Aron's Resource Hub and Review on Key Aspects of Biosecurity

Aim of the document:

1. To provide an overview of GCBRs for the scientific audience and summarise the projects and ideas people could get involved with.
2. To help me overview the field (and find low-hanging fruits) and find a career fit
3. To assess where I could start a startup in the field.

Get in touch:

If you would like to get in touch please email at lajkoaron@gmail.com or DM on Twitter at @AronLajko. Feedback welcome.

Executive Summary - Read this

Executive Summary: An Introduction to Biosecurity: Navigating the Risks, Responses, …

Summaries:

My Summary and Hot Takes on Historical Cases of Biological Risks - Aron

A summary on UVC lamps - Aron

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Global Catastrophic Biological Risks

Notes: Summaries under the articles were often generated or semi-generated using Chat-GPT4. This could potentially be improved using my conclusions instead but would require significant time.

1. Global Catastrophic Biological Risks (GCBRs)

- Biosecurity as an EA cause area | Claire Zabel | EA Global: San Francisco 2017 (Video)
  Summary:
  > "In this 2017 talk, the Open Philanthropy Project's Claire Zabel talks about their work to mitigate Global Catastrophic Biological Risks. She also discusses what effective altruists can do to help, as well as differences between biological risks and risks from advanced AI."
- Biotechnology and existential risk | Andrew Snyder Beattie | EA Global: London 2017 (Video)
  > "In the decades to come, advances in biotechnology could pose new risks to humanity. This talk will provide an introductory overview of these risks within the framework effective altruism."
- Hear This Idea: Jassi Pannu and Joshua Monrad on Pandemic Preparedness (Podcast)
  Things discussed:
  > The post-COVID biosecurity landscape, including the American Pandemic Preparedness Plan
  > The Biological Weapons Convention and current issues in dual-use research
  > The role of antivirals, increasing vaccine capacity, and market failures
  > Similarities and differences between GCBR mitigation and general pandemic preparedness

How some interventions are underpinned by global cooperation

- Hear This Idea: Tessa Alexanian and Janvi Ahuja on Synthethic Biology and GCBRs (Podcast)

  Things discussed:

  How synthetic biology began and why it is an exploding field
  The iGEM competition and how to get involved in the community
  Challenges and trade-offs in creating a culture of responsibility is synthetic biology
  Emerging risks in synthetic biology and what this means for global catastrophic risks
  Technical projects in biosecurity and career advice for how to get involved

- Hear this idea: Kevin Esvelt and Jonas Sandbrink on Risks from Biological Research (Podcast)

  Things discussed:

  The concepts of differential technological development, dual-use research, transfer risks in research, 'information loops', and responsible access to biological data
  Strengthening norms against risky biological research, such as novel virus identification and gain of function research
  Connection-based warning systems and metagenomic sequencing technology
  Advanced PPE, Far-UVC sterilisation technology, and other countermeasures against pandemics potentially worse than Covid
  Analogies between progress in biotechnology and the early history of nuclear weapons
  How to use your career to work on these problems — even if you don't have a background in biology.

- Hear this idea: Ajay Karpur on Metagenomic Sequencing (Podcast)

  Things discussed:

  - What is metagenomic sequencing, and why could it matter so much for it to become affordable and ubiquitous?
  - How and why can nonprofits help positive technologies become more accessible?
  - How emerging biotech can help the world respond better to the next emerging (potential) pandemic
  - Refuges against biological threats
  - Analogies between fire protection and pathogen protection through monitoring and cleaner air
  - Career advice for entering biosecurity, especially with an engineering background.

- #4 – Howie Lempel on why we aren't worried enough about the next pandemic — and specifically what we can do to stop it.

  Summary:

  This detailed interview features Howie Lempel, a specialist in pandemic preparedness from Open Philanthropy. The discussion begins by delving into Lempel's role and experiences as a grant-maker. It then moves onto an examination of the escalating problem of pandemics, shedding light on the

severity of the issue and possible solutions. The final section of the interview provides an array of potential fields of study and career paths for individuals interested in contributing to the battle against one of the biggest threats to humankind.

- #12 – Beth Cameron fought Ebola for the White House. Now she works to stop something even worse. - 80,000 Hours
  "**Topics covered include:**
  - The best strategies for containing pandemics.
  - Why we lurch from panic, to neglect, to panic again when it comes to protecting ourselves from contagious diseases.
  - Current reform efforts within the World Health Organization, and attempts to prepare partial vaccines ahead of time.
  - How the Nuclear Threat Initiative, with just 50 people, collaborates with governments around the world to reduce the risk of nuclear or biological catastrophes (also, whether they might want to hire you).
  - Which global health security groups most impress Beth, and what they're doing.
  - What new technologies could be invented to make us safer.
  - Whether it's possible to help solve the problem through mass advocacy.
  - What and where to study, and how to begin a career in pandemic preparedness (below you'll find a lengthy list of people and places mentioned in the interview, and others we've had recommended to us).
  - Much more besides."
- #27 – The careers and policies that can prevent global catastrophic biological risks, according to world-leading health security expert Dr Tom Inglesby
  "**Topics covered include:**
  - Should more people in medicine work on security?
  - What are the top jobs for people who want to improve health security and how do they work towards getting them?
  - What people can do to protect funding for the Global Health Security Agenda.
  - Should we be more concerned about natural or human caused pandemics? Which is more neglected?
  - Should we be allocating more attention and resources to global catastrophic risk scenarios?
  - Why are senior figures reluctant to prioritize one project or area at the expense of another?
  - What does Tom think about the idea that in the medium term, human-caused pandemics will pose a far greater risk than natural pandemics, and so we should focus on specific counter-measures?
  - Are the main risks and solutions understood, and it's just a matter of implementation? Or is the principal task to identify and understand them?
  - How is the current US government performing in these areas?
  - Which agencies are empowered to think about low probability high magnitude events?
  - Are there any scientific breakthroughs that carry particular risk of harm?
  - How do we approach safety in terms of rogue groups looking to inflict harm? How is that different from preventing accidents?

    - If a terrorist group were pursuing biological weapons, how much would the CIA or other organizations then become involved in the process?
    - What are the biggest unsolved questions in health security?"
- #65 – Ambassador Bonnie Jenkins on 8 years of combating WMD terrorism
  "**Topics covered include:**
    - How listeners can start a career like hers
    - The history of Cooperative Threat Reduction work
    - Mistakes made by Mr Obama and Mr Trump
    - Biggest uncontrolled nuclear material threats today
    - Biggest security issues in the world today
    - The Biological Weapons Convention
    - Where does Bonnie disagree with her colleagues working on peace and security?
    - The implications for countries who give up WMDs
    - The fallout from a change in government
    - Networking, the value of attention, and being a vegan in DC
    - And the best 2020 Presidential candidates."
- #70 – Dr Cassidy Nelson on the twelve best ways to stop the next pandemic (and limit COVID-19)
  "**Things discussed:**
    - How Cassidy went from clinical medicine to a PhD studying novel pathogens with pandemic potential
    - The pros, and significant cons, of travel restrictions
    - Whether the same policies work for natural and anthropogenic pandemics
    - Where we stand with nCoV as of today."
- #74 – Dr Greg Lewis on COVID-19 and reducing global catastrophic biological risks
  "**Things discussed:**
    - Reflections on the first few months of the pandemic
    - Common confusions around COVID-19
    - How COVID-19 compares to other diseases
    - What types of interventions have been available to policymakers
    - Arguments for and against working on global catastrophic biological risks (GCBRs)
    - Why state actors would even use or develop biological weapons
    - How to know if you're a good fit to work on GCBRs
    - The response of the effective altruism community, as well as 80,000 Hours in particular, to COVID-19
    - And much more."
- #104 – Dr Pardis Sabeti on the Sentinel system for detecting and stopping pandemics
  "**Things discussed:**
    - Pardis' history with trying to control emerging contagious diseases
    - The potential of mRNA vaccines
    - Other emerging technologies
    - How to best educate people about pandemics
    - The pros and cons of gain-of-function research
    - Turning mistakes into exercises you can learn from
    - Overcoming enormous life challenges

    - Why it's so important to work with people you can laugh with
    - And much more"
- #112 – Carl Shulman on the common-sense case for existential risk work and its practical implications

  "**Things discussed:**
    - A few reasons Carl isn't excited by 'strong longtermism'
    - How x-risk reduction compares to GiveWell recommendations
    - Solutions for asteroids, comets, supervolcanoes, nuclear war, pandemics, and climate change
    - The history of bioweapons
    - Whether gain-of-function research is justifiable
    - Successes and failures around COVID-19
    - The history of existential risk
    - And much more"
- #114 – Maha Rehman on working with governments to rapidly deliver masks to millions of people

  "**Things discussed**:
    - The results and experimental design of the Bangladesh RCT
    - The challenges of data collection in this context
    - Disasters and emergencies she had to respond to in the middle of the project
    - What she learned from working closely with the Lahore Commissioner's Office
    - How to get governments to provide you with large amounts of data for your research
    - How she adapted from a more academic role to a 'getting stuff done' role
    - How to reduce waste in government procurement
    - And much more"
- #116 – Luisa Rodriguez on why global catastrophes seem unlikely to kill us all

  "**Things discussed:**
    - What the world might actually look like after one of these catastrophes
    - The most valuable knowledge for survivors
    - What we can learn from fallen ancient civilisations and smaller-scale disasters in modern times
    - The risk of culture shifting against science and tech
    - How fast populations could rebound
    - Implications for what we ought to do right now
    - 'Boom and bust' climate change scenarios
    - And much more."
- #118 – Jaime Yassif on safeguarding bioscience to prevent catastrophic lab accidents and bioweapons development

  "**Things discussed:**
    - The importance of reducing emerging biological risks associated with rapid technology advances
    - How we can make it a lot harder for anyone to deliberately or accidentally produce or release a really dangerous pathogen
    - The importance of having multiples theories of risk reduction
    - Why Jaime's more focused on prevention than response

    - Multiple intervention points for reducing risks throughout the bioscience R&D lifecycle: funders, research oversight committees, suppliers of goods and services, and publishers
    - The history of the Biological Weapons Convention
    - How much we can rely on traditional law enforcement to detect terrorists
    - Jaime's disagreements with the effective altruism community
- #131 – Lewis Dartnell on getting humanity to bounce back faster in a post-apocalyptic world

  "**Things discussed:**
    - The biggest impediments to bouncing back
    - The reality of humans trying to actually do this
    - The most valuable pro-resilience adjustments we can make today
    - How to recover without much coal or oil
    - How to feed the Earth in disasters
    - And the most exciting recent findings in astrobiology"
- Making Sense: Special Episode: Engineering the Apocalypse - Rob Reid

  Summary:

  "In this nearly 4-hour SPECIAL EPISODE, Rob Reid delivers a 100-minute monologue (broken up into 4 segments, and interleaved with discussions with Sam) about the looming danger of a man-made pandemic, caused by an artificially-modified pathogen. The risk of this occurring is far higher and nearer-term than almost anyone realizes.

  Rob explains the science and motivations that could produce such a catastrophe and explores the steps that society must start taking today to prevent it. These measures are concrete, affordable, and scientifically fascinating—and almost all of them are applicable to future, natural pandemics as well. So if we take most of them, the odds of a future Covid-like outbreak would plummet—a priceless collateral benefit."
- Making Sense: EPISODE 323 Science & Survival A Conversation with Martin Rees

  Summary:
    - "Sam Harris speaks with Martin Rees about the importance of science and scientific institutions. They discuss the provisionality of science, the paradox of authority, genius, civilizational risks, pandemic preparedness, artificial intelligence, nuclear weapons, the far future, the Fermi problem, the prospect of a "Great Filter", the multiverse, string theory, exoplanets, large telescopes, improving scientific institutions, wealth inequality, atheism, the conflict between science and religion, moral realism, and other topics."
- Filippa Lentzos on Global Catastrophic Biological Risks

  "Things discussed:
    - The most pressing issue in biosecurity
    - Stories from when biosafety labs failed to contain dangerous pathogens
    - The lethality of pathogens being worked on at biolaboratories
    - Lessons from COVID-19"
- Future Perfect: How to Prevent a factory farmed pandemic

  Summary:
    - "What if the next pandemic comes, not from wet markets overseas, but from our own factory farms? Martha Nelson, who studies viruses at the NIH, says

we are playing Russian roulette with potentially dangerous influenza strains on our pig farms."

- Preparing for a World in which Thousands Can Unleash New Pandemics | Kevin Esvelt | EAGxBoston 22
  Summary:
  - "Kevin Esvelt will outline a path to obviating catastrophic biothreats, highlighting key areas where contributions from people with particular skills outside of biology are likely to prove especially impactful."
- Pandemic Prevention Network | Sanjay Joshi | EAGxOxford 22
  Summary:
  - "Sanjay Joshi (Pandemic Prevention Network) gives an introduction to pandemic preparedness policy and how you can get involved."
- EAG 2018 SF: Pandemic pathogens
  Summary:
  - "A sufficiently bad disease could have disastrous effects for humanity, like the 1918 flu, black plague, or even worse. But to protect ourselves as a species from global catastrophic biological risks (GCBRs), we need to know which features make a pathogen more or less likely to pose an existential threat. In this advanced talk from EA Global 2018: San Francisco, Dr. Amesh Adalja covers what types of pathogens are most likely, which transmission methods to worry about the most, and many more considerations for anticipating and preventing GCBRs."
- BBC Radio 4 - Apocalypse How, Death by DNA
  Summary:
  - "The advanced state of DNA technology has reached a point where it could be possible for a rogue scientist or knowledgeable terrorist to create a lethal pathogen using genetic sequences obtained by mail order. Despite the complexity of assembling these gene fragments into a live virus, researchers have already achieved this with horsepox. This progress implies that deadly viruses like smallpox, eliminated in 1977, could potentially be recreated in a lab, possibly even with resistance to existing vaccines. Current deterrents largely depend on scientists' judgment and DNA synthesis companies' customer screening processes. This development could necessitate a reconsideration of how information is handled in the scientific community to prevent misuse."
- The Portal 27: Daniel Schmachtenberger - On Avoiding Apocalypses
  Summary:
  - "In the second episode of the Portal, recorded during the COVID-19 pandemic lockdown, Daniel Shmachtenberger, a key figure in the Game B subculture of the human potential movement, discusses the prospects for human flourishing on a single shared planet. Game B theorists posit the existence of a non-conflict-based, evolutionarily stable strategy for coexistence, which contrasts with Game A environments characterised by scarcity and rivalry. Host Eric Weinstein probes Daniel about the promising areas and progress within this movement, which rejects the Twin Nuclei Problem concept - the dilemma of humanity having harnessed nuclear and cellular power in the 1950s without the wisdom to use it responsibly."
- EA Talks: Mitigating catastrophic biorisks | Kevin Esvelt
  Summary:

    - “In a world now painfully aware of pandemics, with ever-increasing access to autonomous biological agents, how can we help channel society’s response to COVID-19 to minimize the risk of deliberate misuse? Using the challenge of securing DNA synthesis as an example, Kevin outlines the key norms and incentives governing biotechnology, lays out potential strategies for reform, and suggests ways in which thoughtful individuals might help safely and credibly discuss and mitigate biorisks without spreading information hazards.”
- Power Corrupts: Biological Weapons
  Summary:
    - “Pandemics are horrifying. But what if one could be unleashed deliberately? How did ancient armies from the Greeks to the Mongol hordes use germ warfare? Why did America conduct tests on unsuspecting people in New York and San Francisco? Can biological weapons be developed to only infect a single person? And why is the US government researching how to use insects as taxis for viruses?”
- Preventing the next pandemic - Kevin Esvelt (video, 70 mins)
- Reducing global catastrophic biological risks | Jaime Yassif | EA Student Summit 2020
  Summary:
    - Introduction to GCBRs and to NTIs work
- Pandemic pathogens | Amesh Adalja | EA Global: San Francisco 2018
  Summary:
    - “A sufficiently bad disease could have disastrous effects for humanity, like the 1918 flu, black plague, or even worse. But to protect ourselves as a species from global catastrophic biological risks (GCBRs), we need to know which features make a pathogen more or less likely to pose an existential threat. In this advanced talk from EA Global: San Francisco 2018, Dr. Amesh Adalja covers what types of pathogens are most likely, which transmission methods to worry about the most, and many more considerations for anticipating and preventing GCBRs.”
- Assessing global catastrophic biological risks | Crystal Watson | EA Global: San Francisco 2018
  Summary:
    - “In the last century, humanity's successful eradication of smallpox shows that major victories against deadly pandemics are possible. And it's a good thing too, because global catastrophic biological risks, or GCBRs, have the potential to be even worse. In this talk, Dr Crystal Watson of the Center for Health Security at Johns Hopkins discusses GCBRs, the new field of study around them, and what effective altruists can do to aid in the fight.”
- The next outbreak? We’re not ready Bill Gates, TED talk, April 2015. (Gates founded CEPI the year after this, so he put his money where his TED talk was.)
- Biorisk research, strategy, and policy
  Summary:
    - “Biorisk careers could have a high impact as they involve mitigating global catastrophic risks, like pandemics. Although much effort is already being dedicated to this, current efforts are deemed inadequate, especially in terms of preparing for potential human-made pandemics. The field of biorisk

involves various interventions and roles that individuals from different academic and professional backgrounds can contribute to, and these can be categorised into policy and technical careers. Policy careers focus on reducing risks through policy development and implementation, often in government, academia, think tanks, and civil society. Technical careers emphasize the development and application of technical solutions to biorisk, such as creating vaccines or improving personal protective equipment. It's important for individuals considering a career in biorisk to assess their aptitude, interests, and fit for the field and to consider developing a 'T-shaped' distribution of expertise, with a broad familiarity across the field and deep expertise in a specific area."

- Human Agency and Global Catastrophic Biorisks

  Summary:

  "Global catastrophic biological risks (GCBRs) are potentially devastating events, such as pandemics, that could have intergenerational consequences, and research into them is deemed valuable despite the high uncertainties involved. The existing health security community already undertakes much relevant research, but there are questions around whether specific GCBR-focused research is needed. One such question is whether the majority of GCBR risk comes from human activity rather than natural sources, with many theoretical arguments supporting both sides but requiring thorough investigation. It is argued that certain technologies should be accelerated to counter future risks, such as investment in medical countermeasures and biosecurity research. It's suggested that the creation of a GCBR community would aid in understanding and mitigating these risks, building on the work of health security and global catastrophic risk communities."

- Preventing catastrophic pandemics

  Summary:

  "COVID-19 has exposed our vulnerability to pandemics, and with advances in biotechnology, the risk of engineered pathogens poses the potential for even more catastrophic outbreaks. Reducing biological catastrophes and preparing for their mitigation is crucial, and can involve better governance of research, strengthening international commitments to bioweapon restrictions, and developing broad-spectrum treatments. While the biosecurity field has contributed significantly to reducing global catastrophic biological risks (GCBRs), projects specifically aimed at reducing these are currently underfunded and somewhat neglected. Therefore, entry into the field of biosecurity with a focus on reducing GCBRs could present valuable opportunities. Needed roles in the field include technical and biological researchers, strategic researchers and forecasters, government officials, and information security experts."

- Reducing global catastrophic biological risks

  Summary:

  "Global catastrophic biological risks (GCBRs), like pandemics, can gravely impact humanity's future, with a threshold suggested at an event killing at least 10% of the human population. Historical occurrences of potential GCBRs and advancements in biotechnology indicate that these risks are plausible, and can be both natural and human-made. Despite these risks, the

paper suggests GCBRs tend to be neglected due to the nature of human cognition and systemic challenges, although they offer areas for improved research, governance and cooperation, such as stronger international adherence to the Biological Weapons Convention and better oversight of dual-use research of concern.

The allocation of resources towards Global Catastrophic Biological Risks (GCBRs) and other existential risk areas like AI safety and nuclear security should be contingent on factors like potential for recovery after a global catastrophe and the threat level to humanity. Uncertainties around GCBRs include defining the threshold for catastrophic events, the likelihood of human civilisation recovery after catastrophe, and the relative dangers posed by biological and AI risks. Anthropogenic risks, particularly deliberate misuse, are believed to pose a higher GCBR threat than natural risks. Current biosecurity measures address GCBR mitigation but may not be optimally allocated from a longtermist perspective. Approaches to intervention can include support for existing efforts, targeting work with greater relevance to GCBRs, and pursuing independent GCBR-reducing work. The relationship between biosecurity and other problem areas, such as global health, factory farming, and AI, is also significant.

Effective Altruists could make significant contributions to Global Catastrophic Biological Risks (GCBRs) mitigation due to their value alignment and understanding of the long-term future, thus making roles that influence prioritization and strategic direction particularly valuable.

Ideal attributes for people working on GCBRs include discretion, focus, domain knowledge, relevant credentials, and US citizenship. It's advisable to either work directly on GCBRs or to build career capital for future influence.

Career paths that impact GCBRs include roles in the US government, scientific community, international organizations, academia, and other nations' government. Alternatives such as grant-making, operations, and public advocacy are also worth considering. It's critical to exercise caution with original research due to potential hazards."

- World 'woefully unprepared' for a biological incident, simulation exercise finds

  Summary:

  "Security experts have warned that the global community remains dangerously unprepared for a biological attack or pandemic, citing deficiencies in pandemic prevention, detection, and response systems. In a simulation conducted by the Nuclear Threat Initiative, a targeted attack on cattle with a genetically engineered virus led to a global pandemic, resulting in 120 million deaths. The simulation highlighted critical issues such as intelligence failures, accountability problems, and cyber-interference, which undermined the response and hampered vaccine development. Experts recommend investing in stronger intelligence capabilities, establishing a United Nations permanent response coordination unit, and prioritising intellectual property waivers."
- Engineering Gene Safety
- Are we doing enough to stop the worst pandemics?
- Let's get serious about preventing the next pandemic
- **[Conversations with Tyler]**

1.1 Definition of GCBRs

- Global Catastrophic Biological Risks: Toward a working definition
  Summary:
  The Johns Hopkins Center for Health Security has proposed a framework to investigate global catastrophic biological risks (GCBRs) - events in which biological agents could lead to extraordinary, uncontrollable disasters. Though considered low probability, such events could cause significant loss of life and inflict sustained damage to national governments, economies, and societal stability, altering the long-term trajectory of humanity. Examples include pandemics, deliberate biological attacks, or accidental release of laboratory-engineered pathogens.
  The center encourages research into GCBRs, aiming to prevent them, control outbreaks, and avoid harmful responses that could intensify the situation. The definition of GCBRs also extends to biological events with significant global impacts, even if they don't cause millions of fatalities. To better understand the potential of GCBRs, the Center studies past events such as the 1918 Influenza, HIV/AIDS, and the Black Death, and hypothetical future scenarios like targeted genetic attacks or widespread food source eradication.
  The study and understanding of GCBRs are critical to focus resources, implement effective preventative measures, and communicate the potential risks. This approach won't divert attention from other biological threats but will help highlight the extraordinary risks that haven't been thoroughly studied or addressed.
- On defining Global Catastrophic Biological Risks
  Summary:
  "The Johns Hopkins Center for Health Security has created a working definition for global catastrophic biological risks (GCBRs). These are biological events that can lead to disasters that are uncontrollable and have lasting impacts on human life and civilization. The Center's definition, however, doesn't decisively categorize past or potential future events as GCBRs, illustrating the ambiguity and complexity of the concept.
  The authors agree with the Center that biological risks warrant attention for mitigation even though they may be difficult to predict and that an all-encompassing focus is needed due to uncertainties over which biological risks could lead to long-term disasters.
  There are several considerations when evaluating GCBRs. The 'extraordinary' level of harm inflicted by GCBRs shouldn't be defined only by fatalities. Other potential impacts, such as long-term debilitating effects or psychological, social, and economic impacts, can also be devastating. Additionally, GCBRs may not occur suddenly or all at once; a series of smaller events or a gradual degradation can together produce a catastrophe.
  Lastly, the Center's definition states that GCBRs are "beyond the collective capability to control." Although some biological events can be contained, 'stress tests' have exposed weaknesses in current response strategies. These weaknesses highlight the need for robust and resilient systems to prevent such events from escalating into GCBRs."
- Existential Risk and Cost-Effective Biosecurity

Summary:

“While the likelihood of human extinction due to bioweapons is very low, the importance of reducing this risk is immense, as it endangers all future human lives. Studies suggest that preventing such existential threats is more cost-effective than many current biosecurity measures. However, this doesn't mean that we should only focus on these risks, as many standard health practices also reduce existential risk. To manage these risks, we should increase investment in research, devise contingency plans for worst-case scenarios, reprioritize current approaches, and strive to prevent the weaponization of biotechnology. These steps can provide robust defense mechanisms, while also tackling less extreme risks.**”**

- Reducing Global Catastrophic Biological Risks - Jaime Yassif

Summary:

“The Open Philanthropy Project is prioritizing the reduction of global catastrophic risks (GCRs), particularly those from biological sources (GCBRs). Pandemics are considered one of the most important, tractable, and neglected causes of catastrophic events. The severity of a pandemic required to seriously destabilize civilization is debated, with suggestions of an event causing at least 100 million fatalities. The most likely source of a GCBR is presumed to be engineered pathogens. However, the challenges to this work include a lack of consensus about the severity of biological risks, as GCBRs are generally considered low-probability events. Despite this, the Project advocates for a broader dialogue on worst-case scenarios and practical risk reduction steps. The focus is on systems that can prevent GCR-level events and contain smaller scale events, and tools specifically useful in mitigating GCBRs, such as diagnostic tools based on DNA sequencing technologies, broad-spectrum antivirals, and systems for rapid countermeasure development.”

2. Existential Risks

- Making Sense: Existential Risk - A Conversation with Toby Ord

Summary:

“In this episode of the podcast, Sam Harris speaks with Toby Ord about preserving the long term future of humanity. They discuss moral biases with respect to distance in space and time, the psychology of effective altruism, feeling good vs. doing good, possible blindspots in consequentialism, natural vs. human-caused risk, asteroid impacts, nuclear war, pandemics, the potentially cosmic significance of human survival, the difference between bad things and the absence of good things, population ethics, Derek Parfit, the asymmetry between happiness and suffering,

  - climate change, and other topics.”

