The American biomedical research enterprise in a post-COVID-19 world

Questions or comments?
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1. Introduction

SARS-CoV2, the virus that causes COVID-19, is not the first novel human pathogen to emerge in the 21st century, nor is it the first to be declared a pandemic. But with the aid of slow, inept, and corrupt governments across the world, the COVID-19 pandemic became a global catastrophe presenting societal, health, and economic challenges that will shape the course of the 21st century.

No sector has been spared in the COVID-19 pandemic, including academic biomedical research. Early in 2020, the U.S. academic biomedical research enterprise largely shut down. This unprecedented event, along with the broader health and economic turmoil caused by COVID-19, will have serious repercussions for the conduct and culture of American biomedical research.

Prior to COVID-19, the U.S. was the global leader in biomedical research, despite clearly identified systemic flaws and an unsustainable workforce model.[1,2] The COVID-19-induced pause in academic biomedical research presents an opportunity for trainees, faculty, departments, universities and federal agencies to rectify many of these flaws and steer the biomedical research enterprise onto a sustainable path.

The COVID-19 pandemic

The first public reports of SARS-CoV2 infections were reported in Wuhan, China, on Dec. 31, 2019.[3] By Jan. 30, 2020, the World Health Organization declared COVID-19 a global health emergency.[4] Because of the high rate of infectivity, the lack of societal infrastructure necessary to block the spread of SARS-CoV2, and the high mortality rate, projections of the course of infection and analyses of hospital capacity led to early predictions that, without intervention, the virus would sweep through the population infecting billions and killing tens of millions.[5]

Despite the dire predictions, governments across the world varied in their response to the newly emergent virus. Some governments acted immediately to implement appropriate measures to safeguard its populace. These countries had relatively small outbreaks and few COVID-19-related deaths. Other countries were slow to respond to the SARS-CoV2 outbreak but eventually enacted stringent lockdown protocols. These countries had a large number of infections and deaths, but the eventual strong actions by the governments slowed the outbreak.

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[1] Alberts et al (2014) Rescuing US biomedical research from its systemic flaws. *Proc Natl Acad Sci*.

[2] Pickett et al (2015) Toward a sustainable biomedical research enterprise: Finding consensus and implementing recommendations. *Proc Natl Acad Sci*.

[3] How the coronavirus pandemic unfolded: A timeline. *The New York Times*. https://www.nytimes.com/article/coronavirus-timeline.html.

[4] Archived: WHO timeline – COVID-19. https://www.who.int/news-room/detail/27-04-2020-who-timeline---covid-19.

[5] How coronavirus control measures could affect its global death toll. *ScienceNews*. https://www.sciencenews.org/article/coronavirus-covid19-control-measures-impact-global-death-toll.

The United States did not fall into either of the above categories. Despite sufficient warning about the spread of COVID-19, the Trump administration failed to marshal the resources necessary to combat the disease in a timely fashion. The lack of national leadership led to the issuance of unclear and contradictory state and federal policies, and a harmful and unnecessary competition among states and the federal government for life-saving equipment.[6] This lack of leadership has led to a prolonged period of virus exposure, infection and death caused by SARS-CoV2 in the U.S. with minoritized communities being disproportionately negatively affected.

The academic response

In the face of the emergent pandemic and the faltering federal response, U.S. academic institutions played important roles. First and foremost, universities did what was needed to protect the faculty, staff and students in their institution—they barred most from entering campus. This shutdown included slowing or stopping research programs, with the exception of those labs studying coronaviruses and associated pathogens, as well as a subset of structural biology, infectious disease, and public health labs.

Labs not in this sliver of the academic research enterprise still made critical contributions. By donating reagents, materials and personnel to public health efforts, especially early in the outbreak, biomedical research labs were able to shore up shortages caused by the fast-moving disease. But these efforts were not always well coordinated and were sometimes hampered by administrative roadblocks. Muddled leadership structures, sparse connections with public health officials, and unclear federal policies interfered with the rapid transfer of materials from academic labs to public health labs.

Troubling times ahead

Universities, and academic biomedical research in particular, are facing an uncertain future. The lack of an effective COVID-19 vaccine, plus the significant health threat still posed by the disease, means the physical distancing and other safety measures of the Spring 2020 semester will spill over into the Fall 2020 semester, if not longer.

The shutdown of campuses during the Spring 2020 semester caused incredible financial hardships on institutions that will reverberate through the system for years to come. Some universities are forecasting losses for the coming year at up to $1 billion.[7,8] These forecasts have already ratcheted up tensions within universities. Most universities have instituted pay

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[6] How the Trump administration has stood in the way of PPE distribution. *Vox*. https://www.vox.com/2020/4/4/21208122/ppe-distribution-trump-administration-states.

[7] University of Michigan makes cuts, forecasts losses of up to $1 billion. *Detroit Free Press*. https://www.freep.com/story/news/education/2020/04/20/university-michigan-makes-cuts-stem-loss-schlissel/5166574002/.

