SYNTHETIC BIOLOGY: IS IT PROHIBITED BY THE BIOLOGICAL WEAPONS CONVENTION OR OTHER INTERNATIONAL LAWS?

Trason Lasley*

Abstract: Just as there continues to be a question on whether or not viruses are biological, scientists create new technologies every year that push up against what is and what is not biological. With these new technologies, it is almost possible to alter DNA using CRISPR/Cas9 technologies in one's garage. Such a development begs the question, to what extent does international law relate to and prohibit these new technologies from being used as weapons? Synthetic biology is an emerging science that pushes up against what is biological and can be split into two categories, a top-down and a bottom-up approach. Are either or both approaches encompassed by and prohibited from being used as weapons under the Biological Weapons Convention or other international law? It appears that the Biological Weapons Convention covers and prohibits synthetic biology's top-down. Still, neither the Convention nor other international laws prohibit the bottom-up approach—or more specifically, biomimetics, CRISPR/Cas9 genome-editing genome editing, and nanotechnology—because top-down synthetic biology reworks preexisting systems, while in contrast, bottom-up synthetic biology may be used to weaponized non-biological agents that can alter biological organisms.

Keywords: Synthetic Biology; Biomimetics; CRISPR; Nanotechnology; Biological Weapons Convention; BWC; International Law

* J. Reuben Clark Law School, Brigham Young University, United States.

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INTRODUCTION

On Wednesday, April 4, 1979, Yakov Klipnitzer called Margarita Ilyenko, asking her, "are any of your patients dying?"[1] Ilyenko was the chief physician of a medium-sized, one-hundred-bed hospital in Sverdlovsk, a city with a population of 1.2 million and the tenth-largest city in the Soviet Union.[2] She often referred patients to the larger hospital where Klipnitzer was the chief doctor at.[3] Klipnitzer had just seen two unusual deaths that came as referrals from Ilyenko's Hospital, both from what he thought looked like a severe case of pneumonia.[4] Ilyenko told Klipnitzer that she had not seen any such deaths at her facility.[5] Not soon after, Ilyenko started to see patients die at her hospital too.[6] These patients were "suffering from high fevers, headaches, coughs, vomiting, chills and chest pain."[7] Roza Gaziyeva, head of admissions at the hospital, recalled, "Some of them who felt better after first aid tried to go home.[8] They were later found on the streets—the people had lost consciousness."[9] Just two days after that initial call, Ilyenko recorded on April 6th that "There are dead bodies, people still alive, lying together. I thought, this is a nightmare. Something is very wrong, very wrong."[10]

The district where Ilyensko's hospital was located included a ceramics factory where hundreds of men worked in shifts in a building with large, high windows.[11] Less than a mile away from the factory was an army base with a closed military microbiology facility.[12] Comprised in the compound was a laboratory that developed and tested for deadly pathogens, including anthrax.[13] On April 2, two days before Klipnitzer and Ilyensko's call, the wind had been blowing down from the army base towards the ceramics factory.[14]

Inside the army base, three shifts worked around the clock, experimented with anthrax, and made batches of the deadly pathogen.[15] They would grow the bacteria used for anthrax before grinding it up into a fine powder so that it could be used in an aerosol form.[16] Anthrax is a dangerous pathogen that can cause a fatal infection.[17] It usually enters the body through inhalation and is caused by a bacteria known as Bacillus anthracis spores.[18] "The bacteria germinate and release toxins that can quickly bring on death if untreated."[19] A single gram of anthrax contains around a trillion death-causing spores.[20] For this reason, anthrax is well-suited

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[1] DAVID E. HOFFMAN, THE DEAD HAND: THE UNTOLD STORY OF THE COLD WAR ARMS RACE AND ITS DANGEROUS LEGACY, 1 (2009).
[2] *Id.* at 1-2.
[3] *Id.* at 1.
[4] *Id.*
[5] *Id.*
[6] *Id.*
[7] *Id.*
[8] *Id.*
[9] *Id.*
[10] *Id.* at 2.
[11] *Id.*
[12] *Id.*
[13] *Id.*
[14] *Id.*
[15] *Id.* at 3.
[16] *Id.*
[17] *Id.*
[18] *Id.*
[19] *Id.*
[20] *Id.*

as a biological weapon.[21] What happened at the army base is still unknown. By one account, what likely happened is that "a filter was removed and not properly replaced, and anthrax spores were released into the air."[22] After several weeks of fighting the outbreak, 358 got sick, and more than sixty people died.[23]

Seven years prior, almost to the date, in April of 1972, the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction was created.[24] The longwinded treaty name has come to be known as the Biological Weapons Convention (BWC). This treaty banned biological and toxic weapons by prohibiting their development, production, acquisition, transfer, stockpiling, and use.[25] This is the first disarmament treaty of its kind to ban an entire category of weapons of mass destruction.[26] As stated in the Treaty, the Convention was "[d]etermined, for the sake of all mankind, to exclude completely the possibility of bacteriological (biological) agents and toxins being used as weapons."[27]

The BWC did not have the effect it desired right away, as seen during the cold war, the Soviet Union still developed offensive biological weapons.[28] They were able to engineer pathogens so deadly that their killing power could be likened to that of a nuclear bomb.[29] The Soviets were able to continue this program into the early 1990s in complete violation of the BWC.[30] Nonetheless, by the late 1990s, it was common to think that the international restrictions on biological weapons—due to the Convention—presented few legal problems because the legal situation had become "so clear" that the only issue was ensuring compliance.[31] At least, that is what was thought until recently.

The Biological Weapons Convention sets up many obligations on States Parties; however, what the BWC does not do is define the scope of bacteriological or biological agents, creating potential holes and ambiguity. For example, viruses were and are still known for lying "at the edge of life."[32] Therefore, viruses were not banned as biological weapons until 1969, when they were finally defined as biological agents, 40 years succeeding the first biological weapons treaty.[33] Recent technological advances again beg the question of what is biological

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[21] *Id.*
[22] *Id.*
[23] *Id.*
[24] Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction preamble, Apr. 10, 1972, 1015 U.N.T.S. 163 [hereinafter BWC].
[25] *Id.*
[26] UNITED NATIONS: OFFICE FOR DISARMAMENT AFFAIRS, *Biological Weapons Convention*, un.org/disarmament/biological-weapons/ (last visited Oct. 31, 2022).
[27] BWC, *supra* note 24.
[28] *Assessing the Biological Weapons Threat: Russia and Beyond: Hearing Before the Subcomm. on Eur., Eurasia, and Emerging Threats of the Comm. on Foreign Aff. H.R.*, 113th Cong. 1 (2014).
[29] *Id.*
[30] *Id.*
[31] Howard S. Levie, *Nuclear, Chemical, and Biological Weapons*, 70 INT'L L. STUD. SER. US NAVAL WAR COL. 247, 258 (Horace B. Robertson ed., 1998).
[32] Durward Johnson & James Kraska, *Some Synthetic Biology May Not be Covered by the Biological Weapons Convention*, LAWFARE: BIOLOGICAL AND CHEMICAL WEAPONS (May 14, 2020, 11:05 AM), https://www.lawfareblog.com/some-synthetic-biology-may-not-be-covered-biological-weapons-convention#:~:text=While%20Article%20I%20of%20the%20BWC%20codifies%20the,employment%20of%20biomimetics%2C%20a%20dangerous%20subclass%20of%20SynBio. This debate continues today in most undergraduate microbiology classes.
[33] *Id.*

and what is not. Synthetic biology is an emerging science that pushes up against what is biological and is split into two categories, a top-down and a bottom-up approach.[34] This paper seeks to determine if synthetic biology, both or either method, is encompassed by and prohibited from being used as weapons under the Biological Weapons Convention or other international law. As outlined below, the Biological Weapons Convention covers and prohibits synthetic biology's top-down. Still, neither the Convention nor other international laws prohibit the bottom-up approach—or more specifically, biomimetics, CRISPR/Cas9 genome-editing genome editing, and nanotechnology—because top-down synthetic biology reworks preexisting systems, while in contrast, bottom-up synthetic biology may be used to weaponize non-biological agents that can alter biological organisms.

Throughout this paper, the aim is to lay out where the potential holes might be in the biological weapons and other customary international laws that would allow synthetic biology to slip through and be allowed as a biological weapon. First, in Part I of this paper, the goal will be to give an overview of the Biological Weapons Convention, outlining obligations under the treaty and how the treaty will be applied, as well as applicable customary international laws. Next, Part II of this paper will focus on introducing synthetic biology and explaining the differences between top-down and bottom-up synthetic biology. Lastly, in Part III of this paper, the goal will be to apply the biological weapons convention and other applicable international laws to synthetic biology, examining how the treaty and other norms apply to both the top-down and bottom-up approaches of synthetic biology.