- Rationally Speaking Podcast: 262: Humanity on the precipice (Toby Ord)

Summary:

“Humanity could thrive for millions of years — unless our future is cut short by an existential catastrophe. Oxford philosopher Toby Ord explains the possible existential risks we face, including climate change, pandemics, and artificial

intelligence. Toby and Julia discuss what led him to take existential risk more seriously, which risks he considers underrated vs. overrated, and how to estimate the probability of existential risk. (December 10, 2021)"

3. Information Hazards and Their Implications

- Information hazards in biotechnology - Lewis et al.
  Abstract:
  "With the advance of biotechnology, biological information, rather than biological materials, is increasingly the object of principal security concern. We argue that both in theory and in practice, existing security approaches in biology are poorly suited to manage hazardous biological information, and use the cases of Mousepox, H5N1 gain of function, and Botulinum toxin H to highlight these ongoing challenges. We suggest that mitigation of these hazards can be improved if one can: (1) anticipate hazard potential before scientific work is performed; (2) consider how much the new information would likely help both good and bad actors; and (3) aim to disclose information in the manner that maximally disadvantages bad actors versus good ones"
- Information hazards: A typology of potential harms from knowledge - Nick Bostrom
  Abstract:
  "Information hazards are risks that arise from the dissemination or the potential dissemination of true information that may cause harm or enable some agent to cause harm. Such hazards are often subtler than direct physical threats, and, as a consequence, are easily overlooked. They can, however, be important. This paper surveys the terrain and proposes a taxonomy."
- Bioinfohazards, Megan Crawford, Finan Adamson and Jeffrey Ladish, EA Forum post, September 2019
  Summary:
  "The article discusses the balance between secrecy and openness in the context of biosecurity, particularly in relation to the risks of sharing or withholding information. It highlights the dual threats from both 'bad' actors, who could misuse the information intentionally, and 'careless' actors, who might inadvertently cause harm due to ignorance or lack of caution. The paper further categorizes the risks of information sharing, including dangerous concepts or implementation details reaching bad or careless actors, information becoming dangerous due to future advances, and the risk of idea inoculation where presenting an idea causes people to dismiss risks.
  At the same time, the article points out that excessive secrecy can also be harmful. It can stifle innovation, prevent the interruption of dangerous work, create information silos, act as a barrier to funding and new talent, and even lead to the Streisand effect, where efforts to suppress information lead to it being disseminated more widely.

The authors argue that a holistic approach to information sharing should balance the potential risks and benefits. They encourage those involved in biosecurity to carefully consider the value of potentially dangerous information and its potential uses before sharing. This approach requires weighing both the potential for misuse and the potential benefits of information sharing for advancing research or helping to solve problems. The authors believe that having these nuanced conversations could lead to a safer world in relation to biological risks.**"**

- What are information hazards?- Convergence Analysis, Michael Aird
  Summary:
  The concept of information hazards relates to risks of harm from creating or spreading true information (not from creating or spreading false information). The concept is definitely very useful in relation to existential risks and risks from technological development, but can also apply in a wide range of other contexts, and at much smaller scales.
  Some information hazards risk harm only to the knower of the true information themselves, and as a direct result of them knowing the information. But many information hazards harm other people, or harm in other ways.
  Information hazards are risks of harm, not necessarily guaranteed harms.

- Information hazards: a very simple typology
  Summary:
  The article presents a typology of information hazards, dividing them into three categories:
  - Capability hazards: Information that provides others with new abilities to cause harm. For instance, instructions for creating nuclear weapons or information useful for blackmail.
  - Direct hazards: Information that directly harms the possessor, like distressing news or distracting political information.
  - Mindset hazards: Information that, although true, can encourage individuals to act detrimentally due to existing beliefs or biases. Examples are controversial and may include inheritability of cognitive traits or potentially damaging actions of public figures.
  - The typology acknowledges overlaps between categories, but posits that in most real-world cases, information hazards fall predominantly into one category. It is designed to be simple, memorable, and to focus on how different types of information might cause harm.
- Slate Star Codex: The Virtue of Silence

4. Dual Use Research

- An adversarial collaboration paper on GoF experiments: Gain-of-function experiments: time for a real debate | Nature Reviews Microbiology
  Abstract:
  "According to the WHO, dual use research of concern (DURC) is "life sciences research that is intended for benefit, but which might easily be

misapplied to do harm". Recent studies, particularly those on influenza viruses, have led to renewed attention on DURC, as there is an ongoing debate over whether the benefits of gain-of-function (GOF) experiments that result in an increase in the transmission and/or pathogenicity of potential pandemic pathogens (PPPs) are outweighed by concerns over biosecurity and biosafety. In this Viewpoint article, proponents and opponents of GOF experiments discuss the benefits and risks associated with these studies, as well as the implications of the current debate for the scientific community and the general public, and suggest how the current discussion should move forward."

- Dual Use Research of Concern - United States Government policy
  This website lists the different policies of the United States concerning dual-use research.
- Dual Use Research of Concern in the Life Sciences: Current Issues and Controversies, US National Academies of Sciences, Engineering, and Medicine, 2017.
  Abstract:
  "The potential misuse of advances in life sciences research is raising concerns about national security threats. Dual Use Research of Concern in the Life Sciences: Current Issues and Controversies examines the U.S. strategy for reducing biosecurity risks in life sciences research and considers mechanisms that would allow researchers to manage the dissemination of the results of research while mitigating the potential for harm to national security."
- Developing DURC today: Rapid Proliferation of Pandemic Research: Implications for Dual-Use Risks
  Abstract:
  "The COVID-19 pandemic has demonstrated the world's vulnerability to biological catastrophe and elicited unprecedented scientific efforts. Some of this work and its derivatives, however, present dual-use risks (i.e., potential harm from misapplication of beneficial research) that have largely gone unaddressed. For instance, gain-of-function studies and reverse genetics protocols may facilitate the engineering of concerning SARS-CoV-2 variants and other pathogens. The risk of accidental or deliberate release of dangerous pathogens may be increased by large-scale collection and characterization of zoonotic viruses undertaken in an effort to understand what enables animal-to-human transmission. These concerns are exacerbated by the rise of preprint publishing that circumvents a late-stage opportunity for dual-use oversight. To prevent the next global health emergency, we must avoid inadvertently increasing the threat of future biological events. This requires a nuanced and proactive approach to dual-use evaluation throughout the research life cycle, including the conception, funding, conduct, and dissemination of research."
- Biological Security: The Risk of Dual-Use Research (40 mins)
  Summary:

"I am certainly convinced that the H5N1 influenza virus poses a serious threat. I also believe that wherever one stands in this dialogue about H5N1 research and dual-use research more generally, we are all seeking to protect the public from life-threatening pandemics.
In my testimony today, I will address 3 topics:
    - 1. The reasons why I am concerned with research on H5N1 avian influenza virus engineered for mammalian transmissibility.
    - 2. The steps I believe we should take now to address these issues.
    - 3. My recommendations for ensuring the success of the new U.S. Government Policy for
    - Oversight of Life Sciences Dual Use Research of Concern"

- Biotechnology Research in an Age of Terrorism (Slightly dated - 2004 - but still comprehensive and particularly valuable for 'US context')

  Summary:

  "In recent years much has happened to justify an examination of biological research in light of national security concerns. The destructive application of biotechnology research includes activities such as spreading common pathogens or transforming them into even more lethal forms. Policymakers and the scientific community at large must put forth a vigorous and immediate response to this challenge. This new book by the National Research Council recommends that the government expand existing regulations and rely on self-governance by scientists rather than adopt intrusive new policies. One key recommendation of the report is that the government should not attempt to regulate scientific publishing but should trust scientists and journals to screen their papers for security risks, a task some journals have already taken up. With biological information and tools widely distributed, regulating only U.S. researchers would have little effect. A new International Forum on Biosecurity should encourage the adoption of similar measures around the world. Seven types of risky studies would require approval by the Institutional Biosafety Committees that already oversee recombinant DNA research at some 400 U.S. institutions. These "experiments of concern" include making an infectious agent more lethal and rendering vaccines powerless."

- Synthetic Biology: Safety, Security, and Promise (Book. A recent concise survey of the area aimed at a general reader)

  Summary:

  "Synthetic biology aims to make biology easier to engineer and to program. Thanks to advances in computing power, the ability to make long tracts of DNA, new tools like CRISPR that can be used to edit genomes, and the enthusiasm of young scientists and even amateurs who want to enter the field, synthetic biology is poised to change the future of medicine, agriculture, and manufacturing. Yet, while this new field promises vast opportunities and benefits, there are also risks. There

are biosecurity risks that these technologies will be deliberately used for harm; safety risks to people and the environment; ethical and social considerations for how to apply these technologies; and there are risks to the competitiveness of nations that do not invest in these technologies that are likely to spur economic growth. This volume is dedicated to a discussion of what can be done to minimize risks and maximize the benefits of synthetic biology."

- A more systematic approach to biological risk
  Summary:
  "In 2015, the White House issued plans to enhance U.S. biosafety and biosecurity in response to labs mishandling pathogens. However, the approach was criticized for relying on inadequate institutional structures and ignoring underlying systemic issues. Since 1975, the management of biological risks hasn't notably improved, with the Asilomar meeting's legacy criticized for insufficient risk management expertise and overemphasis on technical matters. The article urges a shift in leadership on biological risk, integrating scientific and technical expertise with governance and risk management. Current oversight bodies are scrutinized for conflicts of interest and underrepresentation of governance expertise. Effective regulatory oversight, learning from high-risk industries, creating national oversight bodies, and adopting long-term strategic governance approaches are suggested. Failing to address these issues, the article warns, could lead to severe accidents and reactive restrictions on beneficial research."
- Emerging technologies and dual-use concerns: a horizon scan for global public health - WHO report
  Summary:
  "This horizon scan identified a range of technical areas in the life sciences and related fields and gaps in governance that give rise to concern. Governance of responsible use of the life sciences and suppression of misuse concern a wide variety of stakeholders, from individuals to international organizations. They also involve multiple sectors, including health, research, environment, defence, customs, border controls and agriculture."
- Technology Roulette: Managing Loss of Control as Many Militaries Pursue Technological Superiority, Richard Danzig, Center for a New American Security, May 2018.
  Summary:
  "This report emphasizes that U.S. military's pursuit of technological superiority, while beneficial for deterrence, doesn't guarantee security. Introduction of new technologies like AI and synthetic biology can lead to unexpected risks and loss of control. As technological innovation leads to proliferation, the risk grows due to increased complexity and lesser safety standards. The concept of keeping "humans in the loop" is limited in mitigating these risks.
  However, risks can be dampened by planning for inadvertent situations

and designing technologies with focus on mitigation and recovery. Importantly, it calls for global cooperation to minimize risks, emphasizing on shared controls, contingency plans, and norms. The findings should influence discussions about control of dangerous new technologies."

- Improved understanding of biorisk for research involving microbial modification using annotated sequences of concern

  Abstract:

  "Regulation of research on microbes that cause disease in humans has historically been focused on taxonomic lists of 'bad bugs'. However, given our increased knowledge of these pathogens through inexpensive genome sequencing, five decades of research in microbial pathogenesis, and the burgeoning capacity of synthetic biologists, the limitations of this approach are apparent. With heightened scientific and public attention focused on biosafety and biosecurity, and an ongoing review by US authorities of dual-use research oversight, this article proposes the incorporation of sequences of concern (SoCs) into the biorisk management regime governing genetic engineering of pathogens. SoCs enable pathogenesis in all microbes infecting hosts that are 'of concern' to human civilization. Here we review the functions of SoCs (FunSoCs) and discuss how they might bring clarity to potentially problematic research outcomes involving infectious agents. We believe that annotation of SoCs with FunSoCs has the potential to improve the likelihood that dual use research of concern is recognized by both scientists and regulators before it occurs."

- Widening the framework for regulation of dual-use research in the wake of the COVID-19 pandemic

  Summary:

  "In the wake of the COVID-19 pandemic, the global scientific community has directed increased resources and attention towards the study of viruses and emergency medical countermeasure development. Our analysis of publicly available data on publications, preprints, and clinical trials coupled with the Global Health Security Index measure of dual-use oversight suggests that some research activities raise dualuse concerns that have gone unaddressed. While most of the research in this domain is essential to advance vaccines, therapeutics, and diagnostics against SARS-CoV-2, improving responses to natural pandemics must not come at the expense of increasing risks of accidental or intentional biological threats. We argue that certain categories of research that receive more attention following a pandemic pose unique dual-use risks that must be addressed by a comprehensive approach involving: 1) a broader definition of dual-use research of concern that captures experimental techniques that could feasibly be translated to harmful pathogens. 2) creation of regulatory frameworks to oversee the funding and publication of dual-use experiments, especially in countries with large biomedical research output and countries where the GHSI has highlighted shortcomings in national dual-use policies. These policy

changes must also be accompanied by stronger social norms among grant makers and scientists alike, in order to effectively address biosecurity concerns in advance of the next outbreak."

- GERMS, VIRUSES, AND SECRETS: GOVERNMENT PLANS TO MOVE EXOTIC DISEASE RESEARCH TO THE MAINLAND UNITED STATES

4.1 Virology Labs Collecting Virus Samples

- Mitigating Biosecurity Challenges of Wildlife Virus Discovery
- Global Virome Project
  Summary:
  "The present grant focuses on characterizing the human-animal interface, rather than large-scale undifferentiated wildlife virus discovery promoted by the Global Virome Project. This has important implications for benefits and risks."
- What To Do When Research to Stop a Pandemic Could Start One Instead
  Summary:
  This article discusses research on a potentially pandemic avian influenza virus. Scientists infected ferrets to study its transmission, raising concerns about lab-created deadly diseases. The need for oversight, global collaboration, and stricter guidelines is emphasized, along with the debated origins of COVID-19.
- Predict US AID
  Summary:
  "PREDICT's work illuminated both the threat that emerging viruses pose to us, as well as the impact that strategic investments in strengthening preemptive capacity for virus surveillance can have on rapid disease detection and response."
- Global Biosafety Fears Grow Amid Rise in Labs Handling Dangerous Pathogens
  Summary:
  The article highlights the growing number of labs worldwide handling dangerous pathogens, focusing on the rise of BSL4 labs. Biosafety concerns arise due to insufficient oversight in tandem with this expansion. The need for enhanced international standards, transparent reporting, and coordinated action is emphasized. The article provides recommendations to strengthen biosecurity practices and regulate the establishment of new labs.

5. Gain of Function Research

- How likely is it that biological agents will be used deliberately to cause widespread harm?
  Summary:
  "The paper discusses the potential risks associated with research on pathogens with pandemic potential (PPP). It raises concerns about the misuse of PPP by individuals, groups, or countries for harmful purposes. Historical examples are used to highlight that new technologies can be

weaponized during political, economic, or social unrest. It discusses how the proliferation of PPP research in various laboratories could lead to theft of strains due to inadequate security measures. The authors express concerns over the potential deliberate misuse within the scientific community and the public availability of published PPP genome sequences. They call for stricter regulations, including expert risk assessment, increased transparency, and international norms for conducting PPP research. They emphasize caution and thorough risk analysis in future policy-making regarding PPP research."

- Guidelines on working with pathogens of pandemic potential (Post-moratorium guidance/policy in the US).

  Summary:

  "Summary: OSTP Issues "Recommended Policy Guidance for Departmental Development of Review Mechanisms for Potential Pandemic Pathogen Care and Oversight (P3CO)"

  - Risk and Benefit Analysis of Gain of Function Research

    Summary:

    "The report discusses an analysis intended to guide the National Science Advisory Board for Biosecurity (NSABB) and the US government in shaping policy around Gain of Function (GoF) research. The study broadly examines all traits and pathogens mentioned in the GoF research framework to determine risk. It aims to identify which enhanced phenotypes increase pandemic risk and which experiments, despite their risk, have crucial unique benefits. The report is split into three tasks: a risk analysis (RA) of accidents and natural disasters, a biosecurity RA, and a benefit assessment. The RA uses quantitative modeling to predict the probability and consequences of events leading to outbreaks and their termination. The biosecurity RA evaluates data on malicious actors and the effectiveness of security measures. The benefit assessment identifies knowledge gaps that GoF research could fill and barriers to these benefits' realization."

  - Gain of Function Research: summary of the second symposium (Both comprehensive reviews/reports of the discussion around GoF prompted by H5N1 etc).

- Between Publishing and Perishing? H5N1 Research Unleashes Unprecedented Dual-Use Research Controversy (Concise discussion of the H5N1 story)

  Summary:

  "In 2012, an outbreak of bird flu in China sparked concern due to the high mortality rate of the H5N1 virus and its potential to mutate into a form easily transmitted between humans. This led to a debate about the benefits and risks of publishing research on such a potentially dangerous virus, with some suggesting that the information could be used maliciously.
  The situation was further complicated by differing opinions between various organizations. While the U.S. National Science Advisory Board for Biosecurity (NSABB) initially recommended withholding key methodologies used in the research, the World Health Organization (WHO) disagreed and urged full publication. Later, the NSABB reversed its initial decision and supported publication.

This incident brought attention to the need for international norms to manage dual-use research, the question of who has the authority to regulate life science research, and the complex challenge of managing dual-use life science research that carries both significant benefits and potential risks. Lastly, the H5N1 controversy highlights the importance of devising an optimal policy strategy that addresses both the risk of pursuing research on potentially pandemic pathogens like H5N1 and the risk of remaining ignorant about such viruses. The incident offers a unique opportunity to refine regulations managing dual-use research"

- Moratorium on Research Intended To Create Novel Potential Pandemic Pathogens (Editorial/discussion)

  Summary:

  "In this commentary, we discuss key elements of risk analysis and offer an example of an approach that could be taken. We describe benefit analysis, offering an account of the kinds of benefits that are relevant and our own view of those at this point. We note other factors that are important to consider. And we argue that a moratorium is the right approach until a rigorous, objective, and credible risk assessment process can be established."

- Biosecurity Implications for the Synthesis of Horsepox, an Orthopoxvirus

  Summary:

  "The article discusses the biosecurity and biodefense implications of the recent creation of horsepox virus, an extinct species of orthopoxvirus. It states that even though the creation of horsepox virus was not trivial, the synthesis of such viruses is technically challenging and is likely to remain so, thereby limiting potential misuse by certain malicious actors. The article further examines the intended purpose of the horsepox virus synthesis: the development of a smallpox vaccine. If successful, the new vaccine could be eligible for U.S. government incentives for the priority FDA review of medical countermeasures against biosecurity threats. However, if these incentives are found to be counterproductive for security, the priority review voucher program should be more clearly defined or restricted based on need. The authors note that closing off all avenues for illicit misuse of gene synthesis is impossible, but they advocate for implementing policies, regulations, and guidelines that make illicit recreation more difficult, burdensome, detectable, and preventable without negatively impacting the research enterprise. They also encourage scientists to actively participate in safeguarding their technical fields from irresponsible or illicit actions."

- A Critical Analysis of the Scientific and Commercial Rationales for the De Novo Synthesis of Horsepox Virus, Gregory Koblentz, mSphere, March 2018. (A fairly harsh point-by-point takedown of reasons for carrying out the horsepox synthesis experiments.)

  Summary:

  "This article evaluates the scientific and commercial rationales for the synthesis of horsepox virus. I find that the claimed benefits of using horsepox virus as a smallpox vaccine rest on a weak scientific foundation and an even weaker business case that this project will lead to a licensed medical countermeasure. The combination of questionable benefits and known risks of this dual use research raises serious questions about the wisdom of undertaking research that could be used to recreate variola virus. This analysis also raises important questions about the propriety of a

private company sponsoring such dual use research without appropriate oversight and highlights an important gap in United States dual use research regulations."

- A Holistic Assessment of the Risks and Benefits of the Synthesis of Horsepox Virus, Diane DiEuliis and Gigi Kwik Gronvall, mSphere, March 2018. (Using the case study as a jumping-off point to walk through a process of assessing risks more broadly.)
  Abstract:

  "The re-creation of horsepox virus, an extinct orthopoxvirus with similarity to smallpox virus, has caused concerns in the biosecurity and biodefense communities that the technical capabilities achieved could advance the re-creation of smallpox virus by nefarious actors. The work is now published. While the authors went through due biosecurity diligence at their research institution and with the proper Canadian federal authorities, now that the experiments have been published, there is an opportunity to discuss the dual use risks and benefits of the research itself, as well as those associated with publication of such research—all of which challenge current policies. Here, an analytical framework is used to assess the risks and benefits of such dual use research, and relevant components of biosecurity policy and the biodefense enterprise (including the acquisition of medical countermeasures) in the United States are discussed. The authors emphasize the need to use such risk/benefit assessments at the onset of research and throughout its development, followed by an assessment for its responsible communication."
- *Horsepox synthesis: A case of the unilateralist's curse?
  Summary:

  "Canadian researcher Ryan Noyce synthesized a copy of horsepox DNA, raising concerns about the potential for the technique to be used to recreate smallpox. This instance underscores the challenge facing dual-use research in biotechnology known as the "unilateralist's curse", where potentially harmful research decisions are made by the most optimistic individual. This can lead to "action bias", with hazardous work likely to occur due to independent action rather than collective decision-making. The situation could be worsened by the number of potential actors, the passing of time, poor threat assessment, conflicts of interest, and the "tragedy of the commons". The curse also threatens the efficacy of safety mechanisms like funding bodies, regulators, and journals, with the decentralized nature of these entities making it easier for risky research to slip through. To counter this, it's suggested that a consensus approach to research decisions be encouraged, community norms towards caution be strengthened, and non-scientific stakeholders be included in decision-making."
- Biosecurity risks associated with vaccine platform technologies
  Summary:

  "The article discusses the crucial role vaccine platforms have played in expediting COVID-19 vaccine development and the need for their further advancement. Different platform approaches such as virally vectored and RNA-based vaccines, DNA vaccines, and recombinant protein expression systems have various advantages and challenges. Viral vector-based and DNA vaccines have received a significant amount of research funding. However, these platform vaccine technologies may have dual-use potential, meaning they could be used for both beneficial and harmful purposes such as

pathogen engineering, thereby increasing the risk for deliberate biological events. Virally vectored vaccines are considered to have a higher dual-use potential because their development could provide insights into techniques like circumventing pre-existing anti-vector immunity and increasing the number of individuals capable of engineering viruses of concern. In contrast, RNA vaccines are considered to have relatively lower dual-use potential. The article suggests minimizing biosecurity risks associated with platform advancement by focusing on non-genetic modifications, using vectors that are not based on human-pathogenic viruses, or investing more in RNA-based vaccine approaches. It also underscores the need to improve the governance of biotechnology and life science research with dual-use potential and enhance awareness of dual-use risks among scientists outside the pathogen research community. Additionally, both public and private research funding bodies are advised to prioritize evaluating and reducing biosecurity risks."

- Next Steps for Access to Safe, Secure DNA Synthesis

  Abstract:

  "The DNA synthesis industry has, since the invention of gene-length synthesis, worked proactively to ensure synthesis is carried out securely and safely. Informed by guidance from the U.S. government, several of these companies have collaborated over the last decade to produce a set of best practices for customer and sequence screening prior to manufacture. Taken together, these practices ensure that synthetic DNA is used to advance research that is designed and intended for public benefit. With increasing scale in the industry and expanding capability in the synthetic biology toolset, it is worth revisiting current practices to evaluate additional measures to ensure the continued safety and wide availability of DNA synthesis. Here we encourage specific steps, in part derived from successes in the cybersecurity community, that can ensure synthesis screening systems stay well ahead of emerging challenges, to continue to enable responsible research advances. Gene synthesis companies, science and technology funders, policymakers, and the scientific community as a whole have a shared duty to continue to minimize risk and maximize the safety and security of DNA synthesis to further power world-changing developments in advanced biological manufacturing, agriculture, drug development, healthcare, and energy."

- Strengthen oversight of risky research on pathogens

  Summary:

  "Life sciences research offers immense benefits and is crucial for advancements in medicine, public health, agriculture, and management of the environment. But a recent guidance framework by the World Health Organization (WHO) reminds us of the continued lack of awareness and governance structures in many countries for life sciences research that may cause harm through accident or misapplication (1). Robust risk management would enable the full realization and equitable distribution of potential benefits from the life sciences and associated technologies, and reassure the public (1). International guidelines and standards of conduct are needed (2), along with effective oversight institutions and leadership (3). The US government (USG) has played a prominent role to date and is now reviewing its biosecurity policies. We identify substantial gaps and suggest approaches to

address them so as to improve US policies and usefully influence policies globally."

- Making Security Viral: Shifting Engineering Biology Culture and Publishing

  Summary:

  "The tools for gene and genome synthesis and editing have enabled breakthrough applications with profound societal implications, demonstrated in the rapid development of COVID-19 diagnostics, therapeutics, and vaccines. Critical to this progress was the sharing of knowledge, including the use of reverse genetics for the de novo construction of SARS-CoV-2 in labs. However, the distribution of such knowledge, especially in protocols, carries risks, given the harm caused by the virus, the unequal distribution of vaccines and therapeutics, and the interest from laboratories not experienced with highly transmissible pandemic pathogens. The authors recommend steps for enhancing security in the publication of synthetic biology research. They suggest mandatory safety and security reviews for protocol manuscripts synthesizing certain pathogenic viruses; inclusion of security discussion descriptions in such publications; and the development of a governance framework for basic security screening during the publication process of synthetic biology manuscripts. These steps aim to support a safe and secure research enterprise that can maximize positive impacts and minimize negative outcomes."

