### 1

#### Medicines are substances used to prevent, diagnose, or treat harms.

**MRS 20** [(MAINE REVENUE SERVICE SALES, FUEL & SPECIAL TAX DIVISION) “A REFERENCE GUIDE TO THE SALES AND USE TAX LAW” <https://www.maine.gov/revenue/sites/maine.gov.revenue/files/inline-files/Reference%20Guide%202020.pdf> December 2020] SS

[Medicines](https://www.lawinsider.com/dictionary/medicines) means antibiotics, analgesics, antipyretics, stimulants, sedatives, antitoxins, anesthetics, antipruritics, hormones, antihistamines, certain “dermal fillers” (such as BoTox®), injectable contrast agents, vitamins, oxygen, vaccines and other substances that are used in the prevention, diagnosis or treatment of disease or injury and that either (1) require a prescription in order to be purchased or administered to the retail consumer or patient; or (2) are sold in packaging.

#### Medicines solely refer to physical substances.

American Heritage Dictionary of Medicine 18 The American Heritage Dictionary of Medicine 2018 by Houghton Mifflin Harcourt Publishing Company <https://www.yourdictionary.com/medicine>

"A **substance**, **especially a drug**, **used to treat** the signs and symptoms of a **disease**, condition, or injury."

#### CRISPR is a platform technology, not a medicine.

Editas Medicine [(a clinical-stage biotechnology company which is developing therapies based on CRISPR–Cas9 gene editing technology)., No Date, CRISPR Gene Editing, <https://www.editasmedicine.com/crispr-gene-editing/>] Justin

CRISPR (pronounced “crisper”) is an acronym for “Clustered, Regularly Interspaced, Short Palindromic Repeats,” and refers to a recently developed gene editing technology that can revise, remove, and replace DNA in a highly targeted manner. CRISPR is a dynamic, versatile tool that allows us to get to and edit nearly any location in the genome, and has the potential to help us develop medicines for people with a wide variety of diseases. We view CRISPR as a “platform” technology because of its ability to target DNA in any cell or tissue.

#### The card they read on solvency is about CTX001 which was made by CRIPSR but is not CRISPR itself.

#### Negate –

#### 1] Limits – their model explodes it to medical devices, any form of strategy for medical research, databases that are used to create medicines and more – only our definition creates a reasonable caselist for medicines while they make prep impossible and wreck engagement

#### Use competing interps – reasonability invites arbitrary judge intervention

### 2

#### Interpretation: The aff may not defend WTO member nations reducing intellectual property protections for a subset of medicines.

#### Violation: They only defend CRISPR

#### Vote neg:

#### 1] Limits – you can pick anything from COVID vaccines to HIV/AIDS to random biotech to insulin treatments and there’s no universal disad since each one has a different function and implication for health, tech, and relations – explodes neg prep and leads to random medicine of the week affs which makes cutting stable neg links impossible.

#### No RVIs – a) illogical – you shouldn’t win for being fair – it’s a litmus test for engaging in substance

### 3

#### Gene editing decouples Ghana’s cocoa industry from climate change and enables it’s survival

Gakpo 19 Joseph Opoku Gakpo, June 13, 2019 "Gene editing could save Ghana’s cocoa from extinction, scientists say - Alliance for Science." Alliance for Science, allianceforscience.cornell.edu/blog/2019/06/gene-editing-save-ghanas-cocoa-extinction-scientists-say.

A new study warns that climate change could drive Ghana’s cocoa (cacao) industry to extinction — a fate that scientists say could be reversed through gene editing. A study by the Climate Change Unit of Ghana’s Environmental Protection Agency (EPA) and the Cocoa Research Institute of Ghana is predicting the country’s environment will no longer be conducive to growing cocoa by 2080 if current climate change trends continue. The study supports a 2017 prediction by scientists that cocoa could go extinct across the world in 40 years. Ghana is the world’s second largest producer of cocoa, which is the main ingredient in the production of chocolate. Cocoa is the primary ingredient in chocolate. The Ghana study found that the reduced rainfall and increased temperatures resulting from climate change will make the country’s cocoa belt unsuitable for production of the crop by 2080, Angelina Mensah, public affairs director of Ghana’s Environmental Protection Agency, told a Ghana newspaper. “In the study, it was identified that due to warm temperature conditions being experienced currently in the country, the dry season, which spans from September to March, has exacerbated. This means cocoa, which is very sensitive to drought, in terms of growth and yields, would be affected,” she explained. “(Soil) moisture level in the years ahead will not be adequate for profitable cocoa production. Unless immediate interventions are rolled out to tackle climate change, cocoa would only be in the history books for the next generation to read.” If such interventions are not forthcoming, gene editing could be the solution to breeding new cocoa varieties that can survive the changing conditions. “Gene editing has the potential to accelerate the breeding of new cocoa varieties with resistance to climate stress and pests and diseases,” said Mark Guiltinan, professor of molecular biology at Pennsylvania State University, in an interview with the Alliance for Science. He noted that gene editing has already been used to develop other crops with improved resistance to some of the same climate-related stresses that cocoa is facing. “A key advantage of this approach is that it could be used to edit varieties with special characteristics and locally adapted to environmental conditions, which will avoid the very time-consuming process of moving traits from one access into another, which could take decades,” Guiltinan added. Ongoing work with CRISPR Guiltinan is leading a research project at Penn State that will help produce better cocoa plants using the CRISPR-Cas9 gene editing tool. CRISPR (clustered regularly interspaced short palindromic repeats) is a DNA sequence found in single-celled organisms. It can be used to introduce an enzyme called Cas9 in organisms to precisely edit their genomes and delete, silence or replace specific DNA regions. The researchers have used CRISPR-Cas9 to knock out a cocoa gene called TcNPR3 that suppresses the plant’s disease response. The researchers also created gene-edited cocoa embryos which they hope will grow into mature trees to test the effectiveness of this approach at a whole plant level. “We have regenerated some CRISPR-mediated gene-edited plants with mutations in a repressor of the pathogen defense system,” Guiltinan said. “These plants show strong resistance in lab tests. The plants are now about 2 feet tall and growing fast. Soon we will be able to perform further testing.” Low cocoa productivity in Africa In addition to climate change, cocoa growers in developing nations are facing other challenges, including lack of irrigation and the inability to purchase inputs like pesticides and fertilizers. In Ghana, cocoa orchards are also being displaced by more profitable rubber plantations. An estimated 30 percent of all cocoa produced in West Africa is destroyed by disease before it can get off the farm, which creates an enormous financial burden for farmers. In Ghana, the world’s second-largest cocoa producing country, state regulator COCOBOD revised the expected cocoa output for 2019 downward earlier this year because of an increase in pest attacks and disease. The increased pest and disease attacks have have been exacerbated partly by climate change, which encourages the rampant spread of disease-causing organisms that become more active in warmer weather. The Cocoa Swollen Shoot Virus (CSSV) disease, for example, has destroyed more than 200 million cocoa trees in West Africa and continues to spread on farms in the sub-region. Although it will take some time, Guiltinan is confident that gene editing technology will in due course be able to help farmers deal with diseases on cocoa farms. “The cocoa farmers around the world should know that it will be many years before these efforts find their way to their fields because on top of the technical challenges, there are also legal regulations and the public acceptance of these products that need to be addressed as well,” he said. “In the meantime, we are working to develop transgene-free gene editing in cacao and we are targeting several other genes for traits of interest, such as disease-resistance and quality traits. One trait of special interest for West Africa is CSSV resistance.” If all goes well, Guiltinan said, “I see a strong possibility of the first gene-edited cacao being ready for farmers in about five to 10 years.”

#### Destroys Ghana’s rainforest biodiversity

Omponsah and Tayki 20 Amponsah, Owusu [ Senior Lecturer, Department of planning, Kwame Nkrumah University of Science and Technology (KNUST) ] and Stephen Appiah Takyi [ Lecturer, Planning, Kwame Nkrumah University of Science and Technology (KNUST) ]. "Ghana's cocoa production relies on the environment, which needs better protection." Conversation, April 5, 2020, theconversation.com/ghanas-cocoa-production-relies-on-the-environment-which-needs-better-protection-134557.

Cocoa production has been the backbone of Ghana’s economy since the 1870s. It dominates the agricultural sector and contributes about 30% of the country’s export earnings. Cocoa employs about 800,000 farmers directly. It also supports the livelihoods of others in the commerce, service and industrial sectors of the Ghanaian economy. This makes it an important generator of revenue. Most studies of cocoa production have focused on its economic benefits. Less attention has been paid to its environmental impacts. But cocoa farming has enormous environmental consequences. This is because it can only take place in Ghana’s forest agro-ecological zone. In this zone, the rainfall is ideal for cocoa at 1500-2000mm, with a dry season of about four months. Also, cocoa trees thrive under shade. But with rising demand for cocoa on the world market, large areas of forest cover have been lost to its cultivation. The expansion and cultivation of new parcels of forest land, the replacement of old cocoa trees and the abandonment of old cocoa farmlands due to loss of soil fertility, have depleted the country’s forest cover. Between 2010 and 2015, 117,240 hectares of forest were cleared. Do experts have something to add to public debate? This loss is a threat to the very industry that is causing it. Over the years researchers, policy makers and practitioners in Ghana’s agricultural and environmental sectors have underestimated the environmental impacts of agricultural activities such as cocoa production. The link between low productivity in the cocoa sector and environmental impacts is contributing to uncertainty in the sector’s long-term sustainability. There is, therefore, an urgent need for more research, policies and strategies that will help minimise the environmental impacts of cocoa production. We undertook a study to assess these environmental impacts. We focused particularly on practices such as the clearing of cocoa farms and the use of insecticides and fertilisers.

**Key to prevent extinction**

**Owusu-Afriyie, 2 ---** Aburi Botanic Gardens staff

(George, "The Potential Role of African Botanic Gardens in Environmental Awareness Programmes and the Need to be Involved," 10-1-2, www.bgci.org/education/1703/, accessed 1-15-12)

Today some of the 60 botanic gardens and arboreta in Africa are among those botanic gardens that are leading the worldwide fight to save plant diversity, as well as creating an understanding and awareness for the promotion of methods of conservation and development of plant resources. Despite financial constraints, a number of African botanic gardens are implementing major reforms under the auspices of Botanic Gardens Conservation International, to enable them play a more purposeful role in conservation. The Creation of Environmental Awareness Among the Populace **African's biological diversity is** not only of continental economic importance but is also **of global significance**. Unfortunately, existing arrangements for the utilization of the continent's biodiversity cannot be considered sustainable and this is having serious repercussions on development programmes in Africa. The rich plant diversity in Africa is indiscriminately harvested for a number of purposes including: cultivation and production of food and cash crops for domestic and external interests herbal medicine construction. Luckily, in spite of their continued exploitation, botanic gardens and other habitats still contain some of the **richest assemblages of plant life known on this planet.** Thus African gardens are appropriate institutions with the necessary capacities and plant diversities for use in environmental awareness programmes. The success of environmental awareness programmes will largely depend upon the communities' understanding of the functioning of the environment, the problems it presents, and their expected contribution to its protection and improvement. The pursuit of conservation-oriented practices to halt the degradation and extinction of plant resources will depend not only on their acceptability, but also on the active support and involvement of the populace at large. In addition, people need to be well informed, sensitized and motivated towards adopting specific plant conservation practices and the sustainable use of plant resources. It is well known that plants are the **key to life on Earth** and the **prime element in biodiversity**. They dominate our landscape, providing the framework of natural ecosystems that provide the habitats for animal species and **make life on earth possible for humans** as well as other living beings. Yet in spite of this common knowledge of the importance of plants in human survival, plant life is being lost at an increasing rate not only in Africa, but also throughout the whole world. This is the result of economic pressure on the developing countries and careless human activities. Until unfair transactions, particularly in trading systems, are addressed and humans made the centre of attention, only a limited impact will be made in our effort to control the excessive utilization of resources and the regenerability of the various life-sustaining systems on the Earth.

