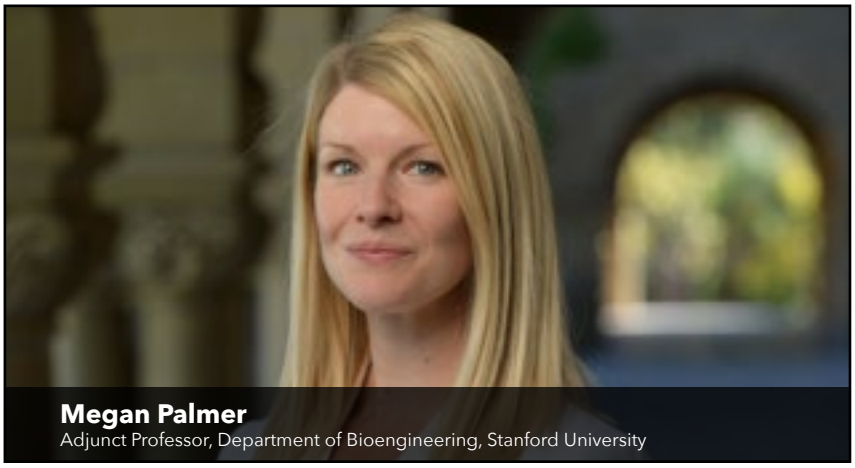
Discussion Guide for "Biosecurity"

a video interview with Dr. Megan J. Palmer,
Center for International Security and Cooperation



Organizing Questions

- What is biosecurity?
- What are biological threats?
- How can we prevent and prepare for biological threats?
- How can citizens engage with biosecurity?

Summary

In this video, Dr. Megan J. Palmer discusses the pandemic brought about by the 2019 novel coronavirus and how it has changed our lives. Dr. Palmer also introduces various types of biological threats and how we can prevent, prepare for, and minimize the risk of such threats. Katherine Healzer, a high school intern with Dr. Palmer's group, shares some ideas on how to engage with biosecurity as community members.

Objectives

During and after viewing this video, students will:

- gain a general understanding of biosecurity;
- learn about different types of biological threats; and
- examine how to prevent and prepare for biological threats.

Materials

Handout 1, *Video Notes*, pp. 4–5, 30 copies
Handout 2, *Biological Weapons Convention*, p. 8, 30 copies
Handout 3, *Engaging in Biosecurity*, p. 9, 30 copies
Answer Key, *Video Notes*, pp. 6–7
Teacher Information, *Video Transcript*, pp. 10–16
Video, "Biosecurity," online at https://youtu.be/mr-c5O1RdbM

Equipment

Computer with Internet access

Computers with Internet access (for student research on Day Two, and also on Day One if doing research in class and not as homework)

Computer projector and screen

Computer speakers

Teacher Preparation

Instructions and materials are based on a class size of 30 students. Adjust accordingly for different class sizes.

1. Preview Video, "Biosecurity."
2. Become familiar with the content of handouts, answer key, and teacher information.
3. Make the appropriate number of copies of the handouts.
4. Set up and test computer, projector, speakers, and video before beginning the lesson.

Time

Two full class periods

Procedures Day One

1. Explain to students that they will be viewing a short video that introduces biosecurity. Dr. Megan J. Palmer, Executive Director of Bio Policy and Leadership in Society at Stanford University, Adjunct Professor in the Department of Bioengineering, and Affiliate of the Center for International Security and Cooperation, is the main speaker.
2. Distribute one copy of Handout 1, *Video Notes*, and Handout 2, *Biological Weapons Convention*, to each student. Give students several minutes to read through the questions and defined terms on Handout 1 and Handout 2.
3. View the Video, "Biosecurity." If necessary, pause the video at various points to allow students to respond to the prompts on Handout 1.
4. Once the video has ended, give students several minutes to write their answers to the questions.
5. Organize students into six groups. Distribute one copy of Handout 3, *Engaging in Biosecurity*, to each student.
6. For homework (or in class), have students begin thinking about their responses and let them know that they will be sharing their responses in their groups. And let them know that they will share some of the responses with the class for discussion.

Day Two

1. Make computers available for student use and allow time for students to research and address the prompts on Handout 3 in their groups. Students may draw from personal experience, refer to all handouts, conduct research on the Internet, as well as use reference points made in the video to create their presentations.

2. Have each group present their findings to the class and as a class, elaborate and discuss any key points that stand out to the class.
3. Debrief as a class using the following wrap-up discussion questions:
   - What is biosecurity?
   - What are biological threats?
   - How can we prevent and prepare for biological threats?