- Protocols and risks: when less is more

  Summary:

  "The article discusses the potential risks posed by the publication of a detailed protocol for the synthesis of the SARS-CoV-2 virus, the causative agent of COVID-19. The authors suggest that while such protocols can accelerate the development of medical countermeasures, they can also potentially be misused to create more dangerous variants of the virus. The detailed protocol described by Xie et al. lowers the barrier for those without direct experience, possibly including malicious actors. The authors argue that expanding the number of practitioners of this protocol increases the chances of accidents, especially among inexperienced researchers without adequate biocontainment. They highlight that the wide dissemination of such a capability can change the risk landscape, with infectious agents with high transmissibility posing special risks. The authors recommend special scrutiny and review for efforts to develop protocols that enable reverse genetic engineering of potentially dangerous infectious agents. They also call for greater clarity, scope, authority, and transparency in the review of such research. To mitigate risks, they propose measures like screening or registration for access to commercial synthesis of specific DNA constructs, public notification of intentions to synthesize known or potential pandemic pathogens, and public disclosure of intended modifications to a known pandemic agent."

- Rapid proliferation of pandemic research: implications for dual-use risks

  Abstract:

  "The COVID-19 pandemic has demonstrated the world's vulnerability to biological catastrophe and elicited unprecedented scientific efforts. Some of this work and its derivatives, however, present dual-use risks (i.e., potential

harm from misapplication of beneficial research) that have largely gone unaddressed. For instance, gain-of-function studies and reverse genetics protocols may facilitate the engineering of concerning SARS-CoV-2 variants and other pathogens. The risk of accidental or deliberate release of dangerous pathogens may be increased by large-scale collection and characterization of zoonotic viruses undertaken in an effort to understand what enables animal-to-human transmission. These concerns are exacerbated by the rise of preprint publishing that circumvents a late-stage opportunity for dual-use oversight. To prevent the next global health emergency, we must avoid inadvertently increasing the threat of future biological events. This requires a nuanced and proactive approach to dual-use evaluation throughout the research life cycle, including the conception, funding, conduct, and dissemination of research."

- The Deadliest Virus, Michael Specter, The New Yorker, March 2012.
  Summary:
  In 1997, an unusual strain of influenza known as H5N1, or bird flu, was identified in Hong Kong following the death of a three-year-old boy. Despite mass culling of chickens in the city, the virus reemerged in 2003 in Thailand and has since killed nearly 60% of the people it is known to have infected. In 2012, Dutch virologist Ron Fouchier announced that he had mutated H5N1, making it highly contagious between ferrets, a model for human influenza transmission. His research sparked fears of a natural pandemic and concerns over biosecurity. The National Science Advisory Board for Biosecurity subsequently recommended delaying the publication of Fouchier's research methods. While some argue the research is essential for understanding potential pandemics, others worry about the risks of this information being misused or the virus accidentally escaping from the lab.
- Biosecurity in an age of open science
  Summary:
  "The article discusses the increasing risk of misuse of biological research due to advances in biotechnology and the spread of open science. The authors explore the impact of open science on biosecurity and biosafety, identifying potential risks and opportunities for risk mitigation. While the open sharing of computational tools, datasets, and protocols could heighten risks, especially in dangerous fields like viral engineering, these risks could be mitigated by using access-controlled repositories or application programming interfaces. The increasing use of preprints to quickly share findings could challenge risk mitigation strategies at the publication stage, underscoring the need for oversight earlier in the research process. The authors suggest that preregistration of research, an open science practice, provides an opportunity for biosecurity risk assessment at the research conception stage. They emphasize the important role of both open science and biosecurity experts in ensuring responsible research with maximum societal benefit.
- Assessing the Bioweapons Threat
  (Little expert agreement about the risk landscape)
  Abstract:
  The U.S. government (USG) has taken steps intended to diminish the likelihood of misuse of research—in one recent action, declaring a funding

moratorium on gain-of-function studies on influenza until a risk-benefit analysis can be conducted. The analysis is expected to examine biosafety concerns, the potential for such research to produce a biological weapons agent, and the possibility that publication may lower barriers to bioweapons development. To analyze the security risks of biological research, however, it is first necessary to determine the likelihood that bioweapons will threaten national security and to what degree legitimate research is at risk of misuse. This type of assessment is fraught with uncertainty.

- Rationally Speaking Podcast: 137: Should scientists try to create dangerous viruses? (Marc Lipsitch)
- Rationally Speaking Podcast: 261: Dangerous biological research – is it worth it? (Kevin Esvelt)

6. AI Increasing Biorisk

- Artificial intelligence and biological misuse: Differentiating risks of language models and biological design tools

  Abstract:

  > "As advancements in artificial intelligence propel progress in the life sciences, they may also enable the weaponisation and misuse of biological agents. This article differentiates two classes of AI tools that pose such biosecurity risks: large language models (LLMs) and biological design tools (BDTs). LLMs, such as GPT-4, are already able to provide dual-use information that could have enabled historical biological weapons efforts to succeed. As LLMs are turned into lab assistants and autonomous science tools, this will further increase their ability to support research. Thus, LLMs will in particular lower barriers to biological misuse. In contrast, BDTs will expand the capabilities of sophisticated actors. Concretely, BDTs may enable the creation of pandemic pathogens substantially worse than anything seen to date and could enable forms of more predictable and targeted biological weapons. In combination, LLMs and BDTs could raise the ceiling of harm from biological agents and could make them broadly accessible. The differing risk profiles of LLMs and BDTs have important implications for risk mitigation. LLM risks require urgent action and might be effectively mitigated by controlling access to dangerous capabilities. Mandatory pre-release evaluations could be critical to ensure that developers eliminate dangerous capabilities. Science-specific AI tools demand differentiated strategies to allow access to legitimate users while preventing misuse. Meanwhile, risks from BDTs are less defined and require monitoring by developers and policymakers. Key to reducing these risks will be enhanced screening of gene synthesis, interventions to deter biological misuse by sophisticated actors, and exploration of specific controls of BDTs."

- Can large language models democratize access to dual-use biotechnology?

  Abstract:

  > "Large language models (LLMs) such as those embedded in 'chatbots' are accelerating and democratizing research by providing comprehensible information and expertise from many different fields. However, these models may also confer easy access to dual-use technologies capable of inflicting great harm. To evaluate this risk, the 'Safeguarding the Future' course at MIT tasked non-scientist students with investigating whether LLM chatbots could be prompted to assist non-experts in causing a pandemic. In one hour, the

chatbots suggested four potential pandemic pathogens, explained how they can be generated from synthetic DNA using reverse genetics, supplied the names of DNA synthesis companies unlikely to screen orders, identified detailed protocols and how to troubleshoot them, and recommended that anyone lacking the skills to perform reverse genetics engage a core facility or contract research organization. Collectively, these results suggest that LLMs will make pandemic-class agents widely accessible as soon as they are credibly identified, even to people with little or no laboratory training. Promising nonproliferation measures include pre-release evaluations of LLMs by third parties, curating training datasets to remove harmful concepts, and verifiably screening all DNA generated by synthesis providers or used by contract research organizations and robotic cloud laboratories to engineer organisms or viruses."

- There's a 'ChatGPT' for biology. What could go wrong?
  Summary:
  The article discusses the potential of AI in protein design, with algorithms like ProtGPT2 and ProGen enabling rapid creation of molecules and proteins for various uses, from improving drug production to neutralizing pathogens. However, there are significant biosecurity risks, including the potential misuse of this technology to create bioweapons or toxins. The authors highlight a lack of awareness among scientists about these risks and emphasize the need for dialogue between the security and life science communities to ensure responsible use of this technology. Concerns also extend to the possibility of AI leading to intrusive forms of surveillance and the creation of targeted biological weapons.
- Artificial intelligence and biological misuse: Differentiating risks of language models and biological design tools
  Summary:
  "As advancements in artificial intelligence propel progress in the life sciences, they may also enable the weaponisation and misuse of biological agents. This article differentiates two classes of AI tools that pose such biosecurity risks: large language models (LLMs) and biological design tools (BDTs). LLMs, such as GPT-4, are already able to provide dual-use information that could have enabled historical biological weapons efforts to succeed. As LLMs are turned into lab assistants and autonomous science tools, this will further increase their ability to support research. Thus, LLMs will in particular lower barriers to biological misuse. In contrast, BDTs will expand the capabilities of sophisticated actors. Concretely, BDTs may enable the creation of pandemic pathogens substantially worse than anything seen to date and could enable forms of more predictable and targeted biological weapons. In combination, LLMs and BDTs could raise the ceiling of harm from biological agents and could make them broadly accessible. The differing risk profiles of LLMs and BDTs have important implications for risk mitigation. LLM risks require urgent action and might be effectively mitigated by controlling access to dangerous capabilities. Mandatory pre-release evaluations could be critical to ensure that developers eliminate dangerous capabilities. Science-specific AI tools demand differentiated strategies to allow access to legitimate users while

preventing misuse. Meanwhile, risks from BDTs are less defined and require monitoring by developers and policymakers. Key to reducing these risks will be enhanced screening of gene synthesis, interventions to deter biological misuse by sophisticated actors, and exploration of specific controls of BDTs."

- AI in drug discovery: A wake-up call (chemical weapon)
  Summary:
  The passage discusses a proof-of-concept presentation on dual-use artificial intelligence (AI) in drug discovery. Collaborations Pharmaceuticals Inc. shared how a generative algorithm could develop the nerve agent VX and numerous analogs, emphasizing the need for discussions on the potential misuse of AI in drug discovery. The authors aim to raise awareness about the consequences of developing powerful technologies without considering their potential for misuse. They hope that their experiment will serve as a wake-up call for users of generative AI.

7. BioHackers

- Garage biotech: Life hackers - 2010
  Summary:
  Physicist Rob Carlson believes in "garage biology," a concept that involves democratizing access to high-tech biological research tools to spur innovation. His idea has inspired a wave of "biohackers" who set up labs at home, purchasing used equipment online and performing various experiments. Critics, however, argue that significant resources are needed for impactful biological research, making DIY biology less feasible. Despite challenges, Carlson remains optimistic, asserting that the decreasing cost of biological research and the rise of protein synthesis companies may facilitate this new wave of amateur scientific innovation.
- Governance: Learn from DIY biologists
  Summary:
  Todd Kuiken argues that the DIY biology community, which is made up of hobbyists and those promoting societal learning and open science, is capable of responsibly handling gene-editing technology such as CRISPR–Cas9. Despite concerns, Kuiken insists that creating harmful organisms is beyond the capabilities and ethical stance of most DIY biologists. The community has established codes of conduct and advisory boards to ensure safe practices, and some have even formed partnerships with security agencies. The emergence of crowdfunding campaigns that aim to distribute DIY CRISPR kits has raised concerns, not because it enhances DIY capabilities but due to possible non-compliance with established conduct codes. As such, Kuiken calls for more comprehensive governance models to ensure responsible research.
- Ellen Jorgensen: Biohacking - You Can Do It Too (TED Talk)
  Summary:
  In this TED talk, Ellen Jorgensen introduces us to the biohacking community and reviews common misconceptions about the dangers of biohacking.

- Cathal Garvey: Bringing Biotechnology into the Home (TEDx Talk)
  Summary:
  In this TEDx talk, Cathal Garvey reviews the benefits of biotechnology and introduces consumer biotechnologies in development; such as bioprinters, customized pets, downloadable DNA, and biochips.
- Nina Tandon: Caring for Engineered Tissue (TED Talk)
  Summary:
  In this TED talk Nina Tandon talks about simple but powerful methods of caring for artificially grown cells by copying their natural environment.

- Gregory Stock: To Upgrade is Human (TED Talk)
  Summary:
  Biotech ethicist Gregory Stock talks about new, more meaningful (and controversial) technologies, like customizable babies, whose adoption might drive human evolution.
- Richard Resnick: Welcome to the Genomic Revolution (TEDx Talk)
  Summary:
  In this accessible talk from TEDxBoston, Richard Resnick shows how cheap and fast genome sequencing is about to turn health care (and insurance, and politics) upside down.

7.1 Various Biohacker Communities

[This needs research!!]

8. Historical Cases of Biological Risks

My Summary and Hot Takes on Historical Cases of Biological Risks

- A century of biological weapons programs (1915–2015): reviewing the evidence (Up to date review of known and suspected state BW programs)
  Summary:
  This article reviews what is known about the proliferation of biological-weapon programs during the past century. Collecting information on biological-weapon programs is difficult, even for intelligence organizations, and there is limited information available on the extent and character of past programs. A review of the open-source literature supports claims that twenty-three states had, probably had, or possibly had a program. The number of active programs has varied over time, from a low of zero in 1920 to a high of possibly as many as eight in 1990. Program size and sophistication also has varied enormously; most were small and unsophisticated, and many existed for only a short period of time.
- What do historical statistics teach us about the accidental release of pandemic bioweapons?
  Summary:
  Historical data shows that research on dangerous pathogens often leads to accidental infections and occasionally escapes into the world. When these

rates are extrapolated, it suggests that any large-scale illegal programs working with bioweapons posing global catastrophic biological risks (GCBRs) would likely result in their accidental release within decades.
Examining the former Soviet Union's biological weapons program, the largest known, reveals that they primarily worked with diseases that weren't capable of pandemic spread. However, they were reportedly engaged in research to produce deadly pandemic pathogens. If future illegal bioweapons programs were to succeed in creating pandemic pathogens, the historical rates of accidental release could pose a greater threat than intentional use in warfare. Notably, pandemic bioweapons would only be intentionally used under extreme circumstances, considering they could decimate the wielder's own population. On the contrary, historical data suggests that accidental community releases are significantly more likely.
This analysis underlines the importance of political efforts to ensure no states are attempting to develop GCBR pathogens, while advocating for advancements in biosafety technology and methodology to reduce the risk of any existing illegal state programs. The absence of visible release of engineered pandemics also serves as evidence against the existence of such large-scale programs in recent decades.

- FLI Podcast (Part 2): Anthrax, Agent Orange, and Yellow Rain: Verification Stories with Matthew Meselson and Max Tegmark
  "**Things discussed:**
  - The value of verification, regardless of the challenges
  - The 1979 Sverdlovsk anthrax outbreak
  - The use of "rainbow" herbicides during the Vietnam War, including Agent Orange
  - The Yellow Rain Controversy

- Summary of historical attacks using chemical or biological weapons
  Summary:
  The following table summarizes the known historical instances of the use of chemical or biological weapons.

- Poor Man's Atomic Bomb? Exploring the Relationship between ''Weapons of Mass Destruction''
  Summary:
  The causes and consequences of nuclear proliferation have received a great deal of academic attention. However, nuclear weapons are rarely discussed in isolation in policy circles. Instead, nuclear weapons are relevant as part of a category of weapons of mass destruction (WMDs) that includes chemical and biological weapons (CBWs). Are the factors that drive CBWs proliferation similar to those that drive nuclear proliferation? What is the relationship between these weapons types? In this article, we explore whether nuclear weapons and CBWs serve as complements or substitutes. Using newly collected data on both CBWs pursuit and possession over time, we find that nuclear, biological, and chemical weapons generally function as complements at the pursuit stage. In addition, countries that acquire nuclear weapons

become less interested in pursuing other types of WMDs and are even willing to give them up in some cases.

- Bioterrorism and Biocrimes: The illicit use of biological agents since 1900 (Long, but interesting survey and discussion of the bioterrorism 'track record')

  Summary:

  The working paper investigates bioterrorism, beginning with a general overview, including its definition, historical occurrences, and methods for acquiring and deploying biological agents. It then explores specific case studies of bioterrorism, categorizing them into confirmed use, probable or possible use, threatened use, confirmed possession, and probable or possible possession of biological agents. Lastly, it discusses cases involving potential interest in acquiring biological agents and false reports or hoaxes.

- Project Coast: Apartheid's chemical and biological warfare programme (Comprehensive, but very long, summary of the South African BW program.

  Summary:

  The paper is an in-depth examination of the Botha Regime's strategy in South Africa, focusing on the context of the region and the development and use of chemical weapons. It investigates Project Coast, a covert South African chemical and biological warfare program, and its connections with police and military units. The paper also discusses how private companies and research laboratories, such as Roodeplaat Research Laboratories, were involved in the project. It delves into alleged fraudulent activities, the intent behind the program, incidents of poisoning, and the structure and management of Project Coast, including its international links. The paper then details the closing down of Project Coast, the arrest of Dr. Wouter Basson - the project's director, and his subsequent criminal trial. It finally examines the implications of the de Klerk years, a period of significant political change in South Africa.

- History of biological weapons: From poisoned darts to intentional epidemics (40 mins)

  Summary:

  The paper explores the historical and ongoing interest in biological weapons, from early uses such as curare and amphibian-derived toxins, to modern efforts to weaponize biological toxins like botulinum and ricin. It highlights the challenges in studying the history of biological weapons due to factors such as secrecy, confirmation difficulties, unreliable data, and the use of biological attack allegations for propaganda and hoaxes.

  The paper delves into early attempts at biological weaponry, the era of modern microbiology, World Wars, and the Cold War, focusing on the development and use of such weapons. It scrutinizes the US and Soviet biological weapons programs, along with the program in South Africa, detailing their rise, operations, and subsequent disarmament.

  The case of Iraq's biological weapons program is separately examined, presumably due to its unique context and global implications. The paper also explores the concept of biological terrorism and bio-crimes, addressing the use of biological agents by non-state entities like terrorist groups and criminals. It underscores the continued interest in these weapons across various domains, suggesting that this trend is likely to persist.

- Japan guilty of germ warfare against thousands of Chinese - Is this accurate?
  Summary:
  A Tokyo court has recognized for the first time that Japan engaged in biological warfare during the second world war, killing thousands of Chinese civilians. The court stated that the imperial army violated the Geneva and Hague conventions by spreading diseases like plague and typhoid in Chinese cities between 1940 and 1942. The ruling concluded a five-year case brought by mostly Chinese plaintiffs seeking compensation for the suffering inflicted by Unit 731, a secret Japanese army unit involved in the germ warfare programme.
  However, the court denied the compensation claims, stating that all reparation issues had been addressed by international peace treaties at the government level. This decision was met with outrage from the victims and their families. Despite the denial of compensation, the legal team representing the plaintiffs welcomed the judgment as it officially acknowledged the atrocities committed by Unit 731, which the Japanese government had long dismissed due to a supposed lack of evidence. The plaintiffs expressed their intention to appeal the decision.
- Dangerous lab leaks happen far more often than the public is aware
  Summary:
  The article discusses the ongoing issue of safety breaches in biological labs worldwide, where workers handle hazardous pathogens. These breaches often result from human error or lax safety standards, and information about these incidents is usually kept secret. This lack of transparency is further highlighted in the author's book, "Pandora's Gamble: Lab Leaks, Pandemics, and a World at Risk". The article stresses that current biosafety regulations are fragmented and rely on self-policing by labs. Given the growing number of high-containment labs globally and the increased interest in the potential lab origins of Covid-19, the author calls for improved oversight and transparency to prevent future pandemics caused by lab accidents.
- Pandora's Gamble (Lab Leaks, Pandemics, and a World at Risk)
  Summary:
  "Pandora's Gamble" is a book by investigative reporter Alison Young that delves into the troubling history of laboratory accidents and the potential risks they pose. The book considers the possibility that COVID-19 might have originated from a lab leak in Wuhan, China, despite attempts by scientists and officials to dismiss this theory. Young exposes the shocking frequency of lab accidents, even in the world's top labs, and the lack of stringent oversight that can lead to such incidents. The book highlights major gaps in government supervision and the efforts by powerful individuals and institutions to keep lab accidents secret. The insights are drawn from extensive reporting and interviews with key figures, such as Dr. Anthony Fauci and former CDC Director Tom Frieden.
- Historical use of bioweapons -short summary and game

9. Policy

- LPI BIORISK - form page 56 - updated 09/01/2023

  Summary:

  Synthetic biology holds enormous potential in fields like medicine, fuel, materials science, agriculture, and more. However, it also presents global catastrophic risks, such as engineered pandemics. Legal and governance structures are crucial to managing these risks and ensuring responsible application of biotechnology.

  Research should focus on reducing risks from intentional misuse (e.g., biowarfare, bioterrorism), accidental release of harmful biological agents, and unintended consequences of the deployment of bio-engineered organisms. It's important to manage dual-use research, where seemingly harmless knowledge or technologies could be used harmfully.

  Law should aim to prevent the release of bio-agents, minimize negative outcomes, steer scientific research responsibly, and distribute benefits and risks. Challenges include maintaining adaptability to emerging technologies, managing information hazards (where dissemination of certain knowledge could be harmful), and ensuring clear and enforceable regulation.

  The document suggests specific research projects in each area and highlights the importance of a comprehensive approach across international and national law, scientific disciplines, and between professionals and amateur biologists. Legal research addressing these risks is crucial, with a focus on global coordination and response, prevention of misuse or accident, and consideration of potential unintended consequences.

- 80 questions for UK biological security

  Summary:

  The UK Biological Security Strategy acknowledges the increasing complexities and challenges brought on by new technologies and globalization in ensuring biological security. To address these challenges, an expert-led study has generated 80 crucial policy-relevant research questions that could help shape UK's biological security agenda. The questions are categorized into six areas: bioengineering, communication and behaviour, disease threats (including pandemics), governance and policy, invasive alien species, and securing biological materials against misuse. The research agenda aims to guide effective management and preparation for future biological threats, including pandemics like COVID-19. The authors suggest that this approach could be replicated globally to tackle emerging biological security issues.

- Biosafety and Biosecurity in Containment: A Regulatory Overview

  Summary:

  “When biosafety for contained use is addressed in international fora and discussions, often the topic is limited to working with genetically modified organisms (GMOs) in facilities such as laboratories, animal facilities, and greenhouses. However, the scope of biosafety in containment encompasses many other types of biological materials, such as human, animal and plant pathogens, nucleic acids, proteins, human samples, animals or plants, or

by-products thereof, and overlaps often with the topic of biosecurity. This is also reflected in the regulations that apply for activities with biological materials in contained facilities. The common denominator of these regulations is the focus on protection of people and environment, while applying the key principles of risk assessment and risk management. This review provides an overview of regulatory frameworks for biosafety and biosecurity in containment around the globe, as well as points out overlap with other regulatory frameworks, such as the Nagoya Protocol, or Plant and Animal Health regulations."

- Centre for Long Term Resilience Future Proof report - "Biosecurity" Pages 16-22 (20 mins)

  Summary:

  "As the UK recovers from the Covid-19 pandemic, there is a call for it to seize the chance to prepare for the next major risk event. Similar to the transformative changes after World War II, like the formation of the NHS and national insurance, this current crisis presents an opportunity for progress. This report suggests that the UK should become a global leader in preparing for extreme risks, akin to the efforts being made in the United States. While the exact nature of the next extreme risk event is uncertain, it is crucial to know what these risks could be and how to prepare for them. The report presents a roadmap for managing these risks, acting as an insurance policy for Britain. It includes recommendations for actions the government should take, analyses of the UK's focus on each risk, and estimated implementation costs. The cost of this investment is reportedly insignificant considering its potential benefits."

- Building the UK's Resilience to Future Pandemic Threats

  Summary:

  "CLTR's Biosecurity Policy Manager, Sophie Rose, recently authored a submission of evidence to the UK Government's public inquiry into the UK's preparations for, and response to, the COVID-19 pandemic
  In the wake of COVID-19, the UK must take steps to improve preparedness for the full spectrum of future biological threats. The submission makes five key recommendations for strengthening the UK's approach to biosecurity:
  (i) Identify the UK Government departments, teams and positions responsible for preventing, detecting or responding to deliberate or accidental biological threats.
  (ii) Task UKHSA with the development of a comprehensive strategy for rapidly identifying and responding to novel pathogens.
  (iii) Expand MoD's investment into R&D for tools and technology that can aid in the detection, characterisation or mitigation of the full spectrum of biological threats.
  (iv) Task UKHSA with directing a cross-sectoral scoping exercise to identify existing surveillance systems and gaps where additional infrastructure or emerging technologies can add the most value.
  (v) The Health and Safety Executive (HSE) should facilitate the transparent reporting of laboratory accidents, serious incidents and the timing and results of high-containment (e.g. CL-3 & -4) lab inspections and audit their findings annually."

- COVID-19, SARS-CoV-2, and Export Controls, Piers Millett and Paul Rutten, Health Security, August 2020
  Summary:
  > Export controls aim to prevent misuse of materials for creating biological weapons, not hinder crucial research during pandemics. The article investigates how these controls could apply to the SARS-CoV-2 virus and reveals the taxonomic and genetic factors contributing to ambiguities in the current export control lists. The authors suggest revisions to these control systems using sequence, disease, and function-based methods in the short, medium, and long term.
- The careers and policies that can prevent global catastrophic biological risks, according to world-leading health security expert Dr Inglesby, April 18 2018.
  "**Things discussed:**
  - Should more people in medicine work on security?
  - What are the top jobs for people who want to improve health security and how do they work towards getting them?
  - What people can do to protect funding for the Global Health Security Agenda.
  - Should we be more concerned about natural or human caused pandemics? Which is more neglected?
  - Should we be allocating more attention and resources to global catastrophic risk scenarios?
  - Why are senior figures reluctant to prioritize one project or area at the expense of another?
  - What does Tom think about the idea that in the medium term, human-caused pandemics will pose a far greater risk than natural pandemics, and so we should focus on specific counter-measures?
  - Are the main risks and solutions understood, and it's just a matter of implementation? - Or is the principal task to identify and understand them?
  - How is the current US government performing in these areas?
  - Which agencies are empowered to think about low probability high magnitude events?
  - Are there any scientific breakthroughs that carry particular risk of harm?
  - How do we approach safety in terms of rogue groups looking to inflict harm? How is that different from preventing accidents?
  - If a terrorist group were pursuing biological weapons, how much would the CIA or other organizations then become involved in the process?
  - What are the biggest unsolved questions in health security?
- Regulation of Synthetic Biology: Developments Under the Convention on Biological Diversity and Its Protocols, Felicity Keiper and Ana Atanassova, Frontiers in Bioengineering and Biotechnology, April 2020.
  Summary:
  > The Convention on Biological Diversity (CBD) is the main international forum addressing the regulation of "synthetic biology", covering aspects such as biosafety of living modified organisms (LMOs) and access and benefit sharing related to genetic resources. Debates have been ongoing for nearly a decade, focusing on topics like risk assessment, risk management, and "digital sequence information". There is currently no internationally accepted

definition of "synthetic biology", which is often used as a catch-all term for new or conceptual biotechnologies. Discussions under the CBD have been marked by divergent views on the sufficiency of existing regulatory frameworks for new types of LMOs. The paper reviews the evolution of these debates, key regulatory developments in biotechnology, and critical issues leading up to the 2020 Biodiversity Conference.