I. BIOLOGICAL WEAPONS CONVENTION AND APPLICABLE CUSTOMARY INTERNATIONAL LAWS

A. The Biological Weapons Convention

In all likelihood, one of the first uses of biological agents in warfare can be traced all the way back to 1346.[35] Based on the 14th-century account of Genoese Gabriele de' Mussi, the Black Death was believed to have entered Europe from Crimea, which prior had been involved in a biological warfare attack.[36] However, no official international restrictions on the use of biological warfare were enacted until the 1925 Geneva Protocol.[37] Despite its prohibition of the use of biological weapons, it failed to prohibit the possession and development of biological weapons, and due to reservations, both with respect to the applicability and use of biological weapons in retaliation, it rendered the Geneva Protocol to become only a no-first-use agreement.[38] It did not stop states like the United States and the Soviet Union from starting and scaling offensive biological weapons programs.[39] It was clear that a more robust treaty was needed that not only prohibited the use of biological weapons but also prohibited the development and stockpiling of such weapons.[40]

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[34] Kevin Jahnke et al., *Proton Gradients from Light-Harvesting E. Coli Control DNA Assemblies for Synthetic Cells*, 12 NATURE COMMC'N 3967 (2021).
[35] Mark Wheelis, *Biological Warfare at the 1346 Siege of Caffa*, 8 EMERGING INFECTIOUS DISEASES 971 (2002).
[36] *Id.*
[37] UNITED NATIONS: OFFICE FOR DISARMAMENT AFFAIRS, *History of the Biological Weapons Convention*, www.un.org/disarmament/biological-weapons/about/history/ (last visited Oct. 31, 2022) [hereinafter *History BWC*].
[38] *Id.*
[39] HOFFMAN, *supra* note 1 at 101.
[40] As outlined in the example of the Soviet Union found in the introduction, even the development and stockpiling of biological weapons can have unwanted and disastrous consequences that harm civilian populations. *See supra* INTRODUCTION.

When the Biological Weapons Convention convened in Geneva in 1969, the goal was to supplement the Geneva Protocol.[41] At first, it was thought that the convention would keep chemical and biological weapons together just as they had been in the Geneva Protocol, but by March 1971, the Soviet Union and its allies—after much opposition to the idea of separating chemical and biological weapons—joined the United States and the United Kingdom in a convention focused on the prohibition of use, development, and stockpiling of biological weapons.[42] On August 5th, 1971, both the United States and the Soviet Union submitted separate but identical versions of the Biological Weapons Convention marking the final step of the negotiation of the Convention.[43] On April 10th, 1972, the Biological Weapons Convention opened for signatures in London, Moscow, and Washington, D.C.[44] On March 26th, 1975, after the deposit of the required instruments of ratification, the Convention came into force.[45] In the creation of this new multilateral convention was the incorporation of the above-mentioned Geneva Protocol into this new treaty.[46]

Since its conception, the convention has long had a goal of universality.[47] For the most part, the Convention has primarily been able to achieve this goal. As of November 2022, the BWC currently has one hundred and eighty-four Parties and four signatory States.[48] Yet there remain nine States that have not signed nor acceded to the Convention.[49] The BWC remains open to all States to join, with each State undertaking the process of ratification, acceding, or succeeding to the Convention according to the States own constitution.[50]

A State can join or has already joined the convention through ratification, accession, or succession—depending on when they join the Convention—if they sign the Biological Weapons Convention and deposit the required instruments.[51] Once the Convention is signed, the required instruments should then be deposited with at least one of the three Depositary States. As laid out in Article XIV of the Convention names, the Depositary Governments are the Russian Federation, the United Kingdom of Great Britain and Northern Ireland, and the United States of America.[52] If joined on a date after the BWC took force, the Convention will

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[41] *History BWC*, supra note 37.
[42] Jozef Goldbalt, *The Biological Weapons Convention – An Overview*, 37 INT'L REV. RED CROSS (SPECIAL ISSUE) 251 (June 30, 1997).
[43] *History BWC*, supra note 37.
[44] *Id.*
[45] *Id.*
[46] Evan J. Wallach, *A Tiny Problem with Huge Implications – Nanotech Agents as Enablers or Substitutes for Banned Chemical Weapons: Is a New Treaty Needed?*, 33 Fordham Int'l L. J. 857, 924 (2009).
[47] UNITED NATIONS: OFFICE FOR DISARMAMENT AFFAIRS, *Achieving Universality*, https://www.un.org/disarmament/biological-weapons/about/universalization-and-joining-the-bwc/ (last visited Oct. 31, 2022) [hereinafter *Universality BWC*].
[48] The four signatory States, which are States that have signed the Convention but have not deposited their instruments of ratification, are Egypt, Haiti, Somalia, Syrian Arab Republic. UNITED NATIONS: OFFICE FOR DISARMAMENT AFFAIRS, *Membership and Regional Groups*, https://www.un.org/disarmament/biological-weapons/about/membership-and-regional-groups/ (last visited Oct. 31, 2022).
[49] The nine non-member States are Chad, Comoros, Djibouti, Eritrea, Israel, Kiribati, Micronesia (Federated States of), South Sudan, and Tuvalu. *Id.*
[50] *Universality BWC*, *supra* note 47.
[51] *Id.*
[52] BWC, *supra* 24 at Art. XIV.

take effect for a State on the day the required instruments are deposited with one of the Depositary Governments.[53]

It might also be important to note at this point that the United States considers the prohibition of the use of biological weapons during situations of armed conflict as part of customary international law.[54] This means that at least as far as armed conflict is concerned, all nations are bound by the BWC, whether or not they are parties to the Convention.[55]

As stated above, it appears that the Convention has achieved its goal of universality, with only nine States not yet signing on to the Convention and those States most likely being bound anyways under customary international law.[56] It would seem at first blush that the only concern of the treaty would be to get those last States to join the Convention and then to make sure that everyone is complying with the articles set forth therein. Nevertheless, recently, there have been concerns about holes in the scope of the BWC. These concerns include whether or not the Convention would cover some aspects of the emerging field of synthetic biology. However, before that, it would be prudent to first define the scope of the biological weapons convention as it is known to the States who are obligated by international law to obey.

1. Obligations Under the BWC

The Biological Weapons Convention has remained unchanged for over fifty years and contains only fifteen articles.[57] Part of the reason the treaty has been able to survive as long as it has is that, over time, it has been interpreted and supplemented by binding agreements that States have reached at eight follow-up review conferences.[58] At the beginning of the Convention, the participating states were focused on the fact that biological weapons disseminated organisms that could harm or kill humans, animals, or plants, were highly contagious, or could not be confined within national borders.[59] The use of such weapons could have dramatic consequences, not just loss of lives, but "food shortages, environmental catastrophes, devastating economic loss, and widespread illness, fear and mistrust among the public."[60]

For these reasons, the Biological Weapons Convention was held in the first place, with the text written broadly. The obligations of States Parties are laid out in the first ten articles of the Convention. Therefore, this paper will next break down some of the applications of the first ten articles, followed by a summary of the remaining articles in the Convention.

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[53] *Universality BWC*, *supra* note 47. Ratification applies only to States that joined the Convention when it was first signed before the Convention entered into force. *Id.* Accession is reserved for States that did not join initially but joined after March 26th, 1975, after the Convention entered into force. *Id.* Lastly, succession is open to States that became newly independent after the Convention entered into force; such States are eligible to succeed to the Convention if the Convention would have applied to them when they were part of another State. *Id.*

[54] *Nuclear, Chemical, and Biological Weapons*, 73 INT'L L. STUD. SER. US NAVAL WAR COL. 459, 478 (1999).

[55] *Id.* at 478-79.

[56] *Universality BWC*, *supra* note 47. This is the case as long as non-party States have not been persistent objectors. Nonetheless, a non-party State's non-action might be evidence that they have accepted it as customary international law.

[57] BWC, *supra* note 24.

[58] UNITED NATIONS OFF. FOR DISARMAMENT AFFAIRS, THE BIOLOGICAL WEAPONS CONVENTION: AN INTRODUCTION: SECOND EDITION, (March 2017), https://front.un-arm.org/wp-content/uploads/2022/11/BWC-brochure-English.pdf.

[59] *Biological Weapons Convention*, *supra* note 26.

[60] *Id.*

Article I contains the central prohibitions of biological weapons; it requires that each state "never in any circumstances to develop, produce, stockpile or otherwise acquire or retain:" actual microbial or other biological agents or the methods to produce them in "quantities that have no justification for . . . peaceful purposes" and any weapons that could deliver such agents "for hostile purposes or in armed conflict."[61] This article does not outright ban specific biological agents or weapons per se, instead, it prohibits particular purposes for which agents could be employed.[62] Nonetheless, the Fourth Review Conference in 1996 affirmed that the "use" of biological weapons was a violation of the BWC.[63]

Article II obligates party States to undertake the destruction of biological weapons or at least divert such biological agents for peaceful use.[64] It also instructs new states to the convention to perform this act "as soon as possible but not later than nine months after the entry into force of the Convention."[65] Also ensuring that it is done with all necessary safety precautions to "protect populations and the environment."[66]

Article III prohibits the transfer, assistance, encouragement, or inducement of any State to acquire or retain biological weapons.[67] The main objective of this article is to stop the proliferation of biological weapons at their origins by "curbing the supply of materials and technology for hostile purposes."[68]

Article IV obligates the States to take national measures needed to implement the BWC within the State.[69] Yet the Convention leaves it up to the State to determine what these implementations look like for each State. A state could implement through "legislation, regulations, government decrees, and administrative orders or executive orders."[70] A non-governmental organization known as VERTIC has undertaken the task of creating a database that has compiled over 1,500 laws and regulations that States have enacted to follow the obligations found in Article IV.[71] As of 2016, VERTIC concluded that there were still gaps in the BWCs implementation because "many States have yet to adopt necessary measures to give effect to certain obligations," even though they have adopted some measures within their own domestic laws.[72] Such implementation of Article IV is an ongoing process, and the BWC's

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[61] BWC, *supra* note 24 at Art. I.
[62] Jenni Rissanen, *The Biological Weapons Convention*, NTI (Feb. 28, 2003), https://www.nti.org/analysis/articles/biological-weapons-convention/.
[63] Fourth Review Conference of the Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction part II, Dec. 6, 1996.
[64] BWC, *supra* note 24 at Art. II.
[65] *Id.*
[66] *Id.*
[67] *Id.* at Art. III.
[68] RISSANEN, *supra* note 62.
[69] BWC, *supra* note 24 at Art. IV.
[70] Sonia Drobysz, *Verification and Implementation of the Biological and Toxin Weapons Convention*, 27 NONPROLIFERATION REV. 487, 488 (2020).
[71] *BWC Legislation Database: The Database*, VERTIC, https://www.vertic.org/programmes/nim/biological-weapons-and-materials/bwc-legislation-database/ (last visited Oct. 31, 2022).
[72] VERTIC, BIOLOGICAL WEAPONS CONVENTION: REPORT ON NATIONAL IMPLEMENTING LEGISLATION 16 (2016).

