# Penn and the Pandemic

## How the University and alumni have responded to the current crisis.

**By *Gazette* Staff and Contributors**

Everyone has a story. When the novel coronavirus struck, Pablo Tebas plunged into vaccine development between shifts on the front line of COVID-19 hospital care. Wharton's Mauro Guillen abandoned his sabbatical to develop a mega-course on the pandemic that drew some 2,500 students from across the University. SEPTA general manager Leslie Richards GRP'93 tackled the unprecedented challenge of running mass transit amid mass contagion. James Beard Award-winning restaurateur Steven Cook W'95 convened the leading lights of Philadelphia fine dining to plot a safe path forward for an industry facing an existential threat. Penn Medicine set up testing sites that swabbed over 40,000 people in the first two months. And from biology to education policy to the history of medicine, Penn faculty rose to the moment the best way they know how: by teaching. Here is how some of them met the challenge this spring.

## Health and Medicine

### The Vaccine Hunt

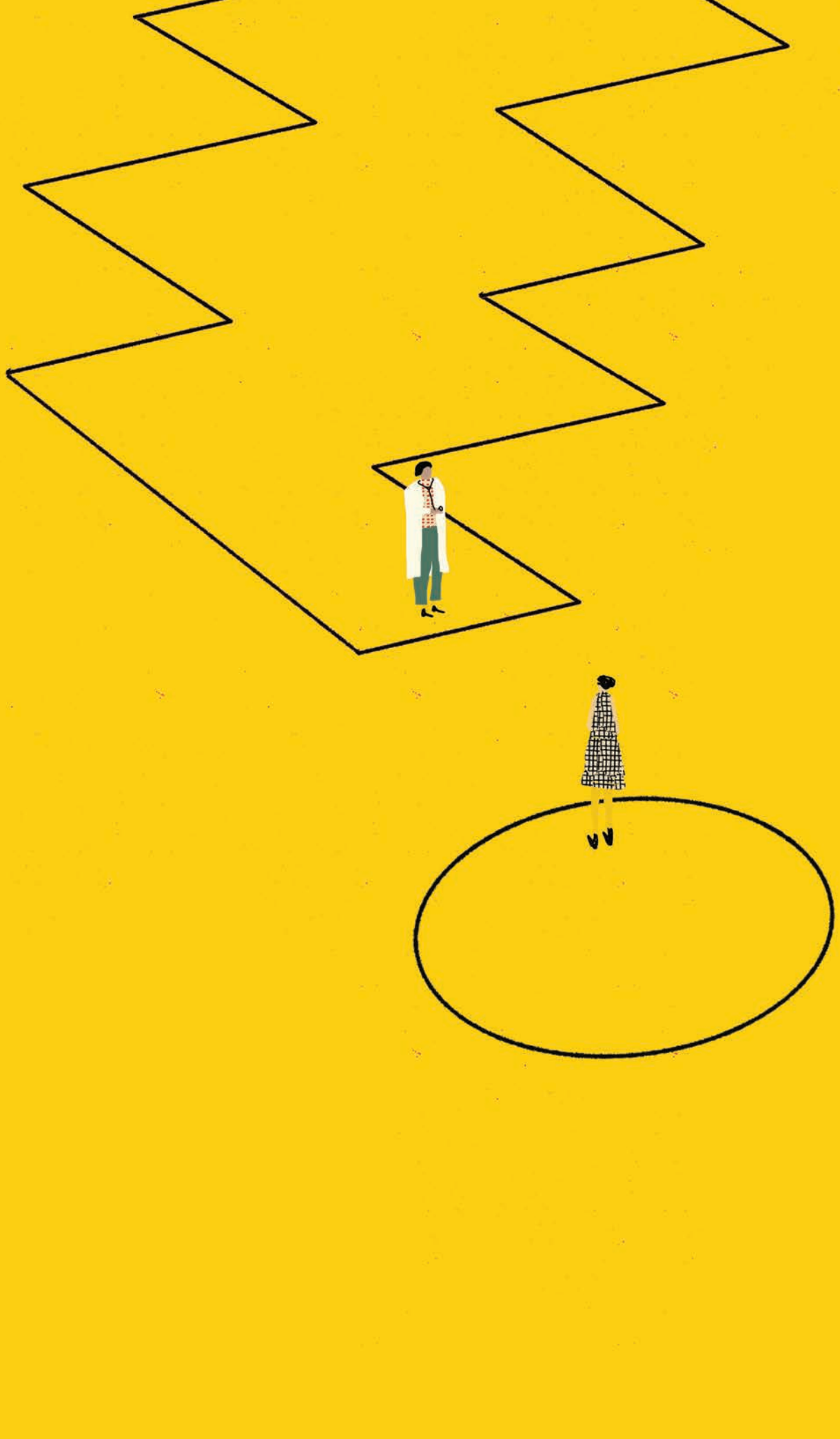
*Two months before COVID-19 upended American life, Penn-affiliated researchers were already racing to create a genetic vaccine.*

BIOMEDICINE

Epidemics have shaped Pablo Tebas's life. The infectious disease doctor has devoted much of his academic career to the treatment and prevention of HIV, and worked on vaccines for Ebola and Zika. So when the COVID-19 pandemic struck, he plunged into action. Doubling down on a partnership with professor emeritus David Weiner, who now directs the Wistar Institute's Vaccine and Immunotherapy Center, Tebas threw himself into the development of a genetic vaccine against the novel coronavirus SARS-CoV-2.

Through Inovio Pharmaceuticals, which was cofounded by Weiner and J. Joseph Kim GEng'94 WG'96 Gr'98 in 2000 (originally under the name VGX Pharmaceuticals) as a spinoff from the School of Medicine, the researchers turned to a technology they had used to create the world's first-in-man vaccine against Zika in 2016. This genetic vaccine is quite different from the shots administered to millions of arms

ILLUSTRATION BY RYAN PELTIER



every flu season, not least because it can potentially be manufactured far more quickly. Tebas talked about this effort with *Gazette* senior editor Trey Popp on April 8—two days after testing the vaccine's safety on the first human volunteer.

**Can you describe the idea behind this sort of vaccine, and how it differs from the traditional vaccine for seasonal influenza?**

Traditional vaccines are usually made of a protein, or killed virus, or live attenuated virus. With the influenza vaccine, people get injected in the arm with a protein. Your immune system reacts against the protein and makes antibodies, and those antibodies are what protect you. The problem with protein vaccines—or killed virus or live attenuated virus vaccines—is that they take a long time to develop. You have to culture the virus, you need to separate the proteins, and you need to isolate the protein that you want to immunize people with. That can take months and months. With influenza, in the spring the WHO says, 'Next year influenza is going to look like this.' And the reason they do that is that the manufacturers of the vaccine have to grow up virus—they have to grow it in eggs, isolate the virus, kill the virus, and isolate the proteins that go into the influenza vaccine. So it takes months.

Our process is much different: you get the genetic sequence of the virus and find the protein you want to target based on prior experience with similar viruses. Then you clone that genetic information into a plasmid, and *that's* what's injected into your arm: the DNA information that will make your cells make the desired protein. So you yourself become the factory that makes the protein that the immune system is going to react against. You don't need to culture the virus [in eggs or some other medium]. So it's much faster to develop. It takes weeks, not months.

You can do that with DNA, as we are doing. Other companies, like Moderna, are using mRNA, but it's the same idea. The main advantage of DNA is that it's stable at room temperature for a long time without deteriorating. So it's easier to keep on the shelf. You don't need a freezer. But you still have to prove that the vaccine is safe, and that it produces antibodies. That's what we are trying to do right now.

**The sequence of the virus was published in January. How quickly did you swing into action?**

It was published in January. David Weiner cloned this protein and put the protein in a vector, and then you have the plasmid. You test it in mice to show that the DNA you have causes the mice to make antibodies. Then you have to manufacture large amounts of the plasmid—you have to scale up to get enough vaccine to be used. That takes a few weeks. And of course you have to design the study and write the protocol. All of that went very fast. We decided to look for healthy volunteers. Then you go to the FDA, and then they authorize you. That happened last week. We already had our approval at the University of Pennsylvania. We vaccinated the first participant on Monday [April 6]. We are screening other people. After the first three patients we have to wait for a week. Then an external safety monitoring board will tell us everything looks fine, no major side effects, you can go ahead and enroll the first cohort, which is 20 people. Then we will increase the dose a little bit, and then we will vaccinate another 20. [In May, the team reported positive results and prepared to advance to the next phase of clinical trials.]

**Has this technique been successfully used against any other pathogen?**

Yes. We had an article about a Zika vaccine published in the *New England Journal of Medicine*. We had an article about an Ebola vaccine. The company has done this for other viruses such as MERS-CoV, which is similar to SARS-CoV-2, which is causing COVID-19. So the technology has been used in other infectious diseases. But it has not led to FDA approval of a product.