- DNA Synthesis and Biosecurity: Lessons Learned and Options for the Future ('Story so far' on US governance and sequence screening. Concisely summarised here)

  Summary:

  The report evaluates the "Screening framework Guidance for Providers of Synthetic Double-stranded DNA" issued by the Department of Health. The Guidance urges DNA providers to screen customers and their ordered sequences, but its implementation suffers from confidentiality issues and ambiguity. The International Gene Synthesis Consortium (IGSC) implemented a protocol that aligns with this Guidance, involving customer and sequence screenings and a system to flag suspicious orders. Some smaller providers struggle with this due to their size, and the shifting market towards cheaper and quicker services may challenge future adherence to these biosecurity measures. The report suggests mandating federal grantees and contractors to only buy from compliant companies, offering a database of concerning sequences, and expanding the HHS Guidance to cover new technologies like single-stranded DNA and benchtop DNA synthesizers.

- Risk Communication Strategies for the Very Worst of Cases, Monica Schoch-Spana et al., Johns Hopkins Center for Health Security, March 2019

  Summary:

  The Johns Hopkins Center for Health Security carried out a project in 2017-18 to inform strategies for communicating about global catastrophic biological risks (GCbRs), which are potentially civilization-altering biological threats. Firstly, the researchers investigated the viewpoints held by influential figures in science, policy, and practice about GCbRs, to better define the risk and inspire commitment to mitigating it. Secondly, they examined historical examples of how similarly existential threats were communicated to policymakers, practitioners, and the public without shutting down dialogue and successfully garnering public attention and action. The project resulted in a set of recommendations for entities interested in more effectively promoting awareness and action on GCbRs.

- Taking Emergency Use Authorization Seriously - Nikki Teran Institute For Progress

  Summary:

  The U.S. lacks sufficient rapid COVID-19 tests due to the FDA's inefficient framework for managing emergencies. While the U.K. offers over 150 affordable rapid antigen tests, the U.S. had only 16 available during the Delta wave peak. This shortage is attributed to the FDA not utilizing the Emergency Use Authorization (EUA) optimally. The agency should relax pre-approval efficacy evidence, provide standardized data to consumers, be willing to revoke authorization for inferior products, recognize that different products

serve different purposes, and prioritize public health benefits. The FDA has insisted on clinical trial data, which slows down innovation and the emergency response. It is proposed that authorization should be given to tests with reasonable sensitivity and specificity based on preclinical data. If more effective tests are available, less effective ones can be removed. Standardized data about each test should be made available to the public, and the FDA's EUA process needs re-evaluation to be better prepared for future emergencies.

- Health Security Memos to the New Administration and Congress (CHS led recommendations to US Gov in 2017. Mostly 'bottom line' recommendations.)
- Federal Funding for Health Security in FY2018 (US government)
  Summary:
  This analysis reviews the FY2018 President's Budget Request, showing a notable decrease in funding for health security programs compared to previous years. The proposed budget includes $12.45 billion for these programs, a 9% decrease from FY2017 and 11% less than FY2016. Over half the funding is earmarked for multi-hazard and preparedness goals, with smaller portions for radiological, nuclear, biosecurity, and chemical security programs. Only the funding for pandemic influenza and emerging diseases programs shows a slight increase.
- Public Health Preparedness Funding: Key Programs and Trends From 2001 to 2017
  Summary:
  This 2017 study evaluated funding trends over 16 years for crucial public health preparedness and response programs in the US Department of Health and Human Services. Findings show that initial funding increased preparedness substantially, but has since decreased: State and local preparedness funding dropped by 31% after its 2002 peak at $940 million, while the Hospital Preparedness Program saw a 50% reduction after reaching $515 million in 2003. Investments in medical countermeasure development and stockpiling remained relatively constant. The study concludes that sustained federal funding is essential for continued progress in disaster readiness and public health infrastructure development.
- President's Council of Scientific Advisors Biodefense Report Focus on PCAST's Recommendations (pages 14-16), but skim the rest of the document to provide context (30 mins)
- Using Export Controls to Reduce Biorisk
  Summary:
  An EA lawyer explores the Bureau of Industry and Security (BIS) at the U.S. Department of Commerce's potential role in reducing biotech risks. Using "export controls," the BIS can restrict the release of key tech and information to foreign countries. The Commerce Control List (CCL) facilitates this, imposing penalties for violations. Recently, the CCL mandate was expanded to "emerging technologies" crucial for national security, including biotech. This could help mitigate "information hazards" by limiting publication of certain

material. However, limitations include a preference for multilateral action, inter-agency involvement, exceptions for "fundamental research," and First Amendment issues.

- Biden appoints former government scientist as first leader of ARPA-H
- Biological Security Strategy (BSS)

  Summary:

  These are the documents describing how the UK protects itself and its interests from significant biological risks, including future infectious disease outbreaks, antimicrobial resistance, accidental releases of pathogens and deliberate biological attacks.
- Response to the UK Government's refreshed Biological Security Strategy (BSS) - CLTR

  Summary:

  The authors of the article appreciate the UK Government's Biological Security Strategy (BSS), which includes commitments to strengthen biosecurity leadership and governance, invest in biosurveillance, and lead in setting global standards for responsible innovation. However, to implement the 15 priority outcomes in a timely manner, the authors suggest the Government set clear milestones and measurable targets, establish responsible innovation regulations, access diverse expertise, and evaluate various intervention options. The authors also urge sustained investment in line with the urgency of BSS' implementation.
- Review: The UK Government's Updated Biological Security Strategy

  Summary:

  The UK's updated Biological Security Strategy, released on June 12, 2023, emphasizes the potential for biological threats to have catastrophic impacts and aims to strengthen the country's capabilities to tackle such risks. The strategy is centred around four pillars: understanding, preventing, detecting, and responding to biological threats. Key highlights include a Biothreats Radar for comprehensive early warning, efforts to deter deliberate threats, a National Biosurveillance Network, the establishment of a UK Biosecurity Leadership Council, and leadership governance structures. It aligns closely with the U.S. biodefense strategy, emphasizing early warning, public-private partnerships, a 100-day goal for vaccine authorization, and the importance of leadership. The UK's commitment to a £1.5 billion ($1.9 billion) yearly investment for implementation is a significant divergence from the U.S. strategy, which lacks dedicated funding for implementation. The new strategy is lauded as an important step in improving health security, requiring sustained attention on implementation.
- Preparing for Pandemic Preparedness Legislation

  Summary:

  In a letter to the Senate HELP Committee, IFP proposed nine core recommendations to enhance the U.S.'s ability to handle biological threats. Suggestions included expanding the Biomedical Advanced Research and Development Authority's (BARDA) mandate to include threat-agnostic approaches, modifying Project BioShield's mandate likewise, and moving towards a "reconfigurable" Strategic National Stockpile model to include

platform-based technologies for threat response. They also advised increasing transparency in the Public Health Emergency Medical Countermeasures Enterprise (PHEMCE) decision-making processes by creating an external advisory committee. This multi-pronged approach aims to address the evolving nature of biological threats and keep the U.S. at the forefront of pandemic preparedness.

10. Biosafety and Biodefense

- The Apollo Program for Biodefense – Winning the Race Against Biological Threats

  Summary:

  "The Apollo Program for Biodefense is an ambitious goal-directed program to develop and deploy the technologies needed to defend against all biological threats, empower public health, and prevent pandemics, no matter what the source."
- What if There Was Never a Pandemic Again?

  Summary:

  Over the last two centuries, advancements in technology have significantly reduced pandemic risk. Innovations like clean tap water, soap, and sanitation practices are often overlooked but vital for disease prevention. Today, COVID-19's airborne transmission reveals a gap in our preventative barriers, which can be closed by improving air sanitation technologies. We need advancements beyond improved ventilation and filtration, possibly including germ-killing light wavelengths. Moreover, metagenomic sequencing can help detect all pathogens in a sample, providing an important tool for monitoring patients. Vaccine delivery can also be revolutionized through self-administered microneedle vaccine patches and nasal sprays that could be sent to every household. It is essential to view the investment in transformative technologies to ward off pandemics as a key aspect of public health strategy. With the right commitment, we could potentially make COVID-19 the last pandemic.
- BWC assurance: increasing certainty in BWC compliance

  Summary:

  "Following the 2001 end to negotiations on a legally binding protocol, states parties to the 1972 Biological and Toxin Weapons Convention (BWC) developed entrenched positions about the necessity of treaty verification, hindering progress on treaty aims. The study described in this article was designed to facilitate dialogue on verification-related issues outside the context of those positions, using the term "assurance" to represent the degree of certainty that states parties are meeting their treaty obligations. From August 2020 to July 2021, the researchers conducted 36 interviews—16 with state-party delegations and 20 with independent experts, representing 20 countries. They performed mixed-methods analysis on the interviews, including quantitative metrics on qualitative interview content. Interviewees' views on verification, compliance, and related concepts varied widely. Future efforts by states parties to achieve common understanding on these topics could facilitate concrete progress. While no single mechanism is sufficient to

achieve verification or assess compliance, packages of mechanisms could increase assurance. Interviewees expressed general support for implementing assurance mechanisms, even in the absence of a comprehensive, legally binding protocol or verification regime, even among states parties for which that is the primary goal. Avenues to increase assurance among BWC stakeholders merit further discussion in the current intersessional program."

- Filippa Lentzos on controlling dangerous biological research

  Summary:

  "Countries like the U.S. and Russia are heavily investing in synthetic biology and biosecurity, despite the Biological Weapons Convention (BWC) prohibiting biological agents' development for harmful purposes. The BWC, however, struggles to handle rapidly evolving biological research due to its narrow focus on weapon development and manufacture. As biology advances, global attention must pivot to biological research's security and governance. The U.S. has implemented "Dual-Use Research of Concern" policies, which review research involving high-consequence pathogens, but these policies have significant weaknesses. For more effective biosecurity, it's crucial to shift to collective decision-making and ensure that researchers prove their work's safety, following the "first do no harm" principle. Despite the challenges, political will can leverage existing frameworks like the BWC to reduce biosecurity risks."
- Improving Security through International Biosafety Norms - Gronvall et al. (2016) [30 mins]

  Summary:

  "The focus of this project was the potential for a biological research laboratory accident to spark an epidemic, and become an international public health problem. We examined what norms and expectations nations should have of each other to maintain a biosafety infrastructure capable of preventing and mitigating consequences a catastrophic biocontainment failure."
- Notes on Apollo report on biodefense

  Summary:

  These notes cover the Apollo Program for Biodefense, a proposal advocating extensive biosecurity changes via technological advancements. The plan includes prevention, detection, containment, and recovery measures against biological threats. Notably, many recommendations, such as vaccines for prototype pathogens, ubiquitous sequencing, and advanced personal protective equipment, have been included in recent policy proposals like President Biden's budget. The notes emphasize the importance of effective policies, robust funding, and the potential of these technologies in significantly reducing future pandemic risks.
- Technologies To Address Global Catastrophic Biological Risks
- 100 Days Mission to Respond to Future Pandemic Threats

  Summary:

  "A 100 Days Mission for Diagnostics, Therapeutics and Vaccines
  1. The first 100 days when faced with a pandemic or epidemic threat are crucial to changing its course and, ideally, preventing it from becoming a

pandemic. In those 100 days, non-medical public health interventions like social distancing, isolation, contact tracing and personal protective equipment (PPE) are essential, but the three best weapons we have to defeat a pathogen threat are diagnostics, therapeutics and vaccines. Together, they can save millions of lives.
2. Building on the target set by the Coalition for Epidemic Preparedness Innovations (CEPI) - to have effective vaccines within 100 days of a pathogen being sequenced - we propose an Apollo Mission for the modern age to galvanise the international community.
3.In the first 100 days from a pandemic threat being identified (defined by when WHO declares a PHEIC) we should aim for the following interventions to be available, safe, effective and affordable:

- Accurate and approved rapid point of care Diagnostic tests;
- An initial regimen of Therapeutics; and,
- Vaccines ready to be produced at scale for global deployment."

- Synthetic biology and biosecurity: challenging the "myths", Catherine Jefferson, Filippa Lentzos and Claire Marris, Frontiers in Public Health, August 2014. (Blog post version also available: The myths (and realities) of synthetic bioweapons.)
- WILMOT JAMES AND ANDREW ILIFF: Seizure of Khartoum's laboratory triggers upscaling of biosecurity

Summary:

The National Public Health Laboratory in Khartoum, Sudan, recently fell into the hands of warring parties, creating concerns of potential bio-risk from the exposure of infectious samples. This incident emphasizes the importance of robust biosafety and biosecurity systems, especially in laboratories studying dangerous pathogens. Sudan lacks strong biosecurity safeguards and training, making the situation more precarious. The incident provides three important lessons:

Governments must understand where dangerous pathogens are stored and the work being done in those facilities.
Protocols to reduce risk during times of instability are critical.
Investment in biosafety and biosecurity within national health institutions is essential to avoid deliberate or accidental biological events.
The incident also highlights the need for improved biosecurity data and the shortcomings of existing biosafety protocols. Two proposals aim to close this gap by creating systems to investigate outbreaks of uncertain origin. The recent proliferation of laboratories working on dangerous pathogens underscores the urgent need to address these biosecurity gaps.

- Making Trouble

Summary:

"U.S. virologists plan to modify a strain of the monkeypox virus to better understand its lethality and improve treatments. However, some scientists are concerned about potential risks if a more potent version of the virus accidentally escapes the lab. Current regulations regarding potential

pandemic-causing pathogens might exempt this study from special review since it only involves swapping natural mutations. This plan has reignited debates about the oversight of studies modifying pathogens, with some arguing for stricter regulations and transparency, while others worry such changes could impede vital research and create bureaucratic obstacles."

- Delay, Detect, Defend - Kevin Esvelt overview paper on the threat from engineered pandemics

  Summary:

  The key takeaways from this text suggest the potential risks posed by pandemic-capable viruses, which could be exploited by malicious actors to trigger multiple simultaneous pandemics. The text emphasizes that these biological threats could potentially be more lethal than nuclear devices. It proposes a series of measures for delay, detection, and defense against such threats. These include:
  Delay: A pandemic test-ban treaty could prevent proliferation without hindering beneficial research. Introducing liability and insurance for catastrophic outcomes, as well as secure DNA synthesis screening, could limit unauthorized access to potential pandemic agents.
  Detect: The text highlights untargeted sequencing as a reliable method to detect all exponentially spreading biological threats.
  Defend: A multi-faceted defense strategy includes the distribution of pandemic-proof protective equipment, strengthening supply chains and outbreak control systems, and the use of germicidal low-wavelength lights that can reduce pathogens by over 90% and are believed to be harmless to humans.
- Editing Biosecurity,

  Summary:

  "Researchers from George Mason University and Stanford University initiated a two-year multidisciplinary study, Editing Biosecurity, to explore critical biosecurity issues related to CRISPR and related genome editing technologies. The overarching goal of the study was to present policy options and recommendations to key stakeholders, and identify broader trends in the life sciences that may alter the security landscape. In the design of these options and recommendations, the research team focused on how to manage the often-competing demands of promoting innovation and preventing misuse, and how to adapt current, or create new, governance mechanisms to achieve these objectives.
- Pandemic Prevention Platform (P3)

  Summary:

  The Pandemic Prevention Platform (P3) program aims to accelerate the creation of medical countermeasures against infectious diseases to support military readiness and global stability. The goal is to develop a platform capable of producing effective doses against any known or unknown infectious threat within 60 days of its identification, thus aiding in containing an outbreak. P3 focuses on DNA- and RNA-encoded medical countermeasures, a technology providing the body with instructions to

produce protective antibodies immediately. The program aims to advance three key areas: virus growth methods, antibody maturation, and the delivery of nucleic acid constructs. These nucleic-acid-based treatments would not integrate into a person's genome and the antibodies would remain in the body only temporarily, providing a "firewall" to halt disease spread and buy time for longer-term responses.

- "Designer bugs": how the next pandemic might come from a lab (2018)

  Summary:

  The Biological Weapons Convention (BWC), aimed at prohibiting the development of biological weapons, is focusing on threats from synthetic biology which could enable engineered pandemics. While biotechnology advancements can bring benefits, there are concerns about misuse, potentially leading to the creation of harmful pathogens. This global issue is difficult to manage due to challenges in enforcing compliance with treaties like the BWC. Solutions proposed include improvements in biotechnological regulation, increased funding for the BWC, the development of rapid diagnostic tools, broad-spectrum antivirals, and fostering a culture of responsibility within biological research.

- Mother Nature is not 'the ultimate bioterrorist'

  Summary:

  The saying "Mother Nature is the world's worst bioterrorist" has been used historically to highlight the risks posed by naturally emerging pathogens. However, it's increasingly used to downplay the growing risks from bioterrorism and human-engineered biological threats. With advancing biotechnology, humans are gaining the ability to potentially cause harm on a large scale, either maliciously or accidentally. Unlike nature, human actions can be driven by interests, motives, and political goals. States with resources to develop biological weapons and accidental releases from laboratories pose significant threats. It's vital to recognize the evolving biological risks and to work towards solutions with an understanding of the potential dangers of biotechnology.

- How do we control dangerous biological research?

  Summary:

  Both the US and Russia are increasingly investing in synthetic biology for defense purposes. Despite assurances that the focus is on "defensive" biosecurity, the line with offensive use is blurred. The Biological Weapons Convention, established in 1972, isn't well-equipped to handle rapid advancements in this field. It is critical to differentiate between "research" and "development", with the latter being prohibited. To ensure biosafety, the international community needs to focus on collective decision-making, transparency, and applying a "do no harm" principle. With the right political will, these measures can mitigate potential security risks from advances in biology.

- The Biodefense Stack

  Summary:

  The biodefense technology stack, enhanced by advancements in genome sequencing and synthetic biology, includes:

Early detection: Rapid identification of dangerous pathogens using various techniques.
Pathogen characterization: Determining if a pathogen is harmful, new, or spreading quickly.
Infectious disease intelligence: Sharing information about detected dangerous pathogens with relevant entities for a coordinated response.
Biohardening the physical environment: Using hardware to detect infection and sterilize surroundings.
Medical countermeasures: Quickly creating and distributing treatments or vaccines in response to new threats.
Accelerants: General inputs like threat intelligence software, lab automation, and biomanufacturing to enhance biosecurity.
Despite therapeutic advancements, early detection and rapid response remain key to managing significant threats.

- Hitting a Moving Target: A Strategic Tool for Analyzing Terrorist Threats (Book)
  Abstract:
  > "The subject of terrorism risk can be confusing for both the general public and for those responsible for protecting us from attack. Relatively minor terrorist threats are often conflated with much more serious ones, in part because it is hard to quantify either intent or technical ability to carry out an attack. Plotting threats on a ''potential mass casualties'' versus ''ease of obtainment or production'' matrix creates some order out of a seemingly endless array of worldwide threats, and it highlights those threats that are in need of more urgent attention. The specific threats on this 2x2 matrix can fall into one or multiple quadrants, which can be qualitatively described as ''most dangerous,'' ''dangerous but difficult,'' ''worrisome,'' and ''persistent terror.'' By placing threats into these quadrants and illustrating movement within and between them, the matrix can help (1) visualize and parse a diverse set of threats, (2) view how threats have changed over time and judge the efficacy of current countermeasures, and (3) evaluate the merit of future actions and investments. Having a dynamic matrix that can visually map the comparative risk of terrorist threat events in toto and that can help us monitor the effectiveness of present and future resource investments can add intellectual rigor to some of the most difficult and daunting decisions pertaining to our nation's safety and security"
- Biological Threats in the 21st Century (Book, but covers a lot of ground - case studies of bioterrorists and state programs, policy context, disarmament, etc).
  Summary:
  > "Biological Threats in the 21st Century" is a 2016 book providing a modern, multi-perspective view on biological threats to national security. Composed by around 40 experts, it delves into the politics, history, and science of biological weapons, including personal experiences. The book underscores the role of individual decisions and moral standpoints in the development, use, and prohibition of such weapons, aiming to educate future generations to prevent their production."
- Barriers to Bioweapons: The Challenges of Expertise and Organization for Weapons Development (Book, argues persuasively that there are considerable barriers to BW development beyond the 'in principle' science, and many attempts fail on these grounds.)
  Summary:

In "Barriers to Bioweapons", Sonia Ben Ouagrham-Gormley challenges the belief that producing bioweapons is an easy task for states or terrorist groups. Drawing from interviews with former bioweapons scientists and historical documents, she argues that developing bioweapons is a challenging, lengthy, and costly process. She stresses that the unpredictable behavior of living organisms used in bioweapons, coupled with the need for specialized knowledge, makes their development difficult. This challenge is amplified in covert programs, where the need for secrecy conflicts with knowledge production.

- Driving in the Dark: Ten Propositions About Prediction and National Security (More general security focus, but highlights the difficulty around 'predicting the next danger', and pushes for broad and adaptable defences)
- Public health response to biological and chemical weapons: WHO guidance

  Summary:

  This document emphasizes the necessity for countries to have a public health system capable of responding to the deliberate release of chemical and biological agents, as evidenced by past events like the use of poison gas in the war between Iraq and Iran, anthrax incidents in the U.S., and the Tokyo sarin nerve gas attack. The Fifty-fifth World Health Assembly adopted a resolution treating the use of biological, chemical, and radionuclear agents to cause harm as a global health threat, and calls on Member States to share expertise, supplies, and resources to contain and mitigate such events. The next step requires establishing adequately resourced national and international procedures to address this need.
- Differential Technology Development: A Responsible Innovation Principle for Navigating Technology Risks

  Summary:

  The current approach to responsible innovation mainly focuses on individual technologies, despite some technologies offering reduced risks or low-risk alternatives to others, as seen in the advancement of low-emission technologies. The authors suggest a new principle known as "differential technology development", which involves leveraging the risk-reducing relationships between technologies and adjusting their development timing. This could involve delaying riskier technologies while advancing safer or substitute ones. Applying this principle requires the capability to foresee or identify impacts and alter the timeline of technology development. The researchers found that this is sometimes feasible and can be beneficial even when introduced late into the diffusion of a harmful technology. Differential technology development could guide government research funding priorities, technology regulations, philanthropic R&D funding, and corporate social responsibility efforts. It could also help mitigate potential catastrophic risks from emerging technologies like synthetic biology and artificial intelligence.
- Pandemic prevention as fire-fighting

  Summary:

  The article discusses the parallels between pandemic prevention and fire control, proposing that strategies used to prevent fires can be used to mitigate future pandemics. It emphasizes four key strategies: active protection, detection, passive protection, and prevention.

Active protection entails rapid development and approval of vaccines, antivirals, and antibodies. Detection calls for an advanced global surveillance system and next-generation sequencing techniques to promptly identify new threats. Passive protection proposes measures such as improved air filtration, innovative microbial suppression technologies, and enhanced personal protective equipment to curb pathogen spread.
The article acknowledges risks of pandemics originating from lab leaks and intentional biological attacks, despite international conventions and the advent of technological safeguards. It highlights proposed prevention plans like the American Pandemic Preparedness plan, which demand significant funding and political support. The recent release of the National Biodefense Strategy and Implementation Plan offers a new opportunity for action.

- Research and Development to Decrease Biosecurity Risks from Viral Pathogens, Medium-Depth, Open Philanthropy Project, April 2018
  Summary:
  The report highlights the growing risk of global catastrophes due to natural and engineered pathogens, particularly viruses, accentuated by advancements in biotechnology. Potential solutions to substantially reduce this risk include the development of broad-spectrum antivirals, rapid immunity conferment methods, intrinsic biocontainment technologies, better countermeasures for pathogens, inexpensive diagnostics, and metagenomic sequencing. The report emphasizes the importance of vaccines and antivirals and suggests promising research areas including advanced methods to confer immunity and host-directed antiviral compounds. While the vaccine and diagnostics fields are crowded, there seems to be a funding opportunity in developing broad-spectrum antivirals.
- A Very Brief Introduction To Surveillance Detection
  Summary:
  Surveillance detection is the covert attempt to determine if surveillance is being conducted and gather information about the surveillance entity. This article provides a brief introduction to surveillance detection while acknowledging that it is a complex field with numerous exceptions and contingencies. It clarifies that the article does not teach surveillance detection but aims to provide an overview. The introduction explains the two components of surveillance detection: understanding what to look for and understanding how and from where to look. It emphasizes that obvious indicators of surveillance are usually avoided by well-trained operatives and highlights the importance of correlations to the target as the key indicator of surveillance. The article suggests that experiencing surveillance firsthand can help in detecting it. It also discusses surveillance vantage points and the challenges of remaining covert while observing the target. The article concludes by mentioning that future articles will explore surveillance detection in more detail and encourages readers to leave comments and questions for further discussion.
- Pathogens as Weapons: The international security implications of biological warfare
  Summary:

The global diffusion of dual-use biotechnology, coupled with incentives for revisionist states and extremist groups to use biological weapons, poses a severe challenge to international peace. Policy prescriptions to counter this danger include: strengthening defenses, enhancing intelligence capabilities, limiting access to dangerous resources, and strengthening the norm against biological weapons.

- Nonpharmaceutical Interventions for Pandemic Influenza

  Summary:

  The World Health Organization (WHO) recommends nonpharmaceutical interventions to handle influenza pandemics due to insufficient global availability of vaccines and antiviral agents. These strategies aim to contain and delay the spread, and reduce the impact of the disease at national and community levels, with exit screening of travelers departing from infected countries also suggested. Previous attempts at screening and quarantine at international borders have shown limited effectiveness. The success of these measures depends heavily on the specific transmission characteristics of the influenza subtype in question.