**Ghana and each country of Africa is key- its key to prevent extinction- key region and species to global life-support systems**

**Richard, 10** -- science and technology editor

(Michael Graham, "The True Size and Importance of Africa," 10-13-10, www.treehugger.com/clean-technology/the-true-size-and-importance-of-africa-map.html, accessed 1-16-12)

Don't Overlook Africa! Because of the way flat maps distort the size of countries (the closer they are to the poles, the more distorted they are), most people don't really know just how big the African continent is. This leads many people - and the smart and powerful aren't immune to this - to underestimate Africa's importance. The map above shows just how wrong our perception can be (unless we've already seen a map like this before). It shows that you could fit the whole USA, China, India, Spain, France, Germany, the UK, Italy, Switzerland, Japan, and Eastern Europe, inside of Africa and still have some room left. We're All Inter-Connected Africa matters a lot because of the number of people who live there (about 1 billion as of 2005, with projections of 2 billion by 2050), but also because of the **number of indigenous animal and plant species**, because of the vast expanses of land that aren't being protected, because of the huge ecosystems that are uniquely found there, because of the impact that it can have on the global climate (especially deforestation and desertification), because of all the solar power potential and other natural resources, etc. It is one of the **key regions** that needs to improve on many levels for the welfare of its people and **to safeguard the integrity of our planet's life-support systems.** Africa is too often the forgotten continent, but it shouldn't be, and humanitarian problems should make us forget environmental issues because both go hand in hand. The degradation of the environment will affect the most vulnerable people there.

#### CRISPR causes agricultural gene drives – wrecks ag

Montenegro 19 Maywa Montenegro, Human Ecology, University of California Davi Maywa Montenegro de Wit (2019) Gene driving the farm: who decides, who owns, and who benefits?, Agroecology and Sustainable Food Systems, 43:9, 1054-1074, DOI: 10.1080/21683565.2019.1591566. [Note – Driving is short for “gene driving”, the process of using gene editing tech like CRISPR to release new strains of plants or animals into the wild]

Does driving genes through wild populations resonate with biologically diversified farming? Does it seek to control and simplify agroecosystems rather than cope with organisms (like pests) that may not always behave as we want but that serve important roles in complex ecological webs? While most current drive experiments are confined to laboratory settings, with sophisticated biosecur- ity protocols in place, the entire point of drive is to eventually introduce genes into wild populations to propagate virally. We need ecologists and agroecologists to help us better understand what the effects of such releases might be. If, for example, we successfully wipe out a problematic pest, what happens to the beneficial insects or birds that used to rely on them for food? Or what happens if collapsing one population opens up food resources or habitats for new types of pests to move in? In what ways –if we can even count them –will gene drive ripple across the food web in ecosystems in and around the farm? What are the risks –ecological and social –of ecosystem engineering and are they being seriously appraised? The idea implicit in gene drive is that scientists can know the risks and can steer the trajectory of drives, stopping them from spreading or running amok. But gene drive researchers themselves acknowledge great uncertainties in the scope, durability, and control of drives. For example, Kevin Esvelt, 1062 M. MONTENEGRO a prominent drive expert at MIT, has become something of a maverick in his field for publicly criticizing the hubris of many biotechnologists. When the first UC Irvine demonstration of drive was published in 2015, Esvelt told MIT Technology Review that, in his opinion, the California researchers had not used strict enough safety measures. Locked doors and closed cages are not enough, he said. Instead, they could be installing a genetic “reversal drive”so the change can be undone, if necessary (Regalado 2015). Similarly, Hank Greely, a bioethics law specialist at Stanford, says environ- mental uses are more worrisome than a few modified people. “The possibility of remaking the biosphere is enormously significant, and a lot closer to realization,”he told the Technology Review (Regalado 2015). More recently, scientists have gone even further to say that gene drives are too risky for field trials (Zimmer 2017). In 2017, a team of Harvard and MIT researchers created a detailed mathematical model to describe what happens following the release of gene drive organisms. In a paper published on the preprint bioRxiv server, they discovered unacceptable risk: “Current CRISPR gene drive systems,”they said, “are likely to be highly invasive in wild populations”(Noble et al. 2017). In other words, in the name of conservation a drive might spread to places where the species isn’t invasive at all, but is part of a well-established ecosystem. What does this mean for agriculture? Can we expect that releasing gene drives to eliminate invasive insects or plants in one territory will not spread into agroecosystems that depend on a variety of “unplanned”pollinators, predators, habitats, and food-providers? Can we be confident that drives will preserve the integrity of agrobiodiversity, especially in Indigenous and tradi- tional cropping systems where boundaries between “wild”and “domesti- cated”are porous and intentionally traversed? Championing the notion of releasing drives into nature, Esvelt admitted in 2017 was “an embarrassing mistake”(Zimmer 2017). While other scientists express similar precautions about gene driving wild ecosystems, agriculture, as a “human-dominated”system, is a likely space for more aggressive inter- ventions to seem acceptable. Thus, it is here especially that we need agroe- cologists to help us understand the complex dynamics of patchy landscapes, where conservation and agriculture, cultivated and noncultivated converge (Perfecto and Vandermeer 2010). And we need geneticists like Esvelt to own up to the limits of certainty –and the known and unknown risks of what gene drive can do.

#### Agricultural genetic diversity collapse – extinction!

Fowler Moonet 90. Cary Fowler and Pat Mooney, Rural Advancement Fund International, Shattering: Food, Politics, and the Loss of Genetic Diversity, 1990, p. ix

While many may ponder the consequences of global warming, perhaps the biggest single environmental catastrophe in human history is unfolding in the garden. While all are rightly concerned about the possibility of nuclear war, an equally devastating time bomb is ticking away in the fields of farmers all over the world. Loss of genetic diversity in agriculture—silent, rapid, inexorable—is leading us to a rendezvous with extinction—to the doorstep of hunger on a scale we refuse to imagine. To simplify the environment as we have done with agriculture is to destroy the complex interrelationships that hold the natural world together. Reducing the diversity of life, we narrow our options for the future and render our own survival more precarious. It is life at the end of the limb. That is the subject of this book. Agronomists in the Philippines warned of what became known as southern corn leaf blight in 1061.' The disease was reported in Mexico not long after. In the summer of 1968, the first faint hint that the blight was in the United States came from seed growers in the Midwest. The danger was ignored. By the spring of 19701 the disease had taken hold in the Florida corn crop. But it was not until corn prices leapt thirty cents a bushel on the Chicago Board of Trade that the world took notice; by then it was August—and too late. By the close of the year, Americans had lost fifteen percent of their most important crop—more than a billion bushels. Some southern states lost half their harvest and many of their farmers. While consumers suffered in the grocery stores, producers were out a billion dollars in lost yield. And the disaster was not solely domestic. U.S. seed exports may have spread the blight to Africa, Latin America and Asia.

#### Gene editing wrecks genetic human diversity – extinction

Christian Wolfe 9, Associate Editor for American Association of Inside Sales Professionals, "Human Genetic Diversity and the Threat to the Survivability of Human Populations", https://www.ohio.edu/ethics/2003-conferences/human-genetic-diversity-and-the-threat-to-the-survivability-of-human-populations/