Implementation Support Unit has recently issued an information document on how to strengthen national implementation in 2018 and again updated its recommendation in 2019.[73]

Article V requires individual States to undertake cooperation with other States under the Treaty to solve "any problems that may arise in relation to the objective of, or in the application of the provisions of, the Convention."[74] In the Second Review Conference of 1986, the Parties agreed on specific procedures that would make sure that alleged violations of the Convention could be resolved during a consultative meeting when a State Party requests it.[75] This was later elaborated on in the Third Review Conference of 1991.[76]

Article VI gives Party States the right to request the United Nations Security Council to investigate any alleged breaches of the Convention as long as they include all possible evidence confirming the validity of the alleged breach and undertake to cooperate in carrying out the investigation.[77] Despite such a vital provision, as of 2022, no state has ever used this article to file a complaint, even though there have been several states accused of maintaining offensive biological weapons[78]—in particular, the Soviet Union, have been known to stockpile such biological armaments as outlined earlier in this paper.[79] Article VI probably has not been used because the Security Council's permanent five members'—China, France, Russia, the United Kingdom, and the United States—have veto power over Security decisions which includes decisions to conduct BWC investigations.[80]

Article VII obligates States to assist any other State that may have been exposed to danger as a result of a violation of the Convention but only are required to if the United Nations Security Council makes that finding.[81] This Article is not meant to aid victims of biological Weapons attack, it is intended to avert biological weapons attacks from occurring by demonstrating "solidarity among States Parties," because it would reduce the potential of harm.[82] As of 2022, no State has invoked Article VII—like Article VI—yet the Article remains relevant because of the fear that terrorist organizations might acquire biological weapons.[83]

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[73] Meeting of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, July 25, 2018; Meeting of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, Aug. 5, 2019. This paper's topic of enforcement and the problems that come with it are not discussed in detail because it lies outside of the scope this paper wishes to reach. However, as seen in other parts of the paper and footnotes, enforcement of the BWC has been and remains a big problem for the convention.

[74] BWC, *supra* note 24 at Art. V.

[75] Second Review Conference of the Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction Part II, Art. V, Sept. 30, 1986.

[76] Third Review Conference of the Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction Part II, Art. V, Sept. 27, 1991.

[77] BWC, *supra* note 24 at Art. VI.

[78] *The Biological Weapons Convention (BWC) At A Glance*, ARMS CONTROL ASSOCIATION (Feb. 2022), https://www.armscontrol.org/factsheets/bwc.

[79] HOFFMAN, *supra*, note 1.

[80] *Id.*

[81] BWC, *supra* note 24 at Art. VII.

[82] FILIPPA LENTZOS, COMPLIANCE AND ENFORCEMENT IN THE BIOLOGICAL WEAPONS REGIME 4 (2019).

[83] Danciel Feakes, *The Biological Weapons Convention*, 36 REV. SCI. TECH. OFF. INT'L EPIZ. 621, 623 (2017). As alluded to but might not have yet to be outrightly explained, the BWC is only binding to States and not on non-governmental actors. This means that the Convention does not cover terrorist organizations. Thus, this provision is important to the potential risk of terror attacks in promoting health and safety in States that might have had such an attack.

Because of this, the BWCs Implementation Support Unit, in 2018, issued additional understandings and agreements on Article VII that were reached at past Review Conferences.[84]

Article X, despite other provisions, gives States the right to facilitate the "exchange of equipment, materials, and scientific and technological information for the use of bacteriological (biological) agents and toxins for peaceful purposes."[85] This article was implemented so that the Convention would not hamper "the economic technological development of States Parties" in the biological sciences for peaceful purposes.[86] During the Seventh Review Conference of 2011, an Article X database was created to "facilitate the exchange of requests for, and offers to provide, assistance and cooperation among States Parties."[87]

The remaining seven articles found in the convention do not provide any more rights or obligations to the Party States but rather reaffirm past understandings found in the Geneva Treaty of 1925, clarify the objective of the Convention, define procedural mechanisms to join the Treaty, and defines when the Treaty takes force.[88] Because these topics have been discussed above, there is no need to go into detail about them here.

In summary, the Biological Weapons Convention obligates States Parties never to use, assist others to use, stockpile, acquire, or retain biological weapons or agents but rather to actively destroy such weapons or agents not used for peaceful purposes. The Convention requires that each state enforce the Convention in ways the States deem necessary within their own countries' borders and to help other States do the same while also allowing the transfer of equipment, materials, and information for peaceful purposes. Last, the Convention provides a right to the States to request the United Nations Security Council to investigate breaches of the BWC yet still obligating States to cooperate in carrying out the investigation initiated by the Council and then assisting any Party State exposed to dangers that the Security council deems was a breach of the BWC.

Despite all this, the text of the Convention does not define explicitly what a Biological Weapon is. Nonetheless, The United Nations Office for Disarmament Affairs has elaborated on what falls under the BWC as a biological weapon.[89] Because of ever-changing sciences and the vagueness of the original text of the Treaty, the BWC Implementation Support Unit regularly provides information for additional agreements that "(a) interpret, define or elaborate the meaning or scope of a provision of the convention; or (b) provide instructions, guidelines, or recommendations on how a provision should be implemented."[90] Using such information, the BWC has Review Conferences approximately every five years where States seek to "strengthen the effectiveness and improve the implementation of the Convention."[91] The first one of these Review Conferences took place in 1980, and eight others have followed since.[92]

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[84] Meeting of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction part II, July 25, 2018.
[85] BWC, *supra* note 24 at Art. X.
[86] *Id.*
[87] UNITED NATIONS: OFFICE FOR DISARMAMENT AFFAIRS, *Assistance and Cooperation Database*, https://www.un.org/disarmament/biological-weapons/assistance-and-cooperation/assistance-and-cooperation-database (last visited Oct. 31, 2022).
[88] BWC, *supra* note 24.
[89] *What are Biological Weapons*, UNITED NATIONS: OFFICE FOR DISARMAMENT AFFAIRS, *What are Biological Weapons*, https://www.un.org/disarmament/biological-weapons/about/what-are-biological-weapons/ (last visited Oct. 31, 2022).
[90] *Biological Weapons Convention*, *supra* note 26.
[91] *Id.*
[92] *Id.*

As outlined later in this paper, such Review Conferences do not foreclose the potential for the inclusion of the type of synthetic biology that might not be currently covered by the BWC.

2. Biological Weapons Defined Under the BWC

Biological weapons are weapons that "disseminate disease-causing organisms or toxins to harm or kill humans, animals or plants,"[93] they can be used for a wide variety of applications such as "political assassinations," the "infection of livestock," "environmental catastrophes," and to induce "widespread illness, fear, and mistrust."[94] Such biological weapons are made up of two parts: a weaponized agent and a delivery mechanism.[95]

a. Delivery Mechanism

First, this paper will start by quickly defining different delivery mechanisms and what that means for biological weapons. Primarily because this paper will not discuss these mechanisms in much detail later because it is not within the scope of this paper. Nonetheless, it is important to note what a delivery mechanism of a biological weapon is.

A delivery mechanism for a biological weapon is a system used to distribute a biological agent.[96] These systems can take many different forms. Historically some biological warfare programs have made "missiles, bombs, grenades and rockets," spray tanks attached to different vehicles, and smaller sprays, brushes, or needles.[97] Whatever mechanism, the concern of this paper is what biological agents are prohibited by the BWC and not what delivery mechanisms are prohibited. This is because the delivery mechanisms used to deliver a biological weapon are often dual-purposed and can be used for weapons that are both non-biological and biological. Because Article I of the Convention only prohibits delivery mechanisms that deliver biological agents, it is prudent to determine if the weaponized agent that is designed to be delivered in the mechanism is a biological agent first, as defined by the Convention. If it is biological, that mechanism is prohibited by the convention in use.[98] Therefore, the primary analysis that takes place in questions of biological weapons has to do with the agent that is being weaponized.

b. Weaponized Agents

Generally, the Convention does cover almost any disease-causing organism or toxin used as a weapon.[99] These types of organisms include bacteria, viruses, fungi, prions, or rickettsiae.[100] While toxins can be any poison derived from animals, plants, or microorganisms, they can also include synthetically derived substitutes.[101] Historically some biological warfare programs have produced agents like "aflatoxin, anthrax, botulinum toxin, foot-and-mouth disease, glanders, plague, Q fever, rice blast, ricin, Rocky Mountain spotted fever, smallpox, and tularaemia" to be used in biological weapons.[102] The BWC text itself fails to define biological agents with any specificity. Therefore, it will be helpful to look at other defining

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[93] *Id.*
[94] *What are Biological Weapons, supra* note 89.
[95] *Id.*
[96] *Id.*
[97] *Id.*
[98] BWC, *supra* note 25 at Art I.
[99] *What are Biological Weapons, supra* note 89.
[100] *Id.*
[101] *Id.*
[102] *Id.*

sources to analyze the issue at hand. The similarities and differences in the various sources can add insight into how the Convention defines a weaponized biological agent.