  - An EA Forum post on Non Pharmaceutical Interventions (this article was written at the start of the pandemic!)
    The author, a medical science post-doc, advocates for the importance of evaluating non-pharmaceutical interventions (NPIs) like mask-wearing and social distancing in pandemic response. They note a lack of randomized controlled trials for NPIs compared to drugs and vaccines. The author argues that even minor improvements in NPIs can have substantial population-level impacts. They invite discussion and suggest potential research areas, emphasizing the need for ongoing and adaptable NPI evaluation.
- Broad-Spectrum Antiviral Agents: A Crucial Pandemic Tool (This article was written in 2019)

  Summary:

  Viral infections pose a significant pandemic risk due to their high replication and transmissibility and lack of broad-spectrum antivirals. Current antivirals are usually highly specific, limiting their effectiveness across various viruses. Some have broad-spectrum properties, offering potential for repurposing existing drugs. However, there's a notable gap in preparedness for viral emergencies due to a scarcity of broad-spectrum antivirals. Hence, development of such antivirals should be prioritized, while also balancing potential toxicity to the host.
- Biodefense in the Age of Synthetic Biology
- Risks and Benefits of Gain-of-Function Experiments in Potentially Pandemic Pathogens (video, 1 hour)
- Catastrophic Bioterrorism—What Is To Be Done? (Somewhat dated but crisp review of bioterrorism challenges.)

11. Biological Weapons Convention (BWC)

- Wiki article on BWC, written by Darius Meissner (30 mins)

  Summary:

  The Biological Weapons Convention (BWC) is a disarmament treaty that prohibits the development, production, acquisition, transfer, stockpiling, and use of biological and toxin weapons. Since its enforcement in 1975, it became the first treaty to ban an entire category of weapons of mass destruction. As of 2023, 185 states have joined the treaty. Despite its significance, the BWC's effectiveness has been limited due to inadequate institutional support and lack of formal verification regime.

  The convention's history began with the 1925 Geneva Protocol, which only prohibited the use of such weapons. The BWC, however, prohibits even the development and stockpiling. The negotiation of the BWC took place from 1969 to 1972, culminating in its entry into force in 1975.

  The BWC comprises 15 articles, including prohibition of biological weapons, restriction on their transfer, and measures for national implementation. It has been interpreted and supplemented by additional agreements and understandings reached by States Parties at Review Conferences. The convention does not prohibit specific biological agents or toxins but certain purposes for their use. The convention is considered essential to allow national authorities to investigate, prosecute, and punish any prohibited activities.

- Biological Weapons Convention

  Summary:

  Biological weapons, which can cause widespread harm or death, are prohibited by the Biological Weapons Convention (BWC). The BWC, almost universally accepted with 185 State Parties, bans the development, production, acquisition, and use of such weapons. This treaty, supplemented by additional understandings over time, is a key instrument against weapons of mass destruction. Despite changes in science and technology, States Parties strive to maintain its relevance and effectiveness.

- Why is the Biological Weapons Convention not getting attention?

  Summary:

  The ninth review conference of the 1972 Biological Weapons Convention (BWC) took place in Geneva last week, without significant media coverage. The BWC, a legally binding agreement among 184 signatories, prohibits the use, development, and stockpiling of biological weapons. Unlike its counterparts for chemical and nuclear weapons, the BWC lacks a verification regime, making it hard to determine if a state is engaging in prohibited activities. Previous efforts to introduce such a mechanism were mostly blocked by the US due to private sector concerns. With Russia exploiting the lack of verification to fuel propaganda, the US signaled at the conference its readiness to explore effective measures, including possible verification ones. However, advances in biotechnology that facilitate hiding offensive research in civilian programs present a major challenge to establishing a formal mechanism.

- Common Misconceptions About Biological Weapons
  Summary:
  The COVID-19 pandemic has highlighted the devastating effects of biological threats, increasing scrutiny of biological weapons. Despite this, misconceptions persist, such as the belief that developing biological weapons is strategically irrational and that they lack tactical utility. Historically, nations have valued biological weapons for their cost-effectiveness, their potential for chaos, and the difficulty in attributing their use. Furthermore, the pandemic has demonstrated how a biological agent can alter global power dynamics. The belief that nations wouldn't use biological weapons to avoid self-harm is contradicted by instances in history where nations have risked their own forces. Countries have also been willing to develop and weaponize transmissible diseases, weighing the benefits against the risks. Finally, the belief that the risks of biological weapons development are too great underestimates governments' willingness to engage in risky programs, even when faced with health and geopolitical risks. Therefore, it's crucial to dispel these misconceptions to better counter the threat of biological weapons.
- The Biological Weapons Convention protocol should be revisited, Lynn C. Klotz, Bulletin of the Atomic Scientists, November 2019.
  The Biological Weapons Convention of 1975 has been criticized for lacking monitoring mechanisms. In the 2000s, a protocol was proposed to rectify this by adding site visitation and investigation provisions. However, the U.S. withdrew due to verification concerns, and the protocol was never enacted. The protocol's advocates argue that its main goal was promoting transparency. Recently, false allegations by Russia about biological weapons in former Soviet states have raised concerns, suggesting the protocol needs revisiting. The protocol's revival would require adaptations for modern developments and technologies.
- CBW Events report (this contains reports of the 2022 BWC)
- NSC wants rules on research that could lead to biological weapons
  Summary:
  The U.S. National Security Council plans to enforce greater federal control over studies of lethal diseases and toxins to prevent potential misuse by terrorists. This move is expected to introduce guidelines allowing agencies to delay or limit the publication of sensitive research findings. However, concerns have been raised about possible restrictions on scientific openness and bureaucratic delays that could hinder crucial health-related discoveries. This decision follows high-profile cases where research into the H5N1 avian flu virus, capable of causing deadly pandemics, was delayed due to fears of misuse. These new guidelines aim to give federal agencies the legal authority to restrict the disclosure of certain research, particularly involving pathogens posing significant public health threats.
- A Peer-Review Mechanism for the Biological and Toxin Weapons Convention (Part of the 'verification'/confidence building measures/implementation challenges around the BWC. Exec summary and intro are probably sufficient.)
- The Germy Paradox
  Summary:

The author reflects on their first year of graduate school, where they explored the question of why, despite advancements in biotechnology and concerns over biodefense, biological weapons (BW) are not commonly developed by states. This inquiry, termed the "germy paradox", questions why, if biological weapons are as accessible and lethal as feared, they aren't more prevalent. The author details a brief history of BW, from their early classification as "poison" weapons in the 1400s to modern constraints by the Biological Weapons Convention. They also outline how despite these weapons' potential for devastation, no nation currently declares having a BW program or has used them for large-scale attacks since WWII. The article series will delve into the history of state biological weapons programs, the reasons we don't see their prevalent usage, and what future BW may look like. The author plans to release new posts twice a week.

- Adherence to and Compliance With Arms Control Nonproliferation and Disarmament Agreements and Commitments - US Department of State
- Chemical and Bacteriological (Biological) Weapons and the Effects of their Possible Use (Pre BWC report on the dangers, now mostly historical - 1969)
- Improving implementation of the Biological Weapons Convention: The 2007-2010 Intersessional Process (Recent survey of directions of travel in the BWC. Section D probably has the greatest contemporary interest, and is aimed at a lay reader.)
- Germ Warfare: A Very Graphic History (20 mins)

12. Tabletop Exercises (TTX)

- Preventing Global Catastrophic Biological Risks: Lessons and Recommendations from a Tabletop Exercise held at the 2020 Munich Security Conference, Beth Cameron, Jaime Yassif, Jacob Jordan, and Jacob Eckles, Nuclear Threat Initiative, September 2020.
- Navigating the Storm: Report and Recommendations from the Atlantic Storm Exercise (TTX of deliberate international smallpox attack)
- Shining Light on “Dark Winter (TTX of smallpox attack in the US)
- Event 201, October 18, 2019. (Explored incentives for producing vaccine stockpiles, economic effects of trade and travel restrictions, potential ramifications of a pandemic for the global financial system, and mis- and dis-information. Participants included representatives from UPS, Johnson & Johnson, Gates Foundation, NBCUniversal, and others.)
- Clade X, May 15, 2018. (Explored decisions available to US national security personnel in the event of an emerging engineered pandemic. Participants included a former senator, the president of AAAS, a former CDC director, and others.)
- Navigating the Storm: Report and Recommendations from the Atlantic Storm Exercise (TTX of deliberate international smallpox attack)
- We need Bold action to prevent the next biological catastrophe
- Preventing Global Catastrophic Biological Risks

13. Review of COVID-19 Responses

Hot takes in Review of COVID-19 Responses

- [The coronavirus crisis and our new review of how to prevent the worst possible pandemics]
  Summary:
  This summary was written at the start of the COVID-19 pandemic, highlighting our lack of preparedness for global health crises. It points out a potentially greater threat: engineered biological risks that could cause catastrophic harm. It calls for increased focus on scientific research and policy, underlining the urgent need to effectively address these biological risks, as illustrated by the ongoing pandemic.
- [Making Sense: EPISODE 311 Did SARS-CoV-2 Escape from a Lab? A Conversation with Matt Ridley and Alina Chan]
  Summary:
  Sam Harris speaks with Matt Ridley and Alina Chan about the origins of the COVID pandemic. They discuss the evidence of a lab leak from the Wuhan Institute of Virology, media and academic censorship of this topic, the history of collaboration between western scientists and Chinese labs, the risks of "gain-of-function" research, the evidence for the zoonotic origins of SARS-CoV-2, the initial complacency and denialism of the Chinese, the biosafety levels at the Wuhan Institute of Virology, molecular evidence of a lab leak, the practical constraints on synthesizing viruses, lack of international cooperation, conspiracy theories promulgated by the CCP, EcoHealth Alliance, different kinds of "gain-of-function" research, virus hunting, the history of lab leaks, risk and reward in the search for knowledge, Anthony Fauci, and other topics.
- [Making Sense: What Have We Learned from the Pandemic? - A Conversation with Nicholas Christakis]
  Summary:
  In this episode, Sam Harris speaks with Nicholas Christakis about the lessons of the COVID pandemic. They discuss our failures to coordinate an effective response, the politics surrounding vaccination, vaccine efficacy, vaccine safety, how to think about scientific controversies, the epidemiology of excess deaths, transmission among the vaccinated, natural immunity, selection pressures and new variants, the failure of institutions, the lab-leak hypothesis, the efficacy of lockdowns, vaccine mandates, boosters, what would happen in a worse pandemic, and other topics.
- [#103 – Max Roser on building the world's first great source of COVID-19 data at Our World in Data]
  Summary:
  Max Roser, an Oxford economist and founder of Our World in Data, and his small team became the world's primary source for COVID-19 updates despite their initial focus on long-term trends like life expectancy. Observing the inadequacies of the World Health Organization's conflicting data, insufficient press coverage, and nations' obscure data posting, they committed to making the COVID-19 data accessible. They revamped their software to

accommodate daily data and commenced compiling COVID data. Despite initial funding struggles and the unreliability of development statistics, their efforts significantly aided the global understanding of the pandemic. When there was a lack of global vaccination statistics by late 2020, they stepped in to fill the gap again.

Additional discussion topics include their early struggles for funding, why government agencies often present data poorly, and which agencies did well during the COVID pandemic, particularly the European CDC. They also discuss the impact of Our World in Data in enhancing global understanding, how to address the unreliability of development statistics, why research shouldn't be published as a PDF, why academia tends to under-incentivise data collection, and topics like the history of war among others.

- #76 – Tara Kirk Sell on COVID-19 misinformation, who's done well and badly, and what we should reopen first

  Summary:

  Dr. Tara Kirk Sell, a senior researcher at the Johns Hopkins Center for Health Security, provides insights on her work surrounding pandemic preparedness and response. Amidst COVID-19, CHS, recognized for its research on major biological, chemical or nuclear disasters, played a key role in shaping the understanding and response to the pandemic.

  Dr. Sell contributed to significant projects, including the "Collective Intelligence for Disease Prediction," which nearly shut down in December but received a last-minute funding boost to respond to COVID-19. She also aided in producing a report explaining the varying risks associated with different activities resuming after lockdown, emphasizing that some businesses can adapt to minimize transmission risks while others should remain closed. Additionally, she discusses the challenges of misinformation during disease outbreaks, pointing to the 2014 Ebola crisis as an example of how difficult it can be to distinguish between accurate and misleading information, thus leading to significant risks in understanding virus transmission.

  In the conversation, various critical issues are addressed, including who overperformed and underperformed during COVID-19, when mistrust in authorities is justified, the media's responsibility for accuracy, the prioritization of policies for future pandemics, the necessity of preparing for future pandemics amidst COVID-19, the significance of considering non-COVID health issues, the psychological impacts of mandatory versus voluntary stay-at-home orders, potential mistakes made by the general public, and the emergence of technologies with the potential to reduce global catastrophic biological risks. The dialogue underscores the importance of learning from the current pandemic to enhance responses in the future.

- Making Sense: EPISODE 190 How Should We Respond to Coronavirus? A Conversation with Nicholas Christakis

  Summary:

  ”In this episode of the podcast, Sam Harris speaks with Nicholas Christakis about the coronavirus pandemic. They discuss the likely effects on society, proactive vs reactive school closures, community transmission, false comparisons between coronavirus and flu, the imperative of social distancing, the timeline of the pandemic, Trump’s political messaging, the widespread

distrust of expertise, the importance of “flattening the curve” of the epidemic, the possible failure of our healthcare system, gradations of personal response to this threat, and other topics.”

- Making Sense: EPISODE 191 Early Thoughts on a Pandemic A Conversation with Amesh Adalja

  Summary:

  In this episode of the podcast, Sam Harris speaks with Amesh Adalja about the spreading coronavirus pandemic. They discuss the contagiousness of the virus and the severity of the resultant illness, the mortality rate and risk factors, vectors of transmission, how long coronavirus can live on surfaces, the importance of social distancing, possible anti-viral treatments, the timeline for a vaccine, the importance of pandemic preparedness, and other topics.
- Making Sense: EPISODE 201 A Conversation with Yuval Noah Harari

  Summary:

  “In this episode of the podcast, Sam Harris speaks with Yuval Noah Harari about the Covid-19 pandemic and its future implications. They discuss the failures of global leadership, the widespread distrust of institutions, the benefits of nationalism and its current unraveling in the U.S., politics as a way of reconciling competing desires, the consequences of misinformation, the enduring respect for science, the future of surveillance, the changing role of religion, and other topics.”
- Making Sense: EPISODE 214 A Conversation with Siddhartha Mukherjee

  Summary:

  ”In this episode of the podcast, Sam Harris speaks with Siddhartha Mukherjee about our ongoing failure to adequately respond to the Covid-19 pandemic. They discuss the significance of asymptomatic spread, the lack of Chinese cooperation, the failures of testing, travel restrictions, the missteps of the FDA and the CDC, controversy around masks, the lack of coordination among the states, conspiracy thinking about mortality statistics, the political contamination of public health information, electronic medical records, preparing for the next pandemic, the immunology of Covid-19, the long term consequences of the disease, concerns about a vaccine, the coming prospect of school openings, and other topics.”
- Making Sense: EPISODE 222 A Pandemic of Incompetence A Conversation with Nicholas Chrisakis

  Summary:

  ”In this episode of the podcast, Sam Harris speaks with Nicholas Christakis about the Covid-19 pandemic. They discuss the breakdown of trust in institutions and experts, the corruption of science by politics, the ineptitude of the Trump administration in handling the pandemic, whether the gravity of Covid-19 has been exaggerated, preparing for future pandemics, whether Covid deaths are being over-reported, bad incentives in the medical system, tracking “excess death” statistics, the prospect that the novel coronavirus will evolve to become more benign, the efficacy of current treatments, safety concerns about a rushed vaccine, the importance of public health communication, when life might return to normal, the economic impact of the pandemic, long term social changes, the future of universities, Nicholas’s

personal habits during the pandemic, the importance of rapid testing, and other topics."

- Making Sense: EPISODE 233 In the Groves on Misinformation A Conversation with Zeynep Tufekci

  Summary:

  "In this episode of the podcast, Sam Harris speaks with Zeynep Tufekci about the problem of misinformation and group-think. They discuss the Covid-19 pandemic, the early failures of journalists and public health professionals to make sense of it, the sociology of mask wearing, the problem of correcting institutional errors, Covid as a dress rehearsal for something far worse, asymmetric information warfare, failures of messaging about vaccines, the paradox of scientific authority, the power of incentives, how to reform social media, and other topics."

- # – Emergency episode: Rob & Howie on the menace of COVID-19, and what both governments & individuals might be able to do to help

  Summary:

  Rob and Howie discuss the potential impact of the coronavirus crisis, including death toll estimates and personal health risks. They discuss potential individual and governmental responses and strategies to reduce infection risks. They also touch on the virus' characteristics, countries' varying responses, and the importance of learning from this pandemic to prevent future ones. The conversation is optimistic despite the challenges. This episode, released quickly due to the urgent nature of the topic, is accompanied by 70 links for additional resources and opportunities for involvement in COVID-19 related projects. A rough transcript and a 'problem profile' on global catastrophic biological risks are also available.

- #77 – Marc Lipsitch on whether we're winning or losing against COVID-19 (May 18th, 2020)

  Summary:

  In an interview, Professor Marc Lipsitch from Harvard's Center for Communicable Disease Dynamics discusses the current state of the COVID-19 pandemic, vaccine development, and potential strategies for improvement in future responses. He indicates that island nations like Taiwan and New Zealand are effectively suppressing the virus, but most other countries are struggling. Despite effective test and trace systems, even countries like Singapore have lost control over the virus. The infection fatality rate is confirmed to be 0.5-1%, and herd immunity is still far off in most affected countries. Positive news includes evidence that most infected individuals do develop immunity, albeit temporary. Lipsitch recommends a strong focus on vaccines, antivirals, mass testing, and exploring creative solutions. However, he notes that training and funding for experts in the field are currently dwindling. Other topics discussed include potential contributions from listeners, instructive modelling failures, trustworthy sources of information, support for infection trials to speed up vaccine development, and the need for population-level surveillance during future pandemics.

- #84 – Shruti Rajagopalan on what India did to stop COVID-19 and how well it worked

  Summary:

Shruti Rajagopalan, a Senior Research Fellow at the Mercatus Center, discusses the unique challenges and policy responses to COVID-19 in India. Given that many homes in India lack reliable piped water, mass distribution of hand sanitizer was necessary. Contextual differences mean that strategies effective in developed countries may not work in India. For instance, installing shared handwashing stations, though not recommended in developed countries, could be the best option in India. Strict lockdown measures, while crucial to control the virus due to limited healthcare capacity, took a significant human toll due to large populations of migratory workers without income support. On a positive note, facemask wearing was less politicized in India, perhaps due to existing pollution issues, past pandemic experiences, or intergenerational living. Despite hardships caused by COVID-19 policies, public support for measures and government remains high. Topics discussed include the value of economists in studying pandemics, India's low mortality rate, the public reaction to lockdowns, future policy recommendations, the qualities of a good constitution, and Emergent Ventures.

- FLI Podcast: Lessons from COVID-19 with Emilia Javorsky and Anthony Aguirre

Summary:

The global spread of COVID-19 has put tremendous stress on humanity's social, political, and economic systems. The breakdowns triggered by this sudden stress indicate areas where national and global systems are fragile, and where preventative and preparedness measures may be insufficient. The COVID-19 pandemic thus serves as an opportunity for reflecting on the strengths and weaknesses of human civilization and what we can do to help make humanity more resilient. The Future of Life Institute's Emilia Javorsky and Anthony Aguirre join us on this special episode of the FLI Podcast to explore the lessons that might be learned from COVID-19 and the perspective this gives us for global catastrophic and existential risk.

Topics discussed in this episode include:

The importance of taking expected value calculations seriously
The need for making accurate predictions
The difficulty of taking probabilities seriously
Human psychological bias around estimating and acting on risk
The massive online prediction solicitation and aggregation engine, Metaculus
The risks and benefits of synthetic biology in the 21st Century

- How The Pandemic Will End by Ed Yong

Summary:

The article critiques the global response to the SARS-CoV-2 pandemic, focusing on the US's lack of preparation and effective measures. It discusses the significant socioeconomic and mental health impacts of the crisis, particularly affecting low-income individuals and those with chronic health conditions. Despite the devastation, the pandemic presents opportunities for societal change, such as improved cooperation, health practices, and preparedness strategies. The future could bring a shift toward more international cooperation and a focus on public health. However, the direction depends on whether the nation turns inward or adopts a more globally cooperative approach.

- Coronavirus: The Hammer and the Dance

  Summary:

  The article discusses two approaches to the COVID-19 pandemic: mitigation, which involves controlled spread of the virus with the aim of achieving herd immunity, and suppression, involving strict social distancing and control measures. The author criticizes mitigation due to potential healthcare system overload, numerous deaths, and the risk of virus mutation.

  The article proposes a strategy named "The Hammer and the Dance". The "Hammer" represents the initial aggressive response, including rapid testing, contact tracing, enforced quarantines, isolation, and social distancing, aimed at reducing the virus's reproduction number (R) as close to zero as quickly as possible. This phase aims to control the outbreak in weeks rather than months.

  The subsequent phase, "The Dance", seeks to maintain the virus under control until a vaccine is available. This phase focuses on keeping R below 1 through a balance of measures adjusted based on case numbers. This stage aims to return life to near-normal, requiring public compliance and disciplined execution.

  The success of South Korea and Singapore in controlling the virus through efficient testing, tracing, and quarantine measures is highlighted. The article recommends countries not heavily impacted yet to take preemptive action and encourages those with existing outbreaks to adopt the Hammer and Dance strategy. The author urges governments to fight the virus rather than surrender and citizens to demand action.

- Epidemic Calculator

  Summary:

  The author has developed a calculator using the SEIR (Susceptible → Exposed → Infected → Removed) disease model to help understand the COVID-19 pandemic's progression. The calculator can assess an individual's risk based on their exposure and the current attack rate. The model further breaks down infection and recovery stages into mild, moderate, and fatal cases, assuming all fatalities occur in hospitals post the infectious period. The article also presents various estimates for epidemic parameters from different studies.

- Epistemic humility

  Summary:

  The article criticizes the handling of COVID-19 based on the misguided perception that the virus was entirely novel, despite it being a type of coronavirus, for which there's prior knowledge from dealing with similar viruses like SARS. The author suggests that officials could have applied existing knowledge while acknowledging uncertainties, rather than starting from scratch. The writer also highlights the misplaced assumptions around COVID-19's seasonality, criticizing the belief that the virus would decline in the summer, and the failure to prepare for a potential surge in fall/winter. Recommendations include encouraging outdoor activities during summer, prioritizing postponed medical treatments, and supporting psychological health. The author concludes by urging the adoption of higher-quality masks,

especially for vulnerable groups, and reiterates the need to balance caution with understanding of the virus based on past experience.

- COVID-19: Analysis, resources and how you can help

  Summary:

  The comprehensive resource page on COVID-19 presented by 80,000 Hours includes research and advice for coping with the pandemic and contributing towards its resolution. It provides updates on their initiatives, podcast interviews, advice on personal protection and guidelines on self-care. The organization emphasizes the need for research, determining effective public health and economic policies, healthcare expansion, slowing the spread, and maintaining societal functionality. The page lists opportunities to help the global response to COVID-19, primarily in research, policy, technology and startups, focusing on the US and UK. It also features a job board for COVID-19 related roles.

- Essential Facts and Figures - COVID-19 (written: April 2020)

  Summary:

  The document details the symptoms, spread, and potential treatments of COVID-19. It highlights that cough and fever are the most common symptoms, with a typical onset time of seven days post-infection. Age and gender are significant risk factors for severe disease. The virus is likely spread primarily through droplets from coughs and sneezes, and potentially also through smaller aerosols. The number of eventual infections depends on response measures, with uncontrolled spread possibly resulting in tens of millions of deaths. Recommended prevention measures include staying home, limiting contact with others, thorough hand-washing, and covering coughs and sneezes. Currently, there are no proven pharmaceutical treatments or vaccines, though trials of antivirals and vaccine development are ongoing.

- Good news about COVID-19 (Published April 3rd, 2020)

  Summary:

  The article focuses on positive aspects amidst the ongoing COVID-19 crisis. It mentions the successful efforts of countries like South Korea, Taiwan, and Singapore in controlling the virus, and the slowing rate of new cases in Spain and Italy. It highlights a lowered estimated death rate by the Oxford Centre for Evidence Based Medicine, though it notes this is lower than most estimates. The article also observes the rapid increase in testing, with the US conducting 101,000 tests by April 1st. It reassures that food supplies remain stable, with supermarkets restocking and expanding their workforce to meet demand. It discusses the important ongoing surveys to determine infection rates, and the rapid technological progress being made in testing and vaccine development, with companies like Abbott Laboratories and Johnson & Johnson leading the way. The article concludes by emphasizing the collaborative global efforts in combating the pandemic, which will hopefully result in us being better prepared for future health crises.

- Options for donating to fight COVID-19

  Summary:

  The article provides suggestions for those interested in donating specifically to COVID-19-related work. Three options are suggested:

1. Johns Hopkins Center for Health Security (CHS): CHS provides influential information and analysis to help inform policy responses to the crisis, and is expected to have a pivotal role in policy response to future pandemics.
2. The Gates Foundation COVID-19 Funds: These funds are primarily focused on research for vaccines, diagnostics and therapeutics, which are considered key in ending the crisis. The Gates Foundation was early in its response to the crisis and has expertise in global health and biomedical research.
3. The Center for Global Development: This organization focuses on aiding the global poor during the crisis. They have a successful track record in advocating for policies to help the global poor and are currently developing policy advice for middle and low-income countries.