Through advances in reproductive technologies humans will eventually have the ability to utilize nearly fully artificial selection on human populations. These technologies raise many ethical and theological concerns. I will address one of the pragmatic ethical concerns, the potential loss of genetic diversity. Genetic diversity has a direct relation to the fitness and survivability of various species and populations; as genetic diversity decreases within a population, so does the fitness and survivability of that population. An examination of the genetic diversity argument (GDA) reveals that there is not strongly persuasive evidence regarding the effects on genetic diversity of the reproductive technologies on human populations. The only method available to produce the required evidence is through a very complex form of human experimentation. The type of human experiment that would produce the evidence is incompatible with present ethical codes of conduct. Therefore, any implementation of these technologies on human populations should be banned. There are many emerging technologies that could potentially affect genetic diversity. These include genetic testing and screening, selective breeding, population control, sterilization, selective abortion, embryo testing and selection, sperm donation, egg donation, embryo donation, surrogate pregnancy, fertility drugs, contraception, cloning embryos, and germ line or somatic cell manipulation (Resnik 2000, 454). Each of these reproductive technologies affects the composition of the human gene pool by increasing or decreasing the frequency of different genotypes or combinations of genotypes (Resnik 2000, 454). The germ-cell line, or just germ-line, constitutes a cell line through which genes are passed from generation to generation (World of Genetics 322). Germ-line therapy is often differentiated from somatic cell therapy, which is the alteration of non-reproductive cells. This distinction is not as clear as much of the literature supposes, but the problems with the germ-line/somatic cell distinction are beyond the scope of this paper. The focus of this paper includes the screening of embryos with the possibility of destruction of certain embryos, the modification of DNA (deoxyribonucleic acid) of early stage embryos through in-vitro fertilization (IVF), and the modification of parent gametes (Zimmerman 594-5). These technologies pose the clearest threat to genetic diversity of human populations. Genetic testing and screening examines the genetic information contained in a person’s cells to determine whether that person has or will develop a certain disease, is more susceptible to certain environmental risks, or could pass a disease on to his or her offspring (World 305). Parents could subject themselves to testing to determine whether or not to reproduce based on the likelihood of their potential children inheriting their genetic maladies. Also, embryos can be subjected to testing and screening to determine the likelihood that the future individual will develop a genetic disease. From that information, parents can decide to destroy the embryo, alter the embryo, or leave the embryo unmodified and risk that the child will develop a genetic disease. Germ-line gene therapy (GLGT) is germ-line manipulation on the genetic level in order to prevent genetic diseases in future persons (Richter and Bacchetta 304). The goal of GLGT is to treat human diseases by correcting the genetic defects that underlie the genetic disorders (Anderson and Friedmann 907). Therapy presents an alternative to destroying embryos likely to develop genetic disease by actually correcting genetic defects. Also available is the alteration of parent gametes in order to eliminate the possibility of passing on genetic disease to their offspring. GLGT allows for the alteration of either the early stage embryo or the parent gametes to prevent genetic disease. By either eliminating those genotypes that are likely to produce genetic disease or by altering the genome to actually prevent the genetic disease from developing, these technologies have great potential to affect the genetic diversity of a population. Genetic diversity is the variety and frequency of different genotypes or combinations of different genotypes within a population. A population is a geographically, socially, or culturally linked group whose reproductive decisions affect those within the group. Genetic diversity is measured by genetic variability, which diminishes in a population when the number of different phenotypes or the number of different combinations of genotypes decreases. Since populations are composed of individuals that carry genotypes, individual reproductive outcomes affect the genetic variability within specific populations (Resnik 2000, 452). Genetic diversity provides the resource for phenotypic variation that is integral in determining the rate of evolutionary change in an environment. A population that lacks genetic diversity will be poorly equipped to meet environmental changes and demands (Resnik 2000, 452). The importance of genetic diversity is undeniable; the survivability of a population is directly related to genetic diversity. While genetic diversity has no intrinsic value, genetic diversity has a clear instrumental value. Humans place positive value in genetic diversity as it promotes the extrinsic value of survivability. There is an ethical duty to prevent decreases in the genetic diversity of populations because of its importance in the survivability of those populations. Decreases in genetic diversity in populations are ethically undesirable because actions that reduce the survivability of the population are unethical. The genetic diversity argument (GDA) starts from the fact that scientific and technological developments in the realm of genetics and human reproduction will greatly affect the genetic diversity of human populations. There are both pessimistic and optimistic versions of the argument. I will briefly describe both versions of the GDA. The pessimistic version of the argument contends that the increased ability to control human reproduction will result in a loss of genetic diversity that will threaten the health and survivability of human populations (Resnik 2000, 451). This threat to health and survivability is due to a decrease in the populations’ ability to adapt to environmental changes and demands. In effect, these technologies have the potential to make the pool of available phenotypic traits limited enough so that human populations will not be able to respond to changes in environmental demand. This version of the GDA warns that germ-line altering reproductive technologies will reduce populations’ gene pools and eliminate potentially useful genes. Genetic diversity provides a resource of these useful genes. Evolutionary change is blind and has no way to know which genes are useful, therefore it is potentially damaging to population survivability to eliminate genes of any sort. As Glenn McGee notes, “The point of the GDA is that human beings also have no way of knowing which genes will be useful in the future or in different environments” (cited in Resnik 2000, 456). For instance, genetically homogenous populations of corn face problems with blight due to lack of genetic diversity. Although human populations have an ever-increasing level of control over the environment, the pessimistic response still turns on the inability to determine which genes will be useful in the future. The optimistic version of the genetic diversity argument contends that these reproductive technologies could lead to increases in human health and survivability resulting in an improvement of the well being of populations (Resnik 2000, 457). The basis for this response rests on the historical fact that advances in technology increase humans’ ability to control nature. The ability to control nature often leads to positive changes in the adaptability and survivability of human populations. The optimistic GDA relies on this historical fact and the seemingly obvious inference that the above technologies will increase the ability to affect the genetic diversity of human populations (Resnik 2000, 457). A commonly cited example of how genetic diversity can be increased with the implementation of such technologies is the incredible diversity of canines. Of course, there are important dissimilarities such as the explicit intention to increase phenotypic diversity. A major factor in whether these reproductive technologies will increase or decrease genetic diversity is what model they are implemented under, free market or state control. Each model addresses the concerns and motivations of those affected differently. The free market model is based upon the reproductive decisions of a diverse group of potential parents with separate interests, motivations, and means. The free market is the method by which many consumer decisions are made in the United States. This model is fundamentally based on the interaction between supply and demand. If a market demands diversity of a product, then the market will often supply the desired diversity. If the market demands the standardization of goods, such as building supplies, then that homogeneity is likely to be supplied. Also, markets create new preferences and demands by introducing new goods and services to the market. Most often, advancements in technology increase market variability, except of course if that development results in the formation of a monopoly. The diversity of goods in the free market system of America seemingly justifies the inference that a free market model for reproductive technologies would lead to increases, not decreases, in the genetic diversity of human populations. Both J. Glover and W. Gardner’s individual studies conclude, “Increases in our ability to control human reproduction will result in more genetic diversity in the human population because parents will have a variety of preferences and values that they can use in selecting offspring” (cited in Resnik 2000, 458). Just as technological advancements have increased the availability of diverse consumer products, germ-line altering technologies could increase the available options in reproduction and therefore increase the diversity of human populations. Nevertheless, confounding factors such homogeneity of desirable characteristics makes the above inference much more dubious than it first appears. The major problem with the free market model is the potential emergence of the homogeneity of desirable characteristics. Many characteristics such as intelligence, athleticism, and health, are almost universally accepted as desirable. Other characteristics such as height, eye color, and hair color, also have particular value attached to them. Genetic homogeneity could arise if the consumers of reproductive technologies have similar preferences for traits. As Resnik states, “If most people want tall, intelligent, healthy children with blonde hair and blue eyes, then parental choices could produce a phenotypically and genetically homogeneous population” (2000, 459). This problem is only exacerbated when one considers the phenomenon of fads. Societal pressures and obligations may also produce conformity. While these social effects may not take hold immediately, it seems possible, if not probable that these pressures would eventually affect reproductive decisions. Genetic homogeneity may be an unintended consequence of a population sharing common values (Resnik 2000, 459). If most people within a population have similar characteristic preferences and a desire to conform, genetic homogeneity is almost inevitable. Of course much of this line of reasoning depends on genetic determinism, which is incredibly naïve and misinformed. Environmental factors often play a decisive role in which phenotypes are displayed. If certain desirable traits, such as intelligence or health, were strongly linked to environmental factors regardless of genotype, then the inference from individual choices to phenotypic characteristics would be dramatically weakened (Resnik 2000, 465). On the other hand, if certain genes or series of genes are linked to a trait, and that genotype is most frequently selected, it would still poses the potential threat of a genetically homogeneous population, although not phenotypically homogeneous. There are good reasons to believe that the free market system will create greater genetic diversity within human populations. On the other hand, the influences of societal pressures and expectations should not be underestimated or ignored (Resnik 2000, 459). State control involves the local or federal government dictating the standards of practice in certain industries, such as the power industry, education, and mass transit. This model of control in implementing genetic technologies appears likely to lead to decreases in genetic diversity within a population. It is imaginable that the government would develop specific standards to which all human beings produced in that state would be subject. The effects of state control of reproductive technologies are not clearly predictable. A state controlled system could lead to a genetic caste system. For instance, if the state determined that all people should be a certain height, weight, IQ, color, sexual orientation, etc., then those who diverge from those state determined standards could be forced into different strata of the genetic caste system. Such scenarios are certainly plausible, if not likely under state controlled conditions. Under free market conditions, reproductive technologies could lead to increases or decreases genetic diversity. On the other hand, state control would almost inevitably lead to decreases in genetic diversity, but the extent of such effects is not clear. As David Resnik claims, “the consequences of not exerting social or governmental control over human genetics may be just as troubling, since parents will in all likelihood attempt to provide their children with genetic advantages, and the long-term results of parental control over human genetics may further exacerbate existing social and economic inequalities and create a genetic caste system” (1997, 428). The inability to produce definitive evidence of the effects of reproductive technologies under either control model points to urgency of the issue and the minimal knowledge of these technologies’ implications for the future of humanity. Each version of the GDA provides ground for arguments that could support or undermine the utilization of germ-line altering reproductive technologies. The most obvious conclusion from examining both versions is that there is no definitive evidence that implementing the above technologies will have positive or negative consequences for the survivability of human populations. Furthermore, an examination of the two most plausible options for methods of implementing the technologies within a population does not produce strong evidence that implementation will result in either increases or decreases in genetic diversity. This leaves medical science at an ethical crossroads between either continuing with the technologies and dealing with the results afterwards, or abstaining from research, or at least clinical trials, until such evidence arises. Neither of these paths seems to be positive, or even tenable. The only method for producing clear evidence about the potential threat to survivability that these reproductive technologies pose would be to continue research and perform a massive clinical trial. Animal experimentation is not a viable alternative to human experimentation because it completely eliminates many of the confounding factors such as social influences. Since the arguments on either side of the GDA cannot produce conclusive results, and given the potential harm done to populations if the reproductive technologies are implemented and genetic diversity does decrease, some form of human experimentation seems necessary before the technologies should be implemented. Of course, there are many questions that arise in response to such a claim, including the justification of the inference to the necessity of human experimentation. I will discuss these concerns below. To clarify the inference, one should be reminded of what is at stake with respect to genetic diversity. The cautionary tales of the GDA describe potentially analogous situations, such as the effects of artificial selection on the survivability of maize and the variety of canines that have been produced by artificial selection. It is not at all clear what effects the above reproductive technologies will have on a population’s genetic diversity. Their implementation could result in increases in disease susceptibility like the result of artificial selection on maize, or it could result in populations with incredible arrays of genetically distinct individuals, such as in the canine example. What is clear though is that genetic diversity has an inverse relationship with the adaptability and survivability of populations. Since human populations value their own survivability, it is clear that technologies that pose a great potential threat to genetic diversity should be closely examined before being implemented. Due to the great potential threat these technologies present to humans, it is necessary to produce very strong, if not definitive, evidence about the effects of these technologies on genetic diversity. The only way to produce such evidence is human experimentation. There are many factors that must be accounted for in a human experiment that would produce definitive evidence. The number and diversity of subjects would have to emulate a population that would be affected by the technologies. The experiment would have to be extensive enough to determine the effects on future generations. To account for potential homogeneity of desirable characteristics, the experiment should account for both diverse cultural and societal pressures. Furthermore, the experiment should be carried out under the two control models mentioned above, free market and state control. Also, there would have to be a method of curtailing influences from the non-experimental population. Finally, in the event that something goes awry with the experiment, there must be a method of destroying the test subjects. Given present ethical standards concerning human experimentation, the ethics of such an experiment are, at best, deeply problematic. While ethical norms can dramatically change with time through changes in societal norms and beliefs, the means necessary to employ such an experiment are almost incomprehensible. For instance, it is not at all clear how the experiment would quarantine the subjects or how to handle the necessity of multiple generations of researchers. The role of informed consent is unclear with such an experiment. In the proposed experiment, an unethical researcher could use informed consent in a manner to produce the results that the researcher desires and undermine the purpose of the experiment. Additionally, an integral part of informed consent is the ability to withdraw from the experiment at any time. This element could pose a serious problem for this type of research. Therefore informed consent must either be eliminated or be drastically altered. Under present ethical norms it is clear that the kind of experiment necessary to provide strongly persuasive evidence of the effects of germ-line altering reproductive technologies would be unethical. Ethical considerations aside, the pragmatics of such an experiment are daunting to say the least. The use of germ-line altering technologies should not be implemented until strongly persuasive evidence regarding the effects on genetic diversity is concretely established. Decreases in the genetic diversity of a population would put at risk the survivability of that population. Humans place a clear value in the survivability of populations. Therefore anything that threatens the survivability of populations is unethical. Germ-line altering reproductive technologies may potentially decrease genetic diversity within a population. Until there is concrete evidence demonstrating that such technologies will not lead to decreases in a population’s genetic diversity, those technologies should not be utilized. The only method of assessment to produce such evidence is through human experimentation. The nature of the necessary experimentation involves unacceptable ethical violations and unavoidable pragmatic difficulties. Without strong proof that such technologies do not pose a threat to genetic diversity, and therefore population survivability, those technologies should not be implemented. Due to the fact that such evidence is not possible, germ-line altering technologies should be banned.

## Case

### WTO

**Collapse is inevitable**

Kallis '18 [Giorgos; 5/31/18; ICREA Research Professor at Universitat Autònoma de Barcelona, environmental scientist working on ecological economics and political ecology, formerly Marie Curie International Fellow at the Energy and Resources Group of the University of California at Berkeley, PhD in Environmental Policy and Planning from the University of the Aegean in Greece, et al.; "Annual Review of Environment and Resources: Research On Degrowth," Annual Review of Environment and Resources, Vol. 43, p. 296-29]//GJ

3. ECOLOGICAL ECONOMICS: THE LIMITS OF GREEN GROWTH

Although driven by political, institutional, and discursive processes, growth is also **biophysical**. The economic process converts energy, resources, and matter to goods, services, and **waste** (34). In theory, it seems possible to decouple material throughput from economic output by improving the resource efficiency of production. Ecological economists, however, argue that in practice **absolute decoupling is unlikely**, even though relative decoupling is common (34). **Efficiency should not be confused with scale** (35): The more efficiently we use resources, the lower they cost, and **the more of them we end up using** (36). This is, in essence, growth. Just as increases in labor productivity lead to growth and new jobs, not to less employment, increases in resource productivity increase output and **resource use** (37). Capitalist economies grow by using more resources and more people, more intensively. Accelerating this is unlikely to spare resources.

Growth can become “cleaner” or “greener” by substituting, for example, fossil fuels with solar power, or scarce, environmentally intensive metals with more abundant and less intensive metals. But new substitutes have resource requirements, and life-cycle impacts that cross space and time. Energy is a vital source of useful work (38); growth has been possible because fossil fuels did things human labor alone could not do. Ending the use of fossil fuels is likely to reduce labor productivity and limit output (34). Solar and wind power are constrained only by their rate of flow, but unlike fossil fuels, they are **diffuse**—more like rain than a lake (3). To collect and concentrate a diffuse flow of energy, **more energy is necessary and more land is required**. The EROIs (energy returns on energy investment) of renewable energies are between 10:1 and 20:1, compared to more than 50:1 for earlier deposits of oil and coal (39). An economy powered by a diffuse energy flow is then likely to be an economy of lower net energy and lower output than one powered by concentrated stocks (3). Land use for solar or wind also competes with the use of land for **food production**, and **rare materials** are necessary for infrastructures and batteries that store their intermittent flows, **with significant environmental effects**.

Historical data corroborate ecological economic theory (40). Ayres & Warr (38) find that the use of net energy after conversion losses explains a big portion of the **U**nited **S**tates’ total factor productivity and economic growth. At the global level, GDP and material use have increased approximately 1:1. Carbon emissions have increased somewhat slower than GDP, but still have **increased** (34). **This is unlikely to be a coincidence**. Exceptions may exist, but cross-panel data analysis shows that overall, 1% growth of a national economy is associated with 0.6% to 0.8% increase in its carbon emissions (41) and 0.8% growth in its resource use (42).