Video Notes

You are about to watch a 17-minute video interview with Dr. Megan J. Palmer, Executive Director of Bio Policy and Leadership in Society at Stanford University, Adjunct Professor in the Department of Bioengineering, and Affiliate of the Center for International Security and Cooperation. In this lecture Dr. Palmer will discuss how biological threats shape our world, where different types of threats arise and what we can do to prevent and to prepare for them. Katherine Healzer, a high school intern with Dr. Palmer's group, will also share some ideas on how students can engage with biosecurity topics in their future studies and as members of their local community.

Use the space below to answer each question; you may want to take notes on another sheet of paper as you watch the video.

1. What is biosecurity?

2. How did the 2019 novel coronavirus, or SARS-CoV-2, transform how people live?

3. How is biology seen as both a threat and a tool to improve our lives?

4. Give two examples of previous pandemics that have threatened the world.

5. How do biological threats affect non-human forms of life?

6. What is the dual-use dilemma? Give one example of this.

7. According to Katherine, what are two things that students and community members can do to engage with biosecurity?

Reference: Defined Terms (in order of mention)

biosecurity—defined differently by a variety of different stakeholder groups; at a high level, it is about how we protect against biological threats

pandemic—an epidemic of an infectious disease that has spread across a large region, for instance multiple continents or worldwide, affecting a substantial number of people

biological threat—a biological agent or toxin, including naturally emerging infectious diseases or misapplication of biotechnology, with the potential to cause harm

dual-use dilemma—a trait of new knowledge and technologies that offer a promise for help, but also a potential for harm, e.g., the ability to reconstruct a pathogen so that it can be researched to develop defenses against potential pathogens of the future, which could be used for defensive research but could also be intentionally released to cause disease outbreaks

Biological Weapons Convention—a treaty of the United Nations that prohibits the development, production, acquisition, transfer, stockpiling and use of biological and toxin weapons

Video Notes

1. What is biosecurity?
   - *Biosecurity is defined differently by a variety of different stakeholder groups. At a high level, we are talking about how we protect against biological threats.*

2. How did the 2019 novel coronavirus, or SARS-CoV-2, transform how people live?
   - *Countries locked down and borders closed, shortages of common goods and fractured supply chains, people separated from their friends, families, and communities, businesses closing, rampant unemployment, the loss of people's livelihoods and of course millions of deaths with more to come*
   - *In the United States, there have been big changes: largest social spending programs in American history and a federal election conducted largely by mail*
   - *Transformations in the way people think about and go to work*
   - *Many more changes are still ongoing*

3. How is biology seen as both a threat and a tool to improve our lives?
   - *Biology is the fabric of the living world, and it's what we are made of; we are more vulnerable to biological threats than other types of threats. But we can also use biological knowledge and tools (e.g., vaccines) as a tool to protect us.*
   - *Biology can also be used for harm in the form of biological weapons.*
   - *Accidental leaks—research conducted to develop defenses against both SARS and anthrax both have a history of laboratory accidents. With SARS, those accidents resulted in several additional epidemics after the initial pandemic subsided.*

4. Give two examples of previous pandemics that have threatened the world.
   - *Bubonic plague or Black Death*
   - *Smallpox*
   - *1918 Spanish Influenza*

5. How do biological threats affect non-human forms of life?
   - *All living things—including those that we rely upon for food—can also be threatened by biological threats. Examples include the black-footed ferret, which is a critically endangered species and highly susceptible to Sylvatic Plague, and the American chestnut which was nearly wiped out due to fungal blight.*
   - *Many infectious diseases find reservoirs in animal populations, such as bats, which are a reservoir for several highly pathogenic viruses, including Ebola, SARS, MERS, and Nipah viruses.*

6. What is the dual-use dilemma? Give one example of this.
   - *A trait of new knowledge and technologies that offer a promise for help, but also a potential for harm*
   - *Reconstructed pathogens can be researched to develop defenses against potential pathogens of the future, but could also be released to cause disease outbreaks*
   - *Controversy around reconstruction of the 1918 influenza—researchers used tools of reading, writing, editing evolving DNA to synthesize and assemble an extinct virus and wanted to publish their methods; debate if sharing research of this nature makes us more secure or more vulnerable*

7. According to Katherine, what are two things that students and community members can do to engage with biosecurity?
   - *Global health security: do your part by getting vaccinated and sharing accurate information from reliable sources with others to help protect your communities*
   - *Form a community team or school club to learn about biosecurity and how you can help prepare for, respond to, and recover from public health threats*
   - *Study biology and biotechnology*
   - *Stay informed on new developments in the life sciences and biotechnology, and consider how they relate to issues in your local community*
   - *Participate as a team Member in iGEM, an international competition dedicated to the advancement of synthetic biology through fostering the values of community, collaboration, and security*

Biological Weapons Convention

The Biological Weapons Convention (BWC) prohibits the development, production, acquisition, transfer, stockpiling and use of biological and toxin weapons. It was the first multilateral disarmament treaty banning an entire category of weapons of mass destruction (WMD).