The article also advises large donors or those willing to invest significant time to conduct their own research and identify smaller, high-upside projects. It warns about the potential dangers of the 'unilateralist's curse' and advises potential donors to be cautious of inadvertently making things worse. It suggests looking at what organizations like Open Philanthropy and the Gates Foundation are funding for more specific ideas.

- If you want to help the world tackle COVID-19, what should you do?

  Summary:

  The article outlines five key areas in tackling the COVID-19 crisis: researching the disease and developing treatments or vaccines, determining optimal public health and economic policies, increasing healthcare capacity (including testing and equipment), slowing the disease spread through public health advocacy, and maintaining essential societal functions during the pandemic.

  For individuals seeking to contribute, the article suggests leveraging personal skills to address these challenges. Specific opportunities vary from volunteering for vaccine trials, vetting research papers for errors, synthesizing research for policy-makers, manufacturing healthcare supplies, promoting social distancing or remote working advice, and helping those on the front lines.

  It emphasizes the importance of understanding one's expertise and considering the potential downside risks before embarking on big or controversial initiatives, to avoid inadvertently worsening the situation. The article also discusses the dilemma of whether to work on COVID-19 or continue with existing high-impact work, recommending a consideration of one's skills, motivation, health, finances, and career safety.

- A dataset of non-pharmaceutical interventions on SARS-CoV-2 in Europe

  Summary:

  In response to the second wave of SARS-CoV-2 transmission during late 2020, many European countries implemented non-pharmaceutical interventions (NPIs) at a local level. Accurate modelling of this wave has been limited due to the usage of NPI definitions and data from the first wave. A novel dataset was therefore collected to analyze these interventions from August 2020 to January 2021.

  The dataset, ideal for high-quality modelling, features precise categorization of NPIs allowing for greater differentiation, and the regional granularity enables analysis at the sub-national level. This dataset can aid researchers in

identifying the effectiveness of individual interventions and estimating changes in the effectiveness of NPIs over time. It has already been used in studying the effect of seasonality and mask use on SARS-CoV-2 transmission.
Researchers requiring subnational data, additional context, or those studying the changing response to SARS-CoV-2 over time would benefit from this dataset, which is tailored to the second wave and includes granular differentiation in types of gatherings and business closures. The dataset is also fully validated with semi-independent double entry.

- Mask wearing in community settings reduces SARS-CoV-2 transmission
  Summary:
  This study resolves conflicting results about the effectiveness of mask-wearing in controlling COVID-19 transmission. Previous research focused on the impact of mask mandates, whereas this study examined the direct effect of mask-wearing. Using the largest mask-wearing survey covering 92 regions on six continents (with 20 million participants), the study found that population mask-wearing notably reduced SARS-CoV-2 transmission, corresponding to a 19% decrease in the reproduction number R. These findings suggest that mask-wearing can be a powerful tool in reducing virus transmission, and policymakers could effectively curb transmission by encouraging increased mask wearing. The study considered nonpharmaceutical interventions, and mobility, and also validated its results through numerous sensitivity analyses.
- Understanding the effectiveness of government interventions against the resurgence of COVID-19 in Europe
  Abstract:
  “European governments use non-pharmaceutical interventions (NPIs) to control resurging waves of COVID-19. However, they only have outdated estimates for how effective individual NPIs were in the first wave. We estimate the effectiveness of 17 NPIs in Europe’s second wave from the subnational case and death data by introducing a flexible hierarchical Bayesian transmission model and collecting the largest dataset of NPI implementation dates across Europe. Business closures, educational institution closures, and gathering bans reduced transmission, but reduced it less than they did in the first wave. This difference is likely due to organisational safety measures and individual protective behaviours—such as distancing—which made various areas of public life safer and thereby reduced the effect of closing them. Specifically, we find smaller effects for closing educational institutions, suggesting that stringent safety measures made schools safer compared to the first wave. Second-wave estimates outperform previous estimates at predicting transmission in Europe’s third wave.”
- Founders Pledge Episode 2 COVID-19 briefing with the Johns Hopkins Center for Health Security
- Michael Mina COVID rapid tests - Lex Fridman (Video/Podcast, 2 hours 14 mins)

13.1 Lessons from COVID

- Emerging COVID-19 success story: Vietnam's commitment to containment
  Summary:
  By the end of 2020, Vietnam successfully contained COVID-19, recording only 1,465 cases and 35 deaths, thanks to factors like a proactive containment strategy, a responsive central government, and an established public health system. Their tactics included comprehensive testing, tracing, and quarantining. The experience from SARS and avian influenza epidemics facilitated rapid decision-making and local-level initiatives. Economic reforms since the 1980s and increased public health expenditure have supported Vietnam's robust healthcare infrastructure.
  Vietnam also effectively employed technology, such as the NCOVI and Bluezone apps, for contact tracing, reporting, and public health advisories. A major part of Vietnam's strategy involved testing not just symptomatic individuals but also those at risk due to exposure, which effectively curbed asymptomatic transmission. Quarantine was implemented for international travellers and those exposed to the virus. Despite some economic loss, particularly in the tourism sector, the country has managed to maintain a positive GDP growth rate.
  In conclusion, Vietnam's effective handling of the pandemic can be attributed to early action, strong contact tracing, exposure-based quarantine, clear communication, and a society-wide approach. Despite experiencing a significant outbreak in Da Nang in August, the country swiftly contained the spread and largely prevented community transmission.
- Emerging COVID-19 success story: Germany's push to maintain progress
  Summary:
  Germany initially handled the COVID-19 pandemic successfully with a strong healthcare system, rapid development of diagnostic tests, and effective containment strategies. However, the country struggled with a surge in cases from October 2020. This was due, in part, to Germany's federal system which led to varied approaches across states and a significant proportion of the population remaining vulnerable after the first wave. Although Germany's focus on data collection and communication earned public trust, the second wave saw increased political resistance to restrictive measures.
- Emerging COVID-19 success story: South Korea learned the lessons of MERS
  Summary:
  South Korea's successful handling of COVID-19 was driven by its past experience with MERS, leading to rapid testing, thorough contact tracing, and support for people in quarantine. Extensive reforms after the 2015 MERS outbreak and a robust health system aided the response. Innovative strategies included high-capacity screening facilities, public communication, data-driven contact tracing, and hospital restructuring. Strict but supportive quarantine policies were implemented, and while the economy faced disruptions, the country remained relatively stable due to minimized long-term restrictions and financial aid to households and businesses.
- Comprehensive review of how U.S. handled pandemic lays out lessons learned
  Summary:

The United States' poor handling of the COVID-19 pandemic is the subject of a report co-authored by Philip Zelikow, a professor of history at the University of Virginia. The report claims that despite the fast development of vaccines, the U.S. suffered due to a lack of preparedness and systemic weaknesses. If the U.S. had a death rate comparable to other European nations, an estimated half a million American lives could have been saved.
The U.S. fought the pandemic without a battle plan, according to the report. Despite having resources and funding, there was no strategy or preparation for managing a health emergency. This was evident in numerous areas, such as testing, data gathering, and use of health records, which were fragmented and uncoordinated due to proprietary and regulatory reasons.
The report criticized former President Trump's leadership during the pandemic, labeling him a "comorbidity." However, it emphasized that the problems were deeper than any individual administration, with a health system not equipped to handle a modern pandemic. The report argued that the cultural clash between "trust the science" and libertarian values was exacerbated by a lack of practical plans and solutions. It highlights the need for an action plan to strengthen the health system for future crises.

- What really went on inside the Wuhan lab weeks before Covid erupted

14. Technical Knowledge of Biology and Synthetic Biology

"The **most important** basic science to know in this area is the basic cellular and molecular biology of DNA, RNA, and proteins, and passing
knowledge of contemporary techniques of their investigation and manipulation.

These can be gleaned from a good textbook (although the Wikipedia articles for each keyword or online courses can somewhat substitute). From Albert's et al. *Essential Cell Biology* (4th ed.), these correspond to chapters 1, 2, 4, 6, 7, and 10. *Molecular Biology of the Cell* (6th ed.) gives an even more comprehensive treatment, but overly detailed and inaccessible for those without a scientific background.

Helpful, broadly applicable 'background information' would be scattered over fields - in all cases 'more is better', but the returns diminish steeply for a generalist. I offer an indicative sketch of useful 'bits' and keywords.

- **Cell biology:** Genetics and gene expression, cell membranes and transport, cell signalling, and the cellular mechanisms of infection and immunity.
- **Microbiology:** Bacterial and viral physiology (e.g. that bacteria are prokaryotes, and how they differ from eukaryotic cells; that viruses can 'use' DNA or RNA, with some sketch of the life cycles).
- **Immunology:** The difference between adaptive and innate immunity, some knowledge of how adaptive immunity 'works' (e.g. antigen presentation, MHC, clonal selection/hypermutation), active versus passive immunization, and the

different stereotyped immune responses to extracellular versus intracellular pathogens.
- **Epidemiology:** A sketch of infectious disease epidemiology: surveillance and outbreak detection, some basic understanding of infectious disease dynamics (e.g. R0, attack rate, compartment models).” - Greg Lewis

- What is CRISPR-Cas9?
- What Exactly Is Synthetic Biology?
- Synthetic biology 2020–2030: six commercially-available products that are changing our world
- How To Grow (almost) Anything 2021
- FAQs: Gene drives
- What is PCR (polymerase chain reaction)?
- DNA Databases and Human Rights
- Molecular biology at the cutting edge: A review on CRISPR/CAS9 gene editing for undergraduates
- Concerning RNA-guided gene drives for the alteration of wild populations (Very clear introduction of the relevant basic science)
- The characteristics of pandemic pathogens Amesh Adalja et al.
- Point of View: Bioengineering horizon scan 2020, Luke Kemp et al, eLife, May 2020. (A follow up to 2017’s A transatlantic perspective on 20 emerging issues in biological engineering; worth scanning the tables in each, since the identified emerging issues differ.)
- Why Former Google CEO Eric Schmidt Is Betting Big On The $1T US Bioeconomy
- GP-write Announces ‘Ultra-safe Cells’ as Featured Community Project
- Universal Declaration on the Human Genome and Human Rights
- Designer babies: an ethical horror waiting to happen?
- Scientists program cells to remember and respond to series of stimuli
- Should We Synthesize a Human Genome?
- As D.I.Y. Gene Editing Gains Popularity, ‘Someone Is Going to Get Hurt’
- DNA could store all of the world's data in one room
- Researchers Say They Created a ‘Synthetic Cell’
- Asilomar 1975: DNA modification secured
- Scientists Seek Moratorium on Edits to Human Genome That Could Be Inherited
- What Is Personalized Medicine?
- You're Only Human, But Your Kids Could Be So Much More
- Using CRISPR, scientists efficiently edit genome of viable human embryos
- First human-pig 'chimera' created in milestone study
- Cheap DNA Sequencing Is Here. Writing DNA Is Next
- Concerning RNA-guided gene drives for the alteration of wild populations (Very clear introduction of the relevant basic science)
- A transatlantic perspective on 20 emerging issues in biological engineering
- The second decade of synthetic biology: 2010–2020
- FLI Podcast (Part 1): From DNA to Banning Biological Weapons With Matthew Meselson and Max Tegmark
- Safeguarding the Bioeconomy
- Biomanufacturing to Advance the Bioeconomy
- Concepts to Bolster Biorisk Management

- Bioeconomy Task Force Strategy
- Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy
  Summary:
  This executive order from the U.S. President outlines a strategy to promote biotechnology and biomanufacturing in areas like health, climate change, and national security, with a focus on equity, ethics, safety, and security. The order aims to boost federal R&D investment, create a secure biological data ecosystem, increase domestic biomanufacturing, expand bioenergy and biobased product markets, train a diverse workforce, streamline regulations, manage biological risks, and protect the U.S. bioeconomy from foreign threats. The order also emphasizes international cooperation and establishes a 'Data for the Bioeconomy Initiative' and a National Biotechnology and Biomanufacturing Initiative.

16. Most promising projects

16.1 Surveillance and Early detection

- Overview of the Pathogen Biosurveillance Landscape
- Toward A Global Pathogen Early Warning System CSR
- Germ Catcher
- How to Snuff Out the Next Pandemic
- Towards a genomics-informed, real-time, global pathogen surveillance system
- Pandemics: spend on surveillance, not prediction
- Preventing the Misuse of DNA Synthesis Technology
- Benchtop DNA Synthesis Devices: Capabilities, Biosecurity Implications, and Governance
- Benchtop DNA printers are coming soon—and biosecurity experts are worried
- Breath-based Diagnosis of Infectious Diseases: a Review of the Current Landscape

Companies working on Early detection systems

- Concentric by Ginkgo: provide human testing service
- Fluid Robotics: is Revolutionizing How We Monitor Wastewater
- Biobot Analytics: water waste sampling
- Metabiota: has a mission of making the world more resilient to epidemics through partnering with local stakeholders in LMICs to prevent, detect, and respond to outbreaks. Their data and analytics technology was acquired by Ginkgo Bioworks, in August 2022, due to its extensive breadth of infectious disease outbreak data that is suited for epidemiological tracking and forecasting. They operate on 3 pillars:
  Disease surveillance: plan, support and execute surveillance activities of humans and animals together with local authorities to manage known, and identify new emerging infectious diseases.

Capacity building: drive the development of strong disease surveillance and response capabilities by strengthening infrastructure and workforce to excel at biosafety and biosecurity, diagnostics, response, treatment, and more.
Science: conduct and support local research to understand local disease and epidemic risks.

- Sherlock Biosciences
- Novacyt

16.1.1 Real-time detection systems

Companies Working on Real-time detection systems

- Seaspec Real Time Pathogen Detection at the Point of Care
- Q-linea: Biological Agent Detection and Identification Systems and Technology

16.1.2 Air sampler

Companies Working On Air sample

- Developing air sampler for CBRN Defense Forces

16.1.3 Biological weapon sensors for military and civilian protection

Companies Working in the space

- Proengin SA: Chemical and Biological Particle Detectors for Military and Civilian Security
- Safety and Rescue Region - Mid Sweden Military Safety Training and Testing Services
-

16.1.4 Rapid Diagnostics

- Sherlock Biosciences Receives FDA Emergency Use Authorization for CRISPR SARS-CoV-2 Rapid Diagnostic

Companies Working On Rapid Diagnostics

- Concentric by Ginkgo: provide human testing service

16.1.5 Pathogen detection from smell

- Koniku - smell detection company
- Osmo smell-based diagnostic company

16.1.6 Wast water sampling

- Nucleic Acid Observatory (NAO) (30 mins)
- A Global Nucleic Acid Observatory for Biodefense and Planetary Health

- Airplane lavatories deliver new hope for the CDC's variant hunt
  CDC is partnering with GincoBioworks to monitor waste water of airplanes that are entering the US. The test pilot has already been successfully tested in JFK.

  Companies Working On Wastewater sampling
  - Fluid Robotics: is Revolutionizing How We Monitor Wastewater
  - Biobot Analytics: water waste sampling

16.1.7 Companies developing Breath sampling

Companies Working On Wastewater sampling:
- Owlstone Medical is developing a breathalyzer for disease for the early detection of cancer, inflammatory and infectious disease.
- Noze Developing a device for screening and diagnostics of infectious diseases from biomarkers
- Rosa biotech: biosensor for detecting disease using patient samples

16.2 Vaccines

- Safety and security concerns regarding transmissible vaccines
- Universal Vaccines and Vaccine Platforms to Protect against Influenza Viruses in Humans and Agriculture
- Rapid vaccine development by CEPI
- Promoting versatile vaccine development for emerging pandemics
- RNA vaccines: a suitable platform for tackling emerging pandemics?
- More on mRNA Vaccine Manufacturing
- A multivalent nucleoside-modified mRNA vaccine against all known influenza virus subtypes
- The influenza universe in an mRNA vaccine
- Operational challenges in mass vaccination programs
- Prototype Pathogen Approach for Vaccine and Monoclonal Antibody Development: A Critical Component of the NIAID Plan for Pandemic Preparedness
- US approves 1st vaccine for RSV after decades of attempts

  Companies Working On Vaccines:
  - Centivax Developing broad spectrum Vaccines
  - RaDVaC
  - OSPfound.org
  - Pfizer: The Pfizer-BioNTech COVID-19 vaccine was one of the first to be authorized for emergency use.
  - Moderna: The Moderna COVID-19 vaccine was also among the first to receive emergency use authorization.
  - Johnson & Johnson (Janssen): Their single-dose vaccine was approved for emergency use in 2021.
  - AstraZeneca/Oxford University: Their vaccine has been widely used globally, especially in low- and middle-income countries.
  - Novavax: Novavax's protein subunit vaccine was in late-stage trials as of September 2021.

- Sanofi/GlaxoSmithKline: This partnership was working on a protein subunit vaccine.
- CureVac: A German company focused on mRNA vaccines.
- Bharat Biotech: An Indian biotechnology company that developed Covaxin.
- Sinovac: A Chinese biopharmaceutical company that developed Coronavac.
- Gamaleya Research Institute (Sputnik V): The Russian-developed vaccine.
- Sinopharm: This Chinese company has developed two inactivated virus COVID-19 vaccines.
- CanSino Biologics: This is another Chinese company that has developed a viral vector COVID-19 vaccine.
- BioNTech: This German company collaborated with Pfizer to develop one of the first mRNA COVID-19 vaccines.
- Serum Institute of India: An Indian biotech and pharmaceuticals company that's the world's largest vaccine manufacturer by doses. They've produced versions of the AstraZeneca/Oxford vaccine under the name Covishield.
- Covaxx: A division of United Biomedical, has been developing a peptide-based COVID-19 vaccine.
- Medicago: A Canadian biotech company developing a plant-based COVID-19 vaccine.
- Clover Biopharmaceuticals: A Chinese biotech company developing a protein subunit COVID-19 vaccine.
- Inovio Pharmaceuticals: A U.S. company developing a DNA-based COVID-19 vaccine.

16.3 Sequence Screening and Attribution

- Next Steps for Access to Safe, Secure DNA Synthesis
  Summary:
  “The DNA synthesis industry has, since the invention of gene-length synthesis, worked proactively to ensure synthesis is carried out securely and safely. Informed by guidance from the U.S. government, several of these companies have collaborated over the last decade to produce a set of best practices for customer and sequence screening prior to manufacture. Taken together, these practices ensure that synthetic DNA is used to advance research that is designed and intended for public benefit. With increasing scale in the industry and expanding capability in the synthetic biology toolset, it is worth revisiting current practices to evaluate additional measures to ensure the continued safety and wide availability of DNA synthesis. Here we encourage specific steps, in part derived from successes in the cybersecurity community, that can ensure synthesis screening systems stay well ahead of emerging challenges, to continue to enable responsible research advances. Gene synthesis companies, science and technology funders, policymakers, and the scientific community as a whole have a shared duty to continue to minimize risk and maximize the safety and security of DNA synthesis to further power world-changing developments in advanced biological manufacturing, agriculture, drug development, healthcare, and energy.”
- Inoculating science against potential pandemics and information hazards - Kevin Esvelt

16.4 Personal Protective Equipment (PPE)

- Innovate and Stockpile: Respiratory Protection for Essential Workers in a Catastrophic Pandemic
- The Masks We'll Wear in the Next Pandemic
- "In-depth considerations: how do you avoid contaminating yourself during doffing? How do you sterilize your PPE? One promising option: use low-wavelength light ~222nm. It's prominent in our soon-to-be-published roadmap to eliminating catastrophic biorisk for a reason."

  Companies Working On PPEs:

  - Micronel: Air Purification Masks, Inline and Two-Filter Blowers and Air Flow Monitoring Equipment
  - Antimicrobial clothing for medical staff: Prevent & Deloza: Bespoke Uniforms and Protective Clothing for Military Personnel
  - Micro Climate

16.5 Stopping Gain of Function Research

- I think National Science Advisory Board for Biosecurity (NSABB) worked on this?
- New pathogen research rules: Gain of function, loss of clarity

16.6 HVAC System Improvements

- Indoor Air Quality Is the Next Great Public Health Challenge (Not so biorisk but good general Indoor Air Quality)
- It's past time to address the problem of indoor air quality. A new technology can help (Not so biorisk but good general Indoor Air Quality)
- ASHRAE Approves Groundbreaking Standard to Reduce the Risk of Disease Transmission in Indoor Spaces

Companies developing improved HVAC systems

- Safetraces: is working on verifying ventilation and filtration performance for the removal of airborne pathogens. They measure, verify and manage HVAC system performance.
- RZero: transform your healthy buildings program with IoT-connected sensors and UV-C disinfection devices for every indoor space.
- Particle one: have software to monitor and model the indoor air quality.
- Poppy: working on making indoor spaces infection-resilient and overall more healthy
- The Air Doctor: Air Purification and Filtration Systems
- Blaschke J Wehrtechnik: working on NBC Protective Suits, Ventilation Systems etc
- Beth-El Industries: Filtration, Ventilation and Air-Conditioning Systems
- BORSERINI: Industrial Filtration Technology for Military and Defence Applications
- Kinetics: NBC / CBRN Systems, and HVAC and Cooling Equipment
- CMCA: Air-Conditioning, Power-Generation and Integrated Shelter Solutions for Military Application
- Kinetics: Auxiliary Power Units (APU) Heating, Ventilation and Air-Conditioning (HVAC), NBC/CBRN Systems
- Weiss Defence: Air-conditioning System Specifically Designed For Mobility And The Defence Market

- Temet: Blast Protection and CBRN Filtration Systems To Protect Military Infrastructure

16.7 Sterilizing: UV-C lamps

- Germicidal ultraviolet LEDs: a review of applications and semiconductor technologies
- Far UV-C Radiation: Current State-of Knowledge
- Air Safety to Combat Global Catastrophic Biorisks
- Research Into Far-UVC Systems Can Help Us Prevent the Next Pande
- Germicidal UV Executive Summary (2022-11-09) [shared]
- Possible UV-C Pilot Structure
- Far-UVC light (222 nm) efficiently and safely inactivates airborne human coronaviruses
- Upper-Room Ultraviolet Germicidal Irradiation (UVGI)
- Ubiquitous Far-Ultraviolet Light Could Control the Spread of Covid-19 and Other Pandemics
- 222 nm Far-UVC from filtered Krypton-Chloride excimer lamps does not cause eye irritation when deployed in a simulated office environment
- A Comprehensive Analysis of the UVC LEDs' Applications and Decontamination Capability
- Field study of early implementation of UV sources and their relative effectiveness for public health and safety
- Design of Continuous Flow UVC Lamp for Office Air Germicide Elimination

  Companies in the field:
  - 1Day Sooner
  - Esvelt's lab
  - GAP
  - IFP
  - Lumenlabs Far-UVC
  - Care222 from ushio.co
  - Bankrupt Healthe owes its UV-C supplier and its billionaire owner
  - Steril Ray Inc.
  - Columbia University, David J. Brenner
  - AeroMed
  - Puro Lighting
  - UVC LEDs
  - Eden Park
  - UVC sterilization for Healthcare facilities
  - Lumalier
  - Various UVC products
  - Fresh-aire UV
  - UltraViolet various UV products
  - UVC for HVAC
  - Philips
  - UVC light robots
  -

16.8 Developing pandemic safe buildings

- AN INTRODUCTION TO STRUCTURAL VENTILATION OF THE BUILDING ENVELOPE
- Ventilation Control for COVID-19 & Beyond
- Bryden WA. “Immune Building Program.” DARPA. 2005.
- Building Retrofits for Increased Protection Against Airborne Chemical and Biological Releases.” 2007. NIST.
- Cousins, Daniel and Steven D. Campbell. “Protecting Buildings against Airborne
- Contamination.” 2007. Lincoln Laboratory Journal.
- Guidance for Protecting Building Environments From Airborne Chemical, Biological, or Radiological Attacks.” NIOSH.
- National Research Council. 2007. Protecting Building Occupants and Operations from Biological and Chemical Airborne Threats: A Framework for Decision Making. National Academies Press.
- Psychological selection of antarctic personnel: The "SOAP" instrument
  Companies developing pandemic-safe buildings:
- Hotzone Solutions: NBC Training, Consultancy and Equipment Testing Services
- Lunor: NBC Protection for Shelters and Hardened Buildings
- BoxModul: Ballistic and Blast Protective Safe Shelters
- em.tronic: Stand alone detection system and deployable lab
- Armoured Vehicles and Stand-Alone Protection
- Gamma: CBRN Defence Equipment for the Military Industry (Our company offers complex CBRN building monitoring systems, as well as on-board detection systems for infantry vehicles, special-purpose reconnaissance vehicles and mobile laboratories.)
- NBC-Sys: CBRN Protection Systems for Defense Forces and Population
- Observis: Monitoring and Control Solutions for the Defence Industry
  Critical infrastructure solutions
  It integrates detectors, heating, ventilation and air-conditioning (HVAC) systems and automatic doors into a full automation security system controlled in one highly visual user interface. The device and system independence of ObSAS offers complete freedom to choose the best and most suitable equipment to fulfil the installation’s security design and specifications, from office facility to underground shelter.
- OWR: NBC Protection, NBC Detection and Decontamination System

16.9 Pathogen characterization

- The biosecurity benefits of genetic engineering attribution
  Abstract:
  Biology can be misused, and the risk of this causing widespread harm increases in step with the rapid march of technological progress. A key security challenge involves attribution: determining, in the wake of a human-caused biological event, who was responsible. Recent scientific developments have demonstrated a capability for detecting whether an organism involved in such an event has been genetically modified and, if modified, to infer from its genetic sequence its likely lab of origin. We believe this technique could be developed into powerful forensic tools to aid the

attribution of outbreaks caused by genetically engineered pathogens, and thus protect against the potential misuse of synthetic biology.