In general, the convention elected to adopt a broad definition that is not detailed in much specificity but has some ambiguity.[103] For this reason, it seems that Article IV of the Convention becomes important—at least in some regard. As discussed above, that article obligates the States Parties to create their domestic laws and regulations to fulfill the ends found in the BWC.[104] Therefore, it is important to look to the States for definitions because their laws are essentially the force behind the Treaty. Especially it would be important to look at the depository States because of the treaties focus on the importance of these States. Thus, this paper focuses on the United States and the United Kingdom for their definition of biological agents. Following that, this paper will have a more in-depth analysis of the BWC's second review conference's definition of a biological agent.

Though not necessarily dispositive to the international convention, the US code might bring some insight into what the United States classifies as a biological agent. The US code defines a biological agent as "any microorganism, or infectious substance, or any naturally occurring, bioengineered or synthesized component of any such microorganism or infectious substance. . ."[105] This definition is rather similar to the Convention text. Still, the US code is slightly more specific. Relevant to this paper, the code mentions the science of bioengineering and synthetic biology. Still of note—and discussed below—the bioengineering or synthetic biology prohibited here seems to apply mainly to top-down synthetic biology and not to some forms of bottom-up synthetic biology because it refers to the components of microorganisms or infectious substances that are "altered".

The Commander's Handbook on the Law of Naval Operations gives even more information on how the United States defines a biological agent.[106] In this document, biological agents include "microbial or other biological agents or toxins whatever their origin (i.e., natural or artificial). . ."[107] Again this definition seems to include synthetic biology in some way because of the "whatever their origin" language, then again, in the parentheses use of "artificial." Nonetheless, as discussed below, the science of synthetic biology is comprehensive, and that definition does not mean that this science as a whole is prohibited in use as a biological agent. In an annotated supplement to the handbook, it goes on to say in a footnote that biological weapons are "inherently indiscriminate and uncontrollable. . ."[108] This means that what is intended to be prohibited are biological agents that, when released to a population, it affects almost everyone that comes in contact with it. This applies to whether the organism used was naturally occurring or synthetically made in a lab. As discussed in detail below, this distinction still will not foreclose the use of some forms of synthetic biology.

That same footnote goes on to provide more information on the definition of a toxin. A biological toxin is a "toxic chemical by-product of biological organisms. They can be synthesized chemically and share many of the characteristics of chemical agents; however, they

[103] Throughout the research for this paper, the UN and BWC did not want to define in great detail what a biological agent is under the Convention.
[104] BWC, *supra* note 24 at Art. IV.
[105] 18 U.S.C. § 178 (2006).
[106] DEP'T OF THE NAVY & DEP'T OF HOMELAND SEC., THE COMMANDER'S HANDBOOK ON THE LAW OF NAVAL OPERATIONS (Mar. 2022 ed. 2022).
[107] *Id.* at 10.4.
[108] *Nuclear*, *supra* note 54 at 477-78.

are considered to be biologicals. . . .”[109] This means that toxins that are the same as naturally accruing biological organisms’ toxic by-products are still covered even if they have no biological origins; nonetheless, they remain chemically based and biological. This will also be important to keep in mind in understanding if some forms of synthetic biology are considered toxins and therefore prohibited under the BWC.

Next, the United Kingdom passed the Biological Weapons Act 1974, which is the governing act passed by the UK Parliament in response to the Biological Weapons Convention.[110] Within the act, it defines both biological agents and toxins. The act provides that a biological agent is “any microbial or other biological agent.” while a toxin is “any toxin, whatever its origin or method of production.”[111] Although the definition is short, it provides that as far as toxins are concerned, synthetic biology is covered in the definition of the Convention because it might be a different “method of production.”

With the sources cited above, it is important to remember that the implementation of the Convention in State domestic law is not international law. Therefore, these domestic laws that apply the Convention’s principles are informative rather than binding on the international community. The mere fact that both the Unties States and the United Kingdom—arguably among the two most important States in the conversation because of their role in the convention as dispositors—domestic law do not have the same definition of what a biological agent shows that the Biological Weapons Conventions definition is ambiguous to an extent on what kind agents are covered. While on the other hand, both the United States and the United Kingdom’s laws are pretty much identical when it comes to toxins, so the definition of toxin is better defined by the convention as seen through its application. Nonetheless, this analysis is still important for understanding the coverage of biological agents because it shows that different States might regulate the use of synthetic biology differently. Which would mean that the Convention potentially does not cover synthetic biology clearly enough. With that being said, there has been some clarification on behalf of the Biological Weapons Convention that might help refine the definition for Party States.

In the second review conference of 1986, Bulgaria and the German Democratic Republic submitted a proposal that made sure that the Convention would cover advances in biotechnology that could lead to the creation of new pathogenic microorganisms and toxins.[112] The purpose was to affirm that the BWC covered new technologies even though the original text did not reference synthetically or artificially altered biological agents.[113] This was agreed upon with a broad consensus at the conference and then again reaffirmed at the third, fourth, sixth, and seventh review conferences.[114] Thus at the second review conference, a biological agent was defined as “appli[ng] to all natural or artificially created or altered microbial or other biological agents or toxins whatever their origin or method or production.”[115] This came as a declaration and not part of a formal amendment and revision process. Thus, it is not technically legally binding but an authoritative source for the interpretation of the Treaty.[116] Over time, however, this definition has become a norm in international law, and such norms become customary international law when State practice is consistent with the law and there is opinio

[109] *Id.* at 478.
[110] Biological Weapons Act 1974, c.6 (Eng).
[111] *Id.* at § 1(2).
[112] Johnson & Kraska, *supra* note 32.
[113] *Id.*
[114] *Id.*
[115] Second Review Conference, *supra* note 75.
[116] Johnson & Kraska, *supra* note 32.

juris present.[117] Meaning that states are following the law out of a legal obligation. In this case of international law, both of these elements are present, and thus, this definition has become customary international law.[118]

There is a strong consensus and State practice that the Biological Weapons Convention covers the definition of a biological agent as defined in the second review conference of the Convention. This can be recognized in the adoption of the declaration itself during the second review conference. Nearly all international States have adopted the biological Weapons convention.[119] Thus, the second conference of the convention would include, to some extent, the inclusion of those States. As stated, the declaration by the conference was accepted broadly by those at the conference.[120] This leads to the conclusion that this definition of a biological agent, as covered by the convention, has been widely accepted by international states as law as the definition that should be applied. In addition, State's actions also follow this definition in actual practice. As referenced above, State statutes and regulations like that of the United States either refer to synthetic biological material or some form of production that could include synthetic material.[121] Even though they are not identical in wording, these States have codified this understanding of the Biological Weapons Convention into their domestic laws and regulations.[122] This is a pure form of State practice that is evidence that states have consistently applied this law since the definition was first declared. On the flip side, however, states like Russia completely ignore the biological weapons convention, and there might be some concerns that this would not be customary international law broadly because of their actions. This is not persuasive because even if Russia decided not to obey the convention per se, they still need to object to the declaration put forth during the second conference. Due to the lack of objections by States—even states that might not follow the Convention exactly—there does appear to be, at least, almost universal State practice and acceptance that the definition declared during the second conference of the Biological Weapons Convention is the law.[123]

The actions of the States that are part of the Biological Weapons Convention indicate that they have acted not just to follow along but have acted out of a legal obligation. The doctrine of opinio juris requires that States act not because they are just following along but because they feel legally obligated to do so.[124] This particular doctrine is often hard to define and recognize because it cannot be inferred from State practice.[125] This is the case because opinio juris is more concerned with a State's psychological state and not its actions. Nevertheless, two key facts would seem to indicate that States are following the declaration of the second conference out of a legal obligation. First, the declaration is an authoritative source in interpreting the legal definition of biological agents in the Biological Weapons Convention. This becomes strong evidence when States apply the declaration and codify it into their domestic laws or regulations, and they are likely doing it because they think the statement legally applies to the BWC. Second, there have not been any persistent objections to the

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[117] *Customary International Law*, USLEGAL, https://internationallaw.uslegal.com/sources-of-international-law/customary-international-law/ (last visited Oct. 31, 2022).
[118] *Id.*
[119] *Universality BWC*, *supra* note 47.
[120] *Id.*
[121] *Supra* note 105; *see also BWC Legislation Database*, *supra* note 71.
[122] *Id.*
[123] No sources spoke to no persistent objectors directly, but the fact that there were no sources seems to imply that there likely were no persistent objectors.
[124] *Opinio Juris (International Law)*, LEGAL INFO. INST., https://www.law.cornell.edu/wex/opinio_juris_(international_law) (last visited Oct. 31, 2022).
[125] *Id.*

declaration becoming international law.[126] A persistent objector is a State that sees that an international norm is becoming customary international law and consistently objects to that norm.[127] With nearly all States joining the Convention and the second review conference declaration being broadly accepted by the parties of the convention, the declaration does not need to be formally amended into the Convention to be legally binding and has become customary international law; binding on States.