The BWC is a key element in the international community's efforts to address WMD proliferation and it has established a strong norm against biological weapons. The Convention has reached almost universal membership with 183 States-Parties and four Signatory States. The BWC itself comprises only of 15 articles. The key provisions, as outlined by the United Nations, are listed below:

Article	Provision
Article I	Undertaking never under any circumstances to develop, produce, stockpile, acquire or retain biological weapons.
Article II	Undertaking to destroy biological weapons or divert them to peaceful purposes.
Article III	Undertaking not to transfer, or in any way assist, encourage or induce anyone to manufacture or otherwise acquire biological weapons.
Article IV	Requirement to take any national measures necessary to prohibit and prevent the development, production, stockpiling, acquisition or retention of biological weapons within a State's territory, under its jurisdiction, or under its control.
Article V	Undertaking to consult bilaterally and multilaterally and cooperate in solving any problems which may arise in relation to the objective, or in the application, of the BWC.
Article VI	Right to request the United Nations Security Council to investigate alleged breaches of the BWC, and undertaking to cooperate in carrying out any investigation initiated by the Security Council.
Article VII	Undertaking to assist any State Party exposed to danger as a result of a violation of the BWC.
Article X	Undertaking to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and information for peaceful purposes.

Source: https://www.un.org/disarmament/biological-weapons/

Engaging in Biosecurity

Biosecurity isn't just the responsibility of scientists, lawmakers, and world leaders. It also depends greatly on social responsibility. As both Dr. Palmer and Katherine mentioned, with global health security we can do our part by seriously considering getting vaccinated and sharing accurate information from reliable sources with others to help protect our communities. Prior to the development of vaccines, practicing social distancing, wearing a mask, and washing our hands regularly were all things that people could do to help prevent the spread of COVID-19.

Think about how COVID-19 has transformed your life. Discuss amongst your group the following five points and choose some examples from your group to share with the class. If time allows, as a group choose one of the sample activities that are listed below the five points and complete as homework.

1. Ways that you have been engaged in biosecurity during the pandemic
2. Challenges that you faced during the pandemic
3. Some solutions you came up with to alleviate those challenges
4. If you think your community was prepared for the pandemic
5. What things can be done to better prepare for the next one

Group Homework

1. Develop a poster or webpage that highlights important ways to keep safe from COVID-19.
2. Develop an op-ed piece that highlights information from this lesson that focuses on ways to keep educational spaces safe.
3. Design two graphic stories that focus on hosting a large event: (1) hosting a large event without taking the risk of COVID-19 into consideration; (2) designing an alternative to the same event keeping the risk of COVID-19 in mind.
4. Write a response to Dr. Palmer's comment, "Biology is the fabric of the living world, and it's what we are made of—so we are vulnerable to biological threats in more ways that can be more complex than other types of threats. But we also are able to use biology as a tool to protect us."
5. Develop a one-page description of the dual-use dilemma that is accessible to high school students.

Video Transcript

On-screen text:
Biosecurity
a discussion with Megan Palmer & Katherine Healzer

On-screen text:
Megan Palmer
Adjunct Professor, Department of Bioengineering, Stanford University

Megan Palmer: Hi, my name is Megan Palmer. I am the Executive Director of the Bio Policy and Leadership Initiatives at Stanford University. I'm also an adjunct professor in the Department of Bioengineering and an affiliate of the Center for International Security and Cooperation. Today I'm going to talk to you about biosecurity. And I'm also joined by an intern with our group, Katherine Healzer. Hi Katherine!

On-screen text:
Katherine Healzer
High School Intern

Katherine Healzer: Hi Dr. Palmer! It's an honor to join you.

Megan Palmer: Thanks for being with us.

So, biosecurity. At a high level, what we're talking about is how we protect against biological threats. In this module we'll talk about how biological threats shape our world. We'll talk about different types of threats, what we can do to prevent and to prepare for threats, and also what you can do.