- How biological detective work can reveal who engineered a virus
  Summary:
  Genetic engineering attribution, a method using machine learning algorithms to trace genetically engineered organisms back to their originating labs, is an emerging field. This technique, showcased in the Genetic Engineering Attribution Challenge, achieved over 80% accuracy in predicting the lab that created a specific genetic sequence. The technology has broad biosecurity implications, potentially deterring bioengineered weapons use, holding labs accountable for virus leaks, and protecting biological intellectual property. However, more research is needed to handle fully engineered viruses and bacteria and cases where the lab's "genetic fingerprints" are deliberately concealed.
- Genetic Engineering Attribution Challenge
  Summary:
  AltLabs ran the Genetic Engineering Attribution Challenge, a competition with $30,000 prize pools for both the Prediction and Innovation tracks. Over 300 teams globally participated, aiming to identify the source of genetically engineered DNA sequences. The top teams could predict the origin of an unfamiliar DNA sequence with nearly 95% accuracy given ten guesses, surpassing the previous best of 85%. The challenge showcased a variety of innovative machine learning approaches for genetic engineering attribution, emphasizing the potential for enhanced accountability and transparency in synthetic biology.

16.10 Medical countermeasures

- Creating rapid, inexpensive diagnostics for all known pathogens
  Companies:
  - Resiliance: Biomanufacturing innocation partner, revoltionisin how novel medicines are made, funded and scaled.

16.11 Other Interesting Projects

- Water purification:
  - Companies:
    - Eimco Water Technologies: Deployable Wastewater Treatment for Field Operations and Construction Camps
    - Global Water: Water Purification, Desalination, Wastewater and Wastewater-Effluent Recycling
    - Kaercher Futuretech: Field Camp Systems, Water Supply Systems, Mobile Catering Systems and CBRN Protection Systems
    - Pure H2O: Water Filtration Systems for Harsh Environments
    - TerraGroup: Tactical Water Purification Systems for Military Field Applications
    - Water Generating Systems: Water Sustainability Solutions for Military and Mobile Unite

- Decontamination:
    - Companies:
        - Hispano Vema: NBC / CBRN Decontamination and Protection Systems and Mobile Field Camps
        - Cristanini: CBRN Decontamination Equipment
- Other semi relevant companies:
    - Companies:
        - National Institute for Nuclear, Chemical and Biological Protection: Testing and Training for the CBRN Environment
        - Gamma: CBRN Defence Equipment for the Military Industry
        - Camp Supply International: Container-Based Camp Shelter, Kitchen and Toilet Modules
        - Pimco: Specialist Equipment for Detecting Weapons of Mass Destruction
- List of Lists of Concrete Biosecurity Project Ideas
- Concrete biosecurity projects (some of which could be big)
- Apollo report
- Lynn Klotz on improving the Biological and Toxin Weapons Convention (BWC)
- Filippa Lentzos on controlling dangerous biological research
- Genetic engineering attribution: technology and policy implications
- On building an early warning system for pandemics (CSR piece; Scientific American piece, Nucleic Acid Observatory (NAO) preprint)

17. Fellowships

- Fellowship run by Biological Technologies Office
- Emerging Leaders in Biosecurity Initiative (ELBI) fellowship
- Different programs from Genova Centre for Security Policy

18. Funding sources

- VC funding sources for technical Medtech devices

19. Governmental Agencies

- **Department of Health and Human Services (HHS)**
  "The HHS is responsible for protecting public health through the development of vaccines, drugs, and diagnostic tests to combat bioterrorism, as well as detecting and managing outbreaks of infectious diseases."
- **Department of Homeland Security (DHS)**
  "The DHS is responsible for protecting the nation's critical infrastructure and coordinating the response to a biological attack or outbreak."
- **Department of Defence (DoD)**
  "The DoD also has a role in biodefense through the development and stockpiling of medical countermeasures, as well as the training of civilian and military personnel to respond to a biological threat."

    - **The Joint Program Executive Office for Chemical, Biological, Radiological and Nuclear Defense (JPEO-CBRND)** “leads, manages, and directs the acquisition, fielding and sustainment of CBRN sensors, protective equipment, medical countermeasures, specialized equipment for U.S. Special Forces, integration and information management systems, and defense enabling biotechnologies. The organization also works closely with various government agencies that need CBRN defense equipment.”
    - **Defense Threat Reduction Agency (DTRA)** “provides cross-cutting solutions to enable the DoD, the U.S. Government, and international partners to Deter, Prevent & Prevail against WMDs & emerging threats.”
- The **Department of Agriculture (USDA)”** is responsible for protecting the nation's food supply from terrorist attacks and outbreaks of animal diseases.”
- The **Federal Bureau of Investigation (FBI)** “is responsible for investigating criminal acts related to bioterrorism.”
- And the **National Security Council (NSC)** “coordinates the biodefense efforts of these agencies.”
- Defense Advanced Research Projects Agency **(DARPA)**

19.1 Big governmental programs

- Apollo Program for Biodefense’s technology priorities
- BARDA DRiVe’s portfolio
- DARPA Biological Technologies Office program portfolio
- Public DARPA programs on - Run through GPT-3 for simple summaries
- Department of Defense Fiscal Year (FY) 2022 Budget Estimates

20. Containment Labs around the world

- Biosecurity Map
  This map lists biosecurity labs, animal biosecurity labs and others
- Maximum containment labs around the world
  Worth noting that one of the primary limitations is probably that only English-language publications were considered but report seems to suggest similar analyses for non-English languages are forthcoming - Sophie Rose
- Rush to build high-security labs triggers pathogen escape fears
- Biosafety Level 4 Labs Up Close and Personal.” 2005. HPAC Engineering.
  Summary:
  Biosafety Level 4 (BSL-4) labs are highly secure facilities for handling dangerous biological substances. They became a focus of investment after 9/11 and the anthrax attacks. The labs have primary, secondary, and tertiary barriers to prevent the escape of organisms. Engineering features include pressure-driven airflow control, bioseal doors, and specialized ventilation systems. Safety records show low rates of accidents or infections. Wind-tunnel studies assess risks. BSL-4 labs are costly but crucial for handling infectious diseases.

21. Relevant Labs working on modelling infectious diseases

- Ssematimba A, Hagenaars TJ, de Jong MCM. “Modelling the Wind-Borne Spread of Highly Pathogenic Avian Influenza Virus between Farms.” 2012. PLoS ONE.
  Summary:
  The study develops a model to understand the spread of contaminated farm dust, which can provide insights into mechanisms of disease spread between farms. The model was applied to assess the potential wind-borne transmission of Highly Pathogenic Avian Influenza virus (HPAI) during the 2003 epidemic in the Netherlands. The model incorporates dust deposition process, pathogen decay, and infection process on exposed farms, calculating distance-dependent probabilities of between-farm transmission. However, the comparison between the model's predictions and the observed transmission pattern during the 2003 epidemic shows that wind-borne transmission alone cannot fully explain the epidemic's spread, though it may contribute significantly to short-distance spread, potentially explaining 24% of transmission over distances up to 25 km.

22. Relevant forecast websites

- Metaculus
- Manifold
-

22.1 Relevant forecast questions

23. Newsletters

- Pandora Report from GMU
- Global Biodefense News
- Johns Hopkins Center for Health Security (CHS)
- Health Security Decoded
- Flu Vaccine Roadmap Newsletter
- NTI
- Biopartisan Commission on Defence
-
-
-

24. Websites to follow

- Global Biodefense
- Pandora Report from GMU

25. Labs pushing the limits of biotech

- biodesignlab.co.uk

26. Organisations in the space

The initial version of this was created by: Future of Life Institute

- International Gene Synthesis Consortium (IGSC)
- BWC Implementation Support Unit
- Center for Communicable Disease Dynamics at Harvard Chan
- The Centre for Long-Term Resilience
- Cambridge Working Group: Works to address the risks of Potential Pandemic Pathogen research through promoting public understanding, risk assessment and regulation of such research.
- etc Group: Works to address the socioeconomic and ecological issues surrounding new technologies (especially agriculture) that could have an impact on the world's poorest and most vulnerable people.
- American Biological Safety Association (ABSA): Promotes biosafety as a scientific discipline through forums and peer-reviewed journals for biosafety professionals throughout the world.
- Biomedical Advanced Research and Development Authority (BARDA): Develops and procures needed medical countermeasures (MCMs), including vaccines, therapeutics, diagnostics, and non-pharmaceutical countermeasures, against a broad array of public health emergencies in the US.
- Biotechnology Industry Organization (BIO): A trade association representing biotechnology companies, academic institutions, state biotechnology centers, and related organizations around the world. Researches and developes innovative healthcare, agriculturual, industrial, and environmental biotechnology products.
- Center for Advanced Biotechnology and Medicine: Conducts biomedical and biotech research and development to improve human health.
- Center for Biodefense and Emerging Infectious Diseases (CBEID): Addresses and researches important issues in the protection of the US from biological threats, including bioterrorism, biological warfare, and tropical infectious diseases.
- Center for Infectious Disease Research and Policy (CIDRAP): Works to prevent illness and death from infectious disease threats through research by implementing real world practical applications, policies, and solutions.
- Center for International Security and Cooperation: Stanford University's hub for researchers working together to tackle some of the world's most pressing security and international cooperation issues; and to influence the policymaking agenda in the United States and abroad to help build a safer world.
- Center for Policy on Emerging Technologies (C-PET): A wide network of knowledgeable professionals who identify, clarify, and prioritize the big questions raised in a future perspective to cultivate a context within which solutions can be developed.

- Center for Strategic and International Studies (CSIS): A bipartisan organization that conducts research and analysis, and develops policy initiatives with a future outlook, to help decision-makers chart a course toward a better world.
- Centers for Disease Control and Prevention (CDC): The United States government's center for research, analysis, and detection of new and emerging global health threats. Promotes healthy and safe behaviors, communities, and environments.
- Centre for Cellular and Molecular Platforms (C-CAMP): A research and development center in India which enables bioscience research and entrepreneurship by providing research, development, training, and service in biotechnology platforms.
- Centre for the Study of Existential Risk: A multidisciplinary research center dedicated to the study and mitigation of risks that could lead to human extinction.
- Chemical Biological Incident Response Force (CBIRF): Responds to chemical, biological, radiological, nuclear, or high yield explosive events in order to assist local, state, or federal agencies in consequence management.
- Chinese Center for Disease Control and Prevention (China CDC): A nonprofit institution that works in the fields of disease control and prevention, and public health management.
- Defence Advanced Research Projects Agency (DARPA) - Biological Technologies Office: Researches and designs breakthrough technologies for nation security.
- Defence Threat Reduction Agency (DTRA): The U.S. Department of Defense's official Combat Support Agency for countering weapons of mass destruction.
- EcoHealth Alliance: An international organization of scientists dedicated to the conservation of biodiversity that researches the relationships between wildlife, ecosystems, and human health.
- Emerging Pandemic Threats (EPT) Program: Monitors and increases local capacities of geographic hot spots to identify the emergence of new infectious diseases in high-risk wildlife that could pose a major threat to human health.
- Federation of American Scientists (FAS): Provides a scientific analysis of and solutions to protect against catastrophic threats to national and international security.
- Foresight Institute: A think tank and public interest organization focused on transformative future technologies. Discovers and promotes the technological benefits, and helps avoid the dangers of nanotechnology, AI, biotech, and other similar life-changing developments.
- Global Catastrophic Risk Institute (GCRI): A think tank leading research, education, and professional networking on global catastrophic risk.
- Intelligence: Collects and conveys essential information the President and the members of policymaking, law enforcement, and military communities require to execute their appointed duties.
- International Federation of Biosafety Associatons (IFBA): Supports and promotes biosafety on a national and international level through collaboration among national and regional biosafety organizations worldwide.
- International Geosphere-Biosphere Programme (IGBP): Studies the global-scale and regional-scale interactions between Earth's biological, chemical, and physical processes and their interactions with human systems.

- Lawrence Livermore National Laboratory (LLNL): Applies multidisciplinary science and technology to anticipate, innovate, and deliver responsive solutions to complex global security needs.
- Lifeboat Foundation: An organization dedicated to encouraging scientific advancements while helping humanity survive existential risks and possible misuse of increasingly powerful technologies.
- Middle East Consortium on Infectious Disease Surveillance (MECIDS): Advances the capabilities for early infectious disease and food-borne illness prevention, detection, control, and response between its member countries of Israel, Jordan, and Palestine.
- National Institute of Allergy and Infectious Diseases (NIH): Conducts and supports basic and applied research to better understand, treat, and prevent infectious, immunologic, and allergic diseases.
- New England Complex Systems Institute (NECSI): An independent academic research and educational institution that develops complex systems and their applications to study how interactions within a system lead to its behavioral patterns, and how the system interacts with its environment.
- Nuclear Threat Initiative (NTI): A nonpartisan organization that focuses on strengthening global security by reducing the risk of using and preventing the spread of nuclear, biological, and chemical weapons.
- Resilience Alliance: A research organization comprised of scientists and practitioners from many disciplines who collaborate to explore the dynamics of social-ecological systems.
- Skoll Global Threats Fund: Seeks solutions, strengthens alliances, and spurs actions needed to confront the global threats imperiling humanity.
- Society for Risk Analysis (SRA): A multidisciplinary, interdisciplinary, scholarly, international society that provides an open forum for all those who are interested in risk analysis.
- The Biosecurity Engagement Program (BEP): Engages with Life Scientists to combat biological threats worldwide by providing assistance to improve biosecurity, biosafety, pathogen surveillance, and infectious disease surveillance and response.
- The Center for Bioethics and Human Dignity (CBHD)
- The Club of Rome: An informal association of long-term thinkers interested in and concerned with the future of humanity and the planet.
- The Genome Analysis Centre (TGAC): A research institute focused on the application of genomics and bioinformatics to advance plant, animal, and microbial research to promote a sustainable bioeconomy.
- The Institute for Ethics and Emerging Technologies (IEET): A think tank which promotes ideas about how technological progress can increase freedom, happiness, and human flourishing in democratic societies.
- The Program on Science and Global Security (SGS): Carries out research, policy analysis, education, and training in nuclear arms control and nonproliferation, and provides research and administrative support to the International Panel on Fissile Materials.
- U.S. Department of Defense (DOD): Provides military forces needed to deter war and to protect the security of the United States.

- U.S. Department of Homeland Security (DHS) - National Biodefense Analysis and Countermeasures Center (NBACC): A national resource used to understand the scientific basis of the risks posed by biological threats and to attribute their use in bioterrorism or biocrime events.
- UPMC Center for Health Security: Protects people's health from the consequences of epidemics and disasters, and ensures that communities are resilient to major challenges.
- Wilson Center: A non-partisan policy forum and a leading institution for tackling global issues through independent research and open dialogue to inform actionable ideas for Congress, the Administration, and the broader policy community.
- X-events: A research institute that works with the theory of surpize, studies extreme events, experiments different anticipation methods, and develops tools for research and decision making.
- Prevent Project: PREVENT works to reduce the risks that zoonoses—diseases that move between animals and humans—can pose to public health.
- IGEM
- The Alliance To End Biological Threats from Council on strategic risks
- National Institutes of Health (NIH)
- European Centre for Disease Prevention and Control (ECDC)
- Johns Hopkins Center for Health Security
- Coalition for Epidemic Preparedness Innovations
- Gavi, the Vaccine Alliance: Gavi helps vaccinate children in some of the world's poorest countries, and is playing a critical role in COVAX, the vaccines pillar of the Access to COVID-19 Tools (ACT) Accelerator.
- Bill & Melinda Gates Foundation: This foundation funds research and provides grants to combat infectious diseases.
- Wellcome Trust: A politically and financially independent foundation that supports scientists and researchers to take on big problems in health.
- Open Philanthropy: They identify and fund projects that can have a transformative impact on the world, including potential pandemic risks.
- National Science Advisory Board for Biosecurity (NSABB)
- Center for Arms Control and Non-Proliferation
- World Health Organization (WHO)
- ASBA International - The association of Biosecurity and Biosafety
-

27. Already existing Biosecurity Repositories! Thanks to the creators!

This summary contains their work as well!

- Chris Bekerlee (Bakerlee biosecurity reading list [public])
- Greg Lewis (GCBR reading list)

- GCBR Fundamentals Programme Curriculum (Summer 2022)
- Future of Life Institute
- Decoding Bio
- Sofya Lebedeva for newsletter recommendations
- A Biosecurity and Biorisk Reading+ List - updated 09/01/2023
- Next Generation Biosecurity course a summary of it can be found here
- Publications from John Hopkins
- WMD Spreadsheet for Learn WMD
- Biosecurity EAF subtopic
-

28. Appendix and Summary

Articles on TODO list:

https://www.liebertpub.com/doi/10.1089/hs.2019.0115
https://jme.bmj.com/content/33/6/342
https://www.degruyter.com/document/doi/10.1515/jbbbl-2018-0006/html
https://www.science.org/doi/10.1126/science.abb1466
https://onlinelibrary.wiley.com/doi/10.1111/reel.12289
https://ilr.law.uiowa.edu/print/volume-102-issue-3/science-as-speech
https://onlinelibrary.wiley.com/doi/10.1111/reel.12289
https://councilonstrategicrisks.org/wp-content/uploads/2020/12/Common-Misconceptions-About-Biological-Weapons_BRIEFER-12_2020_12_7.pdf
https://www.tandfonline.com/doi/abs/10.1080/10736700600601194?journalCode=rnpr20
https://uploads.fas.org/2016/03/bioattribution-nps-report-3-14.pdf
https://pubmed.ncbi.nlm.nih.gov/20065941/
https://onlinelibrary.wiley.com/doi/full/10.1111/1758-5899.12786
https://pubmed.ncbi.nlm.nih.gov/24442981/
https://www.jstor.org/stable/resrep24166
https://programs.fas.org/bio/resource/documents/2009-12-22-prevent_biothreats.pdf
https://pubmed.ncbi.nlm.nih.gov/24132385/
Strengthening Security for Gene Synthesis: Recommendations for Governance
COMPLIANCE WEAPONS REGIME
Dual use in the 21st century: emerging risks and global governance
Gaps in the International Governance of Dual-Use Research of Concern
Governance of Dual Use Research in the Life Sciences: Advancing Global Consensus on Research Oversight: Proceedings of a Workshop
ON THE DUAL USES OF SCIENCE AND ETHICS PRINCIPLES, PRACTICES, AND PROSPECTS
A Proposed Framework for Identifying Potential Biodefense Vulnerabilities Posed by Synthetic Biology
Biological Disasters of Animal Origin: The Role and Preparedness of Veterinary and Public Health Services

28.1 Podcast hosts that are exciting

- This week in virology
  Relevant podcasts that are in the field

Others that hav relevant podcasts:

- 80000 Hours
- Sam Harris Making sense
- Rationally Speaking Podcast
- Future Perfect Podcast
- Future of Life Institute Podcast
- Kino Bronic
- BBC 4 podcasts
- Manifold podcast
- 80k After Hours
- Nonlinear
- Conversations with Tyler
- Council on Strategic Risks
- Medical countermeasures
-

28.2 All books

- Biosecurity and Bioterrorism: Containing and Preventing Biological Threats
- Biotechnology for Beginners: An overview of biotechnology for beginners and lay readers. Includes a wide array of biotech sciences such as: genetics, immunology, biochemistry, agronomy, food science, and animal science.
- Biotechnology and the Human Good
- Fighting for the Future of Food
- Introduction to Biotechnology
- Our Posthuman Future: Consequences of the Biotechnology Revolution
- Biosecurity Dilemmas: Dreaded Diseases, Ethical Responses, and the Health of Nations, Christian Eanemark, 2017. (Somewhat philosophical, organized around core tensions/dilemmas in biosecurity and thus recommended by several as a good reference.)
- Biological Threats in the 21st Century: The Politics, People, Science and Historical Roots, Ed. Filippa Lentzos, 2016. (Collection of essays by subject matter experts; expensive but recommended as a good and diverse reference.)
- Barriers to Bioweapons: The Challenges of Expertise and Organization for Weapons Development, Sonia Ben Ouagrham-Gormley, 2014. (Recommended and reviewed here; book-length sceptical take on non-state bioweapons development.)
- Bioterror and Biowarfare: A Beginner's Guide, Malcolm Dando, 2006. (See Notes on “Bioterror and Biowarfare” on the EA forum.)
- Global Catastrophic Risks, Ed. Nick Bostrom and Milan M. Cirkovic, 2007. (GBCRs appear in chapters 14 and 20.)
- Synthetic Biology: Safety, Security, and Promise, Gigi Gronvall, 2016.

- The Dead Hand: The Untold Story of the Cold War Arms Race and Its Dangerous Legacy, David Hoffman, 2009. (Recommended by several people for understanding more about the US bioweapons program.)
- Deadliest Enemy: Our War Against Killer Germs, Michael Osterholm and Mark Olshaker, 2020. (Likely worth getting the May 2020 paperback edition, which has a preface on COVID-19.)
- The Soviet Biological Weapons Program: A History, Milton Leitenberg and Raymond Zilinskas, 2021.
- The Doomsday Machine: Confessions of a Nuclear War Planner, Daniel Ellsberg, 2017. (Not directly about biological risks, but an engaging read that gave me more sense of how the US military operates in the face of catastrophic risks.)

Other books on My list that have not been reviewed:

- "The Great Influenza: The Story of the Deadliest Pandemic in History" by John M. Barry: This book provides insight into the 1918 flu pandemic and offers lessons on how to prevent and manage future pandemics.
- "Spillover: Animal Infections and the Next Human Pandemic" by David Quammen: The book details how pandemics often originate from diseases that spill over from animals to humans and what can be done to prevent them.
- "The End of Epidemics: The Looming Threat to Humanity and How to Stop It" by Dr. Jonathan D. Quick and Bronwyn Fryer: The authors provide strategies for how to prevent epidemics and pandemics.
- "Pandemic: Tracking Contagions, from Cholera to Ebola and Beyond" by Sonia Shah: This book explores the history of pandemics and discusses measures for preventing future outbreaks.
- "The Rules of Contagion: Why Things Spread - and Why They Stop" by Adam Kucharski
- "Deadliest Enemy: Our War Against Killer Germs" by Michael T. Osterholm and Mark Olshaker
- "Pale Rider: The Spanish Flu of 1918 and How It Changed the World" by Laura Spinney
- "The Pandemic Century: One Hundred Years of Panic, Hysteria, and Hubris" by Mark Honigsbaum

28.3 All podcasts

- Biosecurity as an EA cause area | Claire Zabel | EA Global: San Francisco 2017
- Biotechnology and existential risk | Andrew Snyder Beattie | EA Global: London 2017
- Hear This Idea: Jassi Pannu and Joshua Monrad on Pandemic Preparedness
- Hear This Idea: Tessa Alexanian and Janvi Ahuja on Synthethic Biology and GCBRs
- Hear this idea: Kevin Esvelt and Jonas Sandbrink on Risks from Biological Research
- Hear this idea: Ajay Karpur on Metagenomic Sequencing
- #4 – Howie Lempel on why we aren't worried enough about the next pandemic — and specifically what we can do to stop it.

- #12 – Beth Cameron fought Ebola for the White House. Now she works to stop something even worse. - 80,000 Hours
- #27 – The careers and policies that can prevent global catastrophic biological risks, according to world-leading health security expert Dr Tom Inglesby
- #65 – Ambassador Bonnie Jenkins on 8 years of combating WMD terrorism
- #70 – Dr Cassidy Nelson on the twelve best ways to stop the next pandemic (and limit COVID-19)
- #74 – Dr Greg Lewis on COVID-19 and reducing global catastrophic biological risks
- #104 – Dr Pardis Sabeti on the Sentinel system for detecting and stopping pandemics
- #76 – Tara Kirk Sell on COVID-19 misinformation, who's done well and badly, and what we should reopen first
- #93 – Andy Weber on rendering bioweapons obsolete and ending the new nuclear arms race
- #103 – Max Roser on building the world's first great source of COVID-19 data at Our World in Data
- #112 – Carl Shulman on the common-sense case for existential risk work and its practical implications
- #114 – Maha Rehman on working with governments to rapidly deliver masks to millions of people
- #116 – Luisa Rodriguez on why global catastrophes seem unlikely to kill us all
- #118 – Jaime Yassif on safeguarding bioscience to prevent catastrophic lab accidents and bioweapons development
- #121 – Matthew Yglesias on avoiding the pundit's fallacy and how much military intervention can be used for good
- #131 – Lewis Dartnell on getting humanity to bounce back faster in a post-apocalyptic world
- Making Sense: Existential Risk - A Conversation with Toby Ord
- Making Sense: Special Episode: Engineering the Apocalypse - Rob Reid
- Making Sense: What Have We Learned from the Pandemic? - A Conversation with Nicholas Christakis
- Making Sense: EPISODE 311 Did SARS-CoV-2 Escape from a Lab? A Conversation with Matt Ridley and Alina Chan
- Making Sense: EPISODE 323 Science & Survival A Conversation with Martin Rees
- Filippa Lentzos on Global Catastrophic Biological Risks
- Future Perfect: How to Prevent a factory farmed pandemic
- Preparing for a World in which Thousands Can Unleash New Pandemics | Kevin Esvelt | EAGxBoston 22
- Pandemic Prevention Network | Sanjay Joshi | EAGxOxford 22
- EAG 2018 SF: Pandemic pathogens
- Rationally Speaking Podcast: 137: Should scientists try to create dangerous viruses? (Marc Lipsitch)
- Rationally Speaking Podcast: 261: Dangerous biological research – is it worth it? (Kevin Esvelt)
- Rationally Speaking Podcast: 262: Humanity on the precipice (Toby Ord)
- Founders Pledge: Episode 2 COVID-19 briefing with the Johns Hopkins Center for Health Security
- BBC Radio 4 - Apocalypse How, Death by DNA

- The Portal 27: Daniel Schmachtenberger - On Avoiding Apocalypses
- The Portal 30: Ross Douthat - The Rave Before the Fall
- EA Talks: Mitigating catastrophic biorisks | Kevin Esvelt
- Power Corrupts: Biological Weapons
- FLI Podcast (Part 1): From DNA to Banning Biological Weapons With Matthew Meselson and Max Tegmark
- FLI Podcast (Part 2): Anthrax, Agent Orange, and Yellow Rain: Verification Stories with Matthew Meselson and Max Tegmark
- Michael Mina COVID rapid tests - Lex Fridman (Video/Podcast, 2 hours 14 mins)
- Preventing the next pandemic - Kevin Esvelt (video, 70 mins)
- Reducing global catastrophic biological risks | Jaime Yassif | EA Student Summit 2020
- Pandemic pathogens | Amesh Adalja | EA Global: San Francisco 2018
- Assessing global catastrophic biological risks | Crystal Watson | EA Global: San Francisco 2018
- Marc Lipsitch: Preventing catastrophic risks by mitigating subcatastrophic ones
- Engineering Gene Safety
- The next outbreak? We're not ready Bill Gates, TED talk, April 2015. (Gates founded CEPI the year after this, so he put his money where his TED talk was.)
- **[Conversations with Tyler]**
- Making Sense: EPISODE 190 How Should We Respond to Coronavirus? A Conversation with Nicholas Christakis
- Making Sense: EPISODE 191 Early Thoughts on a Pandemic A Conversation with Amesh Adalja
- Making Sense: EPISODE 201 A Conversation with Yuval Noah Harari
- Making Sense: EPISODE 214 A Conversation with Siddhartha Mukherjee
- Making Sense: EPISODE 222 A Pandemic of Incompetence A Conversation with Nicholas Chrisakis
- Making Sense: EPISODE 233 In the Groves on Misinformation A Conversation with Zeynep Tufekci
- # – Emergency episode: Rob & Howie on the menace of COVID-19, and what both governments & individuals might be able to do to help
- #77 – Marc Lipsitch on whether we're winning or losing against COVID-19
- #84 – Shruti Rajagopalan on what India did to stop COVID-19 and how well it worked
- FLI Podcast: Lessons from COVID-19 with Emilia Javorsky and Anthony Aguirre
- Top epidemiologist Marc Lipsitch on whether we're winning or losing against COVID-19
- Podcast: Governing Biotechnology, From Avian Flu to Genetically-Modified Babies with Catherine Rhodes
- Sean Ekins on Regulating AI Drug Discovery
- Sean Ekins on the Dangers of AI Drug Discovery
- Filippa Lentzos on Global Catastrophic Biological Risks
- Future of Life Award 2020: Saving 200,000,000 Lives by Eradicating Smallpox
- FLI Podcast: On the Future of Computation, Synthetic Biology, and Life with George Church
-

28.4 Other interesting podcasts in the field

- Podcast: Governing Biotechnology, From Avian Flu to Genetically-Modified Babies with Catherine Rhodes
- Sean Ekins on Regulating AI Drug Discovery
- Sean Ekins on the Dangers of AI Drug Discovery
- Filippa Lentzos on Global Catastrophic Biological Risks
- Future of Life Award 2020: Saving 200,000,000 Lives by Eradicating Smallpox
- FLI Podcast: On the Future of Computation, Synthetic Biology, and Life with George Church

28.5 All Companies

Database of companies.