Global resource use follows currently the “**collapse by 2050**” scenario foreseen in the “Limits to Growth” 1971 report (43–45). Domestic material use in some developed OECD economies has reached a plateau, but this is because of globalization and trade. If we take into account **imported goods**, then the material requirements of products and services consumed in OECD countries have grown hand in hand with GDP, with **no decoupling** (46). For **water use**, the effects of growth overwhelm any realistic savings from technologies and efficiency (47); water footprints have increased even in regions such as California where water withdrawals were stabilized (40).

Carbon emissions in some EU (European Union) countries have been declining, even after trade is taken into account, suggesting some substitution of fossil fuels by cleaner energies. [Although recession also played a role (34).] These declines are nowhere near the 8–10%, year-after-year reductions in carbon emissions required for developed nations under scenarios compatible with a **50% chance** of limiting warming to 2◦C (48). Further reductions will be harder to sustain once **one-off substitutions** of oil or coal with natural gas are exhausted (34).

Resource use or carbon emissions are a product of the scale of the economy (GDP) times its resource or carbon intensity (kg/GDP or kgCO2/GDP). With 1.5% annual increase in global income per capita, carbon intensity has to decline 4.4% each year for staying within 2◦C; with 0% growth, carbon intensity has to fall 2.9% each year (49). In the period 1970–2013, the average annual reduction rate for carbon intensity was less than 1.5%—and this gets harder to sustain as the share of carbon-intensive economies in global output increases (49). As Jackson (50) showed in his seminal work, **it is practically impossible to envisage viable climate mitigation scenarios that involve growth**. This calls for research on managing, or prospering, **without growth** (50, 51).

Some scenarios deem possible meeting climate targets while sustaining growth, but these generally assume after 2050 some sort of “negative emissions technology,” geo-engineering or otherwise. According to a recent Nature editorial, these technologies remain currently “**magical thinking**” (52). Clean energy investments can stimulate the economy in the short run, but in the **long run** growth may be limited by their **low EROIs**. Studies suggest that economic growth requires a minimum EROI of close to 11:1 (53). Less EROI means less labor productivity, and hence less growth. Indeed, “Limits to Growth” scenarios do not predict growth ending when resources are exhausted but, rather, when the quality of resources declines to such an extent that further extraction diverts more and more investment away from productive industry (44).

Degrowth is defined by ecological economists as an equitable downscaling of throughput, with a concomitant securing of wellbeing. If there is a fundamental coupling of economic activity and resource use, as ecological economics suggests there is, then serious environmental or climate policies will slow down the economy. Vice versa, a slower economy will use less resources and emit less carbon (40). This is not the same as saying that the degrowth goal is to reduce GDP (54); slowing down the economy is not an end but a likely outcome in a transition toward equitable wellbeing and environmental sustainability.

Advancing a position of “a-growth,” van den Bergh (54) proposes ignoring GDP and implementing a global carbon price, indifferent to what its effect on growth turns out to be. Ignoring GDP is a normative position—but at the end, the economy will either grow or not, and if it does not, then there should be plans for managing without growth. Given how entrenched GDP growth is in existing institutional and political structures, a-growth approaches must be advanced as part of broader systemic change (55).

Is it possible to secure a decent standard of living for all while throughput and output degrow? Substantive evidence indicates that **prosperity does not depend on high levels of production** and consumption. Kubiszewski et al. (56) find that the Genuine Progress Indicator, an indicator that includes environmental and social costs alongside output, peaked in 1978, despite subsequent global growth. A similar indicator, the Index of Sustainable Economic Welfare, has stayed at the same levels in the United States since 1950, despite a threefold growth of GDP (57).

Wealthier countries on average have higher levels of life expectancy and education than poorer ones, but above a certain level of GDP, income does not make a difference in wellbeing—**equality** does. Satisfactory levels of wellbeing are achieved by countries such as Vietnam or Costa Rica at a fraction (one-third or less) of the output, energy, or resource use of countries such as the **U**nited **S**tates. Even the lower levels of resource use of mid-income countries, however, would not be sustainable if they were to be generalized to the planet as a whole. No country currently satisfies social wellbeing standards while staying within its share of planetary boundaries, suggesting that radical changes in provisioning systems are necessary (58).

Wealthier people within a country are on average happier than others, but in the long run, overall happiness does not increase as a country’s income rises (59). Nuances of this income-happiness paradox depend on the sample of countries included and how one defines and asks about happiness. Within societies, individuals with higher incomes evaluate their lives as better than others, but do not enjoy better emotional wellbeing (60). Income determines social rank, and rank affects individuals’ assessments of their lives. Growth does not change relative rank or relative access to positional goods (those signifying position) but it does inflate expectations and prices of material goods, **increasing frustration** (61). Relative comparisons matter for personal wellbeing in low-income and high-income countries; for both, the more equally income is distributed, the happier people are (62). **Pro-environmental behaviors** and sharing are also strongly associated with personal wellbeing (63). This suggests that an economic contraction may not impact wellbeing negatively if accompanied by redistribution, sharing, and value shifts (34).

**Growth ensures extinction:**

**Insect loss**

Robert **Hunziker 18**, MA in Economic History from DePaul University, environmental journalist for over fifty publications, 3/27/18, “Insect Decimation Upstages Global Warming,” https://www.transcend.org/tms/2018/04/insect-decimation-upstages-global-warming/

Everybody’s heard about global warming. It is one of the most advertised **existential** events of all time. Who isn’t aware? However, there’s a new kid on the block. An alarming **loss of insects** will likely **take down humanity** before global warming hits maximum velocity.

For the immediate future, the Paris Accord is riding the wrong horse, as global warming is a long-term project compared to the insect catastrophe happening right now! Where else is found 40% to 90% species devastation?

The worldwide loss of insects is simply staggering with some reports of 75% up to 90%, happening much faster than the paleoclimate record rate of the past five major extinction events. It is possible that some insect species may **already be close to total extinction!**

It’s established that species evolve and then go extinct over thousands and millions of years as part of nature’s course, but the current rate of devastation is simply “off the charts, and downright scary.”

Without any doubt, it is difficult to imagine how humanity survives without insects, which are dropping dead in bunches right before our eyes. For proof, how many insect splats do people clean off windshields nowadays? Not many…. How many fireflies do children chase at night? Not many….

Several naturalists and environmental writers believe the massive loss of insects has everything to do with three generations of **industrialized farming** and the vast tide of **poisons** pouring over the landscape year-after-year, especially since the end of WWII. Ours is the first-ever pesticide-based agricultural society. Dreadfully, it’s an experiment that is going dead wrong… all of a sudden!

Insects are basic to thousands of food chains; for example, the disappearance of Britain’s farmland birds by over 50% in 40 years. Additionally, North America and Europe species of birds like larks, swallows, and swifts that feast on flying insects have plummeted.

But, these are only a few of many, many recorded examples of massive numbers of wildlife dropping dead right before our eyes.

Significantly, insects are the **primary source for ecosystem creation and support**. The world literally crumbles apart without mischievous burrowing, forming new soil, aerating soil, pollinating food crops, etc. **Nutrition for humans happens because insects pollinate**.

**Chemical emissions**

Julian **Cribb 17**, Fellow of the Australian Academy of Technological Sciences and Engineering, 2017, “The Poisoner,” in Surviving the 21st Century, p. 113-117

There are two essential points about the Earthwide **chemical flood**. First it is quite **new**. It began with the industrial revolution of the late nineteenth century, but expanded dramatically in the wake of the two world wars—where chemicals were extensively used in munitions—and has exploded in deadly earnest in the past 50 years, attaining a new crescendo in the early twenty-first century. It is something our ancestors never faced—and to which we, in consequence, lack any protective adaptations which might otherwise have evolved due to constant exposure to poisons.

Second, the toxic flood is, for the most part, preventable. It is not compulsory—but **is an unwanted by-product of economic growth**. Though driven by powerful industries and interests, it still lies within the powers and rights of citizens, consumers and their governments to demand it be curtailed or ended and to encourage industry to safer, healthier products and production systems.

The issue is whether, or not, a wise humanity would choose to continue poisoning our children, ourselves and our world.

Regulatory Failure

Despite the fact that around 2000 new chemicals are released onto world markets annually, most have not received proper health, safety or environmental screening—especially in terms of their impact on babies and small children. Regulation has so far failed to make any serious curtailment of this flood: only 21 out of 144,000 known chemicals have been banned internationally, and this has not eliminated their use. At such a rate of progress it will take us more than 50,000 years to identify and prohibit or restrict all the chemicals which do us harm. Even then, bans will only apply in a handful of well-regulated countries, and will not protect the Earth system nor humanity at large. Clearly, national regulation holds few answers to what is now an out-of-control global problem.

Furthermore, the chemical industry is relocating from the developed world (where it is quite well regulated and observes its own ethical standards) and into developing countries, mainly in Asia, where it is largely beyond the reach of either ethics or the law. However, its toxic emissions return to citizens in well-regulated countries via wind, water, food, wildlife, consumer goods, industrial products and people. The bottom line is that it doesn’t matter how good your country’s regulations are: you and your family are still exposed to a growing global flood of toxins from which even a careful diet and sensible consumer choices cannot fully protect you.

The wake-up call to the world about the risks of chemical contamination was issued by American biologist Rachel Carson when she published Silent Spring in 1962, in which she warned specifically about the impact of certain persistent pesticides used in agriculture. Since her book came out, the volume of pesticide use worldwide has increased 30-fold, to around four million tonnes a year in the mid-2010s. Since the modern chemical age began there has been a string of high-profile chemical disasters: Minamata, the Love Canal, Seveso, Bhopal, Flixborough, Oppau, Toulouse, Hinkley, Texas City, Jilin, Tianjin. Most of these display a familiar pattern of unproductive confrontation between angry citizens, industry and regulators, involving drawn-out legal battles that deliver justice to nobody. By their spectacular and local nature, such events serve to distract from the far larger, more insidious and ubiquitous, universal toxic flood.

Chemists and chemical makers often claim that their products are ‘safe’ because individual exposure (e.g. in a given product, like a serve of food) is too low to result in a toxic dose, a theory first put forward by the mediaeval scholar Paracelsus in the sixteenth century. This ‘dose related’ argument is disingenuous, if not dishonest—as modern chemists well know—for the following reasons: Most chemicals target a receptor or receptors on certain of your body cells, to cause harm. There may be not one, but hundreds or even thousands of different chemicals all targeting the same receptor, so a particular substance may contribute an unknowable fraction to an overall toxic dose. That does not make it ‘safe’. Chemicals not known to be poisonous in small doses on their own can combine with other substances in water, air, food or your body to create a toxin. No manufacturer can truthfully assert this will not happen to their products. Chemical toxicity is a function of both dose and the length of time you are exposed to it. In the case of persistent chemicals and heavy metals, this exposure may occur over days, months, years, even a lifetime in some cases. Tiny doses may thus accumulate into toxic ones. Most chemical toxicity is still measured on the basis of an exposed adult male. Babies and children being smaller and using much more water, food and air for their bodyweight, are therefore more at risk of receiving a poisonous dose than are adults.

Chemicals and minerals are valuable and extremely useful. They do great good, save many lives and much money. No-one is suggesting they should all be banned. But their value may be for nothing if the current uncontrolled, unmonitored, unregulated and unconscionable mass release and planetary saturation continues.

Chemical Extinction

Two billion years ago, excessive production of one particular poisonous chemical by the inhabitants of Earth caused a colossal die-off and threatened the **extermination of all life**. That chemical was oxygen and it was excreted by the blue-green algae which then dominated the planet, as part of their photosynthetic processes. After several hundred million of years, the planet’s physical ability to soak up the surplus O2 in iron formations, oceans and sediments had reached saturation and the gas began to poison the existing life. This event was known as the ‘oxygen holocaust’, and is probably the nearest life on Earth has ever come to complete disaster before the present (Margulis and Sagan 1986). Since it developed slowly, over tens of millions of years, the poisonous atmosphere permitted some of these primitive organisms to evolve a tolerance to O2—and this in time led to the rise of oxygen-dependent species such as fish, mammals and eventually, us. The takehome learning from this brush with total annihilation is that it is possible for living creatures to **pollute themselves into oblivion**, if they don’t take care to avoid it or rapidly adapt to the new, toxic environment. It’s a message that humans, with our colossal planetary chemical impact, would do well to ponder.

