verstehen. Wissenschaft wird insoweit nicht nur am Erkenntnisgewinn als

			solchem140 oder an seiner unmittelbar technischen Umsetzbarkeit gemessen, sondern allgemeinen gesellschaftlichen Bewertungen unterzogen.
C189	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 2: Beneficial Biotechnology > Other Benefits	Diese Entwicklung in der Laborsicherheit zeigt, wie erst auf der Basis einer wechselseitigen Verantwortung von Wissenschaft und Gesellschaft ein Umgang mit schädlichen und möglicherweise schädlichen biologischen Agenzien ethisch zu rechtfertigen ist. Dabei geht es nicht um die Gewährung einer Erlaubnis für die Forschung selbst, sondern um die Festlegung von Anforderungen und Bedingungen für deren Durchführung zum Schutz von Menschen und Umwelt. Der Staat hat die Pflicht, die Forschungsfreiheit zu gewährleisten und Forschung, die dem Wohl und Nutzen der Gesellschaft dient, zu fördern. Dazu gehört auch, die Weiterentwicklung des Wissens und der Techniken zur Abwehr erkannter Gefahren und Risiken für Menschen und Umwelt zu fördern. Biologische Forschung ist unerlässlich zur Weiterentwicklung der Prävention und Behandlung von Krankheiten. Dabei sind die Hoffnungen auf Erkenntnisse und die Chancen, die mit der Forschung verbunden sind, aber stets auch abzuwägen mit den möglichen Risiken.
C190	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Formal Regulation > Legislation/Legal Obligations	Das neue Bewusst-sein bezüglich der Biosecurity im Allgemeinen und DURC im Besonderen wirft indes grundsätzliche Fragen auf: Inwieweit muss die lebenswissenschaftliche Forschung auch selbst Verantwortung für einen möglichen Missbrauch ihrer Forschung und Forschungsergebnisse übernehmen? Wie kann man verantwortungsvolles Handeln in der wissenschaftlichen Forschung sicherstellen? Welchen Weg gibt es, relevante Biosecurity-Probleme rechtzeitig bei einzelnen Forschungsprojekten und in der Entwicklung neuer Forschungsfelder zu identifizieren und Maßnahmen zu ergreifen, die einen Missbrauch zu verhindern helfen? Inwieweit können Forschungsinstitutionen die Wissenschaftler auf bestimmte Risikostrategien verpflichten? Und inwieweit kann eine Gesellschaft bzw. der Staat das Befolgen einer Risikostrategie für alle Forscher rechtsverbindlich machen?

C191	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 3: Making of Life Science > The Public	Grundsätzlich gilt die Forderung, dass moderne, technisch verfasste Gesellschaften lernen müssen, sich von der primären Gefahrenwahrnehmung zu einer verallgemeinerbaren und sozial verbindlichen Risikobeurteilung weiterzubilden, um auf Basis dieser Risikobeurteilung ihre Sicherheitsstrategien zu formulieren. Diese Forderung ist eine ethische Forderung. Umzusetzen ist sie in gesellschaftlichen Debatten, in denen – in der Regel anhand konkreter Erfahrungen wie beispielsweise der Beurteilung risikoreicher Biotechnologie – die Inhalte der Sicherheitspolitik bewusst gemacht werden. Dazu gehört auch die Berücksichtigung von Unbehagen in der Gesellschaft, denn oftmals zeigt sich an Beunruhigungen, in welchen Fällen in biotechnologischen Entwicklungen ein Kommunikations-defizit herrscht oder ein tatsächlicher Anlass zur Sorge besteht. Deshalb ist die Einbeziehung zivilgesellschaftlicher Akteure wichtig, denn die Beurteilung von Forschungsnutzen und -risiken kann je nach Interessenlage und Betroffenheit sehr unterschiedlich ausfallen. Differenzen können im Gespräch zwischen Wissenschaft, anderen gesellschaftlichen Akteuren und der allgemeinen Öffentlichkeit offengelegt und gegebenenfalls beigelegt werden.
C192	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 3: Making of Life Science > The Public	Die moderne Wissenschaft unterliegt einer internen wissenschaftsimmanenten sowie einer externen gesellschaftlichen Bindung und Kontrolle, deren jeweilige Ansprüche divergieren können. Insbesondere im Hinblick auf die Risikobeurteilung von Forschung können aus Sicht der Forscher bestimmte Sicherheitsvorkehrungen aufgrund wissenschaftsinterner Kriterien als hinreichende Voraussetzung für eine "sichere" Durchführung von Forschung, etwa in Laboren, angesehen werden, während seitens der Gesellschaft wesentlich weiter reichende Ansprüche an die Begrenzbarkeit und Beherrsch-barkeit des mit Forschung möglicherweise verbundenen Risikopotenzials und ihrer möglichen Folgen gestellt werden.
C193	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 3: Making of Life Science > The Public	Solche Divergenzen in der Risikobeurteilung können nicht einfach mit dem Hinweis auf unterschiedliches Wissen von Laien und Experten und eine hierauf gründende unterschiedliche Beurteilungskompetenz