For these reasons, States and this paper should rely on the customary international law created during the second review conference. Therefore, the most reliable definition for a weaponized agent is "all natural or artificially created or altered microbial or other biological agents or toxins whatever their origin or method or production."[128] For the most part, the State domestic laws in some form follow this definition. Thus, for purposes of this paper, this will be the definition used in later sections that apply the Biological Weapons Convention to synthetic biology. In addition, for toxins specifically, this paper will use the more restrictive definition of a toxin being a "toxic chemical by-product of biological organisms . . . synthesized chemically and shar[ing] many of the characteristics of chemical agents . . . are considered to be biologicals. . . ."[129]

B. Other Customary International Law

In addition to official international treaties that cover biological weapons, it is important to know that any weapon that would be developed would still be subjected to the customary international law of armed conflict.[130] The two additional aspects of the law of armed conflict that will be important to know are that the prohibition of weapons that cause superfluous injury and those that are inherently indiscriminate.[131]

The first rule is often called the superfluous injury rule and is derived from the 1977 Additional Protocol I to the Geneva Conventions.[132] In article 35(2), States are prohibited from deploying weapons in warfare that are "of a nature to cause superfluous injury or unnecessary suffering."[133] The United States has never officially ratified this particular treaty, but the treaty itself has come to be part of customary international law.[134] Although this paper will not do an extensive review into how this treaty has become customary international law because the analysis is very similar to what was discussed earlier in this paper, the United States has mentioned such "superfluous injury" in treaties they have joined—mainly the 1899 and 1907 Hague Regulations.[135] The superfluous injury rule prohibits weapons designed to increase the

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[126] *Supra* note 124.
[127] Patrick Dumberry, *Incoherent and Ineffective: The Concept of Persistent Objector Revisited*, 59 INT'L AND COMPAR. L. Q. 779 (2010).
[128] Second Review Conference, *supra* note 75.
[129] Nuclear, *supra* note 54 at 478. This definition is by no means binding as international law. Still, it is a more restrictive definition. If a form of synthetic biology is not included in this definition of a toxin it would not otherwise be considered a toxin.
[130] OFF. OF GEN. COUNS. DEP'T OF DEF., DEPARTMENT OF DEFENSE LAW OF WAR MANUAL 28-29, 1163 (2016 ed. 2015).
[131] Johnson, *supra* note 32.
[132] ICRC, Protocol Additional to the Geneva Conventions of 12 August 1948, and relating to the Protection of Victims of International Armed Conflicts (Protocol 1) art. 35(2), June 8, 1977, https://ihl-databases.icrc.org/applic/ihl/ihl.nsf/Article.xsp?action=openDocument&documentId=4BEBD9920AE0AEAEC12563CD0051DC9E.
[133] *Id.*
[134] Johnson, *supra* note 32.
[135] OFF. OF GEN., *supra* note 130, at 357-58.

injury or the suffering of an individual "beyond that justified by military necessity."[136] In application, this could mean one of two different things. First, the suffering caused by using the weapon has no military advantage. The other would be that the weapon is disproportionate to any benefit that is militarily expected from the use of the weapon.[137] This does not mean that weapons that cause suffering, death, or even horrible injury are prohibited; instead, such destructive weapons would only be prohibited when the resulting injury, due to the use of the weapon, was not necessary to the military mission at hand.

The second rule that comes from customary international law prohibits inherently indiscriminate weapons and is a product of the ideas of distinction and proportionality.[138] As noted above, the United States has noticed this particular aspect as being important to the weapons covered in the Biological Weapons Convention.[139] This norm has come to be part of customary international law as well. This rule is again reflected in the 1977 Additional Protocol I to the Geneva Conventions, of which the United States is not a part. Article 51(4)(b) defines and prohibits indiscriminate attacks as attacks that are not "directed at a specific military objective," "employ a method or means of combat which cannot be directed at a specific military objective," and have an uncontrollable effect.[140] This rule does not prohibit weapons that have an incidental impact that is anticipated; instead, such destructive weapons are only prohibited when the effect of the weapon is unnecessarily excessive compared to the military advantage gained by using the weapon.

At this point in the paper, the goal has been to define the applicable law that needs to be considered with synthetic biological weapons. Therefore, in summary, a weaponized biological agent or toxin is prohibited by the Biological Weapons Convention when it falls under the above definitions. In addition, a synthetic biological weapon may be prohibited by the superfluous injury rule or the inherently indiscriminate rule. The next part of the paper shifts its focus and seeks to define and explain the different theories of synthetic biology. The application of the law to synthetic biology will happen primarily in Part III of this paper.

II. SYNTHETIC BIOLOGY

In this Part, this paper does not intend to go into a complete history or explanation of the technologies of synthetic biology but instead intends to break down the top-down and bottom-up approaches traditionally used in the discipline. With that breakdown, this paper will go into the important components of the synthetic biology bottom-up approach—mainly biomimetics, CRISPR/Cas9 genome editing, and nanotechnology.

A. Top-Down

In its basic form, the top-down approach to synthetic biology uses genetic engineering techniques to give a living cell new function. This approach has the advantage of using all the components of a host cell, making use of co-factors, metabolites, transcription pathways, and other components, and adjusting them to make the cell more functional or have specific desirable characteristics.[141] More straightforwardly, what the top-down approach does is start

[136] Written Statement of the Government of the United States of America 28-29, June 20, 1995, I.C.J.
[137] OFF. OF GEN., *supra* note 130, at 359.
[138] Protocol, *supra* note 132, at Art. 51(4).
[139] *Nuclear*, *supra* note 54, at 477-78.
[140] Protocol, *supra* note 132, at Art. 51(4).
[141] Mark A. J. Roberts et. al., *Synthetic Biology: Biology by Design*, 159 MICROBIOLOGY 1219 (2013).

with an "unmodified or simplified cell" and add foreign elements or modules.[142] It takes what nature has given and optimizes it or makes it more efficient. "Th[is] might consist of genes encoding proteins that synthesize a molecule of interest in a sort of microscopic assembly line, or that causes a detectable change in response to an incoming signal."[143]

Currently, this is the most common approach in most technological advances of synthetic biology. However, as discussed below, top-down synthetic biology is prohibited by the Biological Weapons Convention when trying to make weapons. This is because the top-down approach requires a living cell as a base point. That living cell is then modified and remains biological. For this reason and because top-down synthetic biology uses something already living, any use of this form of biology would be prohibited as a biological weapon under the Biological Weapons Convention.

B. Bottom-up

It is important to note right off that the bottom-up approach to synthetic biology is inherently more challenging than the top-down approach because it creates something completely new and does not modify an existing organism.[144] The bottom-up approach creates new biological systems by combining non-living biomolecular components. Most commonly, it is used to create an artificial cell. The aim of bottom-up synthetic biology is to construct cell-like systems by starting with molecular building blocks.[145]

This approach remains less common and has been considered an unlikely possibility for a long time. Nevertheless, as technology has progressed, there have continued to be advancements in bottom-up synthetic biology—which comes with its threats. The bottom-up approach, unlike the top-down, starts from scratch, creating something entirely new that may not be able to be categorized as living. However, a subset of bottom-up synthetic biology—such as biomimetics, CRISPR/Cas9 genome editing, and nanotechnology—will be particularly troubling to the Biological Weapons Convention.

1. Biomimetics

One of the best ways to describe the science of biomimicry is that it is a type of bioinspired design that focuses on "learning from and emulating" living systems.[146] This focus essentially is on function, trying to "work like" nature and not necessarily trying to "look like" nature.[147] The main goal of this science is to create new technologies based on what nature is.[148] While it is not about extracting, harvesting, or domesticating what nature has provided.[149] In essence, biomimetics is the use of non-biological materials that mimic biological effects.[150] This science has a lot of potential benefits, and generally, the research in this field is focused

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[142] *Synthetic Biology: Life, Remixed*, MAX-PLANCK-GESELLSCHAFT (Sept. 20, 2014), https://www.mpg.de/8219292/synthetic_biology#:~:text=One%20remarkable%20achievement%20in%20top,emptied%20of%20its%20own%20DNA.
[143] *Id.*
[144] *Id.*
[145] Hannes Mutschler et. al., *Special Issue on Bottom-Up Synthetic Biology*, 20 CHEMBIOCHEM 2533 (2019).
[146] *What is Biomimicry?*, BIOMIMICRY INST., https://biomimicry.org/what-is-biomimicry/ (last visited Oct. 31, 2022).
[147] *Id.*
[148] *Id.*
[149] *Id.*
[150] Johnson, *supra* note 32.

on finding solutions to environmental problems.[151] The general idea is that nature is the best example of renewability and, therefore, the best "artificial" renewable technologies would be those that mimic nature.[152] Of course, these such uses are not what this paper intends to spotlight. This paper intends to discuss this science's potential use for more malign purposes in biological weapons. Such purposes could take the form of fully non-biological systems that mimic current deadly biological agents that could readily harm humans, animals, and plants.