We are in the midst of a pandemic that has reminded us all of the power of biology to threaten our safety, our security, and our entire way of life. We're also reminded, as we are looking to take vaccines that help to protect us, of the importance of biological knowledge and technologies to protect against biological threat.

To understand this current pandemic and what we need to be prepared for in the future, it's important to keep these things in context. This is not the first pandemic we have faced. You'll see in this slide an example of some of the other pandemics of the past, including the Black Death—or the bubonic plague—and smallpox, that were even larger threats. And there's also concern that this might not be the worst we can face. There are other types of threats, not only from natural sources, but those that might be used intentionally, that might cause even more harm and disruption.

And when we're trying to keep these threats in context, it's also important to look beyond biology. If we compare the type of harm that is manifest through this pandemic with other types of human conflict—for instance, in World War I there was an estimated 16 million people who died, but in the same period of time there were about 50 million people who died of influenza. And so biological threats play a huge and potentially growing role in our global security.

You can look here across time at a few of these pandemics of the past, including, again, the Black Death from Yersinia Pestis was the biological agent or H1N1 influenza or COVID-19, which is a coronavirus. And while we have new types of tools to deploy in protecting against these threats, there's also increased human mobility and other types of factors that are making the challenge even harder.

Biological threats don't only involve and don't only threaten just humans. Many of these types of infectious diseases find reservoirs in animal populations. One example here is the bat that has been a reservoir for other types of infectious diseases that might spill over to humans. Other animals including those that we rely upon for some of our food as well as plants, similarly, and those that are outside of our current domestic infrastructure are also threatened by biology. So these are just two examples. On the right is the black-footed ferret, which is a critically endangered species that is threatened by a plague, as well as the American chestnut, which was nearly wiped out due to fungal blight.

One of the things that is really important to keep in mind and has framed many biosecurity discussions is the importance of having a "One Health" approach to many of these issues that goes beyond only humans.

Now while we've been talking a lot about the types of threats that might emerge naturally, there's also other types of threats, including those from countries that might be interested in using the power of biology for harm. And this has a past in human conflict, where countries have developed biological weapons, including in the U.S. On the left-hand side are some images from 1917. There's also been other countries, including those that have pursued biological weapons programs even after there was an agreement not to develop those weapons, which we'll talk about a little bit later.

And it's not just countries, but individuals, small organizations have also been inspired to use the power of biology for harm. Here are a couple examples. On the left is the Amerithrax letters. These were mailed in the wake of 9/11. They killed five people and infected 17 more. And while relatively they didn't kill that many people, it fundamentally reshaped how we think about biological threats and the possibility of that causing widespread harm.

There have also been groups—on the right here is Aum Shinrikyo—that have wanted and pursued biological weapons programs, in this case not successfully. But the idea that this might be used for harm and used against other people is something that we know has a past and might have a future.

As part of this, we're constantly within science and engineering and in public health trying to understand this evolving threat landscape and to be able to develop solutions to counter those biological threats and ideally prevent them, but also prepare for them. But that work is itself not without risk. When we're working with dangerous pathogens, we can expect that there might be accidents that occur. And so this is another source of potential threats that might come from our very efforts to try to mitigate those threats. And there have been a history of this as well, both from past pandemics, including SARS here on the left, as well as efforts to counter and do research on anthrax in order to defend against its potential misuse.

One of the areas that I work closely in is in advances in science and technology to try and both understand biological threats but also develop ways to mitigate against them. And some of the underlying tools in that area, where we can get better at editing, evolving, reading, and writing the underlying code of biology, has caused both much interest and optimism around being able to develop vaccines much more quickly or develop diagnostics, but it's also developed concern that those might enable us to develop even more threatening agents. And also enabling many more people who, again, could make great things to help biological security but might also threaten biological security. We often refer to this as the dual-use dilemma: that these advances may offer promise for help but also promise for harm.

One example of this is the ability to reconstruct a pathogen of the past. This is one example of a study that caused some controversy, where scientists, in order to understand a past pathogen—in this case, the 1918 influenza—they used these tools of reading, writing, editing, evolving DNA—in this case, being able to synthesize and assemble an extinct virus. And then they wanted to publish on it. And this has caused a big controversy on whether or not we should be sharing information of this type, and whether or not, again, that makes us safer and more secure or more vulnerable. In this case the decision was, in the end, to publish.