While it is unlikely that human chemical emissions alone could reach such a volume and toxic state as to directly threaten our entire species with extinction (other than through carbon emissions in a runaway global warming event) or even the collapse of civilization, it is likely they will emerge as a serious contributing factor during the twenty-first century in combination with other factors such as war, climate change, pandemic disease and ecosystem breakdown. Credible ways in which man-made chemicals might imperil the human future include: **Undermining the immune systems**, physical and mental health of the population through growing exposure to toxins Reducing the intelligence of current and future generations through the action of nerve poisons on the developing brains and central nervous systems of children, rendering humanity less able to solve its problems and adapt to major changes; and by increasing the level of violent crime and conflict in society, which is closely linked to lower IQ. Bringing down the economy through the massive healthcare costs of having to nurse, treat and maintain a growing proportion of the population disabled by lifelong chronic chemical exposure. By poisoning the ecosystem services—clean air, water, soil, plants, insects and wildlife—on which **humanity depends for its own survival** and thereby contributing to potential global ecosystem breakdown By augmenting the global arsenal of weapons of mass destruction and hence the risk of their use by nations or uncontrollable fanatics.

#### Trade causes proliferation—results in the spread of dual-use technology

Kassenova 1/25/12 (Togzhan Kassenove- associate in the Nuclear Policy Program at the Carnegie Endowment and a Stanton Nuclear Security Fellow. She specializes in weapons of mass destruction nonproliferation issues, with a regional focus on Central Asia and Southeast Asia; nuclear security; strategic trade management; and civilian nuclear energy programs, January 25, “Preventing WMD Proliferation Myths and Realities of Strategic Trade Controls”, <http://carnegieendowment.org/files/wmd_proliferation_Togzhan_Jan_25_2012.pdf>)

WMD-relevant technology and materials are all around us. Semiconductors, for instance, are indispensable in the advanced electronics we use every day (including computers), but they can also be utilized in a variety of military equipment, such as satellites, infrared imaging products, and transistors. Freezedrying technology used to make instant coffee or instant noodles can also be used in biological-warfare research. Encryption technology has many civilian applications—for instance, in train-signaling systems—but malicious actors can also use it to communicate without being detected by law enforcement agencies. Similarly, satellite technology may have civilian applications, weather monitoring for example, or military ones, such as missile guidance. The broad applications for dual-use goods and technology in everyday life result in constant flows of proliferation-sensitive items across borders. And this poses a real danger. Gradual acquisition of components and technology from various sources that can enable a nonstate or state actor to build a WMD program is a more likely proliferation threat than an actor acquiring an already-built weapon from an external source. The best illustration of how real this threat is in the nuclear realm is the story of the A. Q. Khan network. Pakistani scientist A. Q. Khan and his associates successfully exploited gaps in controls of nuclear exports in Pakistan and beyond during the 1980s and 1990s. The network assisted Iran, North Korea, and Libya in acquiring a whole range of nuclear weapons–relevant items. 1 According to a recent report by nonproliferation expert Joshua Pollack, India, surprisingly, was the fourth customer of the Khan network, procuring uraniumenrichment technology. 2 Unfortunately for the proliferation outlook, progress in high-tech industries, especially in the fields of electronics and biotechnology, as well as the expansion of nuclear power and the globalization of trade, further exacerbate the challenge of firewalling international trade from WMD proliferation.

#### Free trade results in deregulation which makes nuclear materials easier to access

Jackson 11/10/11 (Beckett Jackson, Master’s Candidate at Georgetown University’s Security Studies Program and works as a Security and Military Intelligence Analyst within IHS Jane’s A&D Consulting Practice, “Proliferation Networks Capitalize on Limited Oversight of Service-Based Economies”, <http://journal.georgetown.edu/2011/11/10/proliferation-networks-capitalize-on-limited-oversight-of-service-based-economies/>)

Despite all of the benefits of an increasingly globalized economy, certain authoritarian governments have shunned the system. While these states attempt to limit their societies’ exposure to an increasingly interconnected world, they still use the global economic system for their own benefits. Increasingly, globalization and technological advancement have created a security risk for the United States. High-strength aluminum alloys used in aerospace components also have applications in the production of uranium enrichment equipment. Non-destructive testing machines designed to identify anomalies in automobile parts can be used in the production of solid rocket motors for ballistic missiles. Despite the enactment of sanctions against regimes involved in the proliferation of weapons of mass destruction (WMD), states have exploited a fundamental characteristic of the global trade system to access dual-use equipment and materials used in the fabrication of WMD. In a global economy where the customers, manufacturers and suppliers of a product span multiple continents, delivery times and shipping costs are a priority for commercial enterprises. As a result, financial and transit hubs, such as Hong Kong, Dubai and Singapore, rely on the speed of customs clearance, minimal financial regulations and favorable business policies for consistent GDP growth. However, these services also create a proliferation security challenge. For instance, in Hong Kong, the ease and minimal oversight involved in establishing a business provides a favorable environment for proliferation networks. In 2011, the South China Morning Post reported, “the sheer volume of goods passing through Hong Kong…attracts businesses looking to slip through the cracks.” The U.S.-China Economic Security Review Commission, which provides annual congressional reports on security issues related to trade with China, has identified a single address in Hong Kong out of which 30 Chinese front companies operate. This example illustrates the lack of oversight in Hong Kong and is a symptom of the imbalance between trade facilitation and security in service-based economies.

#### Nuclear war

**Kroenig 15** (Matthew, Associate Professor and International Relations Field Chair in the Department of Government and School of Foreign Service at Georgetown University, 2015. “The History of Proliferation Optimism: Does It Have a Future?” *Journal of Strategic Studies*, Volume 38, Issue 1-2, 2015)

The spread of nuclear weapons poses at least six severe threats to international peace and security including: nuclear war, nuclear terrorism, global and regional instability, constrained US freedom of action, weakened alliances, and further nuclear proliferation. Each of these threats has received extensive treatment elsewhere and this review is not intended to replicate or even necessarily to improve upon these previous efforts. Rather the goals of this section are more modest: to usefully bring together and recap the many reasons why we should be pessimistic about the likely consequences of nuclear proliferation. Many of these threats will be illuminated with a discussion of a case of much contemporary concern: Iran’s advanced nuclear program. Nuclear War The greatest threat posed by the spread of nuclear weapons is nuclear war. The more states in possession of nuclear weapons, the greater the probability that somewhere, someday, there will be a catastrophic nuclear war. To date, nuclear weapons have only been used in warfare once. In 1945, the United States used nuclear weapons on Hiroshima and Nagasaki, bringing World War II to a close. Many analysts point to the 65-plus-year tradition of nuclear non-use as evidence that nuclear weapons are unusable, but it would be naïve to think that nuclear weapons will never be used again simply because they have not been used for some time. After all, analysts in the 1990s argued that worldwide economic downturns like the Great Depression were a thing of the past, only to be surprised by the dot-com bubble bursting later in the decade and the Great Recession of the late 2000s.48 This author, for one, would be surprised if nuclear weapons are not used again sometime in his lifetime. Before reaching a state of MAD, new nuclear states go through a transition period in which they lack a secure-second strike capability. In this context, one or both states might believe that it has an incentive to use nuclear weapons first. For example, if Iran acquires nuclear weapons, neither Iran, nor its nuclear-armed rival, Israel, will have a secure, second-strike capability. Even though it is believed to have a large arsenal, given its small size and lack of strategic depth, Israel might not be confident that it could absorb a nuclear strike and respond with a devastating counterstrike. Similarly, Iran might eventually be able to build a large and survivable nuclear arsenal, but, when it first crosses the nuclear threshold, Tehran will have a small and vulnerable nuclear force. In these pre-MAD situations, there are at least three ways that nuclear war could occur. First, the state with the nuclear advantage might believe it has a splendid first strike capability. In a crisis, Israel might, therefore, decide to launch a preventive nuclear strike to disarm Iran’s nuclear capabilities. Indeed, this incentive might be further increased by Israel’s aggressive strategic culture that emphasizes preemptive action. Second, the state with a small and vulnerable nuclear arsenal, in this case Iran, might feel use them or lose them pressures. That is, in a crisis, Iran might decide to strike first rather than risk having its entire nuclear arsenal destroyed. Third, as Thomas Schelling has argued, nuclear war could result due to the reciprocal fear of surprise attack.49 If there are advantages to striking first, one state might start a nuclear war in the belief that war is inevitable and that it would be better to go first than to go second. Fortunately, there is no historic evidence of this dynamic occurring in a nuclear context, but it is still possible. In an Israeli–Iranian crisis, for example, Israel and Iran might both prefer to avoid a nuclear war, but decide to strike first rather than suffer a devastating first attack from an opponent. Even in a world of MAD, however, when both sides have secure, second-strike capabilities, there is still a risk of nuclear war. Rational deterrence theory assumes nuclear-armed states are governed by rational leaders who would not intentionally launch a suicidal nuclear war. This assumption appears to have applied to past and current nuclear powers, but there is no guarantee that it will continue to hold in the future. Iran’s theocratic government, despite its inflammatory rhetoric, has followed a fairly pragmatic foreign policy since 1979, but it contains leaders who hold millenarian religious worldviews and could one day ascend to power. We cannot rule out the possibility that, as nuclear weapons continue to spread, some leader somewhere will choose to launch a nuclear war, knowing full well that it could result in self-destruction. One does not need to resort to irrationality, however, to imagine nuclear war under MAD. Nuclear weapons may deter leaders from intentionally launching full-scale wars, but they do not mean the end of international politics. As was discussed above, nuclear-armed states still have conflicts of interest and leaders still seek to coerce nuclear-armed adversaries. Leaders might, therefore, choose to launch a limited nuclear war.50 This strategy might be especially attractive to states in a position of conventional inferiority that might have an incentive to escalate a crisis quickly to the nuclear level. During the Cold War, the United States planned to use nuclear weapons first to stop a Soviet invasion of Western Europe given NATO’s conventional inferiority.51 As Russia’s conventional power has deteriorated since the end of the Cold War, Moscow has come to rely more heavily on nuclear weapons in its military doctrine. Indeed, Russian strategy calls for the use of nuclear weapons early in a conflict (something that most Western strategists would consider to be escalatory) as a way to de-escalate a crisis. Similarly, Pakistan’s military plans for nuclear use in the event of an invasion from conventionally stronger India. And finally, Chinese generals openly talk about the possibility of nuclear use against a US superpower in a possible East Asia contingency. Second, as was also discussed above, leaders can make a ‘threat that leaves something to chance’.52 They can initiate a nuclear crisis. By playing these risky games of nuclear brinkmanship, states can increase the risk of nuclear war in an attempt to force a less resolved adversary to back down. Historical crises have not resulted in nuclear war, but many of them, including the 1962 Cuban Missile Crisis, have come close. And scholars have documented historical incidents when accidents nearly led to war.53 When we think about future nuclear crisis dyads, such as Iran and Israel, with fewer sources of stability than existed during the Cold War, we can see that there is a real risk that a future crisis could result in a devastating nuclear exchange. Nuclear Terrorism The spread of nuclear weapons also increases the risk of nuclear terrorism.54 While September 11th was one of the greatest tragedies in American history, it would have been much worse had Osama Bin Laden possessed nuclear weapons. Bin Laden declared it a ‘religious duty’ for Al- Qa’eda to acquire nuclear weapons and radical clerics have issued fatwas declaring it permissible to use nuclear weapons in Jihad against the West.55 Unlike states, which can be more easily deterred, there is little doubt that if terrorists acquired nuclear weapons, they would use them.56 Indeed, in recent years, many US politicians and security analysts have argued that nuclear terrorism poses the greatest threat to US national security.57 Analysts have pointed out the tremendous hurdles that terrorists would have to overcome in order to acquire nuclear weapons.58 Nevertheless, as nuclear weapons spread, the possibility that they will eventually fall into terrorist hands increases. States could intentionally transfer nuclear weapons, or the fissile material required to build them, to terrorist groups. There are good reasons why a state might be reluctant to transfer nuclear weapons to terrorists, but, as nuclear weapons spread, the probability that a leader might someday purposely arm a terrorist group increases. Some fear, for example, that Iran, with its close ties to Hamas and Hizballah, might be at a heightened risk of transferring nuclear weapons to terrorists. Moreover, even if no state would ever intentionally transfer nuclear capabilities to terrorists, a new nuclear state, with underdeveloped security procedures, might be vulnerable to theft, allowing terrorist groups or corrupt or ideologically-motivated insiders to transfer dangerous material to terrorists. There is evidence, for example, that representatives from Pakistan’s atomic energy establishment met with Al-Qa’eda members to discuss a possible nuclear deal.59 Finally, a nuclear-armed state could collapse, resulting in a breakdown of law and order and a loose nukes problem. US officials are currently very concerned about what would happen to Pakistan’s nuclear weapons if the government were to fall. As nuclear weapons spread, this problem is only further amplified. Iran is a country with a history of revolutions and a government with a tenuous hold on power. The regime change that Washington has long dreamed about in Tehran could actually become a nightmare if a nuclear-armed Iran suffered a breakdown in authority, forcing us to worry about the fate of Iran’s nuclear arsenal. Regional Instability The spread of nuclear weapons also emboldens nuclear powers, contributing to regional instability. States that lack nuclear weapons need to fear direct military attack from other states, but states with nuclear weapons can be confident that they can deter an intentional military attack, giving them an incentive to be more aggressive in the conduct of their foreign policy. In this way, nuclear weapons provide a shield under which states can feel free to engage in lower-level aggression. Indeed, international relations theories about the ‘stability-instability paradox’ maintain that stability at the nuclear level contributes to conventional instability.60 Historically, we have seen that the spread of nuclear weapons has emboldened their possessors and contributed to regional instability. Recent scholarly analyses have demonstrated that, after controlling for other relevant factors, nuclear-weapon states are more likely to engage in conflict than nonnuclear-weapon states and that this aggressiveness is more pronounced in new nuclear states that have less experience with nuclear diplomacy.61 Similarly, research on internal decision-making in Pakistan reveals that Pakistani foreign policymakers may have been emboldened by the acquisition of nuclear weapons, which encouraged them to initiate militarized disputes against India.62 Currently, Iran restrains its foreign policy because it fears major military retaliation from the United States or Israel, but with nuclear weapons it could feel free to push harder. A nuclear-armed Iran would likely step up support to terrorist and proxy groups and engage in more aggressive coercive diplomacy. With a nuclear-armed Iran increasingly throwing its weight around in the region, we could witness an even more crisis prone Middle East. And in a poly-nuclear Middle East with Israel, Iran, and, in the future, possibly other states, armed with nuclear weapons, any one of those crises could result in a catastrophic nuclear exchange.

