The National Academy of Medicine 2022 Annual Meeting Transcript

President's Address:

VICTOR J DZAU:

Good morning, everyone. I am so pleased to welcome you all to 2022 NAM annual meeting. I've been saying this all weekend. It's wonderful to see so many smiling faces back here now in the auditorium for our first in-person annual meeting in three years. And for those, joining us online. Welcome back. Welcome and thank you for tuning in. It's just wonderful thinking back of the 50 years of our history. And of course, today you're going to hear about the next 50 years as we can predict. So we have an outstanding scientific program planned today that will focus on revolutionizing the biomedical and health sciences. You will hear from many notable speakers, including our keynote Dr Mariana Mazzucato, in just a while.

Please be sure to stick around for the final session of the day, which I will moderate, called the President's Forum. The topic is transforming the future: perspectives from scientific and institutional leaders, which the meeting that forum will convene diverse perspectives to examine how institutions ranging from philanthropy, federal agencies, government to university and science publication. How to transform and address the challenges and opportunities that lie ahead for our biomedical enterprise.

So now I am delighted to have the opportunity to deliver my annual report as the President of the NAM. First, I'm so pleased that we are able to gather in person to celebrate 50 anniversary of the NAM. Because we should have celebrated this in 2020. But unfortunately, COVID-19 pandemic had other plans. So we're actually 52, but who's counting? So the pandemic has been such a global tragedy, and it's far from over with new variants continue to emerge around the world. But at the same time, COVID-19 has also served as a pertinent reminder of our relevance.

More than 50 years since the founding of the IOM and now the NAM. Health and medicine have been at the forefront of so many society's biggest challenges, including this one. And I'm proud that NAM and the National Academies were able to pivot quickly so it can deliver rapid, expert real-time advice in a time of crisis. But this couldn't have happened overnight. We're fortunate to have a strong five decade foundation on which to build. As we help the nation and the world respond to the pandemic. The NAM and the National Academies have played a major role events in some of the health medicine's greatest achievements, including launching the Global Patient Safety and Quality Movement sounding the alarm on HIV AIDS Epidemic proposing mapping and sequencing of the Human Genome. Improving cancer and mental health care. Steering Progress on the future of nursing and primary care and so many others. We've accomplished a lot of great things over these five decades, and we should rightly celebrate.

But as the past few years have shown us, we certainly have no time to rest on our laurels. Our work is more important than ever. I've spoken about triple essential threats that we face, and they showed this like COVID-19 and the possibility of future epidemics and pandemics. Climate

change, which is already affecting health of millions. Systemic racism, racial economic inequality which are still preventing far too many from reaching their full potential for optimal health and well-being. And of course, to contain rise and weaponization of myths and disinformation have impeded progress on all of these funds, eroding public trust in our institutions, in scientific research, and in the knowledge and expertise of a scientific community. Russia's unprovoked war on Ukraine has triggered a major humanitarian and health crisis, and there's no sign of ending anytime soon. Here in the US familiar and longstanding problems continue to plague us. We've seen far too much gun violence over the last year, including tragic mass shootings like those in Uvalde, Buffalo, and most recently in my hometown, Raleigh, North Carolina, as well as thousands, tens of thousands of other firearm-related murders and suicides.

The Supreme Court decision to overturn Roe v Wade will potentially worsen women's health and increase inequalities in maternal and reproductive health care, especially for people of colour. And this at a time when the United States already has one of the highest maternal deaths of any developed nation. These are grim realities that we face now, and we'll certainly encounter other major challenges and disasters in the years ahead. So, if the last 50 years is any indication. We should also know the signs and medicine can and will provide solutions. Looking back, our parents, grandparents never could have imagined the explosion of new knowledge, tools, treatments and technologies that we have today. As a cardiologist, I'm awestruck by a progress in treating heart disease. You know, 50 years ago, we had very limited treatment for myocardial ischemia, arrhythmia, heart failure. Today, thanks to multiple drugs and new technologies. Heart disease death rates have declined by almost two-thirds and stroke by more than three-quarters.

Since 1960s we are preventing some 1.5 million deaths each year because of these innovations. Our ability to treat many types of cancer. It's yet another modern miracle. We now have 14 million cancer survivors here in the United States, which have been unthinkable even 30 years ago. Rather than being a death sentence, more than two in three people diagnosed with cancer will live at least five years, and many will live well beyond that. And we're poised to do even better. We can now identify molecular features of specific cancers and tailored targeted therapy to individual patients. And through immunotherapy, we can harness the immune system to successfully fight cancer. Similarly, HIV AIDS was once a death sentence, and now with widely available antiretroviral therapies, coupled with tremendous shifts in knowledge of how to treat at risk populations. We have transformed the prognosis. HIV now can be managed as a chronic disease, and we can reduce dramatically the risk of transmission.

These amazing achievements were considered the stuff of science fiction two previous generations. I'm reminded of Aldous Huxley's 1932 novel, The Brave New World, describing a future dystopian society with genetically modified citizens and intellectual-based social hierarchy. Today many of technology the Huxley predicted including genome editing, artificial intelligence, brain-computer interface are no longer limited to one's imaginations. So we have

to do right. Unlike Huxley's dark worldview, we can apply these technologies for the good. And we can also anticipate potential concerns and consequences and really work hard to mitigate them. So it's so exciting. Imagine what science and technology would bring us in another 50 years. New developments in genomics, nanotechnology, engineering. Other fields are sparking radical innovations. Genetic technology could allow us to prevent or cure Huntington's disorder, cystic fibrosis, sickle cell disease and other devastating illnesses. What's more researchers are developing single-shot gene therapies that could make these treatments more available and affordable to patients from all countries and backgrounds.

Big data and artificial intelligence have the potential to significantly improve productivity, efficiency of care, reduce medical errors. In biomedical research, AI can identify new applications for existing drugs, transform the way we pre-screened patients for disease, reducing the need for highly invasive and intensive treatments. Chan Zuckerberg's initiative has set an audacious goal. And I say this in quote, "To cure, prevent and manage all diseases by the end of this century." In other words, 80 years from now or less than 80 years. Well, some researchers believe we can really do this because we humans could one day be made immune to all viruses won't that be nice? And the effects of aging could not just be prevented but reversed entirely. There is such a lot of research going this way. Now, this may sound like a fantasy, but when we consider how rapidly science and technology advancing so much is possible. Just think 80 years ago. Penicillin was relatively new. We had no vaccines for polio, measles, rubella, and we had no effective drugs to treat many conditions hypertension, heart failure.

So I want us to remember the old adage. Most people overestimate what we can achieve in a year, but underestimate what we can achieve in ten years. So the question we have to ask ourselves today is what will we make possible in the next 50 years? Well, I can tell you we can predict everything that will happen in the future. But we can do something far more important. We can help build this. In fact, as scientists and health professionals and together as the NAM the actions we take now and decisions we make every day are determining the future for ourselves, our children, grandchildren and great-grandchildren. So the question is, how can we keep making incredible new advances in science technology while also ensuring that these advances benefit all of society? If we learn anything, especially last few years is this science and technology offer solutions. Are they only tools, how they're used? Who have access to them, how they communicate it, accepted and adapted by society are just as important to their success as the efficacy of the tools themselves.

So in the midst of our desire to innovate. We must commit to clearly about the benefits of science and medicine and earn the public's trust through our words and deeds. As a nation, we spending 20% and probably more of our GDP on health care. And yet many Americans face major barriers to accessing even basic care. And sadly, over the last two years, our life expectancy has fallen dramatically. Americans now living three years less on the average than 2019. I think this is unacceptable. And as always, some groups are more effective than others.

Native American and Alaska Natives now have an average life expectancy of just 65 years, equivalent to the average American life expectancy in 1944. Now, this overall drop in life expectancy in the US is not just due to pandemic. We're seeing more deaths from chronic disease. And of great concern drug overdose, alcoholism, liver disease, which Angus Deaton and NK term is deaths of despair. Longstanding problems of poverty. Discrimination, racism, access to care are continuing and have even gotten worse in some cases.

But it doesn't have to be this way. Our health system in many ways, one of the best in the world, but is fragmented and inequitable. We prioritize treatment over prevention and fail to address the root causes of diseases such as social inequity, poverty and environmental justice. So science and technology are constantly progressing, but also medical education, health education training system is falling behind. Our healthcare providers also have been pushed to the brink, as you know, by the impact of COVID-19, even before then through stress, distress, and burnout. And of course, data science and AI and other innovation could potentially provide benefit for those patient providers, but only if we are prepared to take advantage of them in an equitable and just manner. So how can the NAM all of us be ready to help to build a future we all want? Our mission to improve health for all by advancing science accelerating health equity and providing independent, authoritative and trusted advice nationally and globally is more important than ever.

But to fulfill their mission and meet the many current and future challenges. We need both thinking, creativity, a radical shift in the way we operate. Over the next 50 years, I envision an even more dynamic NAM. One that proactively prepares society to anticipate, to adapt to and respond to future challenges and opportunities. And in order to inform decisions build on the better world, NAM we'll need to commit to a culture of continuous learning and innovation. And hence our capabilities and innovate through strategic deployment of cutting-edge tools, systems and technology. Build deep and diverse networks of partners. And importantly, we must commit to prioritizing diversity, equity, inclusion in all that we do. Let me be clear. Our principles and values would never change. We will always be unwavering in our commitment to scientific excellence, integrity and rigour. We must stand, remain steadfast to our objectivity and independence and to catalyze action for the greater good. Will always be science based organization.

And as science rapidly evolves, we too must lead changes in scientific enterprise. During today's meeting, which is focused on revolutionizing the biomedical and health sciences. We'll explore in depth how to transform our research enterprise to meet future challenges and best help humanity. We take a deep dive into what kinds of disruptive technology strategies we need in governance models, education training, funding mechanisms, scholarly publication, and public-private partnership. And then this issue we discussed in depth in today's meeting, and I look forward to an exciting discussion. So indeed, first our academy must commit to continuous learning innovation. Embracing a more dynamic future requires calculated risk and actively inviting improvement. NAM has long advocate of health communities to harness knowledge to

drive innovation, we need to follow our own advice. Well, we saw many examples of accelerated innovation during pandemic. For example, the National Academies Standing Committee on Emerging Infectious Disease and 21st Century Health Threats developed a new and novel mechanism known as rapid expert consultations.

To provide near-real-time peer-reviewed, evidence-based advice in a matter of weeks to policymakers and the public. Now we're trying to improve on this successful model so we can respond more rapidly to fast-moving events. Of course, these approaches were at times met with skepticism. But we know that it's crucial to foster a culture we're not afraid to try new things, even if we risk failure. As scientists, we understand that failure is an inescapable part of research. The astrophysicist Erika Hamden said, Discovery is mostly a process of finding things that don't work. And we all know that. And failure's is inevitable when you're pushing the limits of our knowledge. The next point I want to make is that we need to become even more proactive, more anticipatory and more visionary for the future. Modern science can make momentous achievements understand the world as it is. But the NAM must begin to consume world as it will be. That means not only investigating problems of today, but also imagining the problems of tomorrow and so many tomorrows to come.

So how can NAM set the future agenda for science in health care? Well, we can predict address problems before they have a major negative impact. So to become more anticipatory, we must harvest ideas from sources across the globe and use cutting-edge research assessment methodologies like horizon scanning, predictive analytics, trends for forecasting because these must allow us to identify early signals, a potential change, predict certain situations, events and leverage data mining technology to judge what we might expect to see in the future. Let us take pandemics COVID-19 as an example. Despite previous warning, the world was not prepared. In the future, it must be our goal to initiate and lead conversations and not merely to contribute to them. We must proactively identify emerging problems and opportunities and apply advanced forecasting methodologies to prepare for the possible and probable events. Indeed NAM should prepare the nation or the world on how best to respond to many political, economic and healthcare possibilities.

This type of strategic thinking allows us to be more flexible, nimble and dynamic in the world that's constantly changing. These innovative approaches depend on data. And so NAM must embrace increasingly large data sets utilize tools such as artificial intelligence, machine learning and linked data from multiple sources, including healthcare data, population community level data wide range of health-related data. To support our vision of a more proactive forward thinking organization. We need to advance our capabilities, redesign our workflows, support new deliverables, and respond to areas of need more quickly than ever. To truly transform. We must use implement state-of-the-art technology planning tools and methodologies. However, our people will always be the backbone of the organisation. They are and will always be the reason for quality excellence of our work. And they embody our principles and values. We need

to build them into a future ready workforce. We need our people to be adapt at continous learning new skills and capabilities.

We must consider how and where we work best and explore new methods and models that, unlike those we employ now. Just think about what covid's done and how much now flexible and virtual working it is for all our staff, for all of us. 50 years from now or sooner, the NAM workforce and workplace will look very different than now. For example, I can imagine a future where committees like you use data science combined with AI to quickly search large databases, combining evidence and synthesizing research to address a huge range of complex issues. We could invest in new technologies, trends in budgeting, forecasting, improved management of projects and workflow, and facilitate collaboration, and enhance the stewardship of our members and volunteer relationship. let's leverage technology to develop living reports that could be updated, reviewed and published in real-time. AI even moving us closer possibly of a hybrid human-automated workforce, ideally improving both effectiveness and efficiency.

We must begin preparing now to ensure that we build a competent, confident workforce that is well-versed in new technology and to create bold new approaches. So to be more proactive, we have to engage stakeholders on the ground and form radical partnerships with a much wider, more diverse range of partners in healthcare and beyond the healthcare sphere. We must find ways to communicate, engage with partners and with researchers, opinion leaders, sponsors, private sector and global institutions. Without broad, diverse engagement, we missed the opportunity to acquire new knowledge, to identify sources of support or potential pain points. To communicate clearly, and to ensure our deliverables meet the needs of the community that they will impact. For example, today through our initiative on emerging science technology innovation. In addition to science innovators, we're working with actually private industry and venture capital investment communities because they are the key stakeholders in addressing emerging technology and the societal implications.