28.5.1 HVAC Systems

- Safetraces: is working on verifying ventilation and filtration performance for the removal of airborne pathogens. They measure, verify and manage HVAC system performance.
- RZero: transform your healthy buildings program with IoT connected sensors and UV-C disinfection devices for every indoor space.
- Particle one: have a software to monitor and modell the indoor airqulity.
- Poppy: working on making indoor spaces infection-resilient and overall more healthy
- The Air Doctor: Air Purification and Filtration Systems
- Blaschke J Wehrtechnik: working on NBC Protective Suits, Ventilation Systems etc
- Beth-El Industries: Filtration, Ventilation and Air-Conditioning Systems
- BORSERINI: Industrial Filtration Technology for Military and Defence Applications
- Kinetics: NBC / CBRN Systems, and HVAC and Cooling Equipment
- CMCA: Air-Conditioning, Power-Generation and Integrated Shelter Solutions for Military Application
- Kinetics: Auxiliary Power Units (APU) Heating, Ventilation and Air-Conditioning (HVAC), NBC/CBRN Systems
- Weiss Defence: Air-conditioning System Specifically Designed For Mobility And The Defence Market
- Temet: Blast Protection and CBRN Filtration Systems To Protect Military Infrastructure

28.5.2 Early Detection

- Concentric by Ginkgo: provide human testing service
- Fluid Robotics: is Revolutionizing How We Monitor Wastewater
- Biobot Analytics: water waste sampling
- Metabiota: has a mission of making the world more resilient to epidemics through partnering with local stakeholders in LMICs to prevent, detect, and respond to outbreaks. Their data and analytics technology was acquired by Ginkgo Bioworks, in August 2022, due to its extensive breadth of infectious disease outbreak data that is suited for epidemiological tracking and forecasting. They operate on 3 pillars:

    - Disease surveillance: plan, support and execute surveillance activities of humans and animals together with local authorities to manage known, and identify new emerging infectious diseases.
    - Capacity building: drive the development of strong disease surveillance and response capabilities by strengthening infrastructure and workforce to excel at biosafety and biosecurity, diagnostics, response, treatment, and more.
    - Science: conduct and support local research to understand local disease and epidemic risks.
- Sherlock Biosciences
- Novacyt

28.5.3 Real Time Detection Systems

- Seaspec Real Time Pathogen Detection at the Point of Care
- Q-linea: Biological Agent Detection and Identification Systems and Technology

28.5.4 Air Samplers

- Develping air sampler for CBRN Defense Forces

28.5.5 Various Early Detection Systems

Smell detection

- Koniku - smell detection company
- Osmo smell-based diagnostic company

Breath sampling

- Owlstone Medical is developing a breathalyzer for disease for the early detection of cancer, inflammatory and infectious disease.
- Noze Developing a device for screening and diagnostics of infectious diseases from biomarkers
- Rosa biotech: biosensor for detecting disease using patient samples

28.5.6 Biological Weapon Sensors for Military and Civilian Protection

- Proengin SA: Chemical and Biological Particle Detectors for Military and Civilian Security
- Safety and Rescue Region - Mid Sweden Military Safety Training and Testing Services

28.5.7 Vaccines

- Centivax Developing broad spectrum Vaccines
- RaDVaC
- OSPfound.org
- Pfizer: The Pfizer-BioNTech COVID-19 vaccine was one of the first to be authorized for emergency use.
- Moderna: The Moderna COVID-19 vaccine was also among the first to receive emergency use authorization.
- Johnson & Johnson (Janssen): Their single-dose vaccine was approved for emergency use in 2021.

- AstraZeneca/Oxford University: Their vaccine has been widely used globally, especially in low- and middle-income countries.
- Novavax: Novavax's protein subunit vaccine was in late-stage trials as of September 2021.
- Sanofi/GlaxoSmithKline: This partnership was working on a protein subunit vaccine.
- CureVac: A German company focused on mRNA vaccines.
- Bharat Biotech: An Indian biotechnology company that developed Covaxin.
- Sinovac: A Chinese biopharmaceutical company that developed Coronavac.
- Gamaleya Research Institute (Sputnik V): The Russian-developed vaccine.
- Sinopharm: This Chinese company has developed two inactivated virus COVID-19 vaccines.
- CanSino Biologics: This is another Chinese company that has developed a viral vector COVID-19 vaccine.
- BioNTech: This German company collaborated with Pfizer to develop one of the first mRNA COVID-19 vaccines.
- Instituto Butantan: A Brazilian biologic research center that has collaborated with Sinovac on the CoronaVac vaccine.
- Serum Institute of India: An Indian biotech and pharmaceuticals company that's the world's largest vaccine manufacturer by doses. They've produced versions of the AstraZeneca/Oxford vaccine under the name Covishield.
- Zydus Cadila: Another Indian pharmaceutical company that has been involved in COVID-19 vaccine development.
- Vector Institute: A Russian research center that has developed a peptide-based COVID-19 vaccine.
- Covaxx: A division of United Biomedical, has been developing a peptide-based COVID-19 vaccine.
- Medicago: A Canadian biotech company developing a plant-based COVID-19 vaccine.
- Baylor College of Medicine: An academic institution involved in vaccine research and development.
- University of Queensland/CSL: An Australian collaboration that initially worked on a COVID-19 vaccine.
- Clover Biopharmaceuticals: A Chinese biotech company developing a protein subunit COVID-19 vaccine.
- ImmunityBio: A U.S.-based company working on a viral vector COVID-19 vaccine.
- Inovio Pharmaceuticals: A U.S. company developing a DNA-based COVID-19 vaccine.

28.5.8 PPE

- Micronel: Air Purification Masks, Inline and Two-Filter Blowers and Air Flow Monitoring Equipment
- Antimicrobial clothing for medical staff: Prevent & Deloza: Bespoke Uniforms and Protective Clothing for Military Personnel

28.5.9 UVC Lamps

- Lumenlabs Far-UVC
- Care222 from ushio.co

- Bankrupt Healthe owes its UV-C supplier and its billionaire owner
- Steril Ray Inc.
- Columbia University, David J. Brenner
- AeroMed
- Puro Lighting
- UVC LEDs
- Eden Park
- UVC sterilization for Healthcare facilities
- Lumalier
- Various UVC products
- Fresh-aire UV
- UltraViolet various UV products
- UVC for HVAC

28.5.10 Medicine

- Resiliance: Biomanufacturing innocation partner, revoltionisin how novel medicines are made, funded and scaled.

28.5.11 Water Purification

- Eimco Water Technologies: Deployable Wastewater Treatment for Field Operations and Construction Camps
- Global Water: Water Purification, Desalination, Wastewater and Wastewater-Effluent Recycling
- Kaercher Futuretech: Field Camp Systems, Water Supply Systems, Mobile Catering Systems and CBRN Protection Systems
- Pure H2O: Water Filtration Systems for Harsh Environments
- TerraGroup: Tactical Water Purification Systems for Military Field Applications
- Water Generating Systems: Water Sustainability Solutions for Military and Mobile Unite

28.5.12 CBRN Defence

- Hotzone Solutions: NBC Training, Consultancy and Equipment Testing Services
- Lunor: NBC Protection for Shelters and Hardened Buildings
- BoxModul: Ballistic and Blast Protective Safe Shelters
- em.tronic: Stand alone detection system and deployable lab
- Armoured Vehicles and Stand-Alone Protection
- Gamma: CBRN Defence Equipment for the Military Industry (Our company offers complex CBRN building monitoring systems, as well as on-board detection systems for infantry vehicles, special-purpose reconnaissance vehicles and mobile laboratories.)
- NBC-Sys: CBRN Protection Systems for Defense Forces and Population
- Observis: Monitoring and Control Solutions for the Defence Industry
  Critical infrastructure solutions
  It integrates detectors, heating, ventilation and air-conditioning (HVAC) systems and automatic doors into a full automation security system controlled in one highly visual user interface. The device and system independence of ObSAS offers complete

freedom to choose the best and most suitable equipment to fulfil the installation's security design and specifications, from office facility to underground shelter.
- OWR: NBC Protection, NBC Detection and Decontamination System

28.5.13 Decontamination

- Hispano Vema: NBC / CBRN Decontamination and Protection Systems and Mobile Field Camps
- Cristanini: CBRN Decontamination Equipment

28.5.14 Others

- National Institute for Nuclear, Chemical and Biological Protection: Testing and Training for the CBRN Environment
- Gamma: CBRN Defence Equipment for the Military Industry
- Camp Supply International: Container-Based Camp Shelter, Kitchen and Toilet Modules
- Pimco: Specialist Equipment for Detecting Weapons of Mass Destruction

28.6 Discussion Promt question (from BlueDot Impact)

28.6.1 Defining the GCBR Landscape

- "What do you think is the probability of extinction from bio? Compare different methodologies and numbers, noting that the Precipice's probability (3.3%) and that quoted in the 80K article (2%)
- How do GCBRs compare to other potential existential risk, such as unaligned AI and nuclear war?
- How do GCBRs relate to other potential X-risks? Which responses would be specific GCBF and which ones could also have positive impact on preventing other X-risks
    - Could pandemics serve as tipping points, start a domino effect to make other X-risks more likely even though pandemics themselves might not be a X-risk? What could such domino effects be? (e.g. pandemics increase societal inequalities → social unrest → governmental instability → increase in probability of nuclear war?)
- How likely is civilisational collapse with different percentages of the global population dying, and how likely this is to lead to eventual extinction, or totalitarian or other lock-in?
    - What other factors might influence whether e.g. a GCBR event leading to ~90% population reduction would actually lead to extinction?
- Do you agree that the risks from engineered pandemics are greater than the risks from natural pandemics?

- How do you think Covid-19 has affected the risk of a global catastrophic biorisk (GCBRs)?
    - How are we more/less vulnerable to biorisks now than we were previously?
- Discuss the "recovery is robust and reliable" view → how much do you believe in it? What are your key questions/uncertainties 'about this? What bottlenecks could we fix in order to make civilisation more robust and reliable?
- Discuss what percentage of resources available to biosecurity interventions participants would allocate to prevention (e.g. policy) vs. response (e.g. technical solutions like vaccines, early detection) vs. "last resort" solutions (e.g. bunkers, seed banks, etc)?
- Ask the participants to define the concept of "actor sophistication"
    - How can we keep entry barriers high or what measures could we undertake to prevent actor sophistication?
- Consider a matrix of pandemics "deliberate vs. accidental - natural vs. engineered" (below). What kind of pandemics would you put in each sector and which sector seems most concerning?

28.6.2 Biosafety and Dual Use Research Concerns

Definitions/Understanding

- Ask participants to define the term "dual-use research of concern" to test their own understanding + to discuss the different definitions for this term in the glossary
- Ask participants to describe what the unilateralists curse is and why the "asymmetry" around it is particularly problematic.

Scientific practice and ethics

- Is open science "dogma" in the scientific community? How can we create better biosecurity norms in the scientific community?
- What mechanisms in the conventional academic scientific process can be used so that dual-use is considered (eg: ethics, funding, regulation, peer review)? What are the pros/cons of each?
- What are the pros and cons of private life science funding?
- What do you think about the idea of introducing regulations around what types of research journals are and aren't allowed to publish? How could it work, would it be beneficial at all? How else could we incentivise journals to take on responsible publishing practices related to infohazards and DURC?
- What downsides could strongly restricting access to e.g. papers on DURC have?
- Marc Lipsitch has commented (I think in the video in the optional reading but not sure!) that most researchers either think that GOF research is low risk and highly useful OR that it is high risk and not very useful. Why do few think it is high risk and highly useful or the opposite? Should we be suspicious of the arguments here (eg: motivated reasoning)?

- Gain of function research like creating a between-human transmissible H5 influenza virus is very controversial. Some people think these viruses shouldn't be created under any circumstances while others argue that the possibility of a natural H5 pandemic arising is like a natural time bomb? Where on this "spectrum" would you put yourself and why?
- How much of a risk do DIY biologists like biohackers pose in terms of GCBRs? Is regulation (or other interventions) possible in the age of biohackers?

28.6.3 The BWC

- If the BWC got 10x as much budget, what should it do with that money? What could an effective verification mechanism look like? Would having an imperfect verification mechanism be a good first step or not create the necessary transparency to stop arms race?
- BWC vs CWC or the IAEE/NPT
    - BWC has no verification mechanism and loads less funding relative to the other bodies
    - Confidence building measures (CBMs)
    - Security dilemmas
- How could the BWC actually track if people in a lab are doing dangerous research?

28.6.4 Biosafety Levels

- Are there differences in how BSL levels work in other countries?
    - How are these different in different countries? How are they regulated globally? How are they maintained?
- Has anyone worked in a BSL-3 or 4 lab? What was the experience like?
- Is a culture change needed in science with regards to how seriously biosafety is taken?

28.6.5 Advances in biotechnology and a note on Information Hazards

Discussion Prompts

Definitions and understanding

- What's the role of CRISPR for modern synthetic biology? Describe its dual-use potential.
- What was the human genome project? How did it impact biosciences?
- The term "risk landscape" was mentioned several times in the readings. How do you understand this term in the context of biorisk?
- What does the term "export control" refer to? How relevant do you think export control measures are in mitigating GCBR?

Advances and current capabilities in Biotechnology

- Do you think that the quick rise of this field can tell us something about the future trajectory? Can we expect advances at the same pace as in the last 20 years?
- Which technologies did you find most interesting in the Horizon Scan? Which timelines are unexpected to you? Was there a particular technology that to you seemed to have particularly high-dual use potential when developed in the future?
- After having read about many of the advancements in synthetic biology: Do you think synthetic biology should be made more accessible, or should access be more regulated and restricted to a smaller group of people?
- Should technologies which have the potential to spread in an unbounded fashion (e.g. gene drives) be subject to more stringent regulation? Consider this vs pathogens (human, animal, plant pathogens etc.) which can also spread and cause disease or ecological disruption. Are they fundamentally different?
- Accidental release vs. deliberate weaponization of biotechnologies. Which one seems more concerning to you at the moment?
- Discuss pros and cons of philanthropy shaping the biological research agenda!
- Looking at some of the iGEM projects: do you feel you over or underestimated the capabilities of undergraduate student groups?

Information hazards

- What do you understand under " misuse of genetic information" ?
- "Biological information is more dangerous than biological material" Do you agree? Comment on this statement.
- What's your take on censoring science? Do you think censorship could plausibly drive biological research underground?
- Having read about the three case studies (Mousepox, H5 influenza, Botulinum toxin), what would you do differently if you were in the shoes of the scientists who conducted these experiments?
- At what stage/s is it best to assess the biosecurity concerns related to research, and how best should we 'censor' dangerous information? (point towards funding only relevant stuff)
- Why is a "classification" of bad actors into sophisticated/non-sophisticated relevant? How is biorisk distributed across the spectrum of these actors?
- What guidance or principles should be used for determining if it is better to release or withhold information?
- Is the Effective Altruism movement overly cautious regarding discussing information hazards?
- Should we teach more synthetic biologists principles of biosecurity or is this too risky regarding the info hazards around this field?

28.6.6 Bioweapons and Biodefense

- What are the incentives to develop bioweapons for states? What are the incentives for cults? Lone wolves?
    - How can we mitigate different actors having these incentives?

- Are the bottlenecks in mitigating bioweapon development/deployment related to technology (e.g. surveillence/screening methods not being good enough), or are they related to a lack of political will for implementation?
- It seems hard to target bioweapons on specific people. What are the implications of this?
- How succesfull does a mitigation method have to be to be impactful? Is it better to raise the barrier slightly on many fronts or should we be searching for a method that completely nips developing bioweapons in the bud?
- Who poses the biggest threat to develop bioweapons of mass destruction?
    - States, individual biohackers (e.g. misanthropists), middle sized groups (e.g. cults, terrorist groups)?
    - Why are bad actors bad actors? What do focus on to mitigate: causes why cults, individuals want to target people (e.g. education, mental health) or rather on preventing "already bad actors" from doing harm?
- Does it make sense for states to develop biological weapons? What are incentives? How about rational vs. irrational incentives/motivations?
    - Does biggest risk come from irrational actors with access to resources (dictators, terrorists)?
    - Can we provide incentives to prevent them from developing bioweapons? Treaties? Conventions?
- How would managed access increase transparency? If states/actors are allowed to hide all kinds of information/access and only share the things that looks good for them wouldn't that be dangerous because they might be developing bioweapons in secret while being perceived as adhering to the convention?
- What does a good verification system look like?
- Why do Chemical Weapons Convention and Nuclear Weapons Convention seem to be more successful in gaining trust/ratification, having verification/enforcing mechanisms and having more funding?
    - What are some of the factors that made the Chemical Weapons Convention more successful? Can these be applied to the BWC?
- What did you find most interesting about the history of bioweapons - what lessons can we draw for the future of bioweapons use and prevention?
- Discuss some of the difficulties we face regulating bioweapons compared to nuclear weapons.
- Why do you think the BWC lacks funding?
- What scenarios do you think seem most plausible (and most concerning) for the development and use of biological weapons?
- What was your favourite fun (or scary) fact about the history of biological weapons?
- How did bioweapons developed in the past compare to those that we’re concerned about now?
- Are biological weapons a thing of the past?
- Why do you think modern bioterrorists have been largely unsuccessful? Do you think this is likely to change, if so why?

- How tractable does the implementation of a verification or transparency protocol for the BWC seem to you? How effective would it plausibly be?
- If the BWC had 10x its current funding, what do you think it should do?
- How much risk comes from single bioterrorists vs. terrorist groups vs. states developing bioweapons programs? Should we be more scared of people with little capability but strong intent to cause a lot of harm rather than states having a lot of resources but not the intention of killing everyone on the planet?
- What's your take on the managed access system for inspections? Would it create true transparency or only the appearance of transparency?
- What are the main incentives for countries to initiate bioweapons programs? What incentives could countries have to stop bioweapons programs (looking at historical examples)
- Compare the regulation of chemical, nuclear and bioweapons. What are the main challenges with the regulation of bioweapons compared to the other two.

28.6.7 Pandemic prevention and diagnostics

Pandemic response

- Should transmissible vaccines be used as a last resort?
- Do receptor decoys seem like a promising response? Why haven't they been researched before?
- Do you agree with Kevin Esvelt's main uncertainty regarding the number of bad actors?
- What do you think is the biggest benefit of genetic attribution?
- How useful is genetic attribution for non-state actors?
- Discuss information hazards/dual use scenarios mentioned in the Esvelt video
- How important/promising do you think digital epidemiology is in detecting pandemics early? How well would it work for different kinds of pathogens (asymptomatic for a long time vs. symptomatic quickly, very lethal vs. very transmissible)
- How do you weigh data privacy concerns against the different options to leverage data from patients, social media users etc. to detect pathogens early? How could public engagement look like to build trust in the population in using such data-collection and -interpretation systems? What properties would these systems need to have (anonymisation at what level? Encryption at what level etc.)?
- What technologies or policies are you most excited about for preventing future pandemics and/or GCBRs?
- What should we do once we detect a novel virus growing exponentially?
- What are the bottlenecks in developing a global early warning system for pathogen detection?

28.6.8 Policy interventions

- What might be some challenges of creating a new joint assessment mechanism (JAM) to rapidly investigate biological events of unknown origin?
- What are some examples of confidence building measures that could be used to build trust and reduce uncertainty between different nations?
- How tractable do you think it is to have universal DNA synthesis screening such screening is commonplace for all DNA synthesis machines and organisations/countries?
- How is the (UK/US) government structured? How might this inform what policies we try to implement and how?
- For strengthening global biosecurity, which governments might we try to prioritise policy change in?
- How likely do you think it is that governments will "fight the last war" and are not generalising the lessons learnt from COVID-19 enough? What might be different in a GCBR scenario? What might be the same?
- What can we learn from different countries' responses to COVID-19 and other previous pandemics, are there any models/plans that stand out that could be best adapted?
    - Discuss the pros and cons of prizes such as the proposed metagenomics prize! What type or people/research orgs would be most interested in participating? What are some possible downsides of prizes compared to just funding specific groups to carry out specific research projects?
- Do you think we could speed up biosecurity governance without speeding general legislation processes?
- Both the CLTR's future proof report and NTI's report suggest founding new biosecurity organisations. Is this a good fix for some of the key problems in biosecurity or would it actually create coordination problems? What could be potential downsides of setting up new biosecurity organisations from scratch?
    - Which seems more tractable: building new institutions or reforming existing ones?
- What expertise would it be important for the National Centre for Biosecurity to contain?
    - What kind of structure would this organisation need to have? Is it worthwhile to bring different skill sets together?
- Why do you think the CLTR focused on the areas they did? Are there other areas you would have suggested or areas they should have skipped?
- How would you prioritise the interventions proposed across the reports?
- What is the best incentive structure to encourage policy innovation? Grants? Prizes? Something different?
- What regulations that were set up or developed for the response to covid could be useful for future (and potentially more severe) pandemics? What types of regulations do we completely lack e.g. mandating essential workers to go to work

- With regards to investigating the origin of an outbreak (lab leak, bioterrorism, bioweapons developed by states actors etc.) the Joint Assessment Mechanism wants the process to be rapid. How could knowledge about the origin of a pathogen help with and guide response?
- *Sneaky hackathon idea* The world is struck with a pandemic (airborne? Surface transmission?) with a fatality rate of x% (let's say 60%). You have a limited budget as society breaks down. How do you apply what you have learned in this course to structure society in the optimal way to recover from this catastrophic scenario? How do you treat people, minimise transmission, and ensure essential services continue? We could run this as a tabletop exercise, maybe for a day, or for a short session, as an open ended problem to solve. As you do it, note down key uncertainties, and where you think society currently lacks the capabilities to respond appropriately. We are actually going to do this."

28.7 Did not make it to the list

- Marc Lipsitch: Preventing catastrophic risks by mitigating subcatastrophic ones
  "Many of the catastrophic risks about which effective altruists concern themselves are likely to result from the failure to control much smaller events, which then grow so large that they do become catastrophic. In this EA Global: Boston 2017 talk, Marc Lipsitch describes examples from infectious diseases — a paradigm case of a growing risk — and implications for the allocation of our attention, effort and funds."
- #93 – Andy Weber on rendering bioweapons obsolete and ending the new nuclear arms race
  "Things discussed:
    - The chances that COVID-19 escaped from a research facility
    - Whether a US president can really truly launch nuclear weapons unilaterally
    - What he thinks should be the top priorities for the Biden administration
    - If Andy was 18 and starting his career over again today, what would his plan be?
    - The time he and colleagues found 600kg of unsecured, highly enriched uranium sitting around in a barely secured facility in Kazakhstan, and eventually transported it to the United States
    - And much more."
- Gene Drives: Pursuing Opportunities, Minimizing Risk, Kelsey Lane Warmbrod et al., *Johns Hopkins Center for Health Security*, May 2020.
- UNODA
- Updated Site-Specific Biosafety and Biosecurity Mitigation Risk Assessment, Volume I. Second part: Updated Site-Specific Biosafety and Biosecurity Mitigation Risk Assessment, Volume II. (Biosafety for factory farms)