#### No econ impact

Walt 20 — (Stephen M. Walt, Robert and Renée Belfer professor of international relations at Harvard University., “Will a Global Depression Trigger Another World War?“, Foreign Policy, 5-13-20, Available Online at https://foreignpolicy.com/2020/05/13/coronavirus-pandemic-depression-economy-world-war/, accessed 11-5-2020, HKR-AR)

One familiar argument is the so-called diversionary (or “scapegoat”) theory of war. It suggests that leaders who are worried about their popularity at home will try to divert attention from their failures by provoking a crisis with a foreign power and maybe even using force against it. Drawing on this logic, some Americans now worry that President Donald Trump will decide to attack a country like Iran or Venezuela in the run-up to the presidential election and especially if he thinks he’s likely to lose.

This outcome strikes me as unlikely, even if one ignores the logical and empirical flaws in the theory itself. War is always a gamble, and should things go badly—even a little bit—it would hammer the last nail in the coffin of Trump’s declining fortunes. Moreover, none of the countries Trump might consider going after pose an imminent threat to U.S. security, and even his staunchest supporters may wonder why he is wasting time and money going after Iran or Venezuela at a moment when thousands of Americans are dying preventable deaths at home. Even a successful military action won’t put Americans back to work, create the sort of testing-and-tracing regime that competent governments around the world have been able to implement already, or hasten the development of a vaccine. The same logic is likely to guide the decisions of other world leaders too.

Another familiar folk theory is “military Keynesianism.” War generates a lot of economic demand, and it can sometimes lift depressed economies out of the doldrums and back toward prosperity and full employment. The obvious case in point here is World War II, which did help the U.S economy finally escape the quicksand of the Great Depression. Those who are convinced that great powers go to war primarily to keep Big Business (or the arms industry) happy are naturally drawn to this sort of argument, and they might worry that governments looking at bleak economic forecasts will try to restart their economies through some sort of military adventure.

I doubt it. It takes a really big war to generate a significant stimulus, and it is hard to imagine any country launching a large-scale war—with all its attendant risks—at a moment when debt levels are already soaring. More importantly, there are lots of easier and more direct ways to stimulate the economy—infrastructure spending, unemployment insurance, even “helicopter payments”—and launching a war has to be one of the least efficient methods available. The threat of war usually spooks investors to

o, which any politician with their eye on the stock market would be loath to do.

Economic downturns can encourage war in some special circumstances, especially when a war would enable a country facing severe hardships to capture something of immediate and significant value. Saddam Hussein’s decision to seize Kuwait in 1990 fits this model perfectly: The Iraqi economy was in terrible shape after its long war with Iran; unemployment was threatening Saddam’s domestic position; Kuwait’s vast oil riches were a considerable prize; and seizing the lightly armed emirate was exceedingly easy to do. Iraq also owed Kuwait a lot of money, and a hostile takeover by Baghdad would wipe those debts off the books overnight. In this case, Iraq’s parlous economic condition clearly made war more likely.

Yet I cannot think of any country in similar circumstances today. Now is hardly the time for Russia to try to grab more of Ukraine—if it even wanted to—or for China to make a play for Taiwan, because the costs of doing so would clearly outweigh the economic benefits. Even conquering an oil-rich country—the sort of greedy acquisitiveness that Trump occasionally hints at—doesn’t look attractive when there’s a vast glut on the market. I might be worried if some weak and defenseless country somehow came to possess the entire global stock of a successful coronavirus vaccine, but that scenario is not even remotely possible.

If one takes a longer-term perspective, however, a sustained economic depression could make war more likely by strengthening fascist or xenophobic political movements, fueling protectionism and hypernationalism, and making it more difficult for countries to reach mutually acceptable bargains with each other. The history of the 1930s shows where such trends can lead, although the economic effects of the Depression are hardly the only reason world politics took such a deadly turn in the 1930s. Nationalism, xenophobia, and authoritarian rule were making a comeback well before COVID-19 struck, but the economic misery now occurring in every corner of the world could intensify these trends and leave us in a more war-prone condition when fear of the virus has diminished.

On balance, however, I do not think that even the extraordinary economic conditions we are witnessing today are going to have much impact on the likelihood of war. Why? First of all, if depressions were a powerful cause of war, there would be a lot more of the latter. To take one example, the United States has suffered 40 or more recessions since the country was founded, yet it has fought perhaps 20 interstate wars, most of them unrelated to the state of the economy. To paraphrase the economist Paul Samuelson’s famous quip about the stock market, if recessions were a powerful cause of war, they would have predicted “nine out of the last five (or fewer).”

Second, states do not start wars unless they believe they will win a quick and relatively cheap victory. As John Mearsheimer showed in his classic book Conventional Deterrence, national leaders avoid war when they are convinced it will be long, bloody, costly, and uncertain. To choose war, political leaders have to convince themselves they can either win a quick, cheap, and decisive victory or achieve some limited objective at low cost. Europe went to war in 1914 with each side believing it would win a rapid and easy victory, and Nazi Germany developed the strategy of blitzkrieg in order to subdue its foes as quickly and cheaply as possible. Iraq attacked Iran in 1980 because Saddam believed the Islamic Republic was in disarray and would be easy to defeat, and George W. Bush invaded Iraq in 2003 convinced the war would be short, successful, and pay for itself.

#### Trade makes even small risks of disease global threats

Kimball and Hodges 10 (Kimball, Ann Marie, Professor Emeritus in Epidemiology at the University of Washington’s School of Public Health, and Hodges, Jill, Masters in Public Health, 2010, “Risky Trade and Emerging Infections”, Infectious Disease Movement in a Borderless World: Workshop Summary, Institute of Medicine (US) Forum on Microbial Threats, <http://www.ncbi.nlm.nih.gov/books/NBK45724/>)

The foregoing cases have demonstrated how **our increasingly global economy, with growing international travel and** trade (including trade in services such as transplantation), **has ultimately made virtually any emerging microbial risk global in nature**. **In the examples of foodborne E. coli and BSE, we see the globalization of direct infectious risk**. In the instance of the overuse of antimicrobials in food animals, **we see the globalization of antimicrobial resistance.** With medical travel for organ transplants, we see traveling patients become potential vectors for the spread of disease.**While microbial risks have been globalized along with commerce, the corresponding health and protective measures for the most part have not**. The second edition of the IHR (2005), which took effect in 2007, provides some important safeguards to help limit the international spread of infectious disease. The IHR require countries to conduct surveillance for and report to the WHO a “public health emergency of international concern,” that is, an event “that may cause international disease spread.” If WHO determines such a threat exists, as it did with the recent H1N1 outbreak, it may issue recommendations to curb the spread of disease, such as quarantine or travel restrictions for affected or potentially affected individuals. As the experience with H1N1 demonstrated, **WHO must carefully balance the threat of disease spread with the potential economic consequences of any travel or trade restrictions in order to minimize disincentives for countries to report potential threats**. While WHO Director-General Dr. Margaret Chan raised the “Pandemic Alert” level to 6 (the highest), WHO actively discouraged trade and travel restrictions after determining that they would not be effective in curbing the spread of the influenza virus and could needlessly result in significant economic repercussions. Instead, WHO focused on identifying and treating individuals with infection and urged those individuals with illness or symptoms to avoid travel and contact with others. This did not stop some countries from instituting their own travel restrictions. Several nations banned flights to Mexico, and China quarantined more than 70 travelers from Mexico (Browne, 2009). Despite the moderated response, Mexican authorities estimated $2.2 billion losses to the nation’s economy as a result of the outbreak, including more than a 40 percent drop in tourism revenue (Llana, 2009).

### Innovation

#### Squo solves – no reason why more innovation is key and other drugs thum p

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Infectious disease is a common cause of death worldwide, but the rise of antibiotic-resistant bacterial strains and lack of effective antiviral treatments means a potential future risk of increased mortality and global economic burden due to untreatable infections. This article discusses how CRISPR-Cas gene-editing technology is helping in the fight against increasingly resistant bacterial infections and rapidly mutating viruses—from facilitating a better understand of host-pathogen interactions and improving diagnosis, to potentially providing a new way to treat infectious disease.

The CRISPR revolution

The CRISPR locus (short for clustered regularly interspersed short palindromic repeats) was first discovered in E.coli in 1987 and found to be the basis of a bacterial adaptive immune system, providing prokaryotes with protection against foreign genetic material.1 The CRISPR-Cas system has since been repurposed into a powerful but relatively simple programmable gene-editing technology. A short single-guide RNA molecule (sgRNA) guides the Cas9 endonuclease to the target site, where a double-strand break is introduced. This activates intrinsic cellular DNA repair pathways, either the non-homologous end joining (NHEJ) pathway that results in a disabling deletion of the target gene, or homologous repair (HR) that allows the integration of a donor sequence at the target locus. As well as gene knockout and targeted changes to the genetic sequence, gene expression can be regulated. Other modifications at the target site are also possible with the use of a catalytically inactive version of Cas9 (dCas9)—the expanded CRISPR toolkit also includes modulation of gene expression (CRISPRi and CRISPRa) and base editing.

Since the first CRISPR gene-editing experiments were demonstrated in 2012, the CRISPR-Cas9 technology has exploded into the biological sciences and been rapidly adopted by the scientific community. CRISPR has already shown promise in the prevention of malaria, tuberculosis, and herpes simplex virus.2 Below, we highlight a few ways in which CRISPR has been recently applied to improving our understanding, treatment, and ongoing diagnosis of infectious disease.