			ignoriert werden. Dies ist insbesondere dann kaum begründbar, wenn, wie in einem großen Bereich innerhalb des Handlungsfelds der Biosecurity, eine Risikobeurteilung nach etablierten Regeln nicht stattfinden kann. Vielmehr unterliegt die Risikobeurteilung dann einem Abwägungsprozess, in den die verschiedenen Beteiligten auch unterschiedliche Rechte, Interessen und Sichtweisen einbringen.
C194	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Formal Regulation > Code of Conduct	Diese zentralen Elemente eines auf Selbstverpflichtung gründenden Ethos der Wissenschaft bildete seit Beginn der Neuzeit die Grundlage für das Vertrauen, das die Wissenschaftler und die Wissenschaft in der Öffentlichkeit erfuhren. Lange Zeit war dieses Ethos nichtkodifiziert.
C195	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Formal Regulation > Code of Conduct	Seit dem Zweiten Weltkrieg hat sich vor allem in den Naturwissenschaften die Tendenz zur "Big Science" herausgebildet. Das bedeutet, dass naturwissenschaftliche Forschung weniger in Einzelarbeit, sondern nur noch oder vorwiegend in Teamarbeit und Projekten unter projektorientierter Finanzierung und häufig in internationalen Dimensionen realisiert werden kann. Mit dieser Entwicklung sind Phänomene der Anonymisierung der wissenschaftlichen Leistung und dem-zufolge der Zerfaserung der Verantwortung verbunden. Das herkömmliche, interne Wissenschaftler-Ethos, das im Wesentlichen auf Interaktions- und Kommunikationsformen innerhalb der Kleingruppe mit ihren Instrumenten der direkten Kontrolle beruhte, hat daher insoweit an prägender Kraft verloren. Deshalb wurden zunächst Verhaltensregeln in Kodizes gefasst, die dann auch rechtlich verbindlich wurden.
C196	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Formal Regulation > Code of Conduct	Selbstverpflichtung der Wissenschaftsgemeinschaft: Der Sensibilisierung der einzelnen Wissenschaftler zur Gefahrenabwehr und Risikovorsorge im Bereich der Biosecurity korrespondiert eine diesbezügliche Verantwortung der Wissenschaftsgemeinschaft, die ihren Ausdruck insbesondere in Elementen einer Selbstverpflichtung finden kann. Eine solche Selbstverpflichtung muss eine hohe wissenschaftsinterne Verbindlichkeit aufweisen
C197	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Awareness/Education	Sensibilisierung von Wissenschaftlern: Eine wichtige Voraus-setzung für eine Gefahrenabwehr im Bereich der Biosecurity besteht in einer Sensibilisierung der Wissenschaftler und des Laborpersonals bezüglich der

			speziellen Gefahren und Risiken im Handlungsfeld der Biosecurity und der damit verbundenen Verantwortung gegenüber der Wissenschaftsgemeinschaft und der Gesellschaft. In der gegenwärtigen lebenswissenschaftlichen Forschung bezieht sich die Verantwortung der Wissenschaftler im Bereich der Biosecurity dabei insbesondere auf das Problem von DURC.
C198	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Awareness/Education	Curricula in der Aus-, Fort- und Weiterbildung: Angesichts der zunehmenden Bedeutung von Biosecurity und der Not-wendigkeit einer Sensibilisierung von Wissenschaftlern in den einschlägigen Lebenswissenschaften in ihrer universitären Ausbildung sowie von Laborpersonal in der Berufsausbildung besteht ein erster Ansatzpunkt darin, die genannten Personengruppen konsequent und stärker als bisher mit den Fragen und Problemen der Biosecurity vertraut zu machen. Das Handlungsfeld der Biosecurity wäre entsprechend angemessen in den einschlägigen Curricula zu berücksichtigen. Zudem könnten Wissenschaftler und Laborpersonal in der Biosecurity-relevanten Forschung zur Teilnahme an periodisch durchgeführten thematisch einschlägigen Fortbildungsveranstaltungen verpflichtet werden, ergänzt um einschlägige Angebote für die persönliche Weiterbildung. Alle diese Maßnahmen könnten dazu beizutragen, dass sich das Bewusstsein für Biosecurity-Fragen neben denen der Biosafety, innerhalb der Biowissenschaften intensiviert.
C199	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Awareness/Education	a) Mit Biosecurity-relevanter Forschung befasste Personen sollen durch Wahrnehmung geeigneter Bildungsmaß-nahmen Kompetenz zur Identifizierung des Dual-Use-Potenzials ihrer Forschung und zur Beurteilung der damit verbundenen Risiken und Missbrauchsgefahren erwerben. Hochschulen und andere Forschungseinrichtungen sollen entsprechende Bildungsangebote unterbreiten