[8] Rising expenses, falling revenues, budget cuts: Universities face looming financial crisis. *The Washington Post*. https://www.washingtonpost.com/education/2020/04/23/rising-expenses-falling-revenues-budget-cuts-universities-face-looming-financial-crisis/.

cuts, hiring freezes and furloughing or laying off tenured faculty and other employees. In response, university faculty have begun calling for changes in the structure of university administrations and pay of high-level officials.[9,10]

For institutions that derive a significant portion of their annual budget from their endowment, they may be able to temporarily sustain a dip in tuition revenue. However, most endowments are invested in stock markets, which present a different vulnerability. Fluctuations in stock prices threaten the stability of endowments, and longer-term economic concerns, such as whether the American economy dips into recession or depression, could also diminish endowments.

Approach

The COVID-19 pandemic has reexposed many of the existing systemic flaws in biomedical research and highlighted the need for urgent correction. The pandemic-related pause in research is an opportunity to implement long-needed reforms. As universities begin to grapple with the panoply of difficulties presented by the pandemic and economic slowdown, they should seriously consider significant policy changes to reform the biomedical research workforce to ensure it is sustainable for the foreseeable future.

To understand how COVID-19 has changed the complexion and priority of specific recommendations, I convened the RBR COVID Discussion Series to delve into a variety of issues most relevant to the pandemic—trainees, underrepresented minorities, faculty and academic pandemic preparedness. I moderated these sessions with two to three panelists and dove into each of these issues at the end of April and beginning of May, 2020.

A list of discussion session speakers and links to videos and transcripts of the discussion can be found in the Acknowledgements. To be clear, the recommendations in this document were culled from prior reports and the points made in the discussion sessions. Participation in the discussion sessions should not be construed as an endorsement on their part of the recommendations that follow.

Intervening events

Between the end of the RBR COVID Discussion Series and the writing of this white paper, two major events happened that will have long-reaching effects on academic research.

First, at the end of May, street protests erupted across the United States in response to the killing of George Floyd, a Black man, by a member of the Minneapolis police department.[11]

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[9] As COVID-19 pummels budgets, colleges are resorting to layoffs and furloughs. Here's the latest. *The Chronicle of Higher Education*. https://www.chronicle.com/article/We-re-Tracking-Employees/248779.

[10] University leaders are failing. *The Chronicle of Higher Education*. https://www.chronicle.com/article/university-leaders-are-failing/248809.

[11] How George Floyd was killed in police custody. *The New York Times*. https://www.nytimes.com/2020/05/31/us/george-floyd-investigation.html.

Thousands of Americans poured into the streets of cities and towns across the country, often masked and trying to keep their distance from one another.[12]

Academic institutions responded to Floyd's death and the recent deaths of other Black Americans with statements of solidarity with the Black community. Demonstrating just how much work needs to be done, minoritized members of the academy launched broad conversations about the realities of working in academia. For example, the #BlackInTheIvory hashtag explored the lived experiences of Black and other minoritized trainees and faculty being mistreated at the hands of White and other well-represented populations in research.

Second, the Trump administration launched new crackdowns on immigration into the United States, specifically targeting Chinese students. In April, President Trump issued an executive order stopping the issuance of new green cards.[13] In June, this order was broadened to include the visas typically used by foreign scientists working in the U.S. and extended through the end of 2020.[14] The administration also issued a second executive order in June blocking Chinese students and postdocs who have any affiliation with the Chinese government from entering the U.S.[15]

These events, on top of the COVID-19 pandemic, will dramatically reshape the biomedical research enterprise for decades.

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Times of upheaval can also be catalysts of great change. That change can be dictated by the broader environment or through proactive implementation of new policies. What follows are recommendations for universities, departments, and federal agencies to consider as universities relaunch research operations.

[12] George Floyd protests: A timeline. *The New York Times*. https://www.nytimes.com/article/george-floyd-protests-timeline.html.

[13] Trump halts new green cards, but backs off broader immigration ban. *The New York Times*. https://www.nytimes.com/2020/04/21/us/politics/coronavirus-trump-immigration-ban.html.

[14] Trump suspends visas allowing hundreds of thousands of foreigners to work in the U.S. *The New York Times*. https://www.nytimes.com/2020/06/22/us/politics/trump-h1b-work-visas.html.

[15] U.S. to expel Chinese graduate students with ties to China's military schools. *The New York Times*. https://www.nytimes.com/2020/05/28/us/politics/china-hong-kong-trump-student-visas.html.

2. A post-pandemic biomedical workforce

When will the health and economic problems caused by COVID-19 end, and what will universities and academic research look like in the wake of COVID-19? The answer to these questions are directly tied to the time it takes for states and universities to ensure a safe work and learning environment. Whether due to a vaccine, treatment, or plan that maintains effective physical distancing measures, minimizing or eliminating the transmission of SARS-CoV2 is paramount to fully relaunching the American research enterprise.