2. CRISPR/Cas9 Genome-Editing

In general, genome editing includes a group of technologies that allows one to change an organism's DNA.[153] Using genome editing, genetic material can be added, removed, or altered at specific locations in an organism's genome, effectively changing that organism's functions and characteristics.[154] CRISPR/Cas9 is perhaps the most well-known genome editing technology because it is "faster, cheaper, more accurate, and more efficient than other genome editing methods." [155] CRISPR/Cas9 is short for clustered regularly interspaced short palindromic repeats and CRISPR-associated protein 9.[156] This technology was adapted from a naturally occurring genome editing system that some bacteria use in their immune defense.[157] This science is mainly interested in the prevention and treatment of human diseases.[158] Current research includes therapy for single gene disorders like cystic fibrosis, sickle cell disease, and even more complicated diseases like cancer, heart disease, and HIV infections.[159] While most changes to cells are done to somatic cells that would not pass on the changes to the DNA to another generation of cells, germline cells could also be edited, which would pass on newly edited genes to the next generation of cells.[160] Such positive uses are not the focus of this paper but instead the potential use as a weapon that could bypass the BWC. Such fear even led the former director of the US National Intelligence, James Clapper, to conclude that gene editing should be included in a list of threats that are considered "weapons of mass destruction and proliferation."[161]

3. Nanotechnology

The science of nanotechnology encompasses any science, engineering, and technology done on the nanoscale.[162] The Nanoscale is considered to be one to one hundred nanometers in length.[163] Today, nanoscience and nanotechnology in practice include seeing and controlling

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[151] *What is Biomimicry?*, *supra* note 146.
[152] *Id.*
[153] *What Are Genome Editing and CRISPR-Cas9?*, MEDLINEPLUS, https://medlineplus.gov/genetics/understanding/genomicresearch/genomeediting/ (last visited Oct. 31, 2022).
[154] *Id.*
[155] *Id.*
[156] *Id.*
[157] Napisa Pattharaprachayakul et. al., *Current understanding of the cyanobacterial CRISPR-Cas systems and development of the synthetic CRISPR-Cas systems for cyanobacteria*, 140 ENZYME AND MICROBIAL TECH. 1 (2020). This idea is very similar to biomimetics.
[158] *What Are Genome Editing*, supra note 153.
[159] *Id.*
[160] *Id.*
[161] Antonio Regalado, *Top U.S. Intelligence Officials Calls Gene Editing a WMD Threat*, MIT TECHNOLOGY REVIEW: BIOTECHNOLOGY (Feb. 9, 2016), https://www.technologyreview.com/2016/02/09/71575/top-us-intelligence-official-calls-gene-editing-a-wmd-threat/.
[162] *What is Nanotechnology?*, NAT'L NANOTECHNOLOGY INITIATIVE, https://www.nano.gov/nanotech-101/what/definition (last visited Oct. 31, 2022).
[163] *Id.* Needless to say, this is very small.

individual atoms and molecules with manmade technologies.[164] The applications of this science are incredibly diverse, including helping conventional devices run better, molecular self-assembly, and the development of new materials with dimensions on the nanoscale that can direct the control matter on an atomic level.[165] This remains a complicated science with many applications and implications for the Biological Weapons Convention. As discussed below, some nanotechnologies are non-biological, and thus the BWC may not cover devices like aerosolized nanobots.

With the majority of this paper thus far giving viable information into the applicable law and the science that is being discussed, Part III's primary goal will be to apply the law and try to answer whether or not the Biological Weapons Convention or customary international law prohibits the use of synthetic biology in weapons.

III. SYNTHETIC BIOLOGY: THE BIOLOGICAL WEAPONS CONVENTION AND INTERNATIONAL LAWS

This part of the paper will start by analyzing synthetic biology's top-down approach, specifically whether it fits within the Biological Weapons Convention. This paper will then discuss synthetic biology's bottom-up approach, how it falls within the Convention, and whether other international laws prohibit it from being used as a biological weapon. Going into more detail specifically about how these laws cover biomimetics, CRISPR/Cas9 genome sequencing, and nanotechnology. As discussed below, the Biological Weapons Convention covers and prohibits synthetic biology's top-down approach. Still, the Convention nor other international laws prohibit the bottom-up approaches of biomimetics, CRISPR/Cas9 genome-editing genome editing, and nanotechnology.

A. Top-down Synthetic Biology and the BWC

The biological weapons convention covers and prohibits synthetic biology's top-down approach because it reworks preexisting biological systems, giving living cells or organisms new functions but remaining biological in nature. In determining whether or not the Convention's scope covers the top-down approach to synthetic biology, it will be necessary to first look at the second review conference of the Biological Weapons Convention.

As stated above, the second conference sought to define what was a biological agent and, thus, what is covered under the convention.[166] At the Conference, a definition was declared that covered what a biological agent is.[167] Even though it is not technically legally binding on States because it was not part of a formal amendment and revision process of the convention, it has become customary international law.[168] The resulting definition of a biological agent includes "natural or artificially created or altered microbial of other biological agents or toxins whatever their origin or method or production."[169] The goal of this declaration was to make sure that the Biological Weapons Convention covered all synthetically created

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[164] *Id.*
[165] Alexey Belkin et al., *Self-Assembled Wiggling Nano-Structures and the Principle of Maximum Entropy Production*, 5 SCI. REP. 8323 (2015); Carlos M. Portela et al., *Extreme Mechanical Resilience of Self-assembled Nanolabyrinthine Materials*, 117 PNAS 5686 (2020).
[166] Second Review Conference, *supra* note 75.
[167] *Id.*
[168] *Supra* Part I.
[169] Second Review Conference, *supra* note 75.

bacteria that could be developed in the future.[170] What is being prohibited here is still fundamentally biological and not something else.[171]

The word "altered" is particularly indicative of the BWC's applicability to top-down synthetic biology. The foundation of synthetic biology is the altering of preexisting cells or biological systems. The top-down approach is taking something biological, keeping it biological, and just changing it to make it function better or more efficiently. In the case of biological weapons, efficiency might mean more deadly or even more transmissible. Nonetheless, an altered biological agent is still biological. Therefore, it will be prohibited by the Biological Weapons Convention because the second review conference's definition is customary international law. Because the Convention would prohibit synthetic biology's top-down approach as a biological agent, there is no need to determine if it would be prohibited as a toxin as well.

When enacted, the Biological Weapons Conventions' scope was not completely clear. Over time subsequent review conferences defined that scope, especially during the second review conference. Even though not binding, the second review conference declaration has become customary international law. Under this definition of biological agent, top-down synthetic biology, as a biological weapon, is prohibited by the Biological Weapons Convention because it does not create something new but rather "alters" preexisting cells and biological systems.

B. Bottom-up Approach and the BWC

Although there might be some aspects of synthetic biology's bottom-up approach that are prohibited by the Biological Weapons Convention and other international laws, there are particular applications of the approach—like biomimetics, CRISPR/Cas9 genome editing, and nanotechnology—that are not prohibited by international law. To understand whether or not the bottom-up approach is prohibited, the BWC and other international laws will need to be broken down into even greater detail.

As stated above, after the Biological Weapons Convention's second review conference, the scope of the Convention included biological agents that were synthetically created or altered. This inclusion has effectively become part of the convention through customary international law; however, this is not the only customary international law needed in this analysis. The additional customary law might go beyond the BWC but is relevant to understand because it is important to know the additional holes in international law. It is important to realize that any weapon that, if developed, would still be subjected to the law of armed conflict.[172] As described above, the two additional aspects of customary international law that will be important to know are the superfluous injury rule and the inherently indiscriminate rule.[173]

Generally speaking, many applications of bottom-up synthetic biology likely violate the superfluous injury rule. It is not hard to imagine creating some virus using either the top-down or bottom-up approach that would cause unnecessary and erroneous. On the other hand, of course, there are straightforward ways that the use of bottom-up synthetic biology could be

[170] Johnson, *supra* note 33.
[171] This distinction will be important later in the paper when discussing bottom-up synthetic biology.
[172] OFF. OF GEN. COUNS. DEP'T OF DEF., DEPARTMENT OF DEFENSE LAW OF WAR MANUAL 28-29, 1163 (2016 ed. 2015).
[173] Johnson, *supra* note 32.

designed and used that would not violate this rule. Instead, some uses of synthetic biology may be designed to be more humane than the current weapons being used in military tactics today. Such weapons created through synthetic biology might be designed in a way that could incapacitate a target, allowing them to make a full recovery instead of causing any permanent physical injury or death. This function could come in the form of impairing physiological tasks that do not threaten life, like "reducing the ability of enemy soldiers to stay awake, maintain balance or perform basic motor skills."[174] Even if created in a way to kill an enemy combatant, bottom-up synthetic biology—especially biomimetics, CRISPR/Cas9 genome editing, and nanotechnology—can be used in a way that does not violate the superfluous injury rule.

It is easy to recognize why, when States sought to prohibit the use of biological weapons, they were concerned with non-discriminatory biological weapons. Especially now that the world is exiting the COVID-19 pandemic that lasted at least two years and has killed, as of November 2022, over six and a half million people.[175] If any virus was non-discriminate, COVID-19 would undoubtedly qualify. With COVID-19, the harm a non-discriminate biological agent can inflict is readily seen. Such a weapon potentially could not be contained and cause vast unintended destructions. Of course, COVID-19 might be on one end of the spectrum. Still, it is an excellent example of why biological weapons are generally prohibited because they potentially harm unexpected and innocent populations. This harm remains a good reason for the banning of biological weapons. There are many applications of bottom-up synthetic biology that this rule would still prohibit. The creation of a virus from the ground up through synthetic biology that affected populations generally without much discrimination among individuals, especially enemy combatants and civilians, would be prohibited by this rule. Such weapons created through synthetic biology might be made in a way that could be programmed to target only a specific predetermined population, like targets with particular traits or prescriptive attributes of enemy soldiers.[176] This way, a State that deployed such a weapon would not be releasing it on the entire human population, but the attack would remain isolated, and in some instances, could be targeted to take down only one person. Even if created to affect a broader population, bottom-up synthetic biology—especially biomimetics, CRISPR/Cas9 genome editing, and nanotechnology—can be used in a way that does not violate the inherently indiscriminate rule.