Functional genomics with CRISPR to determine new antimicrobial targets

There is currently a distinct lack of new antibiotics and antiviral drugs making it to the clinic. Understanding host-pathogen mechanisms that govern how microbes induce pathogenesis is crucial for identifying new targets for rapid drug discovery and vaccine development. Soon after its debut, CRISPR-Cas9 was applied to functional genomic screening. Using a pooled sgRNA library workflow, CRISPR-Cas9 was successfully used at scale to enable high-throughput, genome-wide loss of function studies. CRISPR-Cas9 genome-wide screening has since been employed in a variety of pathogens to determine the molecular pathways that drive pathogenesis. These include identifying how the α-hemolysin virulence factor S.aureus causes cytotoxicity and genes involved in host-cell dependencies from Zika virus.3,4

CRISPR-Cas9 as a next-generation diagnostic for antimicrobial-resistance genes

Since the discovery of penicillin in 1928, antibiotics have been the main treatment against bacterial infections, reducing mortality and significantly improving life expectancy the world over. But the ability of microbes to rapidly mutate and share genetic information, as well as the overprescription of antibiotics, has led to the emergence of superbugs—strains that are resistant to existing treatments. According to the UN, antibiotic resistance is thought to cause around 700,000 deaths per year, which could rise to 10 million by 2050.

Determining whether genes responsible for antimicrobial resistance (AMR) are present is crucial when formulating an optimal treatment strategy to limit the spread of drug resistance. Unfortunately, real-time metagenomic analysis is hampered by the low abundance of resistant pathogens against a high background. Recent work from the Crawford lab at the University of California, San Francisco used CRISPR to develop a novel NGS-targeted enrichment system called FLASH (finding low abundance sequences by hybridization), which they use as a diagnostic.5 By using sgRNA to guide Cas9 to AMR genes, those sequences are cleaved ready for next-generation sequencing. FLASH enables amplification of AMR targets and high levels of multiplexing and was shown to successfully identify AMR genes in patient samples, including those infected with pneumonia-causing bacteria and Plasmodium falciparum, the malaria parasite.

Selectively controlling the microbiome

The human microbiome is a complex ecosystem of species that all play a role in health —but treatment with broad-spectrum antibiotics to destroy pathogens also kills the “good” bacteria, upsetting the delicate balance and the positive symbiotic relationships that help control pathogens. This blunt instrument also provides a selective pressure that can lead to the further development of antibiotic-resistant strains.

In a recent Nature Communications paper, Hamilton et al used CRISPR-Cas9 to selectively target and kill Salmonella enterica but leave other bacteria species in a co-culture unharmed.6 Their work utilizes a conjugative plasmid to put the delivery machinery together with the necessary Cas9 molecules in a cis-conjugative system to selectively target essential genes in S. enterica cells and destroy them. The authors also suggest their new delivery system could be beneficial in controlling microbial imbalances on biofilms with potential applications in medicine, healthcare, and industrial processes—for example in treating Clostridium difficile, a hospital-acquired infection that is placing an increasing economic burden on healthcare systems worldwide.

CRISPR: as nature intended?

In nature, CRISPR is an endogenous bacterial system used to protect from foreign genetic material, so it makes sense that it is now being used in medicine against the bacteria themselves to fight infectious disease. And not only bacteria—recent work from the Broad Institute used the Cas13 protein from the CRISPR system to selectively target and destroy single-stranded RNA viruses, including Influenza A, significantly and rapidly reducing viral load and infectiousness.7

The programmable nature of the CRISPR gene-editing system means that as microbes continue to evolve and mutate, the CRISPR machinery can be quickly altered to destroy the new target as an antimicrobial drug, or detect it as a diagnostic. Work will now move onto demonstrate that these CRISPR-based antimicrobial applications can work in the clinic and help combat the growing specter of antimicrobial resistance and infectious disease.

#### No effective gene editing governance, certainly not in the squo – tech evolves too fast, no institutional checks, no one cares

Monast 18 Monast, Jonas J. C. Boyden Gray Distinguished Fellow, Assistant Professor and Director of the Center on Climate, Energy, Environment & Economics at UNC. J.D., Georgetown University (2002) B.A., Appalachian State University (1995). "Governing Extinction in the Era of Gene Editing." NCL Rev. 97 (2018): 1329.

With CRISPR, the critical question is no longer whether humans can alter genes to eradicate some species and make others resilient to factors that may cause extinction. Instead, the questions are whether we should and, if so, under what circumstances. While the potential benefits are profound, CRISPR could also foment similarly profound, and potentially irreversible, negative impacts for the target species and the broader ecosystems in which they exist.10 Existing laws are not designed to grapple with these important value choices. Gene editing raises many of the hallmark challenges with emerging technology governance.11 These recent advances in biotechnology may fall outside the scope of existing regulatory schemes designed for earlier understandings of technologies. They may also require responses by multiple agencies operating under different bodies of law.12 The pace of scientific developments is occurring much faster than traditional regulation can typically respond.13 There are calls for flexibility and adaptability to allow the technologies to evolve.14 Continued research is necessary to develop new, potentially beneficial uses for the technology, but the research also creates unknown risks. The technology is widely accessible, allowing individual research labs to create and release edited organisms with potentially wide-ranging impacts.15 Nonbinding soft law measures, such as professional standards and codes of conduct, will play important roles in overseeing research and development of CRISPR-edited organisms. Gene editing implicates diverse and deep- seated values, but engaging a broad range of stakeholders is difficult. Developers seek rapid regulatory approval for releasing new genetically engineered (“GE”) organisms.

#### No way CRISPR solves all disease - lifestyle factors, mistakes

Radcliffe 17 Radcliffe, Shawn. Shawn Radcliffe is a science writer and yoga teacher in Ontario, Canada. "Will Gene Editing Allow Us to Rid the World of Diseases?" Healthline, 26 Aug. 2017, www.healthline.com/health-news/will-gene-editing-allow-us-to-rid-world-of-diseases.

CRISPR-Cas9 is a powerful tool, but it also raises several concerns. “There’s a lot of discussion right now about how best to detect so-called ‘off-target effects,’” said Hochstrasser. “This is what happens when the [Cas9] protein cuts somewhere similar to where you want it to cut.” Off-target cuts could lead to unexpected genetic problems that cause an embryo to die. An edit in the wrong gene could also create an entirely new genetic disease that would be passed onto future generations. Even using CRISPR-Cas9 to modify mosquitoes and other insects raises safety concerns — like what happens when you make large-scale changes to an ecosystem or a trait in a population that gets out of control. There are also many ethical issues that come with modifying human embryos. So will CRISPR-Cas9 help rid the world of disease? There’s no doubt that it will make a sizeable dent in many diseases, but it’s unlikely to cure all of them any time soon. We already have tools for avoiding genetic diseases — like early genetic screening of fetuses and embryos — but these are not universally used. “We still don’t avoid tons of genetic diseases, because a lot of people don’t know that they harbor mutations that can be inherited,” said Hochstrasser. Some genetic mutations also happen spontaneously. This is the case with many cancers that result from environmental factorsTrusted Source such as UV rays, tobacco smoke, and certain chemicals. People also make choices that increase their risk of heart disease, stroke, obesity, and diabetes. So unless scientists can use CRISPR-Cas9 to find treatments for these lifestyle diseases — or genetically engineer people to stop smoking and start biking to work — these diseases will linger in human society. “Things like that are always going to need to be treated,” said Hochstrasser. “I don’t think it’s realistic to think we would ever prevent every disease from happening in a human.”

#### No extinction from pandemics

* Death rates as high as 50% didn’t collapse civilization
* Fossil fuel record caps risk at .1% per century
* health, sanitation, medicine, science, public health bodies, solve
* viruses can’t survive in all locations
* refugee populations like tribes, remote researchers, submarine crews, solve

Ord 20 Ord, Toby. Toby David Godfrey Ord (born 18 July 1979) is an Australian philosopher. He founded Giving What We Can, an international society whose members pledge to donate at least 10% of their income to effective charities and is a key figure in the effective altruism movement, which promotes using reason and evidence to help the lives of others as much as possible.[3] He is a Senior Research Fellow at the University of Oxford's Future of Humanity Institute, where his work is focused on existential risk. BA in Phil and Comp Sci from Melbourne, BPhil in Phil from Oxford, PhD in Phil from Oxford. The precipice: existential risk and the future of humanity. Hachette Books, 2020.

Are we safe now from events like this? Or are we more vulnerable? Could a pandemic threaten humanity’s future?10 The Black Death was not the only biological disaster to scar human history. It was not even the only great bubonic plague. In 541 CE the Plague of Justinian struck the Byzantine Empire. Over three years it took the lives of roughly 3 percent of the world’s people.11 When Europeans reached the Americas in 1492, the two populations exposed each other to completely novel diseases. Over thousands of years each population had built up resistance to their own set of diseases, but were extremely susceptible to the others. The American peoples got by far the worse end of exchange, through diseases such as measles, influenza and especially smallpox. During the next hundred years a combination of invasion and disease took an immense toll—one whose scale may never be known, due to great uncertainty about the size of the pre-existing population. We can’t rule out the loss of more than 90 percent of the population of the Americas during that century, though the number could also be much lower.12 And it is very difficult to tease out how much of this should be attributed to war and occupation, rather than disease. As a rough upper bound, the Columbian exchange may have killed as many as 10 percent of the world’s people.13 Centuries later, the world had become so interconnected that a truly global pandemic was possible. Near the end of the First World War, a devastating strain of influenza (known as the 1918 flu or Spanish Flu) spread to six continents, and even remote Pacific islands. At least a third of the world’s population were infected and 3 to 6 percent were killed.14 This death toll outstripped that of the First World War, and possibly both World Wars combined. Yet even events like these fall short of being a threat to humanity’s longterm potential.15 In the great bubonic plagues we saw civilization in the affected areas falter, but recover. The regional 25 to 50 percent death rate was not enough to precipitate a continent-wide collapse of civilization. It changed the relative fortunes of empires, and may have altered the course of history substantially, but if anything, it gives us reason to believe that human civilization is likely to make it through future events with similar death rates, even if they were global in scale. The 1918 flu pandemic was remarkable in having very little apparent effect on the world’s development despite its global reach. It looks like it was lost in the wake of the First World War, which despite a smaller death toll, seems to have had a much larger effect on the course of history.16 It is less clear what lesson to draw from the Columbian exchange due to our lack of good records and its mix of causes. Pandemics were clearly a part of what led to a regional collapse of civilization, but we don’t know whether this would have occurred had it not been for the accompanying violence and imperial rule. The strongest case against existential risk from natural pandemics is the fossil record argument from Chapter 3. Extinction risk from natural causes above 0.1 percent per century is incompatible with the evidence of how long humanity and similar species have lasted. But this argument only works where the risk to humanity now is similar or lower than the longterm levels. For most risks this is clearly true, but not for pandemics. We have done many things to exacerbate the risk: some that could make pandemics more likely to occur, and some that could increase their damage. Thus even “natural” pandemics should be seen as a partly anthropogenic risk. Our population now is a thousand times greater than over most of human history, so there are vastly more opportunities for new human diseases to originate.17 And our farming practices have created vast numbers of animals living in unhealthy conditions within close proximity to humans. This increases the risk, as many major diseases originate in animals before crossing over to humans. Examples include HIV (chimpanzees), Ebola (bats), SARS (probably bats) and influenza (usually pigs or birds).18 Evidence suggests that diseases are crossing over into human populations from animals at an increasing rate.19 Modern civilization may also make it much easier for a pandemic to spread. The higher density of people living together in cities increases the number of people each of us may infect. Rapid long-distance transport greatly increases the distance pathogens can spread, reducing the degrees of separation between any two people. Moreover, we are no longer divided into isolated populations as we were for most of the last 10,000 years.20 Together these effects suggest that we might expect more new pandemics, for them to spread more quickly, and to reach a higher percentage of the world’s people. But we have also changed the world in ways that offer protection. We have a healthier population; improved sanitation and hygiene; preventative and curative medicine; and a scientific understanding of disease. Perhaps most importantly, we have public health bodies to facilitate global communication and coordination in the face of new outbreaks. We have seen the benefits of this protection through the dramatic decline of endemic infectious disease over the last century (though we can’t be sure pandemics will obey the same trend). Finally, we have spread to a range of locations and environments unprecedented for any mammalian species. This offers special protection from extinction events, because it requires the pathogen to be able to flourish in a vast range

of environments and to reach exceptionally isolated populations such as uncontacted tribes, Antarctic researchers and nuclear submarine crews. 21 It is hard to know whether these combined effects have increased or decreased the existential risk from pandemics. This uncertainty is ultimately bad news: we were previously sitting on a powerful argument that the risk was tiny; now we are not. But note that we are not merely interested in the direction of the change, but also in the size of the change. If we take the fossil record as evidence that the risk was less than one in 2,000 per century, then to reach 1 percent per century the pandemic risk would need to be at least 20 times larger. This seems unlikely. In my view, the fossil record still provides a strong case against there being a high extinction risk from “natural” pandemics. So most of the remaining existential risk would come from the threat of permanent collapse: a pandemic severe enough to collapse civilization globally, combined with civilization turning out to be hard to re-establish or bad luck in our attempts to do so.