Tied into ramping up research activities, how the careers of those in biomedical research will be affected by the pandemic is not clear. Hiring freezes have put postdocs seeking faculty positions in an extended holding pattern. Junior faculty are scrambling to relaunch their nascent research plans to acquire grants and receive tenure. Scientists at all levels are suffering mental health issues trying to balance the needs of work, family, and community. These and other problems spring from the systemic flaws in biomedical research. Now is the time to take broad actions to fix them.

What follows are recommendations for departments and universities to ensure their approach to training, hiring and retention reflect the mission of the institution, specifically in regard to equity, diversity and inclusion.

Recommendations

2.1. Integrate equity, diversity, and inclusion work into existing structures and programs

In response to the death of George Floyd and resulting protests, most universities released statements reaffirming their commitments to the Black community and to equity, diversity and inclusion in their institutions. However, academia as a whole has been incredibly slow to diversify. This is due to the deep threads of racism throughout American culture, and a stubborn resistance in academic research to make change.[16]

To demonstrate their commitment to equity, diversity and inclusion, universities must make real change. And just as systemic racism is integrated into American and academic culture, universities must integrate the work of equity, diversity and inclusion into the work of existing committees and structures.

As policies are revised in response to the COVID-19 pandemic, universities and departments should ensure these policies are calibrated to value the broad benefits underrepresented minorities bring to a department in addition to scientific excellence. Rather than forming new committees, already standing committees should reform their own practices to be more equitable and inclusive. This includes graduate admissions, faculty hiring, retention and promotion committees, among others.

[16] http://rescuingbiomedicalresearch.org/blog/equity-power-responsibility-academic-research/

Furthermore, this work should be done by people from well-represented backgrounds. For too long, improving equity, diversity, and inclusion has been relegated to people from underrepresented backgrounds. This places a substantial burden on these faculty to establish a robust researcher program while also being tasked with changing departmental and university culture.[17] This tax on their time is not often considered when considered for advancement. Relieving this burden will place the onus on changing departmental and university culture where it should lie—on the people with the power to change the system.

2.2. Revise evaluations of prospective and current faculty to reflect the values of the institution

Before COVID-19, excessive competition for funding and publications led to the overemphasis of attaining grants and high-profile publications for career advancement.[18] This, in effect, is a system where universities outsourced evaluation of faculty to federal agencies and journals. After the pandemic hit, the professoriate was affected in two ways. First, most universities instituted a hiring freeze for 2020 and some also for 2021. Second, assistant professors working toward tenure have endured incredible disruptions in their progress due to the suspension of research operations in response to COVID-19.

In addition, the pandemic has caused a significant reordering of family life in the United States. Beyond dealing with those who were sick with COVID-19, families have also had to adjust to altered school and camp schedules, working from home and caring for extended family members. These hardships will affect scientists at all career stages.

Universities must take this opportunity to revise their research evaluation methods. With so much of the day-to-day research operations upended, universities should not maintain the same metrics considering publications and grants in hiring decisions or retention and promotion decisions. Rather, departments must reform their policies to value work done outside of acquiring grants and publications to better shape the culture of the department.[19]

In other words, faculty should discard the accomplishments of previous applicants as a bar for consideration. Rather, faculty should ask specifically whether the applicant for a faculty position or tenure enriches the departmental culture beyond the stale metrics of grants received and papers published.

2.2.1. Revise faculty hiring practices and policies

Faculty hiring freezes implemented due to COVID-19 have stalled the job market for postdocs. When freezes are lifted, departments will be faced with a crush of applications from highly qualified faculty candidates. And the large number of well-qualified applicants will render the

[17] The time tax put on scientists of color. *Nature*. https://www.nature.com/articles/d41586-020-01920-6.

[18] Alberts et al (2014) Rescuing US biomedical research from its systemic flaws. *Proc Natl Acad Sci*.

[19] Rethinking research assessment: Ideas for action. https://sfdora.org/2020/05/19/rethinking-research-assessment-ideas-for-action/

metrics often used to winnow the candidate pool—papers published in prestigious journals and grants awarded—moot.

Prior to lifting the hiring freeze, universities and departments should make intentional decisions about the culture of the department and hire accordingly. What qualities does a department value in new hires? How should the department value work done by faculty candidates around equity, service, teaching and scholarship?

This includes intentional decisions about hiring people from traditionally underrepresented groups. There is a sizable pool of qualified applicants, and there are proven strategies for hiring and retaining people from minoritized backgrounds.[20,21] Programs from the NIH and the Howard Hughes Medical Institute could identify promising minoritized faculty candidates, but departments committed to hiring people from underrepresented groups will need to do the work to seek them out.[22,23] Departments should implement policies to improve equity and inclusion prior to their first faculty searches once hiring freezes are lifted.