In the next section of this part of the paper, the focus will be on whether biomimetics, CRISPR/Cas9 genome editing, and nanotechnology fall within the Biological Weapons Convention definition of a biological agent and whether they would be prohibited under other customary international laws. In this analysis, instead of speaking to each of these synthetic biology technologies generally, this paper will discuss specific examples or applications of the technology and whether it could bypass the current prohibitions and, therefore, potentially be used as a biological weapon lawfully. Of course, it is important to remember that each example is a potential technology, being a theoretical possibility and not an actual weapon already created and used.

1. Biomimetics

Many do not realize that biomimicry is everywhere; it is seen almost daily. It can be seen while watching the Olympics with swimmers' swimsuits designed like sharkskin or while

[174] Johnson, *supra* note 32.
[175] *Coronavirus Death Toll*, WORLDOMETERS, https://www.worldometers.info/coronavirus/coronavirus-death-toll/ (last visited Oct. 31, 2022).
[176] Johnson, *supra* note 32.

swimming in a frigid ocean, and how a wet suit is very similar to the thick layer of blubber that beavers have to keep them warm.[177] Each of these examples is of humans taking advantage of something seen in the biological world, making it no longer biologically based and using it in a similar way to how it was used in nature. Following this line of thinking, it is clear that the biomimicry of a new novel virus or bacteria that is non-biologically created but created with non-biological materials and designed to affect selected populations would not be covered by the Biological Weapons Convention or other international law.

The second review conference's definition of biological agents prohibits "artificially created or altered" biological microorganisms or agents, no matter the origin, method, or production.[178] As stated above, the critical element here is that it still needs to be biological. The definition still prohibits a large swath of bottom-up synthetic biology. This is because it prohibits the creation of biologically based synthetically created organisms or agents. Nevertheless, by definition, biomimetics does not concern the creation of biologically based microorganisms; instead, it is learning from and then emulating living systems.[179] Biomimetics simply are non-biological. The Biological Weapons Convention would not cover the creation of a non-biological organism that mimics that of a virus or bacteria and still cause disease or death.

The prohibition of a novel biomimetic cell that mimics a virus or bacteria would then depend on customary international law. First, the superfluous injury rule and then the inherently indiscriminate rule. Under the superfluous injury rule, a biomimetic cell could be created in a way that does not cause unnecessary injury or suffering to a target. Some viruses that infect humans do not cause much suffering or injury to individuals that catch them. One example is a condition called labyrinthitis and vestibular neuritis, which is the "inflammation of the inner ear and the nerve connecting the inner ear to the brain."[180] This condition causes a sudden and constant spinning sensation that can disable a person requiring that person to bed rest.[181] This would be an effective result in warfare that would not cause excessive suffering or injury that can be caused by viruses like with influenza and herpes. This is not a perfect example because not every herpes or flu infection causes labyrinthitis and vestibular neuritis. Still, it is descriptive to show that such a virus has the potential to cause something so debilitating without causing excessive suffering or injury. A biomimetic cell or organism could mimic such functions to cause similar effects in enemy targets. Because a biomimetic cell can be designed to not cause unnecessary injury or suffering, it would not be prohibited by the superfluous injury rule.

The inherently indiscriminate rule would also not preclude biomimetic cells or agents because these biomimetic viruses or bacteria could be designed in a way to cause an effect only on specific groups. Such a virus or bacteria could be coded in a way to only affect a particular group of people with a similar characteristic or even one individual. This kind of targeting is not too common in nature but can be seen in a general sense in leprosy. Leprosy is caused by

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[177] Shea Gunther, *8 Amazing Examples of Biomimicry: How Designers and Engineers Look at Nature for Solutions*, TREEHUGGER (July 21, 2022), https://www.treehugger.com/amazing-examples-of-biomimicry-4869336.
[178] *What is Biomimicry?*, *supra* note 146.
[179] *Id.*
[180] *Labyrinthitis and Vestibular Neuritis*, BETTERHEALTH CHANNEL, https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/labyrinthitis-and-vestibular-neuritis (last visited Oct. 31, 2022).
[181] *Id.*

a bacteria called Mycobacterium leprae.[182] Depending on certain gene variations affecting one's immune system, leprosy will develop differently in different people.[183] This means that those with specific genes could contract the leprosy disease while others without those genes would not. This example, of course, is very broad, but the principles could be applied to biomimicry on a more specific level. Knowing the genetic makeup of an individual or group of enemy combatants could allow biomimetic viruses and bacteria to target those particular groups or individuals. Because this would be discriminatory, it would not be prohibited by the inherently indiscriminate rule.

Biomimicry, by definition, is non-biological, it mimics something biological, but itself is not biological. So, a biomimetic virus or cell would not be covered by the Biological Weapons Convention. In addition, because it could be created in a way that does not cause unnecessary suffering and injury and can be discriminative, it is also not prohibited under customary international law.

2. CRISPR/Cas9 Genome Editing

CRISPR/Cas9 genome editing is a relatively new technique, with CRISPR itself being discovered in 2005 and has only grown in popularity since.[184] Variants of the CRISPR technique have been developed, but Cas9 seems to be among the most popular for its precision and speed.[185] Because of this, CRISPR/Cas9 is the form of genome editing that this paper will be looking at specifically. Most of the current concerns over this new technology are the fear that it could be used to edit the genomes of current pathogens, making them more viral and deadly.[186] This, of course, would be more of a top-down synthetic biology approach. The form of gene editing that this section is concerned with is CRISPR/Cas9 being deployed, as itself, into a weapon that could be used to "disrupt the essential genes in humans, animals, and plants."[187] Because it can be made with synthesized enzymes that are non-biological and designed to target specific genome sequences, it is not covered by the Biological Weapons Convention or customary international law.

Though it is true that, by definition, CRISPR/Cas9 is a tool that edits biological genomes, the system elements that are part of CRISPR/Cas9 may not necessarily need to be biological. Though it is derived and discovered from bacteria—the mechanisms of the process of gene editing—the actual units used could be made up of artificial components.[188] Such a CRISPR weapon would deploy the gene editing devices to a target that could then edit the genes of the target. The editing could potentially biologically harm humans, plants, or animals, or it could kill them by drastically changing their DNA to make cells shut down. In the context of the Biological Weapons Convention, the BWC only prohibits weapons that are biological. CRISPR/Cas9 would be editing something biological, but it itself is not. The BWC does not regulate effects; it only regulates the agents that cause the effects. Here the effect alters

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[182] *Leprosy: Causes*, MEDLINEPLUS, https://medlineplus.gov/genetics/condition/leprosy/#inheritance (last visited Oct. 31, 2022).
[183] *Id.*
[184] Daniel Willingham, *A Fresh Threat: Will Cas9 Lead to CRISPR Bioweapons?*, J. BIOSECURITY, BIOSAFETY, AND BIODEFENSE L. (May 9, 2018), https://www.degruyter.com/document/doi/10.1515/jbbbl-2018-0010/html#Harvard.
[185] *Id.*
[186] *Id.*
[187] Fangzhong Wang & Weiwen Zhang, *Synthetic Biology: Recent Progress, Biosafety and Biosecurity Concerns, and Possible Solutions*, 1 J. BIOSAFETY AND BIOSECURITY 22 (2018).
[188] Pattharaprachayakul, *supra* note 157.

something biological, but the cause of that effect is not biological; thus, because the agent here is the CRISPR/Cas9 system that could be created in a non-biological way, it is not covered by the Biological Weapons Convention's second review conference definition of a biological agent.

The superfluous injury rule will not prohibit the use of CRISPR/cas9 genome editing as a biological weapon because it can be used in a way that either quickly causes death or causes damage to cells that regenerate and do not pass on genome changes, and thus, would have a limited effect. One way that CRISPR could be utilized as a weapon could be inhaled into the lungs. From there, the CRISPR agents would target the lung cells, editing their DNA, and leading to lung failure, with the target's death coming quickly. This death would not be drawn out over a long period and thus would not be unnecessary suffering, possibly a quicker death than other forms of warfare used today, especially because of how fast the Cas9 genome editing works. Another example would be a more debilitating effect on a target's body. In this case, the CRISPR system would be designed to target muscle cells. Doing this could weaken the muscles leaving the target unable to move. This form of harm could potentially not be permanent because it would affect somatic cells that do not pass on the genetic alteration to a later generation of the cell. Specifically, when a muscle cell is damaged, they get stimulated to divide and is then regenerated and repaired.[189] This allows a target to make a full recovery. The use of CRISPR technology in this way would not cause unnecessary suffering and injury because such suffering and injury would not kill the person and only last for a short time. In both cases, using CRISPR/Cas9 does not cause unnecessary injury or suffering, so the superfluous injury rule would not prohibit it.