#### Interconnectedness is balanced by increased immunity and advances in medicine and sanitation

Dr. John Halstead 19, Doctorate in Political Philosophy, “Cause Area Report: Existential Risk, Founders Pledge”, https://founderspledge.com/research/Cause%20Area%20Report%20-%20Existential%20Risk.pdf

However, there are some reasons to think that naturally occurring pathogens are unlikely to cause human extinction. Firstly, Homo sapiens have been around for 200,000 years and the Homo genus for around six million years without being exterminated by an infectious disease, which is evidence that the base rate of extinction-risk natural pathogens is low.82 Indeed, past disease outbreaks have not come close to rendering humans extinct. Although bodies were piled high in the streets across Europe during the Black Death,83 human extinction was never a serious possibility, and some economists even argue that it was a boon for the European economy.84 Secondly, infectious disease has only contributed to the extinction of a small minority of animal species.85 The only confirmed case of a mammalian species extinction being caused by an infectious disease is a type of rat native only to Christmas Island. Having said that, the context may be importantly different for modern day humans, so it is unclear whether the risk is increasing or decreasing. On the one hand, due to globalisation, the world is more interconnected making it easier for pathogens to spread. On the other hand, interconnectedness could also increase immunity by increasing exposure to lower virulence strains between subpopulations.87 Moreover, advancements in medicine and sanitation limit the potential damage an outbreak might do.

#### Humans are too dispersed and disease trends against lethality

Sebastian Farquhar 17, director at Oxford's Global Priorities Project, Owen Cotton-Barratt, a Lecturer in Mathematics at St Hugh’s College, Oxford, John Halstead, Stefan Schubert, Haydn Belfield, Andrew Snyder-Beattie, "Existential Risk Diplomacy and Governance", GLOBAL PRIORITIES PROJECT 2017, 1/23/2017, https://www.fhi.ox.ac.uk/wp-content/uploads/Existential-Risks-2017-01-23.pdf

1.1.3 Engineered pandemics For most of human history, natural pandemics have posed the greatest risk of mass global fatalities.37 However, there are some reasons to believe that natural pandemics are very unlikely to cause human extinction. Analysis of the International Union for Conservation of Nature (IUCN) red list database has shown that of the 833 recorded plant and animal species extinctions known to have occurred since 1500, less than 4% (31 species) were ascribed to infectious disease.38 None of the mammals and amphibians on this list were globally dispersed, and other factors aside from infectious disease also contributed to their extinction. It therefore seems that our own species, which is very numerous, globally dispersed, and capable of a rational response to problems, is very unlikely to be killed off by a natural pandemic. One underlying explanation for this is that highly lethal pathogens can kill their hosts before they have a chance to spread, so there is a selective pressure for pathogens not to be highly lethal. Therefore, pathogens are likely to co-evolve with their hosts rather than kill all possible hosts.39

#### Containment solves---it’s more effective than vaccination

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No disease better illustrates the need for a next-gen vaccine than influenza. "We need to do better with flu vaccine," says Dr. Anthony Fauci, director of the NIH National Institute of Allergy and Infectious Diseases. A healthy market exists for the seasonal-flu vaccine, but because the influenza virus constantly mutates, a new version has to be made each year, a process that takes months. That lag could be deadly during a severe influenza pandemic. Humans have little to no immune protection against new flu strains, which then spread rapidly around the world and--sometimes--cause severe disease. And though the flu usually isn't deadly for otherwise healthy people, it can be, as the 1918 pandemic showed. While flu vaccines didn't exist in 1918, they did in 2009, when a new flu strain jumped from pigs to people and ultimately killed an estimated 203,000 people around the world, a majority of them under the age of 65. Efforts were made to fast-track a vaccine, but the first doses weren't available for 26 weeks, and it would have taken a year to produce vaccines for every American. Since it can require years of testing and well over $1 billion to successfully develop a single vaccine against a single pathogen, drug companies have increasingly shied away from the business. "There's just no incentive for any company to make pandemic vaccine to store on shelves," says Dr. Trevor Mundel, president of the global health division at the Bill and Melinda Gates Foundation. That's why most infectious-disease experts aren't hanging their hopes solely on new treatments or vaccines. After all, that's not what ultimately contained the most recent lethal outbreak of Ebola. It chiefly fell to health workers on the ground and to Frieden, director of the CDC for eight years under President Obama. And on no day did that effort come closer to failure than on July 23, 2014. That was the day Frieden received news that Ebola had arrived in the Nigerian megacity of Lagos. The virus had been killing people for months in Guinea, Liberia and Sierra Leone, but Ebola in Lagos--the biggest city on the African continent, with a metro population of 21 million--represented a threat of an entirely different magnitude. "If it got out of control in Lagos, it could spread through Nigeria and the rest of Africa," says Frieden. "It could still be going on today." But it isn't, thanks largely to the herculean efforts of thousands of expert health workers--U.S. staff from the CDC and Nigerian officials who had been trained in the international effort to stop polio--who were quickly diverted to fight Ebola. This is why Frieden, Gates and others are so bullish about investing in science and foreign aid. Without aid, Nigeria would not have been able to stem the spread of Ebola. And without the next-generation science that helped track the outbreak, far more people would have died. "It's very important that this kind of work continues," says Frieden, "or America is going to be less safe." Make no mistake: for all our high-tech isolation units, top-tier doctors and world-class scientists, the U.S. health care system is not ready for the stresses of a major pandemic. As the infectious-disease expert Osterholm notes, a pandemic is not like other natural disasters, which tend to be confined to a single location or region. Disease can strike everywhere at once. In the event of a pandemic, even the best hospitals could rapidly run out of beds and mechanical ventilators.

#### Gene editing perfects bioweaponry – and is perfect to eradicate massive populations—makes diseases inevitable

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CRISPR-based homing gene drive is a genetic control technique aiming to modify or eradicate natural populations. This technique is based on the release of individuals carrying an engineered piece of DNA that can be preferentially inherited by the progeny. The development of countermeasures is important to control the spread of gene drives, should they result in unanticipated damages. One proposed countermeasure is the introduction of individuals carrying a brake construct that targets and inactivates the drive allele but leaves the wild-type allele unaffected. Here we develop models to investigate the efficiency of such brakes. We consider a variable population size and use a combination of analytical and numerical methods to determine the conditions where a brake can prevent the extinction of a population targeted by an eradication drive. We find that a brake is not guaranteed to prevent eradication and that characteristics of both the brake and the drive affect the likelihood of recovering the wild-type population. In particular, brakes that restore fitness are more efficient than brakes that do not. Our model also indicates that threshold-dependent drives (drives that can spread only when introduced above a threshold) are more amenable to control with a brake than drives that can spread from an arbitrary low introduction frequency (threshold-independent drives). Based on our results, we provide practical recommendations and discuss safety issues. Genetic controlgene drive braketheoretical model The use of engineered gene drives has been proposed as a technique for population control with potential applications in public health, agriculture and conservation (Burt 2003; Esvelt et al. 2014). This technique relies on the release of genetically engineered individuals that can rapidly propagate a transgene of interest into wild populations. Gene drives can be designed to modify, suppress or eradicate various target species (Scott et al. 2018; Rode et al. 2019). Potential target species include disease vectors (e.g., Anopheles gambiae, the main vector of malaria in Africa; Kyrou et al. 2018), agricultural pests (e.g., Drosophila suzukii, a major pest of soft fruits; Courtier-Orgogozo et al. 2017; Scott et al. 2018) or invasive rodents (e.g., invasive house mouse or black rats that threaten biodiversity on islands; Leitschuh et al. 2018). Due to the universality of CRISPR genome editing, CRISPR-based gene drives can potentially be applied to a wide variety of organisms (Esvelt et al. 2014; Raban et al. 2020). Diverse CRISPR-based gene drive systems have already been developed in the laboratory as proofs-of-principle in a few model organisms (homing, split homing, translocation, X-shredder, killer-rescue, cleave-and-rescue and TARE gene drives; Webster et al. 2020; Champer et al. 2020; see Raban et al. 2020 for a review) or as theoretical possibilities (daisy chain drives; Noble et al. 2019). Gene drives have so far only been tested in the laboratory and no field trial has been conducted yet. Among these systems, CRISPR-based homing gene drives are the most adaptable to new species and populations and the most advanced in terms of technological development (Raban et al. 2020). They involve a piece of DNA that includes a guide RNA (gRNA) gene and a cas9 gene (encoding the Cas9 endonuclease). The gRNA is designed to recognize a specific sequence in a wild-type chromosome, so that in heterozygotes carrying a drive allele and a wild-type allele, the Cas9-gRNA molecular complex will cut the wild-type chromosome at the target site. The resulting double-strand DNA break can then be repaired through homology-directed repair (also known as “gene conversion”), using the drive allele as a template, which is designed to harbor sequences identical to the ones flanking the target site. Consequently, the drive allele is transmitted to the next generation at rates beyond those of regular Mendelian inheritance and, if its features allow it, will rapidly spread within the target population. Homing gene drives are sometimes considered as “threshold-independent drives”, i.e., as being able to spread in a population from an arbitrary low introduction frequency (e.g., Marshall and Akbari 2018). Mathematical models of homing gene drives (e.g., Deredec et al. 2008; Alphey and Bonsall 2014; Unckless et al. 2015; Tanaka et al. 2017) have however shown that depending on various parameters (the efficacy of gene conversion, its timing, the fitness cost incurred by the drive allele and its dominance over the wild-type allele), some of the homing gene drives can be threshold-dependent, i.e., only spread if they are introduced above a threshold frequency. Mathematically, when there is an equilibrium at an intermediate frequency of the drive allele (Embedded Image) and when this equilibrium is unstable, then the drive is threshold-dependent; the value of the drive allele frequency at this equilibrium is the threshold above which the drive has to be introduced to spread (Deredec et al. 2008). Given that gene drives can potentially impact biodiversity, national sovereignty and food security (Oye et al. 2014; Akbari et al. 2015; DiCarlo et al. 2015; NASEM 2016; Montenegro de Wit 2019), there is a crucial need to develop strategies to minimize the risks of unintentional spread (e.g., following the escape of gene drive individuals from a laboratory) and to mitigate unanticipated or premeditated and malevolent harm to humans or the environment. For example, a CRISPR-based eradication drive may spread into a non-target population or species (Noble et al. 2018; Rode et al. 2019; Courtier-Orgogozo et al. 2020); a modification drive may alter the target population in an unexpected, detrimental manner; or a gene drive could be used as bioweapon (Gurwitz 2014). Decreasing the environmental risks associated with the development of this technology can be achieved by designing safer gene drives whose spread can be controlled spatially or temporally (Marshall and Akbari 2018; Raban et al. 2020) and by developing countermeasures to stop the spread of an ongoing gene drive (Esvelt et al. 2014; Gantz and Bier 2016; Vella et al. 2017).