2.2.2. Revise promotion and tenure policies

The pandemic shone a light on the many other ways faculty make important contributions to the university and the community. For example, many scientists performed services for their community through science communication and education or by donating supplies to local public health labs. The mentoring and leadership roles of faculty took on renewed importance as trainees struggled with many facets of the pandemic. And quality teaching during times of physical distancing was especially valued as classes moved online.

Hundreds of universities have indicated they will allow at least a one-year extension of the tenure clock for assistant professors as they ramp up research operations.[24] While surely welcome, this is only a stopgap solution. Furthermore, citing delays to research as the reason for the tenure-clock extension signals that the qualities in faculty valued prior to the pandemic will be those valued after it.

Retention and promotion decisions should reflect the values of a department and university. Being hyperfocused on acquiring grants and publications to the exclusion of other measures of faculty quality is a disservice to the department, the trainees at the institution and the scientific community as a whole. Rather than simply making exceptions for the small group of assistant

[20] Bhalla (2019) Strategies to improve equity in faculty hiring. *Mol Biol Cell*.

[21] Gibbs et al (2016) Research: Decoupling of the minority PhD talent pool and assistant professor hiring in medical school basic science departments in the US. *eLife*.

[22] Maximizing Opportunities for Scientific and Academic Independent Careers (MOSAIC) Postdoctoral Career Transition Award to Promote Diversity. https://grants.nih.gov/grants/guide/pa-files/PAR-19-343.html

[23] The Hannah H. Gray Fellows Program. https://www.hhmi.org/programs/hanna-h-gray-fellows-program.

[24] https://docs.google.com/spreadsheets/d/1U5REApf-t-76UXh8TKAGoLlwy8WIMfSSyqCJbb5u9lA/edit?fbclid=IwAR1GXpQUpNKiV1ICaS9Jt3Z7UqWNW_zhl11jZWn4MZHjmSWjJHP5hrtcJz4#gid=0&fvid=238051147

professors affected by the COVID-19 pandemic, departments and universities should use this time to make long-lasting, positive changes to promotion and tenure policies that will improve the equity, quality and culture of the department.

Committees considering faculty advancement should proactively indicate a reemphasis on teaching and service in retention and promotion considerations. This will reflect an appreciation of the non-research work done by faculty during the pandemic. This will also act as a recognition and embrace of all the mentoring, teaching, outreach, communication and advocacy work faculty do. Furthermore, as faculty from underrepresented populations are often asked to time away from their research activities to do equity, diversity and inclusion work, departments should also embrace this work as counting towards retention, promotion and tenure.

2.3 Protect graduate students and postdocs

Similar to faculty, graduate students and postdoctoral scholars have had their research efforts disrupted by COVID-19. Unlike faculty, universities have not stepped up to announce their support of these trainees by extending training times or assuring financial support. Some institutions have even taken the extraordinary step to require graduate students to be present on campus in the Fall 2020 semester or risk losing their stipend and health benefits.[25]

Graduate students and postdocs are the largest part of the research workforce in any institution and a failure to provide a commitment threatens an institution's ability to generate world-class research. Institutions and federal agencies should consider several recommendations to support young researchers:

2.3.1 Revise graduate admissions standards

Because of the pandemic, many institutions changed classes in Spring 2020 from graded to pass/fail. This will affect the GPA of graduate school applicants, and grad schools need to determine how to deal with this widespread change. Additionally, many schools are dropping the GRE as a prerequisite for grad school applicants because it is not an indicator of grad school success and is biased against women and underrepresented minorities.[26,27]

Universities and departments should accelerate the pace of revising grad school admissions standards by eliminating the GPA and GRE as admissions requirements altogether.

2.3.2 Revitalize graduate training

The careers of graduate students were upended by the COVID-19 pandemic. Many had to slow or stop their research projects until it was safe to return to their labs. They lost valuable time in

[25] Boston University gives PhD students a choice: Come back to campus or your health insurance and salary. *WGBH*. https://www.wgbh.org/news/local-news/2020/06/24/boston-university-gives-student-workers-a-choice-come-back-to-campus-or-lose-your-health-insurance-and-salary

[26] Beyond the GRE. https://beyondthegre.org/

[27] A test that fails. *Nature*. https://www.nature.com/articles/nj7504-303a

progressing to their degree, and some may be forced from their positions due to university budget cuts or time restrictions on how long they can be funded as students.

Universities and departments should immediately reevaluate their training programs. Simply sticking with the same training program—classes, journal clubs, lab expectations—is no longer sufficient in a post-COVID world. The non-bench skills valued during the COVID-19 pandemic will likely be highly valued after the pandemic recedes—science communication, outreach, journalism, advocacy, and more.