C200	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Actors > Scientists > Knowing the dangers	Eine wirkungsvolle Risikobeurteilung ihrer Arbeit können Lebenswissenschaftler aber nur dann vornehmen, wenn sie diese Risiken verstehen und ihnen die Gefahren, die damit verbunden sind, bewusst sind. Auch Verhaltenskodizes können ihre Wirkung nur dann entfalten, wenn die Wissenschaftler über die Dual-Use-Problematik so gut informiert sind, dass sie ein Bewusstsein und Verständnis für entsprechende Risiken entwickeln und somit auch ein Interesse daran haben, sich mit Kodizes zu befassen und sie zu befolgen.
C201	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Awareness/Education	Damit das Instrument des Forschungskodex zur Übernahme von Selbstverantwortung eine bessere Wirkung entfaltet, bedürfte es allerdings in Deutschland der Entwicklung eines Kodex, der im Unterschied zu den bisherigen Ansätzen erstens für alle an relevanten Forschungsvorhaben beteiligten Personen und Institutionen in Deutschland gilt, der zweitens die materiellen Vorgaben für verantwortliches Handeln konkreter benennt und dessen institutionelle Anbindung und Implemetierung drittens gesichert ist. Hierbei ist zu berücksichtigen, dass gerade der Prozess ihrer Erarbeitung unter Beteiligung aller relevanten Akteure hierzu einen positiven Beitrag leisten kann. Für eine nachhaltige Bewusstseinsbildung zu Biosecurity-Belangen wird zudem eine bessere Integrierung solcher Inhalte in die Aus-, Fort- und Weiterbildung der in den Lebenswissenschaften tätigen Personen als notwendig erachtet.
C202	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Awareness/Education	Nach Analyse bisheriger Erfahrungen sowohl in Deutschland als auch in ausgewählten anderen Staaten sowie der überwiegenden Einschätzung von Biosecurity-Experten reichen bewusstseinsbildende Maßnahmen und Kodizes aber nicht aus. Für eine angemessene, am Vorsorgeprinzip orientierte Strategie für den Umgang mit Biosecurity-Risiken hält der Deutsche Ethikrat über solche verantwortungsfördernden Maßnahmen hinaus ergänzende rechtliche Regelungen für erforderlich, mit denen zugleich ein transparenter Abwägungs-prozess bei der Beurteilung von besorgniserregender Biosecurity-relevanter Forschung gewährleistet werden soll.

C203	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Assessing Dangers (Abstract Code) > Awareness/Education	Damit stellt sich die Frage, ob bestehende gesetzliche und sonstige rechtliche Lücken bei der Regelung besorgniserregender Biosecurity-relevanter Forschung mithilfe von Forschungskodizes geschlossen werden können, die Forscher und Forschungsbeteiligte im Biosecurity-relevanten Bereich ausreichend für Missbrauchsgefahren sensibilisieren und faktisch verhaltenssteuernde Wirkung entfalten können. Für diesen Bereich relevante Kodizes sind in Deutschland bislang zum Beispiel von der Deutschen Forschungsgemeinschaft, der Max-Planck-Gesellschaft und der Leibniz-Gemeinschaft formuliert worden.
C204	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Formal Regulation > Code of Conduct	Forschungskodex: Eine Selbstverpflichtung der Wissenschaftsgemeinschaft zur Wahrung von Biosecurity ist durch einen wissenschaftsinternen Kodex erreichbar, der sich an die Wissenschaftler und das Laborpersonal in den einschlägigen Disziplinen richtet und der von allen relevanten öffentlichen und privaten Forschungseinrichtungen in Deutschland übernommen und bei Bedarf konkretisiert wird. In ihm sollte mit Blick auf Biosecurity das Ethos des Wissenschaftlers und seine gesellschaftliche Verantwortung festgeschrieben werden. Zudem sollten die Wahl angemessener Forschungsziele und Forschungsmethoden sowie die im Zusammenhang mit Biosecurity einzuhaltenden Sicherheitsstandards definiert werden. Auch wenn ein solcher Forschungskodex nicht unmittelbar rechtsverbindlich ist, kann er insofern erhebliche faktische normative Bindungswirkung entfalten, als seine Grundsätze und Leitlinien einen Maßstab für verantwortungsvolle Forschung darstellen. Dies führt dazu, dass jede Nichtbeachtung eines solchen Kodex als ethisch nicht zu rechtfertigendes oder verantwortungsloses Verhalten qualifiziert werden kann. Die starke Bindungswirkung setzt allerdings voraus, dass bestimmte Vorgaben bei der Entstehung und der Festlegung der materiellen Standards eines solchen Forschungskodex eingehalten werden. Der Kodex kann zudem über eine zum Beispiel arbeitsrechtliche Verankerung mittelbare Rechtsverbindlichkeit erreichen. Gegen das Instrument eines solchen Kodex könnte ein-gewandt werden, dass es, soziologisch verstanden, für soziale Kontrolle in modernen Gesellschaften viel eher typisch ist, de