**What has stood in the way of FDA approval?**

We did Phase 1 studies, where you look at safety and immunogenicity—in other words, does the vaccine make people make antibodies against the protein? Those studies tend to be small and relatively fast. But then you have to prove the vaccine is effective—that those antibodies people make actually prevent infection. Those Phase 3 studies are large. You have to demonstrate that if you vaccinate a bunch of people, and don't vaccinate others, the treated group is at less risk of getting the infection. But that's a massive study, and it takes time.

And when we did this with Zika, it looked good—it was safe, it made people make antibodies. But when we were trying to do the Phase 3 study, the Zika epidemic ended. That's the problem with some of these epidemics: no matter how fast you go, the epidemic goes faster, and disappears, at which point it's very difficult to prove that it's efficacious in the field. That has been one of the reasons why some of these vaccines have not been approved by the FDA. The epidemics end, and then there is no economic interest. If there is no Zika, no company wants to develop a Zika vaccine. There has to be an economic incentive for a manufacturer to develop a vaccine.

**But our experience so far suggests that perhaps COVID-19 may not burn out so fast as those others?**

It's difficult to know at this point. Everything is going to depend on how much we contain the disease. With SARS and MERS, the epidemics died out. There was a reservoir in animals, but people were able to control it, so we have had no cases of SARS since 2003, and MERS since I think 2012, aside from very sporadic cases. That is one possibility of how the epidemic ends. Because of social distancing, if there are no more cases of transmission, the epidemic dies that way. But if there is continued transmission, and there is a human reservoir, then the epi-

demic might come back later—we can have a second or third wave.

At this point, we don't know. Hopefully the epidemic will end and that will be it. But at this point we don't have enough information. Because of the emergency, we're trying to convince the FDA that if the vaccine is safe, that we could go to a much larger study much faster.

**What are your days like? How does the present moment compare to the professional pace you kept before the pandemic?**

It is very busy. I am an infectious disease doctor, so I see patients in the hospital with COVID-19. I'm involved in therapeutic trials—not only in this prevention study. There are a lot of conference calls about different interventions, and what we can use on patients. And I have been involved in building clinical trials with NIH, treating COVID-19 patients with a medication called remdesivir to see if that works. It is busy clinical work. I have been coming to the hospital I don't know how many weeks in a row, every day. But I am an infectious disease doctor—this is what we study for.

It is sometimes a little bit heartbreaking when you see young people on ventilators, very sick. But it's also a positive experience. You realize how good the people in critical care and infectious diseases and internal medicine are, how good the personnel in the hospital are, how much they care about the patients. Everybody is willing to take care of people with this infection and are willing to take the risk. That warms your heart and makes you feel good, and is a little bit exhilarating, to see how hard people work to take care of people with this disease.

**Do you remain in good health? How is your family?**

I am well. My family is quarantined. You have to be careful when you go back home. I went back to my residency days—I wear my scrubs, I wash my clothes every day, I use gym clothes and I remove my shirt before entering the home. You try not to bring the virus home. I mean, you're always worried about the patients during the day, and when you go home you're worried about your family. And of course you worry about yourself. Every time you have a cough, or you wake up in the morning with a little bit of nasal congestion because you have allergies, you wonder, is this coronavirus? But you keep working and keep doing what you have to do.

**"You yourself become the factory that makes the protein that the immune system is going to react against."**

**Emotionally, does this work feel different to you?**

It is busy and a little bit draining at times. But I don't want to complain. The important thing is that everyone does what they can to help contain this disease. People should practice social distancing. They should keep up with recommendations from CDC. Washing hands, using masks. The only way to get out of this nightmare is to prevent transmitting this infection to others. Don't think that you are not at risk because you are young or because you don't have any comorbidities. I see people in the ICU that are 20 years old, that were Ivy League athletes, and they are sick and they are intubated. This disease has no respect for anybody. You can be young, and you can be very, very sick. So follow the recommendations and use common sense. And help to flatten the curve. Everybody can do their part.

## The Future of Nursing Homes

*An expert on long-term care facilities offers a way out of the darkness.*

ELDER CARE

Even before the horrifying news reports began to surface, Ashley Ritter Nu'07 GNu'10 Gr'18 could sense what was coming.

"To me, the writing was on the wall early that nursing homes were going to be significantly impacted and didn't have a system in place to address it," says Ritter, a geriatric nurse practitioner, Penn Nursing postdoctoral fellow, and Penn Leonard Davis Institute (LDI) associate fellow. "And, to be honest, we still don't really have a system in place to address what's happening in nursing homes."

The vulnerability of nursing homes to COVID-19 was predictable, even though many put strict regulations on who was entering their tight quarters early in the outbreak. The problem with that strategy, however well-intentioned, was that an asymptomatic person could still bring in the infection—and "without testing," Ritter notes, "making judgments on who's sick and not sick based on clinical symptoms was totally insufficient."

Also somewhat predictable, given that older individuals face higher risks for developing more serious complications from COVID-19, was how the pandemic ravaged nursing homes across the country. According to a *New York Times* report on May 9, one-third of all US coronavirus deaths to that point were nursing home residents or workers.

But the outbreak has exposed deeper flaws in these long-term care facilities, from staff shortages to crumbling infrastructure to a model that places patient care in tension with the profit motive. And help has been hard to find.

"They sit in between these worlds," Ritter says. "They're not necessarily a home and not necessarily a hospital, so it puts them in this very tenuous region where nobody really pays attention and all you hear are the bad stories."

Although admittedly "fearful" about the future of nursing homes, Ritter does believe there's a path forward on the other side of the pandemic—but only if major changes occur.

One of the top priorities, in Ritter's view, is investing in the workforce—a point she's hammered home in articles and virtual seminars for LDI. While nursing assistants provide the majority of hands-on care for the some 1.3 million permanent nursing home residents across the US (and the 3 million more who are discharged annually to nursing homes following a hospital stay to receive skilled rehabilitative care), there's "not a lot of people in line for this low-paying, very, very difficult job." That left residents without adequate care during a crisis even as it placed overburdened staff—mostly women and minorities—in a dangerous situation, often without the same amount of personal protective equipment as hospital workers.

"We need incentives in place to encourage the nursing workforce to stay in nursing homes," says Ritter, noting that the high level of employee turnover is "really expensive" for nursing homes—and worse for patient outcomes. "Just because a nursing assistant doesn't have a college degree does not mean it's unskilled work. It's a very skilled job."

While cutting back on staff is one way that nursing homes have dealt with falling occupancy rates (which is also influenced by the growing preference of older adults to age at home), Ritter believes that "we need to critically evaluate for-profit nursing homes and how that model fits into our healthcare system." According to a *New York Times* report on May 7, nursing homes with private equity owners were particularly ill equipped to protect residents and workers. Says Ritter, "It's a lucrative business for some but it's not great for patients."

Oversight is another concern. Instead of states regulating nursing homes with yearly surveys and fines—which she calls "a punitive, reactive system" that creates anxiety and a negative culture—she'd like to see a strategy implemented in which small groups of nursing homes work together to troubleshoot problems with each other and local health departments.

And, Ritter says, positive stories should be told—particularly about frontline workers who have put themselves in harm's way to provide both healthcare and emotional support to residents whose family members have been locked out. She's been particularly galled by news commentary calling nursing homes "death pits."

Even before the pandemic, "you see a lot of blame and shame" going around about nursing homes, along with "this belief that they are not necessary, and you can find ways to provide care in other settings." Ritter disagrees. Although home care might be the best option for many people discharged from a hospital and needing post-acute care, "the utility of nursing homes really serves low-income, single individuals," Ritter says. For many without family, they serve as housing. "By doing away with nursing homes and not having another option, you're saying those individuals are not worth taking care of."

Despite several examples of the botched handling of nursing homes, steps were eventually taken to slow COVID-19's spread. Three days after a *Philadelphia Inquirer* report exposed Pennsylvania for failing to protect nursing home residents, the commonwealth announced a plan to begin coronavirus testing for every resident and employee in a long-term care facility. Other states did the same, following a nationwide call from the White House in mid-May for coronavirus testing in all of the country's 15,000 or so nursing homes.

Even still, "the loss of life is going to be profound," Ritter says. "And the individuals caring for people in nursing homes will be very struck by the gravity of the situation. We must address that and be there to support our colleagues, just like we've been supporting the workforce in hospitals and ICUs."

From those immediate concerns, she then hopes to look at the data to find which nursing homes had the most robust COVID-19 responses. Ritter believes that the VA's nursing homes, which are more integrated into the health system than other facilities, could provide a smarter blueprint moving forward. But she stresses that all nursing homes deserve support and improvement. "It seems to me without some investment and critical thinking about their role and their position, many are going to shut down," she says. "And we don't have an alternative plan right now.

"If we don't elevate the importance of their position in society," she adds, "there can be some really horrible unintended consequences for the most vulnerable members of our society." *—DZ*

## History and Policy

### Plagues and Peoples

*What the "social X-rays" of epidemics reveal.*

PANDEMIC HISTORY

Early in "Plagues Past and Present: Pandemics in Historical Perspective," a virtual presentation he did for Perry World House in April, David S. Barnes paused to identify his Zoom background: the newly renovated facade of the Lazaretto, the oldest surviving quarantine facility in the Western Hemisphere.

Built in the wake of a series of devastating yellow fever epidemics that struck Philadelphia in the 1790s, the Lazaretto operated from 1801 to 1895 on the Delaware riverfront, quarantining ships and cargo, and treating sick passengers in its hospital, before they could enter the city.

Barnes, an associate professor of the history and sociology of science, is working on a book about the Lazaretto and has been involved in efforts to preserve the site. His other books include *The Making of a Social Disease: Tuberculosis in 19th Century France* (University of California Press, 1995) and *The Great Stink of Paris and the Nineteenth-Cen-*

*tury Struggle Against Filth and Germs* (Johns Hopkins University Press, 2006).

"I think people are understandably hungry for lessons from history," Barnes said. Epidemics have always served as "social X-rays," he added. "They reveal otherwise hidden fractures and weaknesses in society," and also function as "inequality accelerators," widening existing disparities. "We're seeing that happen today all around the world." Historians can help to see that the novel coronavirus has not "come out of nowhere and affected us all equally. It hasn't affected us all equally."

In 1793 yellow fever killed 10 percent of Philadelphia's population within weeks and returned three more times over the next decade or so, Barnes said. The first epidemic led to the creation of the first board of health in Philadelphia in 1794. The board was responsible for the construction of the Lazaretto and improving sanitary conditions. "They enforced quarantine and cleaned up the city, which was something that was productive and relatively effective."

In the 19th century, waves of cholera in 1832 and 1849 roughly coincided with a period of revolutionary upheaval in Europe. "The earlier wave seeded the ground," intensifying social cleavages that manifested themselves following the mid-century epidemic, he said, ultimately leading authorities to build parks and other green spaces, construct water supply and sewer systems, and make broad efforts to improve unsanitary urban living environments.

After 1849, the Great Powers also got together to create a series of international sanitary conferences that were intended to develop uniform plans for quarantine—but at this they failed completely. "Quarantine always remained a political issue," he said, "as it remains today." A longer lasting impact of these conferences was the development of infrastructures and relationships among health departments in different countries, the legacy of which is the information sharing and transparency that, with some exceptions, does work when everybody tries, he said.

By the time the misnamed "Spanish Flu" emerged in 1918 (most likely in Kansas) the overall infrastructure for public health was in place and history's worst pandemic had little impact in changing approaches. "The geopolitical order was transformed after World War I, but not because of the pandemic."

Barnes called it a "central fact" that the decline of infectious diseases in the industrialized world is the greatest achievement in the history of public health. But how that came about is subject to several common myths and misconceptions that continue to impede efforts to develop "pragmatic, effective ways of improving public health," he said.

The first is that health policy consists "essentially in providing medical care and pharmaceutical products." Instead, history shows that the greatest impact on population health has been from policies that improve overall standards of living and empower populations to take control of their lives.

Second is the belief that effective public health responses to specific diseases or health threats must be disease-specific, such as "vaccines or drugs that target specific germs." Such an assumption is "understandable," he said, "but it's frankly wrong," and there are numerous examples of successful responses in the absence of dramatic developments in medicine or treatments.

A third major misconception has to do with immunity—which he called "the critical dimension of inequality in the COVID-19 pandemic [and] in most epidemics throughout history." Immunity is generally understood as binary ("you're either immune to something or you're not") and dependent on either genetics or a vaccine. In fact, immunity is "relative and is profoundly amenable to policy interventions," he said. "In other words, public policy can, and I would say must, focus on improving people's ability to withstand infections like COVID-19."

The fourth misconception he cited—that "germs don't discriminate"—is especially damaging, he added. True, "microorganisms can't see or hear or perceive race or class or gender, [but] it's abundantly clear throughout history that germs do discriminate, have always discriminated, and are discriminating right now," he said. "They affect populations unequally, and it's that unequal impact that is our responsibility to investigate and to fix."

Finally, the assertion that "public health isn't political and should not be politicized" is similarly wrongheaded. While it is the case that policy decisions shouldn't be exploited for partisan advantage, "public health is and always has been inherently political—because it's about distribution of resources in societies and that's the essence of politics," he said.

"COVID-19 is a political problem, and it ought to be addressed with political solutions. That doesn't mean conservative solutions or progressive solutions. It doesn't mean partisan solutions. It means solutions that address the distribution of resources and access to resources within society," he added. "That's the only way that we can solve the underlying problems that are making certain people particularly vulnerable to COVID-19—and the same has been the case throughout history."—*JP*

## Health and the Body Politic

*How societies learn—or don't—from the successes and failures of public health.*

PUBLIC HEALTH

"So many things are historically novel about this current pandemic, including the world we're now living in," says Robert Aronowitz, a medical historian who chairs the History and Sociology of Science Department. "It's so much more interconnected. We've discovered that our infrastructure with which to deal not just with COVID but all other medical problems is part of a global network of terribly minor things, like IV fluid," he continues.

"We've made our bodies vulnerable to dependence on modern medical care, and the level of interdependencies in our medical sector is astounding."

Aronowitz, who is a physician as well as the Walter H. and Leonore C. Annenberg Professor of Social Sciences, spoke with *Gazette* senior editor Trey Popp in mid-April about what history can and can't teach us about the trajectory of COVID-19.

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**Do you find any historical episodes of disease that offer any insight into the present moment?**

The historical lessons learned by people in epidemics are often a matter of who controls the narrative—not necessarily what happens. Probably the best historical book for understanding epidemic disease is called *Cholera Years* (University of Chicago Press, 1962, 1987), which was written by my mentor Charles E. Rosenberg. He observed that the disappearance of cholera was attributed to strong public health and progressive politics in postbellum New York and other places, and that this in turn cemented the idea that a certain kind of science, tied to progressive politics, would be a way to advance American democracy and improve society. That was all based on the idea that public health had something to do with the disappearance of cholera. But we have no reason to believe that is true! Cholera disappeared from almost everywhere in the 19th century. But what is true is that people create a story, and the story is believed and has a lot of power.

**Do you think this pandemic gives meaningful insight into what is right and wrong with our healthcare system, or do you think COVID-19 is an outlier case that's a shaky basis for such generalizations?**

It depends on what kinds of generalizations you're making. We have firemen even though we don't have fires every day. We have a sense that not only may they happen, but they may happen in a way that you might need a set of national resources that can be shared to address it. And yet we don't think of health vulnerabilities in these terms at all. There's such a minor investment in public health infrastructure. There's no sense that you need an infrastructure of surveillance and case workers, people who can do legwork that all of a sudden we need in terms of testing and contact tracing, and capacities to rapidly produce tests and things. This has exposed a chronic weakness in our ability to think about health not just as an individual matter but as a collective problem. I'm hoping—and everyone wants to hope—that people will learn from this. But one thing that's clear from cholera epidemics is that people forget pretty quickly.

There have been many what seem now like prophetic voices. And not minor voices, either, but Bill Gates. Especially since 9/11, there have been so many global health people talking about bioterrorism and threats of pandemics and preparedness. People have been talking about this for 20 years, but we've done virtually nothing to prepare.

**What are the historical reasons for that?**

The notion that the market will solve problems of healthcare in our country is an underlying problem. Investing in fire stations is not a market-based decision; it's a decision based on the government's responsibility to protect people's homes. To the degree that we think about health as a problem to be solved by individual centralized hospitals and companies making products they make a profit on, COVID presents a set of problems and solutions that don't fit under the market rubric. But as the expression goes, there's 50 reasons you don't catch a fish; there are a lot of reasons we haven't done something. There are all kinds of political failures. There's the individualist ethos in American life…

As far as COVID being an outlier, it's an outlier waiting to happen. Most of our threatening infectious diseases emerge from animal-human interaction. That's true in the past, too. Measles, mumps, and almost all the other diseases we vaccinate against had their beginnings in animal-human interactions. So COVID is not an outlier in that sense. It's consistent with Ebola, SARS, MERS, influenza, bird flu… all these things are in a direct line.

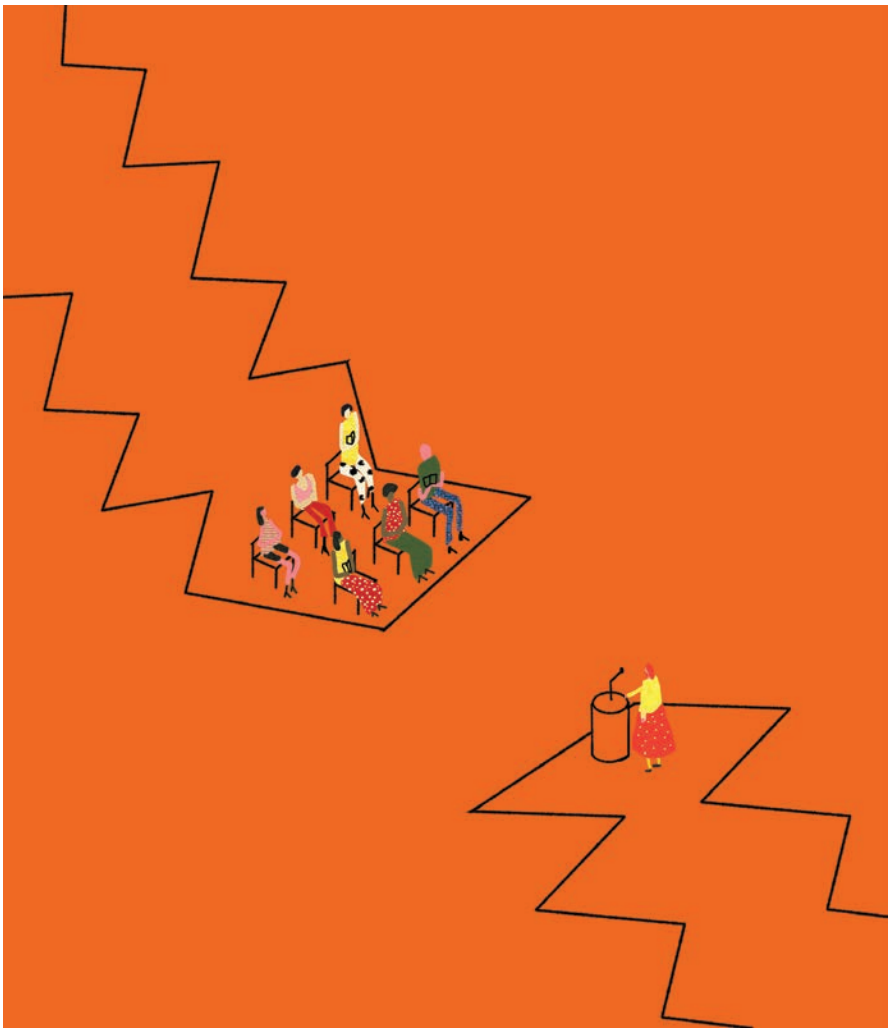
**What factors are likely to shape the social recovery from this pandemic?**

I'm very concerned about the day after: how people go from being told to wear masks and isolate themselves, to being told to loosen up restrictions and go out. In chronic diseases like cancer and heart disease, what we've developed since World War II are all kinds of interventions that in a sense control uncertainty and reduce our fear. They also may have scientific efficacy—but they do or they don't. We effectively do a lot of things because they give us a feeling of control: that we won't get prostate cancer because we get a PSA test, for instance, or that if we take a statin it will ward off heart disease. Similarly, every person who goes to a modern American hospital in labor gets a fetal heart monitor slapped onto their bellies—which has been shown objectively to *not* improve health outcomes, and maybe increase the number of C-sections—but this is reassurance that the baby is being monitored. I've been very critical of these things ["Our Labs, Our Health," Jan|Feb 2016], but I understand why they happen: people need, or seem to have needed in chronic disease, routines—pills, surveillance tests—to feel reassured that they're taking action against something they fear. So with COVID, over and above the need for testing to have good data to inform policy, or to do contact tracing to isolate people and their contacts, people may need a similar sense of personal control. They may need to be knowledgeable about their status, and maybe even their community's prevalence rate and where hotspots are, in order to get out of bed in the morning and go out into world.

## Education

### One Class, One Penn?

*The leader of a whirlwind effort to organize a popular online course about the pandemic suggests "we don't need a crisis to do this."*



It wasn't the way Mauro Guillen would have chosen to spend the spring of his sabbatical year, but when campus closed down in March the Zandman Professor of International Management was at least not otherwise occupied when the Wharton School called on him to develop a six-week online course in which various faculty members would analyze the public health, political, and economic ramifications of major disruptions like the novel coronavirus ["Gazetteer," May|Jun 2020].

DISTANCE LEARNING

"It was actually good, because I didn't have any other teaching commitments that would interfere," Guillen said in early May, with classes finished but grading still in process. "So I returned from sabbatical, so to speak, and I've been doing this for the last six weeks pretty much full time. I mean, it's been really, really intense."

Guillen was trained as a sociologist and is an expert on globalization, the subject of his forthcoming book *2030: How Today's Biggest Trends Will Collide and Reshape the Future of Everything* (look for more about that in our Sep|Oct issue). He's also a "big supporter" of online education who has been teaching on platforms like Coursera and through Wharton Online, which offers a certificate program that mirrors the MBA core curriculum, going back to when the acronym MOOC (for massive open online course) was current ["MOOC U.," Mar|Apr 2013]. His course on global trends in business and society has been taken by 5,500 people around the world, he says, and another, "Managing in the Global Digital Economy" recently launched.

"It's a mistake to think about online education and all the different ways we can deliver it as a substitute for classroom education. The two in the future will coexist one way or another," he said. "I think there are a lot of synergies between classroom teaching and online teaching." He added that the discipline required of online classes—where lectures must be pre-recorded, immediate audience feedback is lacking, and students are often much more diverse in background—can sharpen traditional classroom technique as well.

Guillen professed himself satisfied that the spring course, "Epidemics, Natural Disasters, and Geopolitics: Managing Global Business and Financial Uncertainty," delivered on its main goals of featuring faculty expertise on a critical issue, offering students the opportunity to earn credit when many study trips had been cancelled, and reaching new audiences beyond campus. "So far, so good," he said. "We are done with the class, but the students are writing their papers now. But I think yes—essentially, mission accomplished."

At the time, Guillen said he was still fielding 80-120 emails a day from students, who were working on their final papers in teams of three or four. There were 20 teaching assistants assigned to the course, and students were also doing peer evaluations of other teams' work. "And then I will go over all of that and make the final determination," he said. "But we're engaging them not just as writers of papers, but also reviewing other student's papers."

Because of time zone differences, schedule conflicts, and other issues, about half of the students attended class in real time while the rest watched a recording. "But for those following it live, we enabled the Q&A feature" online, he said. "We had two mod-

Illustration by Ryan Peltier

erators who would feed me the questions, and then I would ask the faculty member. So in each lecture we would probably handle about 30 questions from the audience, which is not bad considering the numbers."

About 2,500 people participated in the class, including 500 or so auditors. "To put things in perspective, that's about 11 percent or 12 percent of Penn students," Guillen said. "It was a big experiment."

He also suggested that it could be a model for future courses built around a key topic with broad appeal. "Under certain circumstances, to go fully online like we did in this class—out of necessity, of course—makes sense if you want to deliver something really quick to a lot of people," he said. "Even once we no longer have social distancing, at some point in the future, I think there's a need for these kinds of classes at Penn."

Drawing an analogy with the Philadelphia Free Library's One Book, One Philadelphia program, he suggested there could be an annual One Class, One Penn. "People can take it for half a credit, we get 2,000 people taking it every year, and the topic rotates. Using this technology we can do it in a way that everybody can participate," he said. "I think that's for me the biggest potential. We don't need a crisis to do this. We can do this during so-called normal times as well." —*JP*

## Trading Places

*Higher education's future may be a hybrid of online and in-person learning.*

EDUCATION
ECONOMY

When Robert Zemsky was a boy in Tucson, Arizona, in the 1940s, a burgeoning baby boom meant there wasn't enough space in the local schools—which managed by instituting split sessions.

America's campuses, he says now, might need to consider something similar to cope with coronavirus. Half the students could be assigned to remote learning for a few weeks, after which they'd trade places with the other half.

Currently a senior scholar at Penn GSE's Alliance for Higher Education and Democracy, Zemsky joined the faculty in 1964 and gained firsthand knowledge of the issues facing campuses as the University's chief planning officer and master of Hill College House. For 20 years, he was the founding director of the University's Institute for Research on Higher Education.

He's in demand lately because of the pandemic—and because, by coincidence, he and two coauthors have just come out with a relevant new book. *The College Stress Test: Tracking Institutional Futures Across a Crowded Market* was written with Susan Shaman, Penn's former director of institutional research, and Susan Campbell Baldridge, a former provost at Middlebury College.

From his home in Lancaster, Pennsylvania, where his dogs raucously announced the arrival of a FedEx delivery, Zemsky sat for a Zoom interview with *Gazette* contributor Daniel Akst C'78 on the future of higher education in the time of coronavirus.

**How did you come to study the higher education marketplace?**

Forty years ago I was Martin Meyerson's faculty assistant when he was the University's president, and he would ask me questions to which I had no answers. So I went and figured out the market. At least a third of my career has been doing market analysis of higher education, and after a while I got pretty good at it.

In February we brought out *The College Stress Test*. We were interested in how many institutions were really likely to close, and the answer we came up with is: a lot fewer than most people were imagining.

**What was the state of affairs before the pandemic? In your book you said one in 10 colleges were at serious risk.**

The rich were getting richer and the big were getting bigger. And that's a classic description of Penn. But if you were a private institution with less than 1,500 students, you ought to worry. If you were also in the Midwest, you should worry. And if you had been cutting your price trying to keep enrollment and it wasn't working, you should really worry. Yes, 10 percent were likely to close. But they only account for 2 percent of enrollment. For their communities, it's sad, the way it was a loss for some towns when military bases closed. But it is not about the whole academic enterprise.

**OK, that was pre-coronavirus. How does the pandemic change things?**

One of the things that happened in early March was that a whole lot of authority passed out of the institutions. Public officials began to determine what was going on, and it has been that way ever since. By late April it was clear the disease was not going away. I actually have a mini roundtable of college presidents. We convene in a Zoom zone every Sunday afternoon. One of the presidents said, "You want to know the sad news in a nutshell? We're all going to learn to live with disease and death."

**And the implications for campuses in trouble?**

It's not 10 percent anymore, it's 20 percent. If the pandemic forces the cancellation of the coming academic year, those schools may never come back. Those institutions are losing enrollment, but they're also getting less cash per student. They're cutting prices and getting less volume. You can't survive that way.

**But will most schools reopen in September?**

Oh, yes. They say, "We have no choice. We're opening." Originally everybody said everything will get cleaned up and we can have a normal fall. There isn't anybody expecting a normal fall now. Now what they are thinking about is, how do we open under social distancing? All of them run dorms with doubles, some with triples. How are they going to operate in that world?

In the late 1940s when I was in elementary school, they didn't have nearly enough

seats in classes to accommodate all the kids. So they began to have split sessions. Half the school came in the morning, the other half came in the afternoon. The higher education equivalent would be a curriculum in which students were in residence every other month—and learning remotely the months they were not on campus. I don't know if it's the solution. What I do know is things have to be different. We can't just open the doors.

Nor can we just say, "We'll teach them online." I am convinced that we won't want to give up in-person education. We just can't have it the way we had it before. So we're going to ration in-person education in some way.

**How about Penn? Is it safe from these trends?**

Penn is safe as hell, but Penn will change. And Penn actually has the space and the resources to change, which causes us to ask: "Are you taking advantage of that to rethink your processes?" Because the world is going to be different. I would argue that Penn has an obligation to experiment with alternate paths forward because it's truly in the safe zone.

**You've been advocating significant change in higher ed for years. What kinds of things have you been suggesting?**

Well, how about a three-year baccalaureate? You teach basic skills the first year such as statistics and writing and foreign language. The second year you actually teach the major. And the third year is when you round them out. So don't teach them Shakespeare until they're actually in their last year, and then they'll appreciate Shakespeare. Now that's not necessarily the answer, but it's the kind of answer that I keep pushing. Let's think this through differently. We know things aren't working as is. The retention rates at many schools are not acceptable.

**The pandemic has changed things. But the students had already changed, hadn't they?**

They aren't like us. It isn't just that they're younger, they're wired differently. Students today are sophisticated gamers, and you need to teach a gamer differently than you teach a reader. The problem with today's faculty is, we were almost all readers, so we teach them the way *we* wanted to be taught, and that creates a distance between us and them. So there are a whole set of issues, and this could either be a period of just one funeral after another for institutions of higher ed, or it could be a wonderful blooming because we will now abandon things that weren't working and therefore there's no reason to keep.

## Biology 406

*David Roos has always used his course on infectious disease biology "to convey something about the whole nature of the scientific enterprise." COVID-19 was this year's case in point.*

Back in January, the syllabus for Biology 406, "Molecular Mechanisms of Infectious Disease Biology," noted that the expected topics of influenza, HIV, bacterial pathogenesis, the microbiome, and malaria were subject to revision. One possible example: "the recent coronavirus epidemic in China."

ZOOM CLASS

David Roos, the E. Otis Kendall Professor of Biology, who has taught the course since 2008, doesn't have a crystal ball. But the 63-year-old parasitologist is keenly attuned to infectious diseases, having spent three decades researching malaria, the AIDS-related infection *Toxoplasma gondii*, and other infections. In recent years he has been developing tools to design and mine pathogen genome databases. It's not surprising that news of a novel coronavirus in China had caught his attention.

In fact, Bio 406—a graduate-level course popular with undergrads—has always been designed to accommodate whatever outbreak might be plaguing humanity. SARS, Zika, avian influenza, and Ebola had all previously sparked mid-semester shakeups. This year, when classes resumed remotely following Penn's extended spring break in March, the focus pivoted to COVID-19. Nothing like living what you're learning. "I couldn't have timed this better for the benefit of everybody in the class," says Roos via Zoom from his book-lined home office.

It helped that he had already asked students to imagine how they would scientifically handle a new disease outbreak. The first half of the course focuses on interpreting data and analyzing methods and conclusions discussed in research papers. The class picked apart published research on chloroquine and azithromycin as a COVID-19 treatment and looked at the promise of the drug remdesivir, along with papers covering Ebola and other infections.

"Everything we talk about is driven by the evidence," Roos says. "What I care about is whether they can think, to get people to understand not just what the answers are, but how anybody does science."

Roos was drawn to infectious disease research for the way it calls upon many specialties, from cell biology to immunology, field biology, epidemiology, and molecular genetics, "because you're focused on not a technique but a problem," he says. "I realized the field of malaria biology was really limited by a lack of an experimental system for genetic molecular manipulation," he says. "I thought, 'I can develop that.'"

After joining the Penn faculty in 1989, Roos developed a transfection system that introduced biomarkers to manipulate parasites for molecular genetic experiments—a long-sought tool now used worldwide. Roos also discovered a novel organelle (stolen by malaria parasites from an ancient alga) that has proved to be a popular target for the development of new treatments. Since 2000 he has focused on bioinformatics, leading a 60-person global team that supports research on parasites, fungi, and insects that spread disease. The Eukaryotic Pathogen, Host & Vector Genomics Re-

source (VEuPathDB.org) gets about 68,000 users each month.

On a Wednesday in April, about 15 students joined the three-hour, weekly class via Zoom to discuss five papers related to the possibility of developing anti-virus monoclonal antibodies as a specific treatment to inhibit an infectious disease outbreak. Roos had proposed about a dozen questions to guide class discussion.

Three guests dialed in: two executives involved with research at biotech company Regeneron, offering insight on antibody-based treatments for COVID-19; and Dinkorma Ouologuem Toure Gr'14, an assistant professor of cell biology at the Faculty of Pharmacy of Bamako, Mali, who researches malaria.

Roos asked the students to consider how specific experiments detailed in the papers were accomplished: how, for example, human monoclonal antibodies that recognize the spike glycoprotein of the SARS-CoV-2 were isolated. For each paper, he probed: *How did they do this? What did they find? What challenges might they have faced? Why do we care? What more do we want to know?* The students mostly rose to the challenge, many gaining a newfound appreciation for the limits and flaws in research studies—especially around COVID-19.

"If you're answering, you really have to know your stuff and be prepared to defend what you say," reflected physics and biochemistry major Samuel Kim C'21. "He really emphasizes deep understanding of methods."

Toure was a TA for the class as a graduate student. She had joined via Zoom, in part, to help with a similar class she was teaching in Mali on cell biology. "There is no way you find this kind of discussion in a textbook."

Of course, that's the point: "to convey something about the whole nature of the scientific enterprise," as Roos puts it, "*how* interactions work and *how* anybody does science"—and, he adds, in the time of coronavirus, "*how* one sorts out the unknown." *—Lini S. Kadaba*

## Commerce and Society

### Stop and Go

*Inside the chaotic new world of Philly's public transportation chief.*

MASS TRANSIT

When she accepted the position of general manager of the Southeastern Pennsylvania Transportation Authority (SEPTA) at the end of last year, Leslie Richards GRP'93 had big plans to help the nation's sixth largest public transportation system "move into the future," she says. "The reason the board wanted me, and why I wanted to be here, was to work on equity and accessibility issues and to make sure we are serving all of our communities." Her to-do list included fare restructuring, bus network redesign, trolley modernization, and sustainability and public engagement efforts.

Then things went off the rails.

As the coronavirus outbreak swept through the region, SEPTA found itself in the midst of a rapidly unfolding crisis that caught everyone by surprise. "I was working towards our first 100 days and so proud of what we could say we had already gotten done," Richards recalls. "All of a sudden, we're two and a half months in and everyone's moving out of our offices and I find myself in the unlikely situation of asking our customers not to use our system except for essential trips."

That unenviable mandate was the start of a hectic few weeks that found Richards and other SEPTA execs careening from reactive to proactive and back again. They started by implementing enhanced cleaning efforts of stations and vehicles in early March, even before the state and city called for the shutdowns of businesses and schools. Service reductions followed, with buses, trains, trolleys, and regional rail lines running on Saturday schedules. In early April, SEPTA instituted something it called "Lifeline Service," discontinuing some routes to prioritize others that offered direct access to hospitals, grocery stores, and other key locations. Social distancing measures were put in place, halving ridership capacity and requiring all operators and passengers to wear masks.

The ride along the way was often bumpy.

Take the issue of masks. "We wanted to make sure that our 9,500 employees were safe, as well as our customers," Richards says. "We were listening to the officials and medical experts, but there were a lot of mixed messages. We were all told not to wear masks at first. Then masks were OK." When SEPTA tried to make mask-wearing compulsory, the effort backfired. Over Easter weekend, more than 10 million viewers watched video footage of police officers dragging a non-masked rider off a bus. In response, SEPTA toned down its language to say that customers were "urged" to wear masks. (Facial coverings were again required after June 8, as the region began a phased reopening.)

"Our adrenaline was running at crisis mode for weeks," Richards says. "We never got a reset and a lot of it was counterintuitive to how we would normally operate."

Meanwhile, the virus raged on. Within a week of the first known SEPTA worker testing positive for COVID-19, the transit system implemented rear door bus and trolley boarding. Intended as a measure to protect drivers from contact, it also meant suspending fare collection. But workers kept falling sick, and at certain points employee absentee rates rose to 30 percent. (By mid-May, more than 270 SEPTA employees were confirmed to have contracted COVID-19, and seven had died.)

In late April, dissatisfied union leaders threatened a "job action" to protest what they viewed as unsafe conditions. When Philadelphia Mayor Jim Kenney entered the picture, a strike was averted and negotiations saw SEPTA relax its sick leave rules while promising to look into new protocols such as regular temperature checks, employee testing, and more frequent cleaning of facilities and vehicles.

"I've dealt with crises before," says Richards, who arrived at SEPTA after a five-

year stint as the Pennsylvania Department of Transportation (PennDOT) Secretary, the first woman in that role. During that time, there were "major bridge fires, freak snowstorms, the papal visit, the NFL Draft, the Democratic National Convention," she says. "Still, nothing could have prepared me for this. I've learned no matter how tough the crunch, to first think things through, though. And I've learned that if the information or situation changes and your decision isn't the right one anymore, it's OK to change your mind, to be flexible and nimble."

It's a lesson that the 52-year-old city planner imparts to the graduate students in her "Practice of Transportation Planning" course at Penn, where she joined the Weitzman School of Design faculty in January. "They've certainly gotten their effort's worth," she says with a laugh. "In every class for the last several weeks, we've discussed SEPTA's challenges and how we're responding. They've been really helpful, too, in giving suggestions on how to best communicate to different populations and offering their personal feedback on how they use the system. I've brought a lot of that back to the office."

The original syllabus, dealing with budgets and maintaining infrastructure, has "morphed into how transit agencies throughout the country have changed and will continue to change," she continues. "How fortunate for them that they've chosen a field where they will be needed and will have direct impact on how people live their lives."

Regular service on most lines resumed in mid-May, but Richards admits that much will be different for SEPTA—and public transit in general—going forward. As former commuters realize they can work from home, and businesses look at implementing staggered work shifts, ridership—down by more than 90 percent across all modes—will "definitely not snap back to prior levels immediately, or perhaps ever," she says.

She predicts SEPTA will continue to improve everything from its social distancing policies to social media outreach. "But I think the biggest change will be in how we get our revenue," she continues. Right now, about 40 percent of the authority's funding stems from fare collection. The bulk comes from state (50 percent) and regional (7 percent) subsidies via the collection of sales tax and highway tolls and the like—income streams that have been hammered by the pandemic.

Instead, Richards is laying her bets on a different outlook. Just as the coronavirus brought newfound appreciation for unsung frontline workers like grocery cashiers, Amazon warehouse stockers, and UPS delivery people, she says that we now know that public transit operators are essential.

"I think SEPTA will be seen as the necessary service that it is, just like law enforcement or fire fighters," Richards says. "To work together to solve problems like we've never seen before and to be in a position that impacts so many people during this very critical time has been an extremely gratifying but also heartbreaking experience for me. But I'm optimistic because I know that we will get through this, and SEPTA will exist and be very important to both the economy and our communities." —*JoAnn Greco*

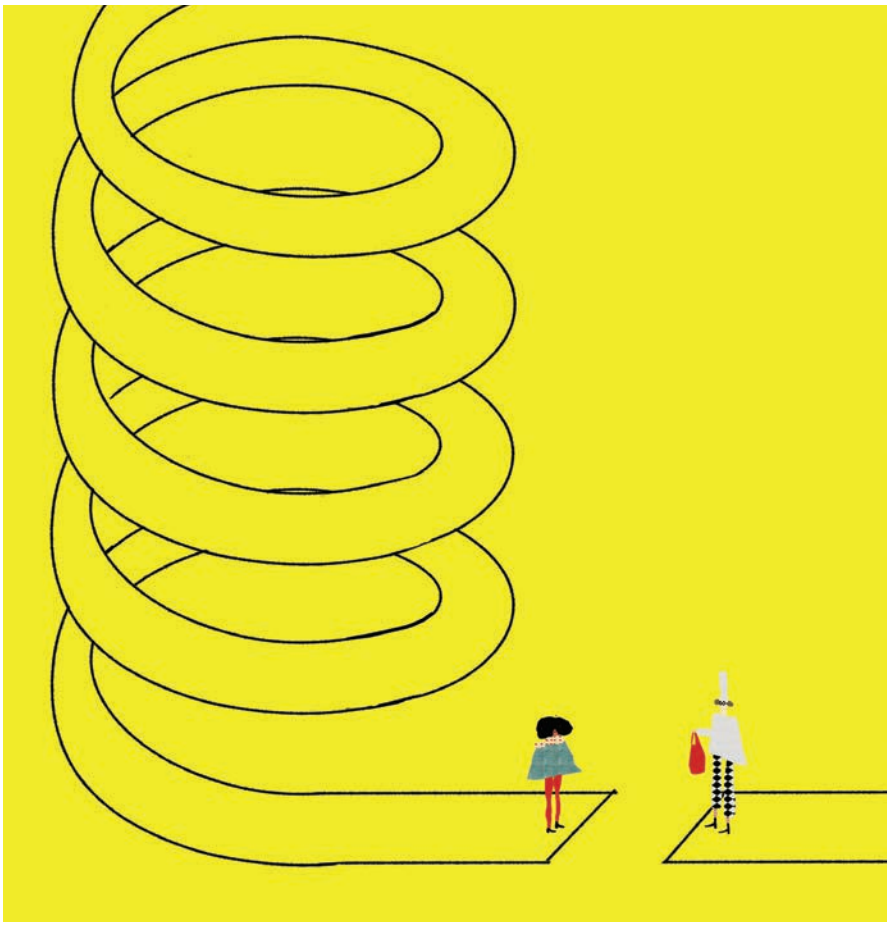


Illustration by Ryan Peltier

## Table for None

*Steven Cook reflects on the restaurant business in the COVID era.*

DINING

The second week of March may go down as the strangest time in the history of the Philadelphia restaurant business. Monday, March 9, brought assurances that the city's 250th Saint Patrick's Day Parade would proceed as planned the following Sunday. Tuesday night, officials abruptly canceled the event under the threat of COVID-19. On Wednesday the NBA suspended its season and President Donald Trump W'68 announced a ban on travel from Europe to the United States. Yet even against that foreboding

backdrop, business continued to boom for Steven Cook W'95 and Michael Solomonov, the James Beard Award-winning owners of Zahav, Dizengoff, Federal Donuts, and several other popular Philadelphia restaurants.

"We were having huge nights," Cook recalled during a mid-April interview with the *Gazette*. "Some of the fast-casual stuff was trailing off a bit, but some of those locations were as strong as ever. And that Saturday night, Laser Wolf, which is the new restaurant, had its busiest night [since opening one month earlier]."

Yet a queasy anxiety was mounting. "I remember thinking, in the week leading up to the 16th, 'I wish someone would just tell us what to do.'" But no one did, so Cook and Solomonov invited about 30 or 40 local restaurateurs to a meeting at Zahav on the morning of Monday, March 16. The impromptu assembly soon coalesced around a common opinion. "There was a will among us to shut everything down," Cook recalled. "For the most part, we were all on the same page that it was not responsible to have people dying in our restaurants."

As it happened, later that day Philadelphia Mayor Jim Kenney ordered the closure of all non-essential businesses, including dine-in restaurants (which were permitted to fulfill pick-up and delivery orders). From there, things progressed quickly.

The CookNSolo group laid off "somewhere north of 450 employees" across 16 locations, Cook said. "For the first five weeks we did some limited takeout packages from Zahav. And after paying for that food, we put the net profits into a relief fund for our salaried managers, to help bridge the gap between their last paycheck and whenever unemployment would kick in. We had done something similar with a gift card promotion for hourly employees." The skeleton staff also produced about 400 meals a week for Broad Street Ministry, a nonprofit faith organization. "They needed it," Cook said, "and it felt better to do something than to do nothing."

In April the CookNSolo group secured a forgivable loan through the federal Paycheck Protection Program, which permitted the rehiring of about 40 or 50 salaried managers for eight weeks. Cook was grateful to be able to do that, but he lamented the mismatch between the program's terms and the reality of the restaurant business.

"The way it's written, you get the money and have eight weeks to spend it," he said. "The first problem is that none of us are open—or we're open and doing 20 percent of revenues [through takeout and delivery]. So really, we become, in a way, the unemployment office." He wished he could have instead waited until business operations meaningfully resumed to restore those jobs, so that the wages might actually generate additional economic activity. "If we were able to take that money and delay spending it until we were able to open, then you're not just paying people, you're generating real revenues: you're paying your vendors," he said. "Our farmers and butchers and dry good purveyors, they're sitting there—with our company alone—on tens of thousands of dollars of receivables from February and March that nobody's able to pay. So if I could spend that money when we're open, that money becomes fuel for the economy. Right now, I get to pay people, but the effects don't really emanate outward from there."

Nevertheless, bringing back any jobs, even for a limited time under suboptimal circumstances, was better than the alternative. For the eight weeks CookNSolo could pay wages with federal funds, Cook and Solomonov hoped to earn enough through limited takeout meals and catering to repay their vendors. "So hopefully after eight weeks, if we return to something like normal, the revenue outlook will be shitty but at least our balance sheet won't be a mess," Cook explained.

But normality seemed hard to envision.

"I'd like to think that after eight weeks we'll roll into something approaching normal operations," he said. "But I don't have a lot of confidence in that. And even if we are legally able to open our restaurants, I don't think any sit-down restaurant can make money at 50 percent capacity or less, which are the guidelines we're seeing start to coalesce in other states."

The restaurant business faces an uncertain future—especially in places like Philadelphia, where cramped and crowded spaces are a hallmark of dining at virtually every price point. "For sit-down dining, we need to get to a point where there are not as stringent limits on capacity issues," Cook said. "Bigger picture, we need better testing so people can feel comfortable going out. Ultimately the holy grail is a vaccine.

"I think people's behavior is going to be changed, if not permanently, then certainly for a long time," he added. "I don't know when people are going to walk into a restaurant and not look for the hand sanitizer. It's just going to be different.

"Thank God I have a partner to go through this with. Thank God my family is healthy and we're spending a lot of time together," Cook said. But this is unlike anything he has faced in his 16 years in the business, so even his final expression of hope had a plaintive edge. "This is going to be, I hope, the biggest challenge of my career."—*TP*

## Institutional Response

### The View From Day 60

*Penn Medicine leaders look back on the early response to COVID-19, contemplate the next stage in confronting the disease, and consider healthcare delivery and research in a post-pandemic world.*

HEALTH SYSTEM

In a May 13 webinar hosted by Penn Alumni, leaders of the Penn Health System—J. Larry Jameson, executive vice president and dean of the Perelman School of Medicine; CEO Kevin Mahoney; and executive vice dean and chief scientific officer Jonathan Epstein—shared insights on the University's response to the pandemic on

the front lines of patient care and in a broad range of research efforts designed to better understand the novel coronavirus, improve treatments, and develop a vaccine for COVID-19.

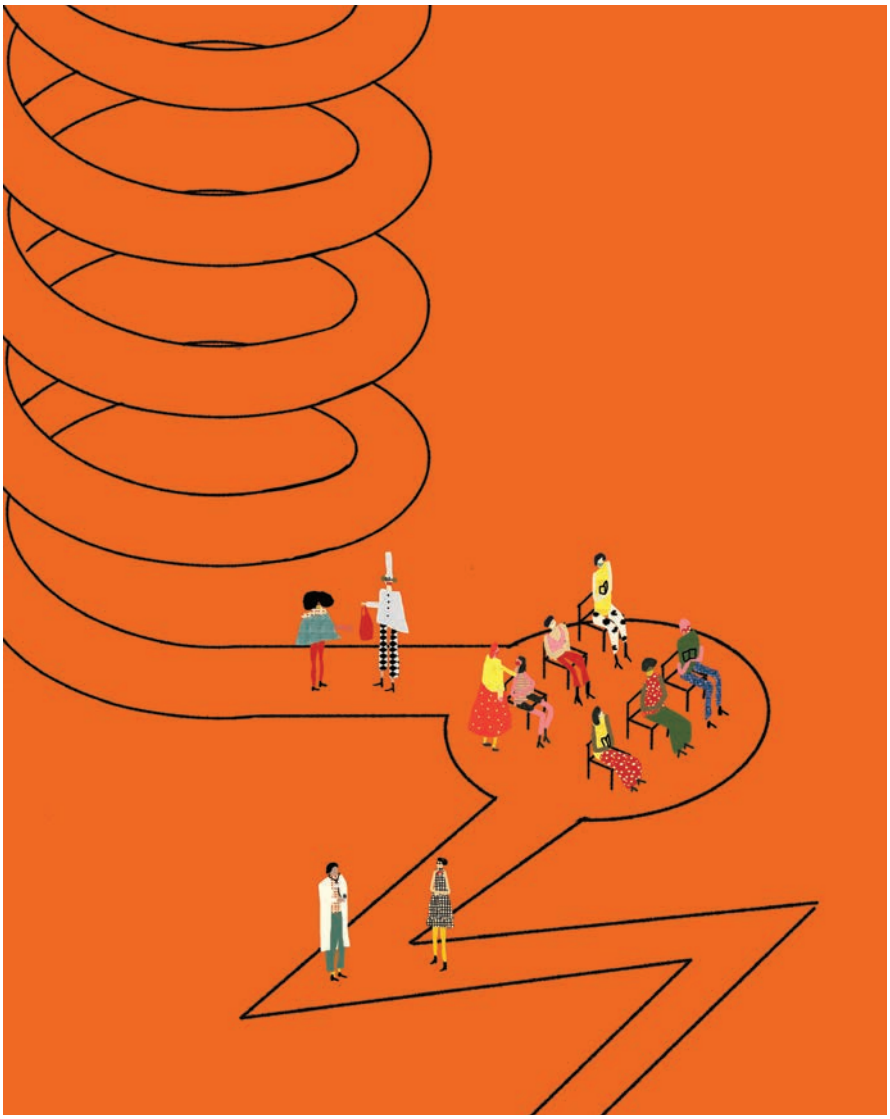
Jameson, who served as moderator, noted that the date marked two months since Penn sent students and most employees home in response to the pandemic. Since then, he said, Penn had provided patient care and testing to thousands in the community, served as a trusted source of information, and launched the Penn Center for Research on Coronavirus and Other Emerging Pathogens to pursue research in areas from drug development to testing to contact tracing through social media.

"We will innovate our way out of this crisis," Jameson predicted. "We will invent better tests. We will find new drugs. We will assist in the development of new vaccines. We will continue to support our local communities. We will learn lessons from this pandemic and use these lessons to create a better future in education, the workplace, and in healthcare. We will continue to lean into this crisis, so that all of us can return to more normal lives."

At the time, Penn Medicine had treated some 2,000 coronavirus inpatients. As new case counts in the area fell from a mid-April peak, the system had begun to shift to "learning how to coexist with COVID until a vaccine is discovered," Mahoney said.

More than 40,000 people had been tested at drive-thru testing centers Penn set up in Philadelphia and suburbs; for the 8,000 who tested positive, "we initiated contact tracing to help stamp out any hotspots in our community." Penn also reached out to local nursing homes "to help them provide appropriate care and honor the most fragile [part of our] community and prevent the spread of this disease."

Mahoney called the safety of employees and patients "our North Star." The University moved "aggressively" to secure supplies of personal protective equipment (PPE), he said, expressing gratitude



to the alumni who had used international connections or provided other help in that effort. To assist staff in other specialties reassigned to care for COVID patients, refresher courses were developed that have been viewed from 58 countries, he noted, "spreading the Penn knowledge to all reaches of the globe."

He also highlighted a new digital platform designed to address employees' "pressing mental health needs." Dubbed Penn-COBALT, the platform invites users (who can remain anonymous) to answer a series of questions to help determine the kind and level of support needed, and had been accessed 8,000 times, as part of a suite of services offered through the website PennMedicineTogether.

Recognizing that virus cases could overwhelm hospitals, Penn created the text-based app COVID Watch to facilitate home monitoring and treatment. Mahoney said the app had been used to follow 3,000 patients. While 15 percent were eventually hospitalized, the rest could be cared for at home "without stretching our thin human resources preparing for the surge." COVID Watch is in use at all six Penn hospitals and has been made available at no cost to other regional health systems as well, he added.

Contactless registration has also been implemented, with consent forms, copays, and other "paperwork" being handled digitally in advance. With Google, Penn developed a chatbot to provide information about the virus, freeing clinicians for direct patient care, which had answered 12,000 questions from 4,500 people.

Illustration by Ryan Peltier

Long-term investments in information technology facilitated a quick pivot to virtual healthcare when the virus made that issue critical, Mahoney said. "We took the high touch practice of medicine and made it possible from six feet away." Although only about 150 patients were remotely evaluated during the first two weeks of March, more than 200,000 telemedicine visits took place in the subsequent two months.

"With COVID-19 the future came sooner than we anticipated [but] much of the flexibility we exhibited in recent days reflects these early long-term investments," Mahoney said. The key question now "is what investments will we make today that will allow us to survive in the future without shutting down the entire system again?"

Epstein noted that stay-at-home orders and social distancing measures had flattened the curve and helped spare the Philadelphia area from the "acute surge" that afflicted New York, northern Italy, and some other hotspots. "Now we have to map a path forward," Penn Medicine's chief scientific officer added. "We envision a 12- to 18-month playbook that begins with the transition from isolation to intensive testing and contact tracing."

Epstein assigned a task force in early May to create new approaches to testing and he expressed optimism that capacity could be scaled up quickly to meet the need. "Penn investigators and others are working with people all around the world. We're coming up with new ways to test for the virus at very low cost and in minutes." He called the discovery that the virus can be detected in saliva a "game changer," removing the need for "uncomfortable and logistically difficult nasal swabs."

Epstein drew a distinction between antibody testing and testing for the virus itself. "Antibody testing provides information about past exposure to the virus, and possibly about immunity," he said. While accuracy problems have been seen with many antibody tests marketed in the US, Penn researchers have developed a "very sensitive and quantitative antibody test," he added. "So far we've tested well over 1,000 of our frontline healthcare workers."

One encouraging sign was that only 2 percent of healthcare workers tested showed a history of exposure to the virus, compared to 7 percent of pregnant women coming to the hospital to deliver babies, seen as a representative sample for community exposure. (Testing also provided more evidence of disparities in community exposure, Epstein added: just 1 percent of white women tested positive versus nearly 12 percent of black women.) But the limited exposure among healthcare workers was an indication that masks, shields, and other PPE do work. "We can come to work every day in an environment with known and common exposures and be protected," he said. "If we get people to follow the rules, we can probably work and get the economy going."

On the other hand, much of the community has not been exposed, so there are likely many more infections to come. "We're nowhere near herd immunity, even assuming that the presence of antibodies equates to immunity, which is something that we're studying now," he said.

Until it's known whether people with antibodies have immunity or aren't still spreading the virus, Epstein downplayed the value to individuals of antibody testing. Its use lies in helping epidemiologists understand how much infection there has been, for studying the spread of the virus.

Testing for active virus is most important to scale up as quickly as possible, he said. There are studies under way to compare the effectiveness of testing sewage, saliva, and deep or anterior nasal swabs. "For the general population, any of them will be more useful than none," he said. "Whichever is quicker to scale will give the most information."

The playbook for the next 18 months also depends on identifying better medicines, which alone or in combination could reduce mortality and symptom severity until a vaccine is developed. "After all, remember we haven't yet been able to come up with a vaccine for HIV/AIDS after many years," Epstein said, "but we have found combinations of medicines that have transformed the implications of acquiring the infection and transformed the lethality of acquiring that infection."

**"I've never seen research move more quickly."**

Penn was part of a multicenter study that showed a "modest benefit" from the much-in-the-news drug remdesivir, which targets a key enzyme required by the virus, "although it's not nearly enough." More than 150 drugs have been tried on COVID-19 patients, though mostly not in controlled clinical trials, "so much of the information coming from their use is uninformative to the rest of us," Epstein added, expressing eagerness for more controlled trials that yield actionable data.

Penn has also been screening all 3,000 FDA approved medicines in a high-tech containment laboratory to "see if they might have activity against this virus." About 40 had been identified by mid-May, and the best of these will be tested in humans "as soon as possible," he said. Some of these drugs are generics that are affordable and widely available. "If they work alone or in combination that would be another game changer."

Treatments that could serve as a bridge to an eventual vaccine will likely involve a combination of drugs "that target different parts of the virus life cycle," Epstein said. "Most infections find ways to get around a single blockage caused by a drug, but have trouble getting around two or three." He added that one promising strategy—prompted by the benefits seen with remdesivir—would involve combin-

ing an antiviral with a drug that acts on the immune system.

Penn is developing therapies to counteract the extreme immune responses known as cytokine storms that sometimes strike coronavirus patients, proving more deadly than the virus itself. "There's something regulating the individual response to the virus," he said, and the immune response to COVID-19 is also "quite different" than to other viruses like the flu. "It would be informative to look at those people who don't even seem to get symptoms. Their immune system is doing the right thing."

Adapting Penn's pioneering work on treating cancer (as in the CAR-T therapy developed at Penn ["The T-Cell Warriors," Mar|Apr 2015]) and other diseases could lead to new tools to "tweak" immune response. Penn labs could test "thousands of parameters," he said, in an effort to understand why the response to the novel coronavirus varies so widely and make it possible to adjust it.

There are therapies now in clinical trials to "dampen down" immune response, "but you can imagine the risk of trying a medicine that damps down the immune response in an infectious disease when you need an immune response," he said. "So it's just going to be critical for us to learn how to tweak and dial the immune response appropriately without overdoing it."

Penn's experts in gene therapy are also working on a preventive therapy "that would be inhaled into the lungs, delivering a neutralizing antibody to lung tissue to prevent infection," he said. "This unique and innovative approach is particularly attractive to me because it can be tested relatively quickly, and it can be produced at scale—but it will be several months before we know if this can work."

The ultimate goal is a vaccine. Of the 100 or so potential candidates in development, about eight are in clinical trials. "We've completed a Phase 1 safety testing trial with a DNA-based vaccine with the Wistar Institute, and we hope to enter Phase 2 in order to test the efficacy of that very soon," Epstein said. (See page 28 for more on this effort.)

In a post-pandemic world, Mahoney suggested, healthcare delivery will be more decentralized. "We have come off of 40 years of building large buildings and bringing a lot of people to one location, which is based on reimbursements and operational efficiency," he explained. The future will see more "pop-up clinics" nearer to patients and with "less human density." Penn is already working on how to surround the community with these kinds of "smaller, more intimate locations."

He also predicted a further shift to value-based payments, "where we will get a set fee based on clinical outcomes for patients," rather than the current system in which Medicare and most insurance companies require that "you have to be seen and document a certain amount to bill." Meanwhile, billing will be "simpler and more virtual." And remote work will continue to be the new normal for a larger segment of Penn and the Health System's 42,000 employees, one impact of which will be reduced operating costs.

Epstein emphasized how the pandemic has transformed research and collaboration. "I've never seen research move more quickly," he said. Data and results are being shared at an unprecedented pace, often before peer review. "There's a risk to that," he added. "People could share lousy data and others could be misled." On the other hand, "it is a very rapid way to learn about new discoveries, and that is greatly increasing the pace of work right now."

This has been accompanied by an environment of "much more transparency" among colleagues at different institutions, which is a development worth preserving, Epstein said. "I've had conversations with my peers about what can we do to make this persist after COVID, because there is real value in this quantum change in how people are being willing to collaborate."—*JP*

## Look for the Helpers

*When the outbreak hit, many people looked for ways to assist those most affected. Below is a small sampling of Penn alumni who started or adapted businesses and other initiatives to lend a helping hand.*

**Joe Ammon WG'19 — Clove**
Launched by Ammon last year, this company designs comfortable, easy-to-clean sneakers specifically for healthcare workers. In response to COVID-19, it donated more than $50,000 in footwear to nurses and doctors across the country, including some in the Penn Health System.

**Anna Dailey C'19 — Perfect Strangers**
This COVID-19 relief nonprofit coordinates volunteers to deliver groceries, prescriptions, and other essential goods to those in need, including the elderly and the immunocompromised. It currently serves communities in Boston, Philadelphia, Washington, and the Bay Area, where Dailey has worked as a regional captain since returning home to quarantine with her family.

**Grace van Arkel C'17 — Fuel the Fight**
This former Penn women's squash captain has helped lead an initiative that supports local restaurants by buying meals and donating them to hospital workers on the frontline of the pandemic. She brought what had started in Philadelphia to New York City, where it quickly raised over $100,000 on GoFundMe. Several other cities have since come on board.

**Kayla Lebovits C'13 — Bundle**
For anyone trying to juggle working from home with young children crawling all over them, this business aims to provide a much-needed break. Like everything else these days, it's done virtually with trained instructors giving personalized one-on-one learning experiences to kids—and maybe offering just a little bit of quiet time to parents.

**Ashley Stinnett C'17 — CoronaMetro**
Not using public transportation anymore because of quarantine orders? Stinnett created a website that links New Yorkers who need MetroCards to work-from-homers who can donate. "Doesn't look pretty," the site reads. "But it does the job. Just like the subway."