Universities must take the time immediately following the reopening of institutions and research programs to revitalize their training programs. The National Academies Graduate Education report from 2018 lists a variety of positive changes graduate education programs should make, including the expansion of training for the breadth of careers available to Ph.D.s.[28]

Universities should also broaden the classes provided to graduate students to give them a broader sense of how science affects their community. This includes incorporating lessons learned from non-Western science, a history of science and minoritized populations, and the social aspects of applying science to current health problems.

2.3.3 Stop the exploitation of foreign trainees

The American university system has long been the global hub for biomedical training and research. However, many foreign-born researchers are exploited due to loopholes and omissions in federal and university policies. Despite editorials declaring how much the research enterprise appreciates foreign-born scientists, academia has done little to address the exploitation of these researchers.

American postdocs are typically paid on the NIH National Research Service Award fellowship pay scale, whether they have a fellowship or not. However, foreign-born postdocs, who make up nearly two thirds of the U.S. postdoc population, are commonly paid less than their American counterparts, sometimes below the NIH NRSA pay scale.[29] There is no clear reason or justification for lower pay for these people.

Furthermore, most foreign-born researchers need a visa to enter the U.S. If they are fired from their postdoc position, the visa is canceled and foreign-born researchers can be required to leave the country within as little as 24 hours. This precarious position limits these researchers abilities to effectively advocate for better pay and job prospects. On top of this, the Trump

[28] Graduate STEM education for the 21st century. https://www.nap.edu/catalog/25038/graduate-stem-education-for-the-21st-century

[29] National Science Foundation (2017) Doctorate Recipients from U.S. Universities: 2017. https://ncses.nsf.gov/pubs/nsf19301/data.

administration has long worked to keep non-Americans out of the U.S., and this was amplified during the COVID-19 pandemic.[30]

Universities should immediately implement policies that require equal pay and benefits for all trainees regardless of national origin. This should apply to all people affiliated with the university, whether they are paid from a grant or by the university itself.

Universities should also establish a safety net for immigrants at their institution. Universities should implement a system that relieves the pressure of potentially having to immediately leave the country at the whim of an abusive employer, possibly by providing a two or four week window between firing and visa cancellation. This time would allow these researchers time to find a new position before being forced to leave the country. It would also allow immigrants the space and security to advocate for themselves.

2.3.4 Press the National Institutes of Health and other federal agencies to immediately issue more training grants and fellowships.

Providing more funding for training grants and fellowships is a perennial recommendation in reports about the biomedical academic workforce. The COVID-19 pandemic starkly showed the need for these funding mechanisms: By having funding streams independent of a lab research grant, securing funding specifically for trainees, like training grants and fellowships, can provide independence for trainees and a degree of stability.

In the short term, the NIH and other funding agencies should create new funding mechanisms similar to training grants and fellowships. These mechanisms could be time-limited to two or three years to provide trainees financial stability until universities recover. Furthermore, these awards should be based on the need to support trainee populations rather than based on scientific merit.

In the longer term, federal agencies should convert the funds used for short-term trainee support to establish longer lasting training grants and fellowships. This will provide trainees with an independent base of financial support and stability during minor and major disturbances to their abilities to conduct research. Furthermore, federal agencies should place contingencies on these awards that universities should be able to demonstrate good-faith, successful efforts to improve equity, diversity and inclusion in their institutions.

2.3.5 Hire more staff scientists

Many universities are responding to the COVID-19 pandemic, in part, by instituting hiring freezes. However, this will put tremendous pressure on the rest of the academic job market. Postdocs ready to apply for faculty positions will be forced to compete for a smaller pool of opportunities or to wait until hiring freezes are lifted. Graduate students interested in moving on will find a dwindling number of postdoc positions available.

[30] Trump suspends visas allowing hundreds of thousands of foreigners to work in the U.S. *The New York Times*. https://www.nytimes.com/2020/06/22/us/politics/trump-h1b-work-visas.html.

Because long-term university finances are uncertain, universities should consider short-term solutions to continue their research programs like encouraging labs to hire staff scientists. Staff scientists are highly skilled Ph.D. scientists who are no longer in a training position. These positions are often discounted as a solution to workforce problems because staff scientists are more expensive than trainees, but in the present situation, the position presents some benefits.

Staff scientists are highly skilled and can contribute to a research program almost immediately, in contrast to graduate students and postdocs who need some training before becoming productive. Furthermore, universities can offer staff scientists short-term contracts to be renewed or ended at the end of the contract. Such a situation will allow universities to attenuate the number of researchers they can support, propel their research programs, and maximize their budget in a time of uncertainty.

2.4 Provide financial support to cover the costs of ramping up research

The COVID-19 pandemic has put research on hold for all labs, regardless of whether they are led by junior, mid-career, or senior faculty. These labs need grants to conduct research, publish, and apply for new grants. By not generating research during the period of physical distancing, the ability to secure future lab funding is threatened.

At greatest risk are labs on internal university funding, startup funding or with grants expiring in fiscal 2020. The COVID-19 pandemic hit at a time critical for these labs to generate research and secure future grant funding. While those with grants expiring in FY21 or beyond will have more time to generate data for publications and grant applications, they may also suffer consequences of the research slowdown that threatens the continuity of the lab.