			facto den moralischen Vorwurf ("Du handelst verwerflich!") durch den Bezug auf das geltende Recht ("Du handelst rechts-widrig!") zu ersetzen. In diesem Bezug auf das geltende Recht kann gerade ein Freiheitsgewinn und eine Friedensfunktion des Rechts gesehen werden. Diese Friedensfunktion könnte eingeschränkt werden, wenn es zunehmend zu einer "Ethisierung des Wissenschaftsrechts" kommt und es im Zuge dessen erforderlich wird, Forschungsvorhaben an nicht-rechtliche Leitlinien anzupassen und in diesem Sinne "ethisch" zu bewerten. Diesem Einwand kann jedoch entgegengehalten werden, dass eine Öffnung des Rechts für – oder seine Ergänzung durch – nichtrechtliche Verantwortungsstandards nicht grundsätzlich dem Charakter der deutschen Rechtsordnung, die eine Gerechtigkeitsordnung im weitesten Sinne sein will, widerspricht, sofern sich solche im normativen Sinne verstandenen ethischen Standards inhaltlich und prozedural rechtfertigen lassen. Der Einwand verdeutlicht jedoch, dass ein solcher Verantwortungsstandard für Biosecurity tragenden Verfassungsprinzipien wie insbesondere den Grund- und Menschen-rechten und ihrer Abwägung gegeneinander, aber auch dem Bestimmtheitsgebot Rechnung tragen muss. Zu diesen Grund- und Menschenrechten gehört die Wissenschaftsfreiheit ebenso wie der Schutz von Leib und Leben des Einzelnen. Verpflichtet damit ein Biosecurity-Forschungskodex die Forschung auf verantwortliche Forschung, muss dieser auch hinreichend genau bestimmen, was verantwortliche Forschung ist oder was zu den grundlegenden ethischen Prinzipien für verantwortliches Handeln des Forschers zählt. Will man eine normative Einheitlichkeit der Verantwortungsstandards gewährleisten, bedarf es eines deutschlandweit einheitlichen Biosecurity-Forschungskodex. Da Biosecurity ein Staatenübergreifendes Anliegen ist, wäre zudem ein internationaler Konsens für den verantwortungsvollen Umgang mit Biosecurity-relevanter Forschung anzustreben.
C205	Deutscher Ethikrat. (2014). Biosicherheit – Freiheit und Verantwortung in der Wissenschaft.	Dimension 4: Responses > Formal Regulation > Legislation/Legal Obligations	4. Gesetzlicher Regelungsbedarf Eine rechtlich verbindliche Regelung von DURC soll umfassen: >> die gesetzliche Definition von DURC (Empfehlung 4.1);

			>> die Verpflichtung, vor Durchführung von DURC eine Beratung durch die DURC-Kommission einzuholen (Empfehlung 4.2); >> die Einsetzung einer DURC-Kommission (Empfehlung 4.3); >> die Verankerung eines Verfahrens zur Evaluation des DURC-Beratungsverfahrens (Empfehlung 4.4); >> die Ausweitung der Aufgaben von Beauftragten für die Biologische Sicherheit auf den DURC-Bereich.195 Einige Mitglieder des Deutschen Ethikrates empfehlen, das DURC-Beratungsverfahren um ein Genehmigungsverfahren durch eine Bundesbehörde, wie zum Beispiel durch das Robert-Koch-Institut, zu ergänzen. Als Vorbild kann das Genehmigungsverfahren des Gentechnikgesetzes unter Einbeziehung der Zentralen Kommission für Biosicherheit dienen