The inherently indiscriminate rule would also not prohibit using CRISPR/Cas9 genome editing as a weapon because it could be targeted for specific genome sequences found only in certain populations or groups. The way that the CRISPR technology could be designed is for it to target and edit certain genes that contain a specific genomic sequence. This specific targeting could be a group or a person that would have this sequence which Cas9 is known to be able to do.[190] Additionally, this use of the CRISPR technology would only affect those initially infected by the weapon because it would not replicate and reproduce as a bacteria or virus would. Meaning it would not be contagious and passed on to potentially unexpected victims down the road. Therefore, in using CRISPR/Cas9 genome editing by targeting specific genomic sequences and not being contagious, the technology would be discriminatory and not prohibited by the inherently indiscriminate rule.

The use of CRISPR/Cas9 genome editing might affect biology—specifically the very DNA of a target—but despite the effect, the agent causing the effect would be non-biological and not prohibited by the Biological Weapons Convention. In addition, because it could affect targets in a way that would cause quick death or cause debilitation that would last for a short time and would not have unexpected consequences to a greater population, it is not prohibited under international law.[191]

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[189] UNIV. OF LEEDS: THE HISTOLOGY GUIDE, *Muscle: Muscle Regeneration*, https://www.histology.leeds.ac.uk/tissue_types/muscle/muscle_regeneration.php#:~:text=Muscle%3A%20Muscle%20regeneration&text=When%20the%20muscle%20is%20damaged,muscle%20fibres%20themselves%2C%20cannot%20divide (last visited Oct. 31, 2022).

[190] *What Are Genome Editing*, supra note 153.

[191] One interesting point not being discussed in detail here in this paper is that the Biological Weapons Convention and the law of armed conflict apply only to States. In the likelihood that the technologies referenced

3. Nanotechnology

When thinking about nanotechnology, visions of Tony Stark as Iron Man, Star Trek, and other science fiction creative works come to mind. Though at times, the thought of nanotechnology might have been a thing only for science fiction, nanorobotics or nanobots are becoming more of a reality of our day.[192] Nanobots, in essence, are robots that are near the scale of a nanometer.[193] Such nanobots could be aerosolized and inhaled, from there entering into a target's bloodstream, there causing damage to an infected individual. Those nanobots could be made so that they act like a virus, yet do not cause harm to any infected with them until they reach the individual it was programmed with specific DNA sequences to kill or wound.[194] These nanobots would be created without biological material, and possibly even 3D printed.[195] Nanobots are not biologically based and can be programmed to cause harm to specific individuals; therefore, they would not be prohibited by the Biological Weapons Convention or customary international law.

Although some forms of biotechnology can be biologically based, that is not the case with nanobots. Thus, these incredibly small robots are neither created nor altered biological agents as defined in the second review conference of the BWC. Judge Evan J. Wallach of the United States Court of International Trade claims that the Biological Weapons Convention is sufficient to prohibit the use of nanotechnology as a weapon, stating, "development of the ban, its culmination in the Geneva Protocol, and its incorporation into the BWC . . . leave no genuine room for play in any sort of legitimate, good faith argument . . . whatsoever for any . . . type of . . . biological nano weapons."[196] Yet after stating this, Wallach suggests that the BWC should be modified to make sure that States Parties intend to cover any forms of nano weapons or other forms of analogous weaponry.[197] Although Judge Wallach's good faith arguments are somewhat persuasive, his contextual analysis of the Biological Weapons Convention misses the fundamental bases of the convention, that being that the agent the Convention bans is biological. Though his analysis does seem to apply to some forms of nanomimicry, it would not apply per se to nanobots. Therefore, the creation of a non-biological nanorobot that could cause harmful effects on humans is not covered by the Biological Weapons Convention because they are not biologically based.

Under the superfluous injury rule, nanobots could be prohibited if they cause unnecessary injury or harm. However, this issue could be analyzed similarly to that of biomimicry and gene editing because of the way that the nanobots could be programmed to cause quick death or simply incapacitate. Nevertheless, some ethical issues might be presented; whether or not a nanobot that debilitates a target and that target then recovers could then be used again to cause the same effect at a later point. Though this situation might be concerning

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here become illegal—and the chances of that probably will become more and more likely as technology develop—that still would not necessarily apply to non-State actors like terrorist groups. The CRISPR/Cas9 genome editing technology, in particular, would be of concern. This technology is becoming increasingly available and, with time, could be developed with unsophisticated hands and materials like what terrorist groups could readily obtain. So, although not discussed much in this paper, the policing of such a transformative technology in the future, even if prohibited as a weapon, might still be hard to prohibit on non-state actors.

[192] NATHAN A. WEIR ET AL., A REVIEW OF RESEARCH IN THE FIELD OF NANOROBOTICS 8 (2005).

[193] *Id.*

[194] These technologies are very similar to that depicted in a recent Hollywood film. *See* James Bond: No Time to Die.

[195] Prof. Sung-Hoon Ahn, *Micro Robot by 3D Printing (Seoul National University, Korea),* YOUTUBE (Jan. 30, 2012), https://www.youtube.com/watch?v=f4IavKUzK2c.

[196] Wallach, *supra* note 46, at 956.

[197] *Id.*

and ethically hard to comprehend, it would not need to cause unnecessary injury or suffering if the use was limited to military operations. Because of the programmability of the nanobots, the harm could be done when necessary and proportional to a military mission and thus would not cause unnecessary injury or suffering and would not be prohibited by the superfluous injury rule.

The inherently indiscriminate rule would not preclude nanobots because, although they could spread to everyone non-discriminatively, they would only cause harm or death to specifically programmed individuals. There might be concerns about the spread of the nanobots because they would be infecting almost everyone, spreading as a virus might. However, as long as they do not harm those in whom the nanobots remain dormant in and only affect those targeted explicitly by the technology, this would be a discriminatory weapon. Such nanobots could be designed so that it is coded only to harm a particular group of people with similar characteristic or even one individual. Knowing the genetic makeup of an individual or group of enemy combatants could allow nanobots to target those specific groups or individuals. Because this would be discriminatory, it would not be prohibited by the inherently indiscriminate rule.

With the conclusion that each of the above technologies is not a biological agent nor prohibited by other international laws, there remains the last question as to whether they are toxins as defined under the Convention. Because the analysis of whether biomimetics, CRISPR/Cas9 genome editing, and nanotechnology are toxins would be the same for each, this next section of Part III will couple all three of the technologies together instead of separating that analysis into different sections.

C. Biomimetics, CRISPR/Cas9 Genome Editing, and Nanotechnology as Toxins

For each technology—biomimetics CRISPR/Cas9 genome editing, and nanotechnology—they would not be toxins as defined in the convention. Under the definition—as excepted earlier in this paper—a toxin is a chemically based toxic by-product of biological organisms.[198] This includes synthetically created toxins that resemble chemical agents.[199] Fundamentally, what is evident by this definition is that toxins are chemically based as a toxin. The reason the BWC covers them is likely because some toxins can be extracted from biological microbials. Nevertheless, the toxins themselves are still chemically based. This fact would still prohibit the outright bottom-up synthetic creation of toxins that strongly resemble naturally occurring biological toxins. However, the technologies discussed in this paper are not chemically based; instead, they are systems created from the ground up that are non-biological. They are not chemically based in the same way that a toxin is because toxins are simple chemical molecules that can cause harm solely based on what they are. At the same time, the technologies discussed are biological-like systems that cannot be simplified to a chemical formula.[200] Because technologies like biomimicry, CRISPR/Cas9 genome editing, and nanotechnology are complex systems and not chemically based, they are not toxins under the definition of the Biological Weapons Convention.

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[198] Nuclear, *supra* note 54, at 478.
[199] *Id.*
[200] This is not to say that chemical toxins are simple, but they are considered simple compared to much more complicated bacterial cells that discharge such toxins.

CONCLUSION

The Biological Weapons Convention does cover and therefore prohibit synthetic biology's top-down approach under the second review conferences definition of a biological agent, but neither the Convention nor customary international law prohibits aspects of the bottom-up approach—more specifically, biomimetics, CRISPR/Cas9 genome-editing genome editing, and nanotechnology—because top-down synthetic biology reworks preexisting systems, while in contrast, bottom-up synthetic biology may be used to weaponized non-biological agents that can alter biological humans, plants, and animals that is discriminatory and does not cause superfluous injury.[201]

In solving this apparent hole in the convention, tweaking the second review conference's definition of biological agents could easily change the Convention to cover bottom-up synthetic biology. This could be done in a subsequent review conference, and such changes should be made preemptively before these technologies develop further. The technologies of biomimetics, CRISPR/Cas9 genome editing, and nanotechnology are all on the edge of what could be considered life. However, as the definition of viruses was categorized as biological to be covered by biological weapons bans, so can these technologies be included under the Biological Weapons Convention so that they do not cause unnecessary and irreversible harm.

[201] Not discussed in this paper but would remain a concern of international law even if these forms of synthetic biology became prohibited under the Convention or other forms of international law would remain the problem in the policing these technologies. That is, the BWC prohibits not only the use of biological weapons but also the development and production of them. Nevertheless, it has an exception prohibiting this if it is not used to promote health. Here each of these technologies—as mentioned above—have very good uses that could promote the health and prosperity of citizens of a state. This exception means that, unlike the horrible accident that occurred in Russia that was mentioned at the beginning of this paper, where the Soviet Union had no excuse for developing Anthrax in the factory, States will have actual excuses to use these and develop the technology that would be excluded from the Convention.