2.4.1 Press Congress and the NIH to extend all grants for at least one year

During the pandemic-imposed campus shutdown, grants funds are still being used to support salaries. This, plus the cost of ramping up research once operations resume, means that all lab budgets will be under strain. To resolve this, universities should lobby Congress and federal agencies to grant funding extensions of at least one year to all grants. This will give all labs some breathing room to recover from the COVID-19 slowdown and allow them to reasonably ramp up research operations.

It may be attractive to extend funding only for those grants expiring in FY20. While helpful, this could drive significantly higher levels of competition for grant awards in FY21. This competition would ripple throughout the system for several years as faculty try to overcome the increased number of people competing for awards. To avoid this, federal agencies should extend all current grants.

Furthermore, federal agencies could make this extension voluntary. Some labs have substantial research funding and may not need or want an extra year of funding on a grant. By allowing these grants to expire, they could ease some of the financial burden of extending all grants.

2.4.2 Use federal COVID support to shore up internal research funding pools

University budgets are under significant strain due to COVID-19. The problems are especially acute for new and non-tenure track faculty, who depend on internally funded grants and startup funds to support their labs. Startups are necessary for new faculty to build the foundation of their research program prior to receiving a grant. Internal grants are important funds for faculty who want to start new projects or who are ineligible for federal grants.

However, with universities in severe financial distress due to the pandemic, there is a real concern that those who rely on these institutional funds will face budget shortfalls in the near future, especially if they are unable to secure external grant funding.

The Research Investment to Secure the Economy Act would provide $26 billion to universities to mitigate some of the economic effects of COVID-19.[31] Should Congress pass the RISE Act or similar provision, universities should ensure the funds they receive are used to extend startup funding and internal grants so that the labs that depend on these funds will be able to survive.

[31] DeGette introduces bipartisan legislation to support U.S. research community during pandemic. https://degette.house.gov/media-center/press-releases/degette-introduces-bipartisan-legislation-to-support-us-research.

3. A coordinated mobilization strategy

The spread of COVID-19 was truly an unprecedented event in recent history and it is understandable that universities had a range of responses in supporting the local public health infrastructure. However, COVID-19 demonstrated how a pandemic could threaten the academic system, and universities must seriously plan for the possibility of a new pandemic. Universities should improve policies that streamline coordination between academia and the public health sector to save critical time, especially early in an outbreak when speed is of the essence.

Academic institutions are reservoirs of materials, personnel and expertise that can be used to support the public health system in times of crisis. A coordinated mobilization strategy that marshals the resources of academia to support the public health system could minimize disease spread and keep people safe during the next pandemic.

Academic institutions should implement policies that govern how they act in the face of a global public health emergency. Many of the recommendations here were implemented by some institutions in the face of COVID-19, but very few implemented all of them. This led to a patchwork quilt of academic commitments to responding to the pandemic. Before the next pandemic, institutions should establish policies that allow them to react quickly and positively at the earliest stages of a spreading infection.

Recommendations

3.1 Establish pathways of communication with national and international public health centers so that institutions can be responsive to their research needs in times of crisis.

The research topics of university labs are incredibly diverse, and the work of some academic research labs could be critical for preventing the spread of emerging diseases. During the early phases of a disease outbreak, universities should consult with national and international public health organizations to determine what research is needed to further our knowledge and defenses against an outbreak.

Many institutions shut down their research operations during the COVID-19 outbreak as a way to prevent disease spread among university workers. Sensibly, labs working directly on coronaviruses were exempted from the shutdown. In addition, some labs were able to shift their research to focus on coronavirus or to become testing facilities after COVID-19 had spread globally. The labs that were able to do this typically had the equipment and expertise necessary to make this transition prior to the emergence of the pandemic. While there are substantial dangers to continuing to gather during times of pandemics, universities and public health centers should develop reasonable guidelines to determine which labs should stay open and which labs should suspend operations.

After consultation with national and international public health organizations, universities should make preliminary determinations of labs that are working directly in the same or highly similar research areas, those that could reasonably and quickly retool to support testing and

research efforts, and those that should shut down. University faculty, administrators and other relevant employees should be notified that the institution is tracking a novel public health threat and is identifying labs which may continue or be shut down should the disease spread.

Importantly, the guidelines should establish a high bar for which labs should be exempt from a shutdown. Ideally, exempt labs would be those directly studying the disease vector, although those studying highly related vectors or systems whose research could reasonably provide timely information on the ongoing outbreak could be included as well. Similarly, labs attempting to retool to support research and testing efforts should be held to a high bar.

Universities will need to balance the benefit of continued research operations with the public health risk of keeping select labs open. Having a plan in place in advance of a health emergency would help labs, departments and universities respond in a more timely and coordinated fashion.