So what are some of our protections against biological threats? Some of these are at the level of policies. The Biological Weapons Convention is arguably the most important. It's when states, countries, got together and decided that they were no longer going to pursue these dangerous weapons. That it was in the interest of them and others not to do so. This is probably the most important safeguard that we have in ensuring we can benefit from the peaceful purposes for biology. There are two images here. One is from the 1969 United Nations Conference on Disarmament. And on the right is many years later, in 2019, where the majority of countries in the world—almost all of them—have signed on to this agreement. But as we mentioned before, we always have to safeguard against ensuring that we hold those commitments. There have been countries in the past that have pursued them despite these agreements.

One of the most important safeguards is, again, research and development. Even though we don't work on biological weapons, we work on defensive research. Some of these are shown on the left-hand side. In the U.S., this is Fort Detrick and a new national bio and agro-defense facility, again protecting against weapons that might be used not against humans but against the things that humans rely upon. And on the right-hand side, here we see some now-familiar public health messaging. Our public health infrastructure is so important in protecting against biological threats, as well as many other types of human disease.

Another set of safeguards that we have is, again, the safety of the laboratories—the research laboratories—in which we are trying to understand these potentially dangerous agents. There's actually quite a system that has been developed and refined over time of different safety levels depending on how dangerous that pathogen is and whether or not we have existing tools to counter it. One of the highest safety level labs here is shown on the right, and that includes many different elements that enable the researchers to be protected from those agents, as well as safeguards to protect others outside of those labs. That is itself a really interesting and important design challenge of how to ensure that these spaces are safe and secure.

There are also policies that have been put in place to try to counter this dual-use dilemma. In this case, there have been policies that outline both potentially dangerous organisms—these are existing pathogens—as well as potentially dangerous experiments, either on those dangerous pathogens that might generate even more dangerous biological agents. This continues to be an ongoing challenge of how to define that space of concern and something that we actively work on in my group.

Innovations in biotechnology in science and engineering also are enabling us to come up with new tools to both understand and to mitigate biological threats. You may have received one of the new mRNA vaccines. That's a new vaccine technology that has been fairly recently developed and now deployed globally. We can imagine that there are other types of vaccines that are developed, and we need to think ahead to again understanding what might happen in the future and being prepared, so that we can even more quickly respond as pandemic might emerge in the future.

This is one of the cases where we might even have the power to eliminate entirely biological threats. And there is some hope here. One example is smallpox, which we mentioned before, which thanks to a huge global campaign was successfully eradicated. If we are really committed to many of these types of challenges, we might imagine being able to eradicate future biological threats, either through coming up with these vaccine strategies or again preventing them from occurring entirely through things like the Biological Weapons Convention and other types of agreements around these so-called dual-use areas of science and technology.

Which leads me to my last point. One of the reasons that we're here today is the most important defense we have against biological threats is people. We need great leaders and thinkers who are helping us to navigate the future, where ideally we are much safer and much more secure. It's one of the reasons I am very grateful to be able to work with people like Katherine here as part of my team as we think about what are the challenges that we're going to need to work on tomorrow. So Katherine, I would love if you helped us think about what we should be doing here in the future.

Katherine Healzer: As we celebrate innovations that seek to make our planet safe, including technologies that help mitigate climate change, provide health diagnostics and screening, address biodiversity loss, and prepare for the next pandemic, we must see each discovery through the lens of biosecurity to understand dual-use and ensure safety, equity, and sustainability, all while maintaining our humility. Before the pandemic, biosecurity may have felt distant. But now we see how it touches everyone, everything, and every part of our lives.

It's up to us to work collaboratively in the field of biosecurity, as we are all partners in protecting our planet and ensuring that future generations have a healthy, safe, and equitable place to live. By you asking questions, getting involved in the discussion, and educating yourself about the biosecurity challenge, you can be part of the solution.

In the field of biosecurity, we are always looking for more involvement from various stakeholders, including students in the community. There are many opportunities to get involved, including creating a club dedicated to inspiring the next leaders in biosecurity and promoting the discussion of biological threats and dual-use. Or exploring forums and programs, such as the Next Generation Global Health Security Network and ethics and society community-building events. Or participating as a team member in iGEM, an international competition dedicated to the advancement of synthetic biology through fostering the values of community, collaboration, and security.

It is also exciting to fuel innovation and explore new concepts. And for those interested in a career in biosecurity, the good news is that it occurs at the intersection of so many different fields, including bioengineering, policy, medicine, ethics, law, and so many more. And you can contribute to the field from each of these different disciplines.

Finally, being a citizen scientist may be the most important role for all of us, as a threat to biosecurity is a threat to each one of us, and together through biosecurity let's create a safe future where everyone has a voice and is heard equally. Thank you for having us.