Similarly, in our grand challenge in Climate Change and Human Health Equity is harnessing innovative, collaborative partnerships with multiple public-private sectors outside of health to address this essential threat. And the global arena, we rendered our partnership in collaboration with G20, G-7, the WTO, World Bank and multilateral global agencies. And we need a much deeper engagement at the city, state and community levels. We must strive to bring in more voices, communities and live experience into our work. We must pursue not just multidisciplinary efforts, but true convergence across fields to address complex areas of needs. And of course, we'll always strive to preserve our independence, objectivity, avoid conflicts of interest, and to solve complex problems that societies will face. But we must absolutely draw upon the expertise of all partners, public and private and internationally, regionally and locally. On top of this, we must develop a communications strategy for the future.

Advising and convening stakeholders is not enough. We must ensure that we are considering our entire audience and how we can best reach them. This includes our members, the general

public, policy makers, decision makers nationally and globally. Now, 50 years ago. Well, maybe 20 years ago, 15 years ago, social media did not exist. And the world of communication looks so different. So now we need to use all available tools in the future, especially when you consider the emerging and continuous evolution of social media. Given the world that we live in today and the rise of misinformation. We know this will require a deep understanding of behavior as well as understanding of new ways to communicate and how best to reach different members of the audience. We have a lot of work to do. Above all, we must maintain and grow a deep commitment to diversity, equity, inclusion in all that we do. This commitment is rooted in our program, work, staff, membership and leadership. We are truly committed to this.

First, we must ensure that NAM staff and members represent a diversity of our population and a broad array of demographic factors. These are individuals that are at the heart of what we do, and we should ensure that they are offered the opportunity to speak to this trans. We need to create an inclusive welcoming culture for our members and staff and everyone. I'm really proud that our concerted efforts, led by so many of you to increase diversity of membership are paying off. Last year from a record number of more than 1,000 nominations. We elected 100 new members. But the most diverse cast to date, more than half are women and 50% are underrepresented minorities. This year the newly elected class also very diverse. And we have announced the new members 50% women and 49% underrepresented minorities. This newly elected class also includes eight members from underrepresented states a record number. And we're very excited that we elected three Native American members last year and three this year, bringing the total number of Native American members to seven.

Because there's a lot more work to be done, but it's a good step in the right direction. So as we move toward becoming more of a service institution, more than an honorific society must find ways to engage and our members and ensure our expertise reflect the challenges that we face across society. To that end, our member election process has really evolved over time and developed mechanisms to ensure the inclusion of younger members, those from underrepresented backgrounds. And we have instituted a special emphasis to elect members whose expertise are key to meeting challenges of our time, such as climate, technology and equality. To be a future owner organization NAM needs scientists, clinicians and experts who are the future in the fields. We cultivate the next generation of leaders through our Emerging Leaders program and the fellowships that you've met many new fellows in their entire portfolio. We deeply relying on wisdom of our more experienced members. But we also need these new voices and creative insights.

Embracing diversity, equity inclusion is more than just ensuring diverse representation of work. We must intensely and thoughtfully build a deep, interactive relationship with diverse communities. And more broadly NAM must prioritize health equity as the goal that underpins everything that we do. I've said in my writings and speeches that there can be no health equity without social equity. NAM programs must address root causes of inequities, systemic racism, economic instability, lack of community support and difficulty in accessing education and health

care. This is our vision for NAM future. And in many ways, we are on our way as we also develop and refresh of our strategic plan to roll out in 2023 or 2024. And we look forward to having many of you volunteer to join this work. Our consensus that we have long been considered the gold standard, providing definitive guidance and stands the test of time. But since science and evidence are moving really fast and we must keep pace and innovate, we want to make relevant the contributions to our ever-changing world.

Our institution should strengthen all of its components to achieve continuous success and sustainability and resilience. So as we mark our 50th year in service to the nation in the world. We should be proud of how far we've come in health and medicine. And as a premier academy nationally and globally, we are heading in a bold new direction. We have so much to be excited about in terms of where science technology may take us. Even as we face so many intersecting, fast-moving challenges. And with so much work ahead. We are dealing with several existential crises and without a doubt many other will surely come our way. But at this time. I reflect on everything we already accomplish, but I can't help but feel optimistic. I hope you do too. 50 years ago, few people would have predicted the devastating COVID-19 pandemic, how quickly we developed safe and effective vaccines. 50 years ago, we wouldn't have dreamed of being on the cusp of curing cancer, preventing heart disease, or eliminating devastating genetic diseases.

So what will health medicine look like in year 2070? That answers up to all of us. In the world, the words of the great civil rights activist Ralph Abernathy. I don't know what the future may hold, but I do know who holds the future. We do, every one of us. By working together and using the tools that science medicine provide, we must and we will create a healthier future for everyone. Thank you very much indeed. So before we begin the scientific program, I'm pleased to tell you that the new electric class of 2020 has just been announced. So please visit nam.edu/classof2022 to learn about this class. So next thing our agenda is the scientific meeting. And it's my pleasure to kick off our scientific programme for the day. For those who are just joining us in person online, welcome to the 52nd National Academy of Medicine Annual meeting. Thank you, all of you, for attending. Every October, our annual meeting is the gathering of our distinguished members and the most important meeting of the year for the organization.

Today's program Revolutionizing Biomedical and Health Sciences promise to be stimulating. And for this, we must thank our program committee, including from the NAM Council's Standing Committee for Program Planning. Jeff Balser, who's the Chair. And he will be up here in a few minutes. Karl Deisseroth, Juanita Merchant, (UNKNOWN). And with the participation of other NAM members Katherine Hall Jamieson, Bill Stead, Leslie Vosshall, Keith Yamamoto and the staff support from Jessica Marx. Please join me in recognizing the tremendous work.

New Class, Awards, and In Memoriam:

Every year at our annual meeting, we take the opportunity to introduce the class of NAM members who elected last year. That is 2021, as well as our current fellows and scholars. So it's a great pleasure to welcome such an impressive group of individuals whom I have gotten to know better over the last few days. So let me begin by introducing to the members of the NAM elected in 2021, formally inducted this past Friday.

And you would agree, we have elected a phenomenal class of distinguished individuals, very proud of this 2021 class, not only for its excellence but also for its diversity in gender, race, ethnicity and disciplines. Following the introduction, the new members of the NAM Fellows and Scholars will be introduced. So I ask all of you to hold your applause until all the names are read. We're going to do it by video.

SPEAKER:
Samuel Achilefu. Alexandra K Adams. Richard MK Adanu. Michelle A Albert. Guillermo A Ameer. Jamy D Ard. John M Balbus. Carolina Barillas-Mury. Shari Barkin. Monica M Bertagnolli. Luciana L Borio. Eric Brodt. Kendall M Campbell. Pablo A Celnik. David E Clapham. Mandy K Cohen. Hillary O Critchley. Daniel E Dawes.Ted M Dawson. Job Dekker. Nancy-Ann M DeParle. Maximilian Diehn. Kafui Dzirasa. Katherine A Fitzgerald. Yuman Fong. Howard Frumkin. Andres J Garcia. Jennifer L Gardy. Darrell J Gaskin. Wondwossen A Gebreyes. Tedros A Ghebreyesus. Jessica M Gill. Paul B Ginsburg. Sherita H Golden. Joseph P Gone. Col Retired John D Grabenstein. Trish Greenhalgh. Linda G Griffith. Taekjip Ha. William C Hahn. Helena Hansen. Mary E Hatten. Mary T Hawn. Zhigang He. Edith Heard. Hugh C Hemmings Junior. Rene Hen. Helen E Heslop. Renne Y Hsia. Lori L Isom. Kathrin U Jansen. Christine K Johnson. Marianna J Kaplan. Elisa Konofagou. Jay Lemery. Joan L Luby. Kenneth D Mandl. Jennifer J Manly. Elizabeth M McNally.

Nancy Messonnier. Matshidiso Moeti. Michelle Monje. Vamsi K Mootha. Lennart Mucke. Vivek H Murthy. Jane W Newburger. Keith C Norris. Marcella Nunez Smith. Osagie Obasogie. Nwando Olayiwola. Bruce Ovbiagele. Drew Pardoll. Guillermo Prado. Carla M Pugh. Charles M Rice III. Marylyn D Ritchie. John-Arne Rottingen. Yvette Roubideaux. Eric J Rubin. Renee N Salas. Thomas Sequist.Kosali Simon. Melissa A Simon. Anil K Sood. Samba O Sow. Reisa A Sperling. Sarah L Szanton. Sarah A Tishkoff. Peter Tontonoz. JoAnn Trejo. Gustavo Turecki. Gilbert R Upchurch Jr. Tener G Veenema. Leslie B Vosshall. Rochelle P Walensky. Elizabeth Winzeler. Cynthia Wolberger. Anita KM Zaidi. Shannon N Zenk. Feng Zhang.

The Robert Wood Johnson Foundation Health Policy Fellows 2022 2023.

The NAM/AAN/ANA/ANF Distinguished Nurse Scholar-in-Residence 2022 to 2023.

The NAM Fellows 2022 to 2024.

The NAM Scholars and Diagnostic Excellence 2022 to 2023.

The Emerging Leaders in Health and Medicine Scholars 2022 to 2025. Congratulations.

So will all the new members, fellows, emerging leaders who are here today please stand. We're going to get another round of applause. I hope you feel very welcomed. Our members and fellows are truly remarkable group of leaders who are committed to improving health and making the world a better place for everyone. We rely on them to share the experience the expertise and guide the work that NAM and the National Academies do. Without our members, the NAM could not have made such an impact over the last 50 years as we have discussed yesterday. Now, unfortunately, we have lost several of our colleagues and fellow members since our last meeting. You'll see all the names listed here on the screen. Please stand and pause for a moment of silence to acknowledge them and pay respect to them. Thank you. I'd like to pay special tribute to Paul Farmer. As my colleague and a dear friend for nearly 30 years, who passed away unexpectedly in February this year. His passion to serve the poor and under-resourced remind me of my roots and continues to inspire me every day in my work and life.

Paul said, an important and enduring example for the health community. We must reach out to help those who need it. No matter the scale of the challenge. He was a human being who saw humanity in others. His spirit of service was a rare gift to this world, and he'll be truly missed.

Now turning to awards. Yesterday, we recognized three individuals in the fields of health, medicine and science. Mary Naylor from the University of Pennsylvania's School of Nursing. She's a recipient of the 2022 Gustav O Lienhard Award for Advancement of Health Care. And she received the honor in recognition of her work to improve the lives of millions of older adults living with complex health and social needs through her role as the architect of the transitional care model and pioneer the field of transitional care. So join me again in congratulating Dr Naylor.

Next is Daniel Geschwind from the University of California, Los Angeles, recipient of the Rhoda and Bernard Sarnat International Prize in Mental Health was groundbreaking work and leadership in the area of US autism genetics. His creation of autism, genetic resource exchange demonstrated the power of community resources to expand these important research efforts. Join me in congratulating Dr Geschwind.

And Jeffrey I Gordon from Washington University School of Medicine. He was the inaugural recipient of the 2022 David and Beatrice Hamburg Award for advances in biomedical research and clinical medicine. This award was given now for the first time to him for discoveries that transformed the understanding of how human physiology is shaped by microbial communities. Dr Gordon made a remarkable discovery on gastrointestinal development and the human gut microbiome and translating those breakthroughs into actionable interventions to reduce global health inequities. So please join me in congratulating Dr Gordon.

This way we can we also present awards to NAM members whose service to the mission of NAM and the National Academies have been particularly distinguished. Michael Johns was awarded the Walsh McDermott medal. Dean Jamison was awarded the Adam Yarmolinksy Medal and Dick Jackson was awarded the David Rall Medal. Please join me a round of applause for them.

We also presented the Cecil Awards to staff throughout the National Academies whose service have significantly contributed to progress towards our mission. We recognize Jamal Samuel, Sarah Beachy and the Primary Care Consensus Committee staff team. Please join me also run applause for those individuals. So congratulations again to all our deserving award recipients.

Welcome Remarks:

And now I'd like to invite to the podium the chair of the planning committee, Jeff Balser, who introduced the program and our keynote speaker. Jeff, as you know, is the President and CEO of Vanderbilt University Medical Center, and Dean of Vanderbilt School of Medicine. Welcome.

JEFFREY BALSER:

Thank you. (APPLAUDS) Well, let me add my welcome to NAM's 52nd annual meeting in the 2022 scientific program. Echoing Victor, thank you to our annual planning committee, and the NAM staff for their guidance and invaluable contributions to developing the scientific program. And for their incredible work to organize this meeting the first hybrid in-person and virtual annual meeting. This weekend and with this program, we're celebrating 50 years since the founding of the Institute of Medicine, now the National Academy of Medicine. And as we celebrate, we're also cognizant that the challenges for health and medicine have never been greater. We have at our fingertips powerful genome editing capabilities with the potential for almost unimaginable health benefits, yet the potential for devastating outcomes. We're at the threshold of data science advances that will answer questions with breathtaking speed and scale, but also present unprecedented privacy risks. And we are more than ever before challenged by a divided public.

Some inspired by our advances and others skeptical and even disdainful of biomedical sciences' finest accomplishments. So in planning this scientific program, the committee agreed that while it's certainly a time for celebration, it's also a pivotal time for reflection on the scientific enterprise itself. Well, science has changed remarkably over the past 50 years since our founding. The processes governing science have evolved far more slowly. In 1945, the nation's first presidential science adviser, Vannevar Bush, wrote the pivotal report 'Science the Endless Frontier'. He articulated future directions for the federal support of science and innovation after World War II. Beyond the creation of the National Science Foundation, the Bush report shaped the future direct directions of scientific research that continue to frame our policies and practices more than half a century later, even as the technologies at the forefront of science

have entirely reshaped the nature of discovery. Our paradigms governing training, publication, and funding largely look as they did 50 years ago, even though the challenges facing not only science but the health and well-being of society have changed remarkably.

So what better time than now to look ahead to the next 50 years and boldly consider whether our scientific enterprise is positioned for the challenges and opportunities that lie ahead? And if we are going to re-engineer the biomedical research engine to best serve humanity, how would we actually do it? This broad challenge causes the planning committee to ask even more precise and perhaps uncomfortable questions. For example, what fundamental changes are needed in our models for the publication of science and for the funding of science? How do we conduct science in a manner that not only seeks but compels health equity, and engages everyone to participate in the discovery process? Well, today's scientific program entitled, Revolutionizing the Biomedical and Health Sciences will address those and many more questions. And is followed by a distinguished president's forum led by President Dzau that will build on our discussions today. Our scientific program will feature three panels. The first will focus on factors limiting productivity and innovation, such as reproducibility, skewed incentives in publishing, and the lack of diversity in clinical cohorts, and will be moderated by Judy Woodruff of the PBS NewsHour.

Our second panel will focus on transformative and innovative breakthroughs and paradigm shifts with the potential to redefine science and innovation. And will be moderated by Apoorva Mandavilli of The New York Times. And in panel three will move to examples of breakthrough solutions such as new funding and investing models, the promise of scientific convergence, and compelling ideas for building the next-generation research workforce. This session will be moderated by Mariette DiChristina of Boston University. Now for some general logistical information following the panelist's remarks and moderated discussion, each panel will have about 15 minutes for audience question and answers. For those here in person, we'd ask you to please line up at the microphones in the aisles to ask your questions. And if you're unable to access the microphone, please just raise your hand, and a NAM staff member will bring a microphone to you. We'll also be taking questions from the virtual audience and we ask those listening via webcast to please utilize the Q&A tool under the live stream which will be monitored by our NAM staff.

In addition, after each panel, we will give the audience, all of us, an opportunity to answer a general question regarding the panel discussion using an audience response system called Slido. We look forward to seeing your reactions and perspectives. And now it's my pleasure to introduce the keynote speaker, Dr Mariana Mazzucato. She is a professor in the economics of innovation and public value at University College London, where she's the founding director of the Institute for Innovation and public purpose. Her work challenges orthodox thinking about the role of the state and the private sector in driving innovation. How economic value is created, measured, and shared, and how market-shaping policy can be designed in a mission-oriented way to solve the grand challenges facing humanity. She's the winner of international

prizes, including the 2020 John von Neumann Award, and the 2018 Leontief Prize for advancing the frontiers of economic thought. She currently chairs the World Health Organization Council on the economics of Health for All.

Please join me in welcoming Dr Mazzucato. (APPLAUDS) Mariana, can you hear me? We have a sound, an audio problem. Just give us a moment. Thank you. (BACKGROUND CHATTER) Mariana, can you hear us OK?

Keynote Address:

MARIANA MAZZUCATO:

I can hear you. Can you hear me? (APPLAUDS) I can hear you. (APPLAUDS) (BACKGROUND CHATTER)

JEFFREY BALSER:

Dr Mazzucato we can hear you fine. We're in good shape.

MARIANA MAZZUCATO:

Wonderful. OK. So I'll just share the screen again, OK? Let's do that. OK. So do you wanna just let me know if you can still hear me and see the screen? (APPLAUDS) Yes. (APPLAUDS)

AUDIENCE:

Yes.

MARIANA MAZZUCATO:

No reply. I'll start talking. (LAUGHS) (BACKGROUND CHATTER) We're good?

AUDIENCE:

Yeah. (BACKGROUND CHATTER)

JEFFREY BALSER:

Yes, we can hear you just fine.

MARIANA MAZZUCATO:

Very good. OK. So anyway, I was saying before, when you couldn't hear me that I wish I was there with you all, because I do think that what you're speaking about today, and what I'm gonna try to address is kind of the question of our time, which is, are we learning the mistakes that we're making again and again? Do we really have to go from crisis to crisis to crisis and

always be in reactive mode? What would it look like to have a proactive approach to how we organize business, to how we organize government, to how we also organize all sorts of other sectors, including the third sector, we can call it philanthropy, civil society, these other areas of the economy, which we know in the health sector have been very important to work together in a mission-oriented way? Why is it that it takes a war to teach us again what it means to have outcomes-oriented procurement, right? So it took COVID to remind us that we have the Defense Production Procurement Act, which was developed after the Korean War to actually structure, in that case, one particular instrument of government, procurement, which is government purchasing to be focused on an outcome, right?

We're using it again now with baby formula. Globally, even in Italy, where I'm from, we use that to produce nationally personal protection equipment, which until COVID, we were 100% reliant on Chinese production. And in just three months, and believe me, nothing happens in three months in Italy, in three months, we were able to be 100% independent, producing all of personal protection equipment from 137 Italian Small and Medium Enterprises. A tool like procurement, a tool like a grant, a tool like a public loan, a guarantee, a subsidy, a bailout program, a CHIPS Act, all of these tools can actually be designed in such a way that foster the public good, the common interest, or they can be a wasted opportunity. And this is really what I wanna address how we cannot continue to waste these opportunities, which, unfortunately, often come to us through crises. We're also facing today an energy crisis if we don't learn how to actually govern the system differently. And what do I mean by the system?

As an economist, I'm speaking about the economic system. And there is nothing inevitable in the economic system. Even the inflation that we're experiencing today, which I won't go into, that would be a whole other lecture, you know, it's not inevitable in terms of how we react to it. We need to understand the source of the inflation. If you just increase interest rates, you could actually make things worse, given that people already can't afford their energy bills. Now, they also can't afford their mortgage bills. So how we react to a crisis, but also what causes the crisis is not inevitable. And what I wanna speak about in terms of health innovation, and governing health innovation, very much stems from that. How to begin with the understanding of the economy as an outcome of how we govern our public institutions, our private institutions, and how they interrelate one with the other. And I have the honor to be the chair of the World Health Organization Council, on the Economics of Health for All, which really starts with that question.

The question is, what if, you know, a big what if? What if we actually cared about the mission, the goal? And what if we framed it as Health for All? So in the case of COVID, of course, it wasn't just the vaccines, not just one vaccine, eight vaccines, but vaccinating the world, right? If you have a global pandemic, the mission surely is to vaccinate the world. What would it mean for how we design the economy, how we design intellectual property rights, how we design public-private partnerships, how we design procurement, how we design all the different types of interactions between public and private entities? And this very much comes from also some

work that I've been thinking about for some years. And sorry for the self-promotional slide here, but very much about rethinking the narrative that we use to even describe government policy. The old narrative is that value is created in the private sector. And at best what the public sector can do is to fix so-called market failures. In other words, when the market fails, whether it's because of positive externalities, like the need to invest in research and development.

Negative externalities, the need to have things like carbon taxes. If it's framed as correcting a market failure, you will always be kind of out of breath, when you come to the problem. You will always be patching things up with different types of bandages. And what I think is really needed, and this is very much at the crux of what we're trying to do in the council is a different framing, a different narrative, a different story, a different theory, but also different tools, to co-create, and co-shape the economy we wanna live in, instead of constantly being stuck in this fixing bandaging things up. And I'll be mainly focusing on some of the issues that I talked about in the latest book 'Mission Economy'. But it actually comes from some early thinking around the entrepreneurial state. If you think about public investments in, you know, areas like the National Institutes of Health in the US, which this year invested over 42 billion in taxpayer money and health innovation. What does it actually mean to take that into account in terms of the narrative of where value comes from the first place?

What does that mean for not just the story, but for them the tools that we use to share both the risks, because that's a massive risk sharing, but also the rewards? What does it mean to make sure the prices are right? The intellectual property rights are right to begin with precisely so we don't have to ex-post pick up the mess. And in this wonderful council, which again, is called the Council on the Economics of Health For All at the World Health Organization, which was formed by Dr Tedros, who asked me to chair it two years ago. I should also say it's an all-woman council with 11 women from all over the world across the five continents. What we do is we, again, ask how to design an economy around the goal orientation, broadly defined as Health for All but of course, we unpack that in different elements of Health for All. And the four broad areas of the work we've done have been around measurement, how do we account and value Health for All? You know, the way we actually design our GDP system.

Actually is built to give us a problem when we confuse price with value. It's not a surprise that we haven't been resourcing our health systems enough. We've been clapping our essential workers. At least during COVID, we were clapping them. Did we learn to value that work, the social infrastructure of our global health systems? I fear not. How much of the global recovery, whether it's in the US close to 4 trillion of recovery funds, in Europe are 2 trillion of recovery funds? And globally, how much of global recovery funds have strengthened our health system? I'm afraid the answer is a bit depressing. So second capacity, it's impossible, you know, to actually govern a system without a strong public administration. And when we outsource that administration, when we outsource the resource, as well as not resource it enough, we have a

problem. So how do we also have an all-of-government approach, for example, to the tools in that way that I discussed before with the outcomes-oriented procurement?

What does that mean for the capacity, the capabilities that we need, and the fiscal space that we need? Third, finance. Finance isn't neutral. Money doesn't solve the problem. We need the money, and I just said, we need more money. But even if we had all the money and all the finance in the world, if we don't structure the finance correctly, we have a problem. And I used to do a lot of work on financing of particular sectors, including the biotechnology sector. And I looked at how the financing model has often been the problem. Just think of venture capital. It's you know, it's needed. Of course, we need venture capital. But when that type of finances exit driven, when the exit has to happen in three or five years, exit through an IPO, initial public offering, or a buyout, we ended up rushing the scientific process. And what's happened in the biotechnology sector, for example, is we've ended up with lots of people's product lists IPOs. It sounds like a disease. It is sort of a disease.

And so, you know, we need patient, long-term committed finance in the Global South. Sometimes this comes from development banks. Sometimes it comes from multilateral banking. Of course, it comes from public innovation financing, like the NIH, and so on. But the conditionality embedded in that finance really matters. And we know that in the case of the World Bank and the IMF, it's often been problematic conditionalities, that have actually ended up reducing the fiscal space that some countries in the developing world have been had in order to face their climate and health crises. Anyway, finance the structure, finance matters more than ever. So the financial intermediary fund today, which is supposed to help us prepare for the next pandemic, it can't just be about money housed within the World Bank, how we govern that finance matters immensely. And innovation. This is really my kind of passion. How do we govern an innovation system to really foster collective intelligence? And I love the word collective intelligence.

And it's kind of become a word, post-COVID because we know what happens when we don't have collective intelligence. When the intellectual property rights system is abused, we don't get collective intelligence. And I have nothing against patents, by the way, but when patents are too broad, so too wide, used for strategic reasons. When they are too strong, hard to license. When they are to upstream in the innovation process. So the tools of a research are being privatized. All these three examples, make the patent system part of the problem as opposed to part of the solution. And that's a governance, that's a governance question. And there's nothing inevitable in the patent system becoming a part of the problem. It's the decisions we've made that have... why is this not moving anymore? There we go. So maybe I'll just go quickly through some of these issues in terms of getting the value right, getting the governance right, the business right, the organizational structure right. First, I mentioned the word narrative before.

I've always been struck how this sector, the health sector is one of the most dysfunctional in terms of the story we tell of the collective intelligence. I already gave the example from the United States, but it's true also globally. I live in the UK. We have the Wellcome Trust. We have

different types of public funds being very important for health innovation, but it's not part of the story. And even when Obama, you know, did Obamacare, the idea that he was meddling in people's health care, it's not enough to say, no, we're not meddling, we're making sure that, you know, 60 million people get the insurance they need. It's the meddling word that's the problem. You know, that's what needs to be battled. Meddling in what? When 75% of new molecular entities with priority rating, actually trace their funding back to different types of public funds. You're co-creating a system. You're not just trying to regulate it in the interest of people which is also very important, but you've co-created the sector itself.

And this really becomes important when we think about prices. You know, value base pricing, I think is a very distorted notion of value, when would have that value for whom, but the idea that actually, the prices can basically go to what the market can bear through value-based pricing, and then you need the state to come in later to subsidize it, whether it's through Medicare and Medicaid in the US, whether it's through the National Health Service in the UK, so on and so forth. Why don't we just get the prices right from the beginning? And what should those prices be precisely given how the goods themselves have come about? And you know, the Bayh–Dole Act is fascinating because it actually has within it. This is the Act that allowed publicly funded research to be patented since 1980. It has as part of the Act, that the government should have the right to have margin rights for publicly funded drugs. They've never actually used that right. So I think it's also a confidence problem, even when it's in the law and we don't use it, there's something about the narrative and the energy in the room that makes you almost fearful.

You can put in all that money, 42 billion a year of NIH money, but then you fear, you know, affecting the price and the system because, of course, that's for the market, and maybe the welfare state later to come in to subsidize. Now, I could say more. But I think, you know, others have also been talking about this. I've been talking to some USA lawmakers about it over the last 10 years. And I think this problem is out there. But this is one of the key questions, I think in terms of getting the economy right ex-ante. So we don't have to pick up and bandage up the mess afterwards. And getting the governance right itself is interesting, because it's not enough to you know, put in all this money into the system. What would it mean actually to have conditionality, right? So imagine if the National Institute of Health program itself had stronger conditions attached in terms of sharing the knowledge. You know, just look at what happened with the eight different vaccines we have out there. I think they're a great test case of how we can actually do these things differently.

Sorry, the AstraZeneca vaccine, which was basically negotiated over with the Oxford University researchers determined a certain type of vaccine, which was lower cost, lower price, stronger knowledge sharing around it. Very different from the Pfizer vaccine. Very much as a result of, you know, these two companies being willing or not to negotiate around, I would call it common good principles. And, you know, this issue of business, I think is really important because the word business doesn't mean anything. The word government doesn't mean

anything. I mean, it means something. But what really matters are the details. How do we govern a system with the granular decisions that businesses have to make every day? The granular decisions that governments have to make every day in such a way to be outcomes-oriented. And this means that these governance decisions need to be looked at. So the corporate governance within business. This actually is very different between companies. You have some companies that have become over time, ultra-financialized.

What do I mean by that? A very high percentage of the net income they're earning ends up getting just distributed to shareholders, whether it's through dividend payouts, but also through different types of practices like share buybacks. There's nothing wrong with just buying back your shares sometimes. There's good reasons to do that. But the excessive use of share buybacks and in a kind of Anglo-Saxon form of capitalism has become something that, you know, the business world itself is talking about in terms of changing that away from shareholder value maximization towards stakeholder value maximization, what is it need to put purpose at the center of that? Well, something like 5 trillion, that's 12 zeros dollars have been used by the global 500 companies to buyback their shares in the last 10 years. And historically, the pharmaceutical companies alongside the large energy companies like Exxon, have actually been at the top of that list. So Pfizer and Exxon are actually very high at the top of that list.

So all of these are issues that first of all the world is talking about, the business world is talking about. But it itself could become part of what I would call conditionality, a new social contract between government and business precisely in a sector that receives this huge amount of public subsidy. So conditionality may be making sure that these funds are actually reinvested back into the system. And, you know, in terms of getting the organizational competence and structure right, what I always find fascinating and the reason I wrote Mission Economy is we would have never gone to the moon ever had we just thought of it as a money problem. You know, just putting a bunch of money here from the public sector and a bit from the private sector and we're somehow gonna get to the moon. It required an organizational form. It required an organization like NASA, which, you know, there's other organizations similar to NASA in terms of the dynamism and the project management of the organizations like DARPA, of course, which has been studied by lots of people, including myself, we do that when it's about the military.

You know, DARPA and NASA have been very interesting organizational forms of public investment because they were linked to a military-industrial complex. They, by the way, do get the prices right, including when BARDA, the B-A-R-D-A, BARDA funds, health innovation, because it's been linked to the military complex, they weren't naive about it in terms of making sure that the solutions and the remedies actually reached the people that they were intended for. You know, DARPA itself has funded a lot of health innovation. And they made sure that the prices of intellectual property rights, the procurement was done in such a way that, for example, the soldiers on the battlefield, who get sick receive the remedies that were co-invested in by the DARPA funding. And yet, we haven't done that with health. And this is why

already back in 2017, I actually wrote a report called 'The People's Prescription' with some colleagues where we call for an ARPA-H. This was pre-COVID. And it's nice to see also that this has been kind of highlighted again as an important development.

And the idea really is that it's not enough just to throw money problems, we also need to think of the organizational form that can then collaborate dynamically with the private sector, but also have a flat, nimble, nonbureaucratic structure, have an outcomes orientation, have attention to that public-private partnership, that really kind of, you know, takes on the point that this is about risk sharing. DARPA doesn't pretend, it's just fixing markets, it has always seen itself as an investor of first resort. And hence has also put a lot of attention to the design of the collaboration with the private sector. In my book, Mission Economy, I looked at how NASA even had a no excess profits clause in the Apollo program, in terms of how it worked with the private sector. They also the first thing they did in NASA was to change procurement to be fixed price like a challenge-oriented procurement, with incentives for innovation and quality improvement away from a more kind of cost-plus boring form of procurement, which doesn't inspire innovation.

But also, you know, these kinds of mission-oriented organizations, one of the things I've been thinking a lot about is what does it mean for other fits of our public landscape to think about mission-oriented policy? So mission-oriented organizations of the heart of Buckeye, but also mission-oriented policy. You know, going to the moon and back in a short amount of time, that was the mission. The grand challenge was to beat the Russians. Another today, that means something else, but already back then to beat the Russians. And then what they did was not just aerospace, they brought lots of different sectors together, nutrition, materials, electronics, software. So many different homework problems had to be solved, which got us the spillovers we have today. Camera phones, again, software, foil blankets, baby formula, lots of those innovations came about bottom up in the business sector as solutions for a very strong publicly directed target and mission. And unfortunately, we don't have this often.

What we ended up with is ideas that the importance is to commercialize a sector, including space today, bringing in the private sector, which of course is important. But when we then lack a clear mission statement, that relationship between public and private can go really wrong. And of course, the mission itself can't be commercialization, that should be one of the outcomes. And the irony is that when commercialization is the mission, we don't even commercialize very well, because there's no common goal that actually stimulates a lot of that innovation. I worked with different governments, including the UK government when it was still functional around thinking about mission-oriented industrial strategy. This is just an example of how we worked. In other words, instead of just having a list of sectors like life sciences to throw a lot of money at, what would it look like if we had really clear kind of mission statements like zeroing the digital divide, having carbon-neutral cities across the United Kingdom, but also enhancing the capabilities and quality of life across the course of our increasingly longer lives to

formulate an interesting mission statement around aging and what that would mean for an industrial strategy.

So cross-sectoral investment, cross-sectoral risk sharing, but also a more symbiotic public-private relationship around those. And again, in the work of the council. I won't go through all the great work we've done, but I do recommend you go to our website to look at some of the work that we have done around those four themes of value innovation, finance, and capacity very much trying to bring this kind of, you know, mission-oriented thinking to the table. And you know, it's more important than ever because actually, there's COVID relief funds, recovery funds. There's global funds like, as I mentioned, the financial intermediary fund. And unless we actually govern these funds in a mission-oriented way, we ended up with quite a few problems along the way that we create. And let me just move here. So I just mentioned the financial intermediary fund. Yeah, I think it's really important to also maybe sandbox, you know, like, let's try to do this differently. I already mentioned the vaccine.

I think there's a real opportunity, and I'm not sure anyone's done it to unpick what actually happened with vaccine development and where it went wrong in terms of that public-private relationship. How can we really build, again, this kind of more symbiotic ecosystem from the start, so we don't have to pick up the mess later? And there's an opportunity to do that now with the mRNA technology hubs. There's 15 countries around the world that are contributing to the kind of hub and scopes mRNA governance system. And we're starting through the council to actually work closely with the hub precisely to pay a lot of attention to the conditionality to design of the collaboration, to the design of the knowledge sharing, the patent pooling, the pricing system, but especially the collaboration, because all of this has to be about collaboration. It's not about one party, the government doing everything. That's where, of course, it differs also from the Apollo program where the mission itself actually did come quite a bit top down, even though the solutions came bottom up.

Increasingly, these social challenges that we have, which are harder than going to the moon. So the health challenges, the climate challenges. There's one issue, which is, who actually decides what the mission itself is? How can we truly also co-create it by listening, having more empathy, and truly fostering that collective intelligence also in terms of the mission statements themselves? And one of the things I've tried to do through the institute that I set up at University College London, I can just actually stop sharing in a minute here, is, you know, like really asking, what is the new design of the state itself that all of this requires. You know, and Plato had this wonderful quote, which apparently was actually a quote from the famous Native American Indian. But we can attribute it both to Native Americans and to Plato, which is that, "storytellers rule the world." And there's something about the stories we're currently telling about health innovation, which I truly think are hurting our ability to galvanize that collective intelligence.

And to change the story, we need to talk less about fixing markets, more around co-creating, less about de-risking, more about welcoming the uncertainty, which means you might screw up

along the way. Kennedy's famous quote, "we're doing it because it's hard, not because it's easy," is completely different from the policy wonk terminology we have today, which is all about facilitating and de-risking. And I'm Italian (SPEAKS ITALIAN) means easy. So facilitating means you're making something easier for someone else, it's very different from saying we're doing it because it's hard. So welcoming uncertainty, experimentation, trial and error means also for the civil service itself, public administrations, being willing to accept that failure, but also making sure we're sharing not just the risks, but also the rewards. Away from picking winners. So you know, the point of government is not to choose one technology, one firm, one sector, but really, truly picking the willing and tilting the playing field, not leveling it in the direction.

So rewarding those organizations that are willing to move with you, for example, around an innovation system that is fostering collective intelligence. Why should subsidies, guarantees, or grants be given to or being benefited by companies that refuse to at least reinvest those profits that are collectively created into the system, as opposed to share buybacks? The outsourcing issue is massive. There was the head of procurement in the NASA program and Apollo, this guy Ernest Brackett, he already started witnessing back in the 1960s something that a new book I'm writing called 'The Big Con', the history of how Consulting has weakened our business, infantilized our government and warped our economy. He was already warning against that back then. He said, "if we continue to outsource our brain in government we won't even know who to work with. We will get captured, he said by brochure manship." So this is a huge issue. How do we insource that government capacity? Because we know businesses require capacity.

Of course, they create value. Well of course governments too. And if we haven't been investing within, not just through government, but within government, we will have a problem. And also there's a whole issue of metrics. You know, how do we actually evaluate a system, which is trying to create a market and not just fix one? How do we evaluate a system where the success should be how much economy-wide spillovers, we've been able to foster across all those different sectors, just like going to the moon, as I mentioned, was not just aerospace? Well, surely all our health challenges have as much to do with the preventative areas, including nutrition, but also how we build our mobility systems, how we walk, where we walk, how our cities are constructed? There's all sorts of different, you know, really important challenges there. Let me just turn this off to say goodbye to you with my face on screen. So just to say, it's such an honor to be able to address you today. My time is up. And if there's one, you know, one word or one last thing I'd like to say to you is that I often walk in as an economist to meetings with government officials, and I come out as a life coach 'cause I do believe we have a bit of depression.

There is, you know, just think of what's happening today with the kind of, you know, Elon Musk narrative of space without any real recognition on how he stood on the shoulders of giants. Again, the NASA program, but this is even more true in the health sector. Lots of different actors, biotech companies, large pharmaceutical companies, different types of public entities

globally. We need to rethink the narrative and the story of how to talk about the wealth that's created collectively, but also the tools to make them more outcomes-oriented. And to truly make sure that the benefits of this incredible wealth-creating machine are truly reaching the most people possible. And surely, for the next pandemic, let's make sure we're more prepared 'cause we were really caught off guard. Thank you very much. (APPLAUDS) I can no longer hear you.

JEFFREY BALSER:

Dr Mazzucato. Thank you, first of all, for your patience with our technical challenges at the beginning and, most importantly for your important remarks on reshaping the governance of health by changing the narrative. Thank you so much. And once again, please, let's express our thanks for Dr Mazzucato. (APPLAUDS)

Panel 1: Disrupting Challenges in the Scientific Enterprise

SPEAKER:

Well, now I'm delighted to introduce the first panel of the scientific program, which is entitled Disrupting Challenges in the Scientific Enterprise. Our moderator is broadcast journalist Judy Woodruff, the anchor and managing editor of PBS NewsHour. She's covered politics and other news for five decades at NBC, CNN, and PBS, including as chief Washington correspondent for the PBS MacNeil Lehrer NewsHour and as anchor of the award-winning docu-series Frontline with Judy Woodruff. She and the late Gwen Ifill were the first two women to co-anchor a national news broadcast. Please join me in welcoming Judy Woodruff and our panelists to the stage.

JUDY WOODRUFF:

Thank you very much. It's really wonderful to be here. I was only able to hear the end of the introductory remarks, but what a stimulating way to get this today's session underway. I'm really very happy to be here. And I have to say, I haven't learned how to say no to Victor Dzau. So, that's a lot of the reason that I'm here. And of course, there's not much going on in the news these days, so it was easy to slip away. So, as everybody knows, our discussion has been titled Disrupting Challenges in the Scientific Enterprise. And we want to spend the next hour or so with a candid look at exactly that. What are the main challenges facing the scientific community and facing individual scientists and physicians, including future scientists and physicians who are committed to addressing our nation's greatest healthcare needs and healthcare gaps? There's no question with the COVID pandemic and its sweeping effect on all of our lives, with demographic changes in this country, with international developments, with

shifts in immigration laws and policy, technological and scientific developments, with budget constraints that we are all very familiar with.

This is a difficult moment for basic science, for medical science in the United States. And so we are so fortunate to have this extraordinary panel to tackle these questions this morning. I'm gonna... they are and I'm going to say their names and then say a little bit more about them when they speak they're DR Neil Hanchard, DR Dietram Scheufele, DR Ali Shilatifard, and DR Huda Zoghbi. So, welcome to all four of you. I'm going to give, as I said, a brief introduction when they speak, but I encourage you to please read their full biographies which are printed in your program. They're each going to speak just a word about the process here. They're each going to speak for about 6 minutes. We've been given strict instructions on what we're doing. Then we're going to have a discussion among ourselves for several minutes, after which you in the audience will have the opportunity just to ask questions. So, let's begin with Dr. Neil Hanchard. He is the senior investigator with the Center for Precision Health Research.

He's the head of the Childhood Complex Disease Genomics section at the National Human Genome Institute. Please give a warm welcome to DR Hanchard.

DR NEIL HANCHARD:

Thank you very much for that very warm introduction and for the invitation to participate in this. It's truly an honor. So, I wanted to start by talking about the challenge of diversity in the medical and scientific enterprise. I think all of us are aware that, you know, health disparities are well-documented across the entire health and scientific spectrum. But I think more recently, we started to learn about the importance of who we study and about who studies the who that we study. And so just for a few minutes, I wanted to use some examples from my own field, which is in human genetics, to sort of illustrate this. But I'm sure it's true for almost every other specialty. So, in human genetics, we've known for some time now that there is a diversity gap here looking at genome-wide association studies. These are genetic studies using 1,000s of individuals, of which there have been 1,000s of studies. And we knew for a long time that the vast majority of these occurred in individuals of European ancestry.

If we fast forward now to 2022, you'll see that the situation is not much better. It's arguably a little bit worse. And in fact, if we look at very large sequencing studies where people sequenced the genomes of 100,000s of individuals, again, underrepresented populations remain underrepresented. And this has its own detriments. So, if you take a composite of genetic variants and you're trying to develop these risk scores, you'll almost always find that the accuracy of that risk score is lower in non-European individuals. And this is the same thing that happens when we start to think about artificial intelligence or machine learning in health care. What you train and who you train your initial algorithms on has a downstream effect. And this downstream effect is real. It actually affects patients. So, this work coming out of Vanderbilt demonstrating that individuals with this genetic variant, which predisposes them to a benign low white blood cell count, the variant is much more common in individuals of African ancestry.

But we find that these individuals are much more likely to have a biopsy, bone marrow biopsy, even though that is almost always going to be negative. And so this is an example where the clinical algorithms that were put in place don't really take into consideration having the full diversity of genetic spectrum that is present in the population. Conversely, on the other hand, diversity actually is very much augments medicine. One of the best examples is PCSK9. Loss of function variance in this gene are associated with lower cholesterol and have since been translated into downstream medications. But almost all the individuals with these loss of function variance were African-American in ancestry. And so essentially, this study wouldn't have been positive if those individuals weren't included. In fact, if we even though the participants in these genome-wide association studies are overwhelmingly European, non-European individuals have an outsized contribution to the actual associations and findings that are found in these studies.

And we have done sequencing, genome sequencing in just a handful, 400 or so individuals from the African continent, and identified millions of variants that have not been previously cataloged or captured. And this has the effect... it has a strong effect, we believe, on sort of genomic medicine. It provides a broader reference and certainly helps in the diagnosis of very rare disorders as well. And of course, this problem of the diversity gap is sort of further augmented when you think about the who, who is doing the studying. So, this is data from the NIH showing that you know, individuals, say African-Americans remain heavily underrepresented among PHD recipients. This gets translated further when you start to talk about the career ladder, particularly as you go higher up towards professor and department chair and continued degradation. And of course, this again translates into what we see with research grants and the number of individuals from underrepresented groups who are participating there.

So, what do we do? You know, I think one of the things to think about is the simple idea that we have to be more mindful about who we study. This is something that the all of us program in the NIH has been particularly mindful about, ensuring that there is this engagement with communities to ensure a broader representation of individuals. But this needs to be the norm and not the exception. Similarly, you know, we also have to think about ensuring that all the inlets to our pipelines in academia are filled and how they are accessible to individuals across the spectrum of ancestries. But it's also evident that it's not going to be sufficient to just do this in the United States. We need to be engaging internationally in a meaningful way and particularly engaging investigators in that context, because it's now sort of well understood that by doing just having those kinds of touchpoints, you have this ripple effect that then goes out and impacts the rest of the field and the society. So, I'm going to stop there and just thank you again for the opportunity and look forward to the discussion forthcoming.

JUDY WOODRUFF:

Thank you, DR Hanchard. Our next panelist is Dietram Scheufele. He is the Taylor-Bascom chair in Science Communication and the Villa's distinguished achievement professor at the University of Wisconsin-Madison, and in the Morgridge Institute for Research. You're next.

DIETRAM SCHEUFELE:

Well, thank you so much for having me and for letting me share what I'm hoping are three big challenges and opportunities that also echo some of the things that we've heard all morning. And I will push back a little bit on the idea that science in the first challenge, that science during COVID was science at its best and work the way science is supposed to work, meaning in a self-correcting way. And we knew that going in. Many of you saw Adam Marcus's and Ivan Oransky's piece and (INAUDIBLE) warning us early in the pandemic that science would produce missteps. And as long as we knew that we would, we would be fine. We had actually written about this in the replicability and reproducibility consensus study report where we had said, look, if you see a single study result that contradicts bodies of work, you should be careful about that. And if it should basically never draw conclusions based on single studies. But of course, during COVID, that's exactly what we did. We battled it out in The New York Times.

One study on mask-wearing versus the other, which of course, as a scientific debate, is largely meaningless. And there is some really good... There were really good reasons for that. We were faced with a really unenviable dilemma as a community. We had to correct information that we knew to be wrong with science that we were not quite sure would turn out to be right. And that was not a good position to be in, and it left us extremely vulnerable to political attacks. Here's a tweet from Laura Ingraham, who said, Well, next time they tell you to trust the science. And Victor spoke to this morning. Think of all the studies that got retracted and turned out not to be true. We also heard this morning points about trust. These are data from the General Social Survey. These are the data that typically go into the science indicators that the NSF puts out. And if you look at the latest iteration, you see a wide gap between liberals and the rest of the country. Those are both independents and Republicans who make up about seven in ten Americans.

And that gap is partly produced by us not having taken Republicans and independents with us, but largely by liberals being really excited about science as a partisan tool because Trump didn't believe in science and we do. And the moment science becomes a partisan tool, we're in deep, deep trouble. I'll come back to that in a second. That brings me to our second challenge and Victor also spoke to this morning, and that is that we're operating in a fundamentally different, algorithmically curated environment, information environment than we used to have. Facebook is pretty flippant about this. This is Adam Kramer at Facebook who has said that Facebook is the largest field study in the history of the world. And that's true, except for it's one that most of us have absolutely zero access to in the academic community. It's proprietary data that's largely inaccessible to us. And as we're figuring out trying to figure out as scientists how to better communicate, we're doing so on a platform that is optimized for outrage and conflict, not on a platform that's optimized for consensus and for settled science.

So, how do we do communicate? How do we communicate settled science on a platform that is designed for the exact opposite meaning for disagreement and questioning each other? How do we have debates about reasonable disagreements on policy while bringing in the best available scientific evidence? And how can we get consensus across in those settings? That brings me to the third challenge, and that is that dovetails really nicely from one of the last slides in the keynote, and that is why are we being so unscientific when it comes to communication. This is a study that many of you know it's more than 40 years old and it has eerie wording given what we went through in COVID, an unusual Asian disease which expects to kill 600 people. That eventually was one of the studies that won Daniel Kahneman, a Nobel Prize in economics in 2002. It depends, of course, how you respond to those 600 that are affected. And if you believe in an intervention like mask-wearing or vaccination. If I tell you in the first condition that 200 people will live or in the second condition, that 400 people will die.

Meaning, if we frame it as again as something that is actually working, worth working toward versus a loss we're much more likely to get by on, well, what happened during COVID? This is a study of from 84 countries in terms of how we ended up framing COVID and we framed it as the 400 people dying, meaning loss framing with no clear benefits in terms of behavioral or other outcomes. So, 40 years later, and this really echoes what we heard in the keynote. We're repeating the same mistakes because we're not paying attention to the best available science that's out there. So, let me use my last minute just to highlight or frame this, reframe this and listen to my own lessons and reframe this as opportunities rather than problems. One is, I think we need to think for the next 50 years as Victor accrued up earlier about our scientific structures ready for what we have called in a piece in slate and in issues accelerated wickedness. There were no best scenarios out of COVID and we had to make decisions really quickly.

Lots of studies got retracted and they got retracted not for malfeasance or misconduct, and that's a good thing. They got retracted because they probably shouldn't have been published in the first place, and we pushed them through way too fast and that ended up causing long-term damage to science. And we need to do better the next time around. Number two, when it comes to new information environments, we typically respond and we say, well, people need to we need to build literacy. People need to better grasp these new algorithmically curated environments. But that's like telling Kasparov after he lost to Deep Blue that he needed to up his chess game. Deep Blue was created to beat Cuban's at chess. Facebook was created to exploit human vulnerabilities in cognition and in emotion. So, our collaborations likely should be with platforms and at a very different level in order to create an information environment that has democratic benefits in the long run. And the last thing I'll say is the power of social science.

When Francis Collins left the NIH he said, "I wish we had more social and behavioral sciences to guide us." The fact that he doesn't know about this is partly due to social science is not communicating in a way that touches other fields and that informs the work in fields like this.

So, I think that the onus is very much on the social sciences themselves. And I just want to end by mentioning the National Academies Committee on Advancing Science Communication that within the academies is trying to do exactly that. So, I'll leave it at that and apologize for having gone over a few seconds. Thank you.

JUDY WOODRUFF:

Thank you, DR Scheufele. I would just add that Francis Collins said that in an interview I did with him. No comment on that. Our next panelist is DR Ali Shilatifard. He is the Robert Francis Furchgott Professor of Biochemistry and Pediatrics, and Director of the Simpson Querrey Institute for Epigenetics at Northwestern University. He's also the editor of Science Advances, The Magazine. DR Shilatifard.

ALI SHILATIFARD:

Well, thank you so much for having me here today. And last night was great to be among you. So, as I mentioned, I'm a biochemist and I study chromosomal translocation that evolve in pathogenesis of heme malignancies in children. So, I sort of go into different meetings throughout my career, both clinical and also scientific. And I've made a religious habit of attending all the poster sessions because, you know, it's a good way of learning on what's going on in the field from the student and individuals who are doing the work. So, the topic that I like to discuss today is that how do we recruit, inspire, promote, and retain our workforce as basic biomedical scientists, as students, postdocs, faculty and inspire them to do what all of us love doing. Experimentation, discovery which result in things such as COVID vaccine, can come out of molecular biology and next-generation sequencing. So, attending all of these meetings and listening to the posters. An alarming statistic, just my own statistic come to me is that large proportion of the students that I have spoken to during the past year or so have chosen not to go to academia for their postdocs.

They're going into pharma, they're going to industry, they're doing some sort of a financial business, or they're just changing the whole career. And so I have, you know, written editorial about this. I've talked to DR Zogby about this. I've talked to my colleagues. And so this, I'm here to today to sort of share with you the problem I see and how are we going to solve this issue as a country together. Because if we don't have strong biomedical research, strong science, we will not advance. Right? So, to develop a collaborative environment that provide us infrastructure to have what we want to have, there are many parts to it. I think mentorship is very important. You know, how do you inspire students not only graduate students and medical students but, you know, kids in their first grade and eighth grade to love science and want to do science and do science for the joy of it? How do you provide equitable educational opportunities? This doesn't again, start at graduate school and medical school.

We need to start that at elementary grade, all of us got hooked on science sometimes early in our lives, right? I did a five with my grandfather. Right. So, I think we really need to inspire our youngers to do that. And most importantly, how do you disseminate scientific information? So,

I'm not going to tell you about my science, but I'm going to put my editor hat on and tell you about dissemination of science. And towards the end, maybe I'll spend a minute with you just say something about funding because, you know, I think that has been a major issue as well as we discuss how do we move on to the next stage and having others join our team to do science with us. Alright. So, ability to publish groundbreaking work within a well-read, well-respected journal in a timely manner is definitely a desire for all of our trainees. They all want to publish in the glossy journals. Why didn't want to do it? Because if they don't, they're not going to get a job. And somewhat this is true because when we look at the promotion committees when we look at the hiring committees, those are very important things where the work is published carries a good bit of weight.

But some other committees, you know, look at the in-depth, what is published in a given paper. So, where to publish I think becomes a very important issue to discuss and or to publish is that what is the reputation of the journal that you have. So, when I tell you about this journal that we started when DR McNutt was the editor-in-chief of science and the Science family and under the leadership of DR Holden Thorpe, and I've served as the editor of the Journal since its inception. It's called Science Advances. And is an open-access journal. And we have one criteria, and our criteria is that how do you set the standard for your journal? And the way we set the standard of Science Advances within Science families, then we hire the best of the best practicing scientists, as our deputy editors is our leaders in their given field. And we asked them one question when a paper comes to you, are you willing to put your coffee down and read it? And if the answer is yes, that paper should go out for review.

And that paper goes to the associate editors, whom also rising star and fantastic scientist in a given field that they have. And they ask the same question and if they agree with the editor, then the paper goes to the reviewer and we ask one question from our reviewer, does the data support the conclusion? And if the answer is yes, we need to publish. Right. And I think this is what we have started. The Journal was started in 2014-15, we receive about 700 papers with a handful of editors and seven years into it are hitting somewhere about 20,000 annual submission, over 500 editors. And now a question for us becomes how do you publish things and disseminate this knowledge in a timely manner? And we have a fantastic office run by Laura Remmers and her team that really push the editors to make sure they stay on time because we want to make a decision as rapidly as possible. And if we decide to review, we want to send those paper out review. And I think this is one way for us to see how to solve the problem.

So, you're in the audience. If you're asked to review for us, join the team, please do it, because this is a great thing for our community, because it's a community-run journal. And I think that that's probably solved an issue regarding publication and the frustration that the trainees are having because they see, you and I spend years on a paper, years on a grant, and don't get it. And so I don't want to do this. I'm going to go do something else. And I think Science Advances is pushing forward at least to solve that problem. The one challenge I don't want to discuss has

nothing to do with the publication is that you know, how do you compensate scientists and provide them a fair level of support, not for themselves, but also for their research? And I kind of spent an hour talking about this. Actually, I wrote an editorial on this thing. I encourage you to read this. And there's a dire need for the support of molecular research. And what talks about is that NIH funding when I started my career 25 years ago was $250,000 and maximum you could get was about two grants.

30 years later, we're still just $250,000 NIH R01 and maximum you can get probably two grants. But a lot has changed with the salaries, with the price of the antibodies, all of that, and the value that NIH R01 had 30 years ago is basically one-third today. And that's really setting us back. And I encourage you to read this editorial and we should think about as a community, you know, how we can encourage NIH to change their ways of being able to fund more R01s where we can do most molecular research. So, with that, I stop.

JUDY WOODRUFF:

Thank you very much. And our fourth panelist we're delighted to have with us is Huda Zoghbi, Doctor Huda Zoghbi. She is professor at the Baylor School of Medicine. She's investigator with Howard Hughes Medical Institute. She's also director of the Jan and Dan Duncan Neurological Research Institute. Welcome, DR Zoghbi.

HUDA ZOGHBI:

It's an honor to be here. So, today I'm going to focus on the physician-scientist among the group of scientists because we do need this group. This is majority of the members of the National Academy of Medicine also have our physician-scientists. And I thought I'll start with a personal story. I was trained as a pediatric neurologist and I had no idea I will do science. But while in the clinic, I encountered medical problems, neurological problems that I thought the only way to help my patients is to do research. With no training in basic science, how am I going to transition? And I was fortunate that I identified the problem. I had this one big family I could study to find the gene and the great mentor. But that was the only thing I had. No preliminary data, no additional training, and I want to hit the ground running. And I was fortunate that during my clinical training, I could write what's called a K08 or mentored training application and started in the lab with funding in hand. That's back then.

Today, a physician if the same thing happens, they have to have so much more clinical data, material, preliminary data and they're challenged, they cannot get the funding, they'll be discouraged. They will never take that same career path. So, that has to change. And of course, I'm just now going to go through additional challenges they face the publications everybody is pressured to publish in high impact journal. Everybody is pressured to have a grant before they go any a competitive job. And often the grant doesn't cover the salary above the NIH cap for physicians so they get pull to do more and more clinical work, taking them away from research. Many of them have debts. So, the financial pressure gives them the option then to go into private practice or clinical practice, or pharma. And there is a frustration about getting access to

data. I hear that from many, and especially for junior investigators, they have no recourse. They don't know how to complain without hurting their careers when they can get access to published data.

And lastly, many do not feel prepared to navigate an academic career. So, these are our challenges. And what I thought I'll do is I'll just run through very few ideas so that we can maybe set the stage for our discussion with you. I think we begin to address these challenges. As we discussed earlier, funders, NIH, foundations, and other funders, they need to think about ways to invest in physicians whose inspiration happened during the clinic. So, they may not have a science background, but if they're committed to that, we do not want to lose this population. I would not have been a scientist if nobody invested in me at that time. We need to support physicians who wish to collaborate with scientists. This doesn't take major effort. A small amount of time protection will be helpful and this is the prime time to do it. Today, surgeons are in the operating room day in and day out, getting access to various tissues from humans. That is so valuable for scientific discovery, but they don't have that skill.

However, if they have a little bit of protected time-funded time so they can collaborate with basic scientists hand of that tissue, we are more likely to make very meaningful discoveries. Another thing we need to think about, we have to think about funding beyond the NIH cap, at least also for certain specialties. Take, for example, neurosurgeons. The brain can benefit so much brain research from having neurosurgeons who are clinicians engage in research. This is a true piece of data from a neurosurgeon who's mapping the tract in the brain to do deep brain stimulation for a psychiatric disorder. If we protect the neurosurgeons' time if we give them the time they need beyond the NIH cap, because otherwise, you will never recruit neurosurgeons to be in research. They will be pulled into clinical practice. We can have them. Even a clinician who doesn't do any research, having that clinician given protected time to talk to a computer scientist so that now the data that the computer scientist will learn from the clinician with all the nuances in clinical medicine will be the input to all that machine learning and artificial intelligence program that's being developed.

The more we have good outputs, meaningful output, the more we will have better algorithms to solve our problems. But unfortunately, our clinicians don't have any time to spare to sit down with the computational scientists and have that dialogue. These are opportunities that are different from how we did medicine a few years ago that we should capitalize on. So, I want to also address the idea of the access to data. I think there have to be consequences NIH demands it, but there are no consequences. Something has to be put in place. Of course, institutions have to play a role. The committees have to focus about the work, not where it is published. All of us, all of our search committees have to take that. And we have to encourage collaborations. And we have to really recognize as scientists for their collaborations that they are part of a team for what they've done, they don't have to be always individual, science is changing. And as I mentioned, we need to support our physician-scientists and treat them as we would basic scientists with proper packages to protect their time.

And they ask for mentorship in soft skills. They need that they don't need no financial aspects of running a lab. We need to dedicate time for that. We also need to educate the mentors in these soft skills to help ensure that there's a healthy lab environment and mentors are attentive to the vulnerability of women underrepresented groups. They're highly capable but the confidence sometimes need that mentorship skill. And lastly, I don't want to forget industry. I think that investment in preparing trainees typically happens in academia, but companies and various industries are the great beneficiaries from that. So, industry builds on the discoveries and many discoveries that happen in academia. However, this pipeline is going to dry if students do not pursue postdoctoral fellowships, as you just heard from Ali. Industry needs to be a partner with us. They have to be a partner by contributing to the support of trainees. This can come in special funds, perhaps given unconditionally to special foundations NIH, to mentor the next generation and to also perhaps support clinicians so they can contribute to the science engine.

Thank you. (APPLAUSE)

JUDY WOODRUFF:

Well, there's a lot for us to think about and to discuss in the time that we have left. I'm gonna come back to you in succession with a question from me, and then I want the other three of you. For example, my first question will go to Dr Hanchard, and then I want the others of you to ask him your own question. But Dr Henchard you, I mean, diversity is something we are all thinking harder about these days. Why has it been so hard, do you think, in the scientific professions, in the medical professions to institute more diversity, racially, ethnically, and so on?

NEIL A HANCHARD:

Yeah. Now that's a great question, although complex. One of the things about engaging communities is that you have to have a measure of trust. And when it comes to engaging cohorts and communities and involving them in research, often that trust barrier is a great one, particularly for communities that have traditionally been underrepresented in those communities, have also been exploited particularly in research contexts. And so there is this trust barrier, particularly in the United States, to being able to engage these communities, to participate in the research. And so, the groups who have had the most success with this have established much longer-term kind of interactions where it's not just a sort of one and done type of deal where they're sort of going into those communities and engaging with community leaders, but then also with individuals from that community. So that's part of it. Another part is, as I said, the sort of inextricable link between who you study and who is doing the studying.

It's not necessarily quantified as well as it perhaps could be. But if you talk to people from communities, they want to see their own people who are looking after them. They want those people to be part of the study as well. And groups, where that has happened, have had a lot more success in being able to recruit individuals. So it's kind of a dual kind of thing, at least at

that kind of level to be able to engage these communities. So some of these things are sort of simple things to sort of outline and sort of well known, but harder things to overcome. And that's where I think we need to be a little bit more nuanced and clever about how we think about it. I think generally people think about diversity and they want more diversity, but not necessarily realize that the purpose of that diversity is to make things more creative, is to allow people to think about things differently. And so people often want diversity, but they want the same status quo just with people who are more diverse looking.

And I think we have to sort of make sure that that is an actual shift and not just a sort of whitewash.

JUDY WOODRUFF:

What do you think is easier to do? Neither one is easy, but which is less difficult, shall we say, changing who has studied or changing who is doing the studying?

NEIL A HANCHARD:

Yeah, I think that who we study is, as I said, particularly in the United States, some of the past histories and so on have created some real almost chasms in terms of being able to engage communities. And you hear it all the time. They talk about the Tuskegee experiments. They talk about the (UNKNOWN) tribe. There are lots of examples out there. And so I think that that's a big chasm. I think we're probably in a position where for some of these studies if we just were able to engage individuals who come from those communities and are studying those things, and particularly that that's what they want to study. My sense is that that would be an easier, lower-hanging fruit. But as you said, they're both very challenging.

JUDY WOODRUFF:

I'd like to get the three of you to speak about your own experiences with diversity, you touched on this, Dr Zoghbi.

HUDA Y ZOGHBI:

And I... I mean, the team I work with had an amazing, surprising experience. We have a group of scientists who solve the unsolvable, diseases, neurological diseases. So, and some of those are rolled with an NIH-funded undiagnosed disease network program where people get sequenced and you try to solve the mystery. To our surprise, we realized that people who don't have medical insurance are less likely to be enrolled in that program because they wouldn't get the medical sequencing if those happened to be people from underrepresented groups. So that left out the whole segment of the population with unsolved diseases that couldn't be solved. So a group of investigators at Baylor in Texas tried to put together an NIH grant specifically to Neal's point to target that population and begin to solve their problems and called it the Texan project that's in Texas. And they made it in Spanish and English because many are Hispanic who

didn't even know this is accessible to them. And it's amazing within it's funded and locally funded by the institutions.

Together now they've solved over 27 cases that have been left unsolved within the first year. But this is again, it's your question. It's really who needs the help and who is doing the help. We need to be communicating that surprise me that this whole segment was left and studies until we became alert that this is not happening.

JUDY WOODRUFF:

No question. What about the two of you? What thoughts?

DIETRAM A SCHEUFELE:

Again, and maybe I can jump in on what Neil said because he already spoke to the historical explanations for a lack of trust. And it also goes back to Victor's point from earlier about, you know, rebuilding trust. And for us, of course, often becomes a communication question. And in the field that I work and it becomes actually a lot more complicated when you don't just look at historical events that may have a tremendous lack of trust. But just the realities of 2022 and an African-American mother in the US that between conception and childbirth is 300% more likely to die than a white mother. That's not a problem of us to be building trust. That's a problem of us addressing health disparities. And that's not just a US problem, in the UK I think that rate is even higher at 400%. But one way or the other, it's not a matter of saying, well, here's why you should trust us. It's actually fixing the very reasons at this very moment in 2022 for the lack of trust. That's actually not unreasonable at all.

And so I think that's where the real complexities come in and why we've had such a hard time to your earlier question why has this been so persistent as a problem?

ALI SHILATIFARD:

For us, I agree with everything said in here. The thing about diversity in education and the pipeline. So and one of the things that we have done is that we've just raised an endowment from our colleague Kimberly Curry in Chicago, where we have this program called the Rise Program, where we go to low-income neighborhoods and kids from first grade to eighth grade, we bring them to our hospital, to our laboratories. We provide grants for their classwork that they know they are able to buy microscopes or magazines and things. And I think the key is the inspiration that if there are kids who have never been exposed to science and medicine and now they come in to spend a full day with us and they get that exposure. Out of 100, if we turn two of them on into science. And to think that's a possibility career for them. That's so that has been our approach and to sort of increase the pipeline in the way that we have. And I think we definitely need to think about elementary, middle school, high school education on science and inspiration, because that's gonna change the pipeline and increase diversity as well.

NEIL A HANCHARD:

Yeah, and I think there's a sort of, you know, sort of synergistic kind of opportunity there as well, is that as you change the mentors as well and have those individuals there, then, they're seeing people who look like them, who are also scientists, they're also physicians, and that becomes a more real possibility.

JUDY WOODRUFF:

Well, we can certainly pick up on that. But I'm gonna move on to Dr Scheufele and some of the points that you made. It's so interesting to hear you talk about communications because in the field of communications, we are wrestling with these very things that you described. I mean, we're dealing with the platforms driven by algorithms that are completely out of our control. We may have discussions with some of these organizations and platforms, but it's way beyond any kind of wall that we're able to penetrate. So, I mean, how do you even think about getting your arms around that? I mean, where do you look for practical solutions? You start having conversations with the executives of these organizations. I mean, what do you... how do you think about that?

DIETRAM A SCHEUFELE:

Yeah. And I think it's really important. I mean, what I outlined almost sounded like a condemnation of these platforms is it makes a lot of fiscal sense for these platforms to do what they do. And that obviously is not the only driver, but it's certainly one of the major drivers. But there's also gonna be, I think, increasingly a policy question. I think we're seeing from both parties now a push to think more carefully, both political parties, I mean, a push to think more carefully about the democratic value of those platforms. And I think for different reasons, they're thinking about regulating. And I think that creates a very unique window of opportunity, especially for a convener of conversations like the National Academies without the proverbial skin in the game that might say, well, you know, there's no reason for you to not pursue certain fiscal goals, but there's also no reason to not couple those fiscal goals with pro-Democratic goals. And I think we've all seen during COVID where that can get us if we don't do that.

So the idea of saying can we, for example, figure out ways to prioritize information potentially or sources of information that we know to be more in line with the best available science over others, so that simply we know from studies that few of us, if any, go beyond the first page of Google searches. So whatever ends up showing up on that first page is crucially important for our information intake. We know that our timelines are all curated in a way that the social environments that I move in influence what shows up prominently on my Twitter or other timeline. The problem is if I'm surrounded by social networks that are as uninformed or misinformed even as I am, that just furthers that. So working, I think a collaboration and this is my somewhat tongue-in-cheek point about Kasparov working with platforms to figure out where we have shared goals and for the academies to play a role that only it can play because most other places, including media organizations, other media or legacy media organizations have a skin in the game, I think would be a really important first step in the Standing Committee

on Advancing Science Communication that I have the honor of co-chairing for the Academy is trying to begin some of those conversations and convenings.

JUDY WOODRUFF:

And again, so much depends, of course, on which audience you're trying to reach, as if the scientific community is that the public, broadly speaking, which is it? What about the other three of you in your own experience? Have you seen particular approaches that seem to be more effective in reaching the public and engendering trust? Or how do you how have you seen this?

NEIL A HANCHARD:

You know, I've especially during the pandemic, I got lots of questions from a lot of people from all over about where they could go to trust information. And so, I guess maybe a question back is how do we sort of not only prioritize but then tailor that kind of information? People... some communities were getting their information from a very limited viewpoint. And how do you overcome that? Like, how do you ensure that that viewpoint is more representative of the best science or, you know, I found that to be particularly challenging as well, is that there was, you know, a certain line that was coming from a certain area and that was hard to overcome.

ALI SHILATIFARD:

I think, one of the key things that we should push forward is open debate, open respectful debate. And I actually wrote an editorial on the subject. We had people writing is that I don't like the decision of this editor, you should fire him or her. I don't like this article you got published, you should retract it. I don't like the way the editor has written decisions to me, you should do something about it. I wrote an article on, basically on respectful debate that if you hear something that you think is not true, you should get up and ask. You should have a respectful debate. And I think that culture is fantastic in us. And as it is, I come from Iran. In Iran, well, what's going on today, there is really not that much freedom. And to have the freedom of a standing of and debating, I think that's very important. And we all need to use that power that we have. And I think once we do that, truth will always rise to the top.

JUDY WOODRUFF:

What you're describing very much reflects the political environment. A sea that we're swimming in.

ALI SHILATIFARD:

Absolutely, this is horrible.

JUDY WOODRUFF:

Dr Zoghbi, any other thoughts?

HUDA Y ZOGHBI:

The only other thought I have learned to deal with in the last two years, particularly through vaccines and knowledge and misinformation, is to really talk to small groups and share my own experience, share what I know and let them feel they're empowered to make the decision. I found that the best approach to get more and more people to really understand and value the science and then engage. That was the only thing. And I feel that we as a community, yes, it's more people were affected. Maybe I was able to communicate with dozens of people or 100 people, but those people have friends. And if we can keep all of us doing that, I think that would be helpful, taking it in that very small step-by-step approach.

JUDY WOODRUFF:

That's the positive side of the way it works, right? I mean, wouldn't you say? I mean.

DIETRAM A SCHEUFELE:

Yeah, I think that's and that's a, especially at the group level, that's a really useful approach. I'm a little bit less optimistic than Ali, but the truth will always rise to the top. (UNKNOWN). It's no, no. Hope springs eternal. I very much agree with you, but I do think it needs help, and so I'll leave it there.

ALI SHILATIFARD:

I mean, I grew up in a country that if you disagreed with the government, they hung you. Right. And that's a walk in the street, seeing people hanging my friend's fathers and bullet in their head. You know, no one had a chance of arguing. And I think we have to live in a culture that we can argue and we should take advantage of that and that our argument will come out with the right answer.

AUDIENCE:

(APPLAUSE)

JUDY WOODRUFF:

Dr Scheufele, just to pick up on your remarks earlier. I mean, it has to be disturbing when you describe, as you said, so many of the young people leaving to go into the different parts of the private sector because they see how hard the process looks. You mentioned they watch their elders work for a long time to try to get something published and they don't. What are the reasons? Is it money? It's that what you just described? What else? Are we...

ALI SHILATIFARD:

I think, a combination of many things. Dr Zoghbi and I had this conversation a long time ago, I was mentioning to her that some of my mentors in biochemistry, people like Arthur Kornberg and Bill (UNKNOWN) Vagelos, you know, Rowley these are fantastic people who are a physician

and they did science and was asking who you know? I don't see it in my medical center. I have two kids in medical school and all of their friends, not many people interested in doing science, is different at Baylor. And she says, well, we have similar issues in here and that the conversation started several months ago on that. And why is it that physicians don't want to get into science and why is it that the students don't want to continue on science? And I think money has a lot to do with it. You go and I talk to my friends, my kid's friends, the four years in medical school, and you make 50, $55,000 a year as a resident. My daughter's class, there are six of them, they're just basically turned on to financial market and making five times as much.

So if you put the value on life, on money, then maybe you're not made for science and medicine anyway. So I think that sort of is the way to do it. But when I go to meetings and I used to go to pollsters, 70% of the people I talk to, they wanted to go to postdocs, academic postdoc. Now, when I talk to you, people are less than 10% want to do that. They all have one reason or another that they want to move on. I think COVID has changed things, right? You know, for a for us, I never thought I could stay away from lab and I never did. Because once COVID happened a week later, I was back in the lab. But there were a lot of people who stayed at home and worked from home. And maybe at some point they realized, I don't have to be in the lab at all the time. So and that made that realization. I think a lot of people who had family members dying. And it's a major impact that you see death. And so I want to do something else with my life. So I think a lot of changes that happened. But at the bottom of it, I think financial support is very important.

If you're not able to sustain in life for you and your family and if you have to struggle and to get a little grant and that little grant, pay some of your salary and a technician and you there is not enough money to do the experiments. And then you go back to renew that grant and you haven't done much to do it. And that becomes frustrating. And then the students are seeing that happening and say I don't want to life.

JUDY WOODRUFF:

I hear you saying that it makes sense. And yet I think people watching over the challenges of science and medicine to come up with ways to address it in the next pandemic, God forbid that's coming down the line, you would think that young people would be inspired to want to go and.

ALI SHILATIFARD:

You would think our government would be inspired. So if you look at the history of development of COVID vaccines seriously, take a look at this. Recombinant DNA technology, molecular biology, and engineering saved the day. You sequence the genome within a week, and without an instrument of NGS, you wouldn't be able to do it. The recombinant DNA technology existed so you could be able to make the viruses and the chemists provide us the means by which to put the drugs of the viruses into the... the RNA into person. And you get translation. So if you look at all of these were funded by basic fundamental research and what

has happened at the NIH with basic fundamental research in past few years, anybody talk about increasing and supporting more R one, no talk of that. And I think our government has learned from all the benefit that we have had from investment in NIH.

DIETRAM A SCHEUFELE:

Can I jump in on that really quickly? Because I think a huge plus one and I think that speaks to one of the challenges we talked about this morning, and that is if something happens and it doesn't get communicated right, we actually have an issue. And one of the things that ended up happening, especially around mRNA-based vaccine platforms for vaccines, is that we celebrated this very often. And the narrative speaking going back to the keynote was really one about a miracle how quickly we got this together. But wasn't it? And this even from some health journalists, including social media, saying this, how impressive it was to get this done in such a short time, which is, of course, a counternarrative to what you just described, meaning we invested in basic science for a long, long, long time. And it started paying off in a short time. But without this investment, it would not have been possible. So yet again, I think a really good illustration for why narratives are crucially important, and especially when it comes to translating to policy.

Just to echo the last points from the keynote.

NEIL A HANCHARD:

You know, that's all true. I guess I'm plus one as well. That's the right way to say it. I found, however, for instance, that the narrative of how fast we got hit in a public sense, that actually a lot of what I got back was too fast. That was too quick. There's no way that could be something that we could possibly trust. And so, again, how you sort of frame the argument is gonna be an important one. And I think that sort of relates also to the idea there is absolutely a financial sort of like pool for people, particularly postdocs and young trainees who are coming through. There's just so much more that can be had outside of the academic pipelines. But we also need to work about the pull in terms of ensuring that people understand just why we do academics, who has been very good to share her story, but it's stories like that that are gonna continue to inspire people to continue in academic medicine.

JUDY WOODRUFF:

But do you want to... Dr Zoghbi do you want to?

HUDA Y ZOGHBI:

No, who does agree? So I do think, I do feel finances is a big deal. Many people, medical students, have debt. So a true physician who is interested in research can't really afford unless they get some funding and protected time to do so. Postdocs, their salaries are quite low, relatively speaking. Many administrators at the university with college degrees make administrative assistants make more money than the postdocs, and they have families and they

don't have childcare. So all of these things play into it. And it seems that the dawn of biotech, an industry that will secure their financial future and that they're doing great science, what they don't realize that's short term because it's still the hard work. A lot of the primary discoveries have been in academia, and I think for us to keep that pipeline, we need people in all aspects of research, both industry, and academia.

JUDY WOODRUFF:

Any one of you wanna say anything else about that? I mean, there's so much to say about it. I'm looking again at what you talked about earlier, Dr Zoghbi, about the need to make sure that physicians have... physicians are included and have access to the latest scientific data. It's not something the public is very aware of. So how do you get that message out to the communities to sign? I mean, obviously, you're speaking at this group, but I mean, how do you get that word out?

HUDA Y ZOGHBI:

So I think this is part of thinking for the future. I think we're used traditionally to scientists doing their research and clinicians just taking care of the patients and handling the patients. But I think there's an opportunity in science today that every physician touching a patient can be part of this big science machine and can advance knowledge. But they need a little bit of protected time. They're under pressure to perform. Their hospital administrators telling them, you have to bring so much money to earn your salary, perhaps with some small investment to allow the clinicians the freedom to interact with basic researchers, provide them tissue, provide them information. I think it's a shift in culture that we use everybody in the biomedical community to help us advance science. And it doesn't take much. Just take some code and recognizing collaboration and giving people a little time to think and breathe and be part of the engine of research.

JUDY WOODRUFF:

So does most of the impetus need to come from the medical side or from science?

HUDA Y ZOGHBI:

I think it has it to... really it's a community. It has to be from the funders. The NIH should recognize this person is a clinician. They have absolutely no track record in research, but they seeing patients and taking tissue every day, that tissue would be so valuable if we give them protected time so they can organize the consent and do all that it takes to pass that tissue to a basic scientist. That's a success. The neurosurgeon is handling the human brain every day. If we give them protected time to tell the information that could be fed into research or machine learning algorithms, that would be so helpful. So it's funders, it's chairs of departments, it's clinicians realizing they have a role to play in the science machine, and of course, scientists being introduced to clinicians. So it's a whole culture shift but has so much opportunity and so much power.

JUDY WOODRUFF:

I want the three of you two to weigh and talk about that.

NEIL A HANCHARD:

Yeah. As a physician-scientist myself, I can sort of underscore what Huda said are enough. I think that the pressures of time up to a year and a half ago, I was actively seeing patients and it was a problem. Just you have work our views and various pressures and the clinical enterprise has their own goal. They are working to see patients. That's how they make money, that's how the business works. And so it's very much at odds with sometimes the sort of scientists viewpoint, which is sometimes it takes time and you have to sort of invest in learning about the patient in more detail. And so sort of says you have to be able to sort of bridge those two things, and that's going to have to come from both sides. And that isn't, I can sort of have to mention or else I won't get back into my house, that that's their home pressures that then also come on top of that in terms of particularly, women in the workforce and the pressures that they have on top of that. So if you add that to the clinical pressures, to the scientific pressures, it becomes unsustainable.

DIETRAM A SCHEUFELE:

And just to add one thought on the catalytic role that philanthropy can play, and there's also lessons to be learned from other fields. Education has some of the same questions and problems, meaning lots of really great research in universities that doesn't immediately or fast enough translate into practice in classrooms where they're very different, precious time pressures and so on. And the William T Grant Foundation has created a long time ago now that has funded over time these research-practice partnerships, saying can we actually incentivize fiscally and free up time for researchers and for practitioners to work together for the benefit of getting the best available science into an elementary school classroom, for example? And I think they're really models to take and lift both in terms of how these collaborations can work, but also how philanthropy can play a catalytic role.

ALI SHILATIFARD:

Comments from audience.

JUDY WOODRUFF:

Do you wanna add...

ALI SHILATIFARD:

Me I'm... 100% agree. I mean, I grew up with a grandfather who was a physician scientist, so I'm great believer in the awesome power of medicine and science.

JUDY WOODRUFF:

And your grandfather was what?

ALI SHILATIFARD:

Physician scientist.

JUDY WOODRUFF:

Physician scientist.

ALI SHILATIFARD:

Radiologist and a physicist. And so basically what it takes at all level, you have to start from the kindergarten all the way down to medical school. And I think it's just a cultural change that you have to do research to understand biology and then back to get into medicine.

JUDY WOODRUFF:

Alright. We are now gonna entertain some questions from you. And I think you are standing in line. So if you would identify yourself and your organization, ask your question.

JEFFREY LIEBERMAN:

Thank you very much. Jeffrey Lieberman, Columbia University. Just wanted to make three quick comments on the topics discussed. I think there is a lack of alignment between the aspirational goals and the circumstances on the ground which incentivize or disincentivize young aspiring scientists, whether they're clinical clinicians who want to become scientists or their backgrounds, in the sense that when you're an instructor or an assistant professor, your goals are you need to make a salary. You need to get promoted. You need to do research and publish in order to do so. The reality is that what science aspires to do is to answer the key questions that will enhance population health and answer scientific questions. And that alignment is not necessarily what motivates people to get publications onto their CV, which will then be able to encourage a promotions committee to advance them in terms of academic rank and get them published or get grants. Secondly, on the diversity issue, if you're doing...

JUDY WOODRUFF:

I just want to because we do want to move to some other people too. Do you want to comment on what you just said on that one?

ALI SHILATIFARD:

(INAUDIBLE)

JUDY WOODRUFF:

Just go ahead and make your second point.

JEFFREY LIEBERMAN:

The point I'm making is that there's... as somebody who mentored and who came up in the same way that Dr Zoghbi did. Individuals are eager to get things on the CV and publish in journals which may or may not be aligned with the key scientific questions and public interest. One way to deal with that is to have a set of guidelines or a statement from the Academy or from any sort of governing bodies as to what the imperatives that should frame careers and should be considered in terms of incentivizing the directions that young investigators take and their career paths and their mentors. And the diversity issue. There's a practical problem that occurs, which is if you're doing clinical research, your subjects come from your catchment area population in whatever geographic area you are. The NIH now requires a certain actually a statement of the different groups that you need to fulfill to achieve a diversity expectation or a goal. And I was a co-author on two articles on clinical trials that were published in the New England Journal, in which in one case the criticism was a lack of diversity in terms of adequate number of African-Americans or Hispanic.

And the other there was too many. And so if there is a need to try and ensure that that kind of representation occurs, then the investigator or the CROs that are doing these studies needs to select sites based on that. And then the third thing is for you, Judy, except with the exception of PBS, when I was president, the American Psychiatric Association, and tried to act as a spokesperson about mental illness in psychiatry, I learned that producers and editors are constantly struggling with the tension between viewers and topics that will be either clickbait or attract attention and what the public needs to be informed about. And I'm not sure how to get around that, but I think that's been a real impediment as to the quality and the amount of information about science and medicine that gets communicate through the mainstream media outlets.

JUDY WOODRUFF:

OK. We appreciate your comments. Any of you want to want to respond? We do have a number of other people who I believe have questions too. Anybody. Alright. A question. Thank you.

ANDREW RAFFERTY:

Thanks. Thoroughly enjoyed the session. My name's Andrew Rafferty. Very proud to be a new inductee.

JUDY WOODRUFF:

I'm sorry. I cannot hear or understand.

ANDREW RAFFERTY:

So, I don't know. Can you hear me now?

JUDY WOODRUFF:

I don't think it's working. That microphone.

ANDREW RAFFERTY:

Is that better?

JUDY WOODRUFF:

Louder, please.

ANDREW RAFFERTY:

OK very proud to be here, a nurse inductee into the Academy my name is Andrew Rafferty. I come from (INAUDIBLE) I'm also a nurse. Very much (UNKNOWN) honestly about trust. We know from polls are the most trusted of professionals, I'd love to hear the views of the panel on the extent to which they believe nurses in research and not just as data collectors, but doctors in running clinical trials because they've seen the infrastructure of randomized controlled trials for years. Including COVID trials. But how can we value the contribution that nurses make? And how have the panel been working with nurses? Do they see that as part of the solution to diversifying the research and scientific enterprise? Thank you.

JUDY WOODRUFF:

Thank you. What about the role of nurses? One of you'd like to tackle that?

HUDA Y ZOGHBI:

I'll be happy to tackle that. They're very critical to the success of the research. And to your point, many nurses and nurse practitioners are not participating, not only in bringing actually giving physicians the opportunity to bring tissues for research, but also in clinical trials and many other aspects. And I think many people here who do both translational and clinical research will attest to that.

JUDY WOODRUFF:

Here. Question, please.

SPEAKER:

Yes, I don't have a question, but I do have a comment that everybody everyone in this audience could act on, and that is that we have done nothing in our institutions, by and large, to improve the capacity of primary and secondary school science teachers to teach science and to teach it in a way that reflects the way we practice science. For 30 years, I've operated a program at Columbia University called the Summer Research Program for Secondary School Science Teachers. The outcome of that program is that 10% more of their kids pass the Regents exam. They stay in teaching science, teaching longer than nonparticipating teachers, and the program is extremely cost-effective. Every one of you in this audience could start a similar program. The

program was published in Science magazine in 2009 as a report of actual research outcomes research showing the program is beneficial, and I'd be glad to talk to anyone who is interested in doing that. If we're ever to change what happens in our schools, it won't change until we change the quality and quantity of teachers.

And the best way to do that is to bring them into our laboratories, our universities, our research institutes, and make it a welcoming environment for them. They'll bring their kids in and their kids and they'll have contacts to find places for their kids in the summer. This is a groundswell. We have in this audience Win Arias who created the Demystifying Medicine Program at the NIH. We have lots of ways in which we not some government authority, but we can change things. And I just exhort all of you to do what you can in your own institutions, because this is not a problem that can be solved at any level other than the ground level.

JUDY WOODRUFF:

Thank you. I see everyone here nodding in agreement that that is an excellent idea maybe, submit an article for science advances.

HUDA Y ZOGHBI:

And and we have this program.

ALI SHILATIFARD:

That's a review although.

HUDA Y ZOGHBI:

We actually have a program at our institution, to your point, for kindergarten, and for high school. So we have it through that. So that's a great suggestion.

ALI SHILATIFARD:

We have the same through the RISE program at Northwestern. So...

JUDY WOODRUFF:

Wonderful.

ALI SHILATIFARD:

Teachers are students and college students very broad. Ours is endowed, actually. So we provide resources for them as well.

JUDY WOODRUFF:

Question. Yes.

ROGER MCCLELLAN:

Roger McClellan I'm an independent advisor and toxicology risk analysis. Albuquerque, New Mexico a member of the Class of 1990. I'm going to offer a comment and challenge the statement in terms of this group as representative of the Biomedical and Health sciences scientific enterprise. It absolutely is not. Our big problem, I think, is breaking down the walls of the elitist silo that we live and work in. When I said that to a group of students last week, I could see they're very perplexed. And finally, one of them spoke up boldly, said Dr McClellan, what is this silo? And I didn't realize I had a cultural background of growing up in the Midwest. I knew what a silo was. They didn't. So I'm going to talk about two silos, science broadly versus the public. We are sub piece of that broad public. We need to break down the silo walls and start communicating with the public broadly. They also are leaders. My plumber is a damn elite plumber and I'm thankful for that. Likewise, the person who does my taxes is an elitist accountant.

The other silo wall and it came up over and over is academia as sort of the scientific paradigm. I'm sorry, it is not the COVID is a great example. Yes, we built on basic science, but it was a private sector also prepared. I'll ask those here who are employed by a private sector employer to raise your hand. Well, we are not representative. Science doesn't start and end in academia. Fortunately, most of our scientists are engaged outside of academia. Let's break down the silo walls and start communicating with the broader community.

SPEAKER:

We can take one more question.

JUDY WOODRUFF:

Alright, I just wanna see if anyone here on the panel has a response? We've only, I think, got a minute left, But what...

ALI SHILATIFARD:

Just respond to the last one. None of us disagreeing here that you got to have pharma to build drugs. But the problem is that if we lose all of our trainees from academia, your student, your post-doc, your best faculty all move into pharma, what's gonna be left of academia to train the next generation and formulate them?

SPEAKER:

I'm damn glad that they're going out there. Oh, but start treating those people as equal to you.

ALI SHILATIFARD:

That's what we're saying, that we need more funding so we can compete with the pharma keeping the best in academia.

SPEAKER:

I'm sorry. Your job as an educator, in my opinion, is to educate a broad group of scientists to engage in all elements of society, not just academia.

JUDY WOODRUFF:

Alright. We've got 3 seconds left and we want to...

LINDA CLEVER:

Thank you. This is Linda Clever.

JUDY WOODRUFF:

Another question, if someone who wanna give me guidance. Take another question or do we have time up?

LINDA CLEVER:

Two quick questions. One, what would happen if all scientists and physicians were taught how to communicate? What would happen if all scientists...

JUDY WOODRUFF:

Could you repeat that if they were taught by what?

LINDA CLEVER:

What would happen if all scientists and physicians were taught how to communicate better?

SPEAKER:

Very important.

LINDA CLEVER:

Second. I'll just do the second. And again...

JUDY WOODRUFF:

I was gonna say the panel's done a good job of communicating this morning. But this afternoon but go ahead.

LINDA CLEVER:

Second, what would happen if the National Academies and PBS started its own platform of communication? Instead of relying on Facebook.

ALI SHILATIFARD:

It's all about communication.

JUDY WOODRUFF:

I can see a reality show around.

ALI SHILATIFARD:

And that fine.

JUDY WOODRUFF:

A PBS's style of reality show. So it's evidence-based and fact-based. Let's give each one of our panelists a hand.

AUDIENCE:

(APPLAUSE)

SPEAKER:

Well, clearly, we struck a nerve. I so appreciate this panel. Thank you so much, Judy and everyone, for your wonderful discussion and your answers. Thank you.

AUDIENCE:

(APPLAUSE)

SPEAKER:

So we will if you could hang here for 2 seconds, we're gonna pose a question to gather your reactions and perspectives based on what you've heard. And so you can see the instructions on the screen. Just scan the QR code and then you can go on to your smartphone. Or if you have a computer and you enter the program code, NAM2022, N-A-M 2022, and answer the question. The question is, are you convinced that the challenges described by the panel justified and compelled... and would compel major changes in our scientific enterprise? Give us a score from 1 to 5. One is, you're not convinced at all. I think there were people that. And five is you're completely convinced. And I think we heard from both groups. So we'd love to know what you think. And I'm gonna pause for a second just to see what comes in. While we're waiting on those. There we go. The sig... the pretty good result. Thank you all. So now for lunch, for those here in person, please attend the general luncheon in the tent. And please note there are some students here who participate in the DC Public Health Case Challenge, and they have their posters up in the Great Hall during lunch.

So this topic was community protective environments and preventing intimate partner violence. Stop and talk with them. We'll see you soon.

Panel 2: Changing the Game: Emergent Sciences and Technology

SPEAKER:

Grab a seat. We're gonna get started. Thank you very much. Welcome back to the 2022 Annual Meeting Scientific program Revolutionizing the Biomedical and Health Sciences. It's my pleasure to introduce the second panel of the scientific program entitled Changing the Game: Emergent Sciences and Technology. But before I introduce the panel, let me just ask that everyone during the audience Q&A to please limit yourself to one question so we can make sure we get through the group. (AUDIENCE LAUGHS) Yeah. (AUDIENCE APPLAUDS) And I know the panelists would appreciate if, appreciate it if you would frame it as a question. Thank you for that. (AUDIENCE LAUGHS) So, our moderator today is Apoorva Mandavilli distinguished reporter for the New York Times, focusing on science and global health. She's recently covered topics ranging from coronavirus and vaccinations to the WHO and Centers for Disease Control. Her team won the 2021 Pulitzer Prize for Public Service for coverage of the Pandemic. And she was also a member of the team that was a finalist for the 2021 Pulitzer Prize for National Reporting.

She is the 2019 winner of the Victor Cohn Prize for Excellence in Medical Science Reporting, and has won numerous other awards for her writing. Please join me in welcoming, welcoming Apoorva Mandavilli and the panel two panelists to the stage. (AUDIENCE APPLAUDS)

APOORVA MANDAVILLI:

Thank you all so much for being here. And it's a real pleasure for me to moderate this panel with all of these people that I've really looked up to and been really interested in their work. So, this is great for me to be able to ask them some tough questions. (LAUGH) As you heard, this panel is called Changing the Game: Emergent Sciences and Technology. And we are in an extraordinary time of science. We have vaccines that have been developed at record speed. We're seeing amazing advances in neuroscience and artificial intelligence and genetics. And yet, as we heard from the panel before us, this is also an extraordinarily difficult moment for this nation and for this world. And so, what we wanna talk about during this panel, you know, we sort of pointed out some burning issues during the first panel. So, it's only fair that we also tell you how to put out some of the fires. So, this panel will talk about some emerging technologies. And we'll try to talk about what does it actually look like when these disruptive technologies that can transform our world are put into use?

So, what are the pitfalls, scientific, societal, ethical? And how do we make sure that everybody in the world and not just some select privileged groups get to use them? So, our panelists today are Karl Deisseroth, who are, who is remote (LAUGHS) over there, Jay Shendure, Bradley Malin and Kirsten Bibbins-Domingo. And their full bios are in the book. But I'll begin with Dr Deisseroth, who is the D.H. Chen Professor of Bioengineering and of Psychiatry and Behavioral Sciences at Stanford University. And he's a Howard Hughes Medical Institute investigator.

KARL DEISSEROTH:

Thanks, Apoorva. It's really an honor to speak on this panel. And I wanna share along the themes you've highlighted some of the opportunities and challenges of bringing people together from across different backgrounds in the service of science. And I'll touch on three

things, a couple of technological advances where bringing people together was, was crucial across boundaries, like, especially chemistry and neuroscience. But then also I'll touch on some of the human interpersonal aspects that are so important for this boundary crossing. So, I'll just begin by noting that, you know, we have the ability now to do something that we wanted to do for a long time, which is to turn on or off individual neurons in the brains of behaving animals. And this has been a long process of technology development over the years, but this is the kind of thing. This movie shows what we can now do the rainbow-marked cells T1 to T10 or in the brain of a living behaving mouse. And we can use light to pick them out and turn them on in synchrony if we want, or asynchronously.

You can see them glowing on the left as we stimulate them with spots of light. And this is a technology that we call single-cell-resolution optogenetics. And it took a while to develop. You can imagine the opportunities. We can find out which cells and populations and ensembles really matter for perception, cognition, and action. But to get there, we really had to take a very unexpected path. There are some ancient proteins that are called microbial options that single-cell bacteria and algae make. And they form a family. The initial members were discovered by a biochemist, Dieter Oesterhelt. And then Peter Hegemann and myself discovered the next couple members of the family. Peter discovered this blue light-activated cation channel from this algae. And then we discovered this red light-activated cation channel from this algae. And that allowed us to get to that single-cell control. And this is a broad family of a lot of different proteins, but it was really chemistry that led us understand how they worked.

We got the high-resolution structures of all these major kinds of microbial channel, including one just this year. And that led us dive deep into the atomic level positioning of relevant chemical moieties and see how the light responsivity was determined and modifying that to allow the single-cell control was crucial. Another example is, is shown here. This is a projection of fibers from neurons all across a mouse brain, starting from cortex at the surface going deep. And this is in an intact three-dimensional brain of a mouse. But we can, without slicing, without dissecting, we can actually track these connections across the brain. And this works through something we call hydrogel-tissue chemistry involves building a new chemical infrastructure in the brain itself, as shown by these wavy green lines, linking important molecules like RNAs and proteins to that new scaffold, and then transforming it, removing lipids. We can remove proteins too, if we want, and we end up with this new composition, which is like a hydrogel that has all the relevant molecules linked to it.

You can then work with this in various fascinating ways. You can even sequence the RNAs if you like. You can do rich labeling. You can swell it or shrink it. And this basic chemical backbone turns out to be very versatile. And we and many other labs now have taken this, this principle and brought it in many different directions, including for sequencing. And this is relevant to some other things that'll come up later in the panel. But we can use this variant of hydrogel-tissue chemistry. And something we developed in the lab is a variant of this called STARmap, where we actually rely on the fact the RNAs are locked in place chemically to make sure they

don't move. And we can do multi-step optical sequencing and turn a three-dimensional constellation of cells that we don't know much about to a richly molecularly informed transcriptomic level understanding of the cells that are, that are present. But the final thing I wanna bring up is that this, and I was asked to talk about this part of my life as well and what the relevance to this panel.

I'm a psychiatrist and I work with patients who have very different brains. And of course, people outside the hospital also have very different brains. And this, this book, which came out last year, highlights some of the, these differences that people have both in natural adaptive life and in acute disruptions that land people in the emergency room. And I touch on depression and grief and mania, autism, which I'm gonna come back to in a moment, borderline personalities, schizophrenia, eating disorders, dementia and depression. And the differences that people have in their brains are really crucial. For this reaching across boundaries, you can't just put people together in a lab and just hope for the best, you can't just rely on the chemists and the neuroscientists to get along, or the engineers and the biologists. It requires a lot of intentional effort to help people understand the different cultures that they're coming from. I play a lot of a translational role sometimes, or a family therapist role in other times.

Realizing people's brains have unique skills that operate on different speeds along different dimensions and helping people overcome those barriers has been really crucial. And on the autism spectrum, particularly, it's very important to help people communicate with each other to operate on different speeds. And this helps us build an inclusive, and we think a more ultimately productive and creative environment. So, I'll pause there. Thank you. (AUDIENCE APPLAUDS)

APOORVA MANDAVILLI:

Thank you. Our next panelist is Jay Shendure, who's a professor... (AUDIENCE LAUGHS) What are you doing over there? (LAUGH) Jay Shendure, I'll try this again. He's the Professor of Genome Sciences at the University of Washington. He's also the Director of the Brotman Baty Institute for Precision Medicine. And like Dr Deisseroth, he's also an investigator at the Howard Hughes Medical Institute.

JAY SHENDURE:

Thanks. Thanks. And great to be here. So, I thought, you know, kind of reflecting on the topic, I thought I would start with this conceptual diagram, which is from a computer scientist, Bill Buxton, this, this concept of a long nose of innovation. And the key point he was trying to make here, and I think this is primarily in relation to a computer mouse when he first described it is that for, for innovative ideas, for kind of breakthrough transformations, there's kind of this long period with a low amplitude of just kind of steady incremental progress. And the bulk of the innovation actually happens behind that elbow or before that elbow in the curve, right, when things really, really take off. And I think this is true for computer products. I think it's also true for a lot of technology innovations and biomedicine and maybe even true for some kinds of

datasets as well. So, so an example of this might be the RNA vaccines that came up earlier. Another example that I'm familiar with just from my own time in graduate school is, is next-gen sequencing.

Right. So, now, we just call the sequencing, I guess, right? But this is essentially massively parallel methods giving rise to short reads that around the mid-2000s, essentially displaced Sanger sequencing very quickly as the primary mode of sequencing. And of course, cost had a lot to do with this displacement or this explosion, or whatever you want to call it. But there was a long curve before that of progressive incremental improvement. And in truth, it wasn't even the cost had already dropped quite a bit below that of Sanger sequencing, that the kind of the key factor that changed at that moment of the elbow was that the reads got just long enough that you could map them to the reference genome. Right. And that, that had a kind of a catalytic impact, 'cause finally, these, these cheap reads were actually useful for, for something. And I think this kind of this, this, you know, it's kind of fun to think about for different technologies and also just different spheres, what corresponds to that elbow moment, right, what actually results in the broad adoption of a technology that might have been progressively developing for quite some time.

So, as I mentioned before, I think this, you know, similar analogy can be made about datasets and you know, what, what finally drives their broad adoption and uptake. So, even the Human Genome Project, right, when that dataset was first released, it was not terribly useful to the vast majority of researchers out there. And it was really other developments such as the ENCODE project and the UCSC Genome Browser that really made it accessible and resulted in that, that magical elbow a few years later. And the time, you know, in the case of the Human Genome Project, and in the Browser, it was pretty contemporaneous