3.2 Create a centralized inventory and donation system to efficiently identify and locate specific reagents and supplies useful for public health centers.

During the COVID-19 outbreak, public health and medical centers suffered severe shortages of necessary testing materials. In response to the shortages, some scientists proactively reached out to their local public health departments to identify needed materials and to organize donations.

As was eventually realized, university labs comprise an incredible reservoir of experimentation materials that may be useful for public health labs in times of crisis. Departments and universities should move to develop a centralized inventory system so they can rapidly deliver critical materials to public health outlets at earlier stages of a public health emergency.

Department and university-level inventories of lab resources would allow institutions to rapidly identify what materials are present on campus and whether they can be donated to support public health outlets. Rapid delivery of these materials is especially critical during the early stages of a crisis when effective testing can be the difference between quick containment and prolonged community exposure.

Importantly, university supplies should not be expected to fulfill all of the experimentation needs of the public health system, especially in prolonged outbreaks. Rather, these donations should be viewed as stopgap measures to shore up supplies and buy state and federal agencies time to relieve the supply shortage.

In addition, labs that remain active during times of disease outbreak should be exempted from any donation system.

3.3 Identify and maintain a cohort of biomedical researchers who can readily transition to support work in public health centers during times of crisis.

Public health labs and biomedical research labs are governed by very different regulations and their work is understandably held to different standards. However, some of the experiments, reagents and protocols used by public health labs and biomedical research labs are similar, if not the same.

During the COVID-19 outbreak, multiple public health testing centers indicated they lacked the personnel necessary to conduct all of the tests they needed to process on a daily basis. Conducting these tests was incredibly critical, and the experiments that formed the backbone of testing were commonly done in labs across academia. Therefore, many labs had members that could reasonably do the work that public health labs needed with minimal to no retraining.

Universities should establish and maintain a cohort of biomedical researchers who volunteer in advance to immediately transition from their university-based research to supporting the public health system in the event of an outbreak. This cohort would likely need basic training on the policies of such a transition and receive annual updates.

The cohort of advance volunteers may not possess all of the skills necessary to support the public health mission during an outbreak. Therefore, at the onset of an outbreak, public health centers should work with campus labs to identify additional researchers with skill sets of value to the public health work. New volunteers will likely need to be rapidly trained in the regular protocols of public health work, and universities and public health centers should also develop training protocols and programs that would allow these researchers to contribute to public health testing as quickly as possible.

Importantly, universities should not enroll every biomedical researcher in its advance volunteers program. First, because the time of researchers is already highly leveraged, regular trainings should be limited to only those who volunteer in advance. Second, because outbreaks are uncommon, regular trainings are likely unnecessary.

Furthermore, universities should partner with states to establish a directory of all people in the state who have lab experience. These scientists no longer working in the lab may still have useful skills, such as pipetting and asset management, that would be beneficial during a pandemic.

3.4 Establish up-front agreements on cost sharing

Lab materials are not free. Once the threat of the disease outbreak has passed and research operations resume, the donation of materials could cause an acute financial strain on labs from where the donations originated.

Similarly, lab-based researchers are often paid from grants that require anyone paid by the grant be working on the projects described in the grant application. The people who transition from research labs to public health labs in the event of a crisis will no longer be doing the research they were hired for. Nevertheless, they should be appropriately compensated.

Universities should establish policies for supporting labs and faculty that made substantial donations to public health outlets, and universities should also establish policies to ensure financial support for researchers who transition to public health efforts continues unabated during times of crisis. Research funding agencies may allow these expenses during a pandemic as they did during the COVID-19 pandemic. However, these decisions came well after universities needed to make decisions on how to proceed. Universities should have policies in place that can be enacted without the input of federal agencies.

3.5 Empower a new structure to lead the university's pandemic response

Universities have layers of policies governing all aspects of how the institution acts. Because pandemics are rare, there is likely no person or group of people familiar enough with university policies to be able to navigate them during times of crisis.

Universities should create a power structure within the institution that, during times of crisis, would assume significant powers to provide direction and decisions to the broader university community. These crisis leaders would be able to make decisions and resolve conflicts-of-interest based on the needs of the community.

These leaders would, under normal conditions, have no extra powers, but they would be responsible for knowing university, state and federal policies should a crisis arise. Appointments to these positions should be three to five-years and should rotate through the university community.

3.6 Establish science outreach and communication groups

Science communication and outreach were absolutely critical during the COVID-19 pandemic. Educating the broader public about what is and is not known is necessary to ensure the public acts swiftly to stop the spread of infection.

In future pandemics, universities that shutter campuses may have trainees and faculty with time to become more engaged in these outreach activities. Universities should organize these scientists to produce materials and platforms to reach out to the local community with best practices for combatting the spreading pandemic.

Some components of these outreach activities will be the same no matter who the audience is, but outreach groups should also tailor their message to different local communities. COVID-19 disproportionately affected Black, Latinx, Indigenous, and other minoritized communities in the U.S., and somewhat different strategies and messages are necessary to ensure each community has the information necessary to stay safe.[32]

3.7 Create the Biomedical Research Enterprise Council and use it to form regional and national networks to share information

[32] What do coronavirus racial disparities look like state by state? *NPR*. https://www.npr.org/sections/health-shots/2020/05/30/865413079/what-do-coronavirus-racial-disparities-look-like-state-by-state.

Labs and scientists that did not have coronavirus research experience still made critical contributions to the fight against COVID-19 by finding innovative ways to generate testing reagents, personal protective equipment, and other necessary supplies. However, there was no clear hub for uploading and disseminating information to all those who needed it.

The National Academies panel studying the biomedical research workforce in 2018 recommended the establishment of the Biomedical Research Enterprise Council to oversee the efforts to solve persistent, systemic problems in the American biomedical research enterprise. The BREC has not yet been established, but if it were established, it would be well-situated to act as a coordinating group to disseminate innovative methods and communicate vital needs during the time of a pandemic.

The BREC, as described, would be a combination of university, government, nonprofit, and industry representatives with deep ties to each of those communities. Transmitting innovative ideas, needs, and methods to the BREC would allow the council to disseminate this information broadly to all institutions across the country.

Furthermore, states should establish a communication method for the state government and local academic, nonprofit, and industry to coordinate actions across the state. Because of state-specific regulations, state-level networks would help universities and scientists adapt activities done elsewhere to what is needed and required in their state.

4. Conclusion

The COVID-19 pandemic that swept the world in 2020 has caused widespread devastation. The United States, due to an absence of federal leadership, is suffering greatly. In particular, the American academic and research systems were acutely affected by the pandemic. Research operations were severely curtailed and institutions began laying off or furloughing staff.

However, the American biomedical research enterprise and academic system will likely survive in some form once the pandemic ends. While the effects of the pandemic on biomedical research will be long lasting, universities, departments, faculty, and trainees all have the opportunity now to fix the systemic flaws in the research enterprise and make a positive change for the future.

Universities and departments should stand behind their claims of solidarity with the Black community and other minoritized groups and act to improve equity and inclusion on campus. Old methods of evaluating research should be discarded, and new methods to properly evaluate what faculty truly contribute to their department should be developed. And universities should act on long-made recommendations to better support their trainees.

Furthermore, there is no guarantee that COVID-19 will be the last pandemic to affect the United States. Universities should put in place policies and structures that will allow them to be more responsive to the emergence of the next global health emergency.

Finally, these reforms cannot be accomplished by a faceless institution. They can only be implemented by people in positions of power with the will to make positive change. Some of those in power will take the lead in making change and others will need to be encouraged. Some will have to be forced. Nevertheless, these reforms are necessary and the university community, and biomedical researchers in particular, must take a hard look at the trajectory of their university and department. These people must decide whether it is acceptable to continue the policies and practices that have failed so many for so long, or to take the bold action necessary to make real, positive, necessary change.

Acknowledgements

The COVID-19 pandemic has illustrated just how fragile and unsustainable the American biomedical research enterprise is. Universities can accept the challenge presented by the pandemic and take this opportunity to address the system's flaws, or they can return to what is clearly an outdated and ineffective system of supporting trainees, faculty, international scholars, and scholars from underrepresented backgrounds.

I have been told that this is the wrong time to release a slate of recommendations because most universities and faculty needed to find a sense of normal before they could consider change. However, returning to some degree of normal means returning to some semblance of the pre-pandemic status quo. In doing so, we would lose the clear opportunity the system has right now to make lasting change.

The recommendations here are thoughts on how to respond to the challenges of this pandemic. While the words are mine, the ideas, recommendations, and rationales in this document have been made countless times by esteemed committees of scientists.

Furthermore, I could not have produced this work without the input of some truly fantastic scientists and advocates who were speakers in the Rescuing Biomedical Research COVID Discussion Series: Prachee Avasthi, Giovanna Guerrero-Medina, Anna Hatch, Heather Hundley, Gary McDowell, Kat Milligan-Myhre, Shakira Nelson, Stephani Page, Nicole Parker, Olivia Rissland and Gene Yeo.

Trainees – Apr. 23

- Panelists: Shakira Nelson, Nicole Parker, and Gary McDowell
- The video and transcript of the event can be found here.

Pandemic preparedness – Apr. 30

- Panelists: Olivia Rissland and Gene Yeo
- The video and transcript of the event can be found here.

Faculty – May 7

- Panelists: Anna Hatch, Prachee Avasthi, and Heather Hundley
- The video and transcript of the event can be found here.

Underrepresented minorities – May 14

- Panelists: Stephani Page, Giovanna Guerrero-Medina, and Kat Milligan-Myhre
- The video and transcript of the event can be found here.

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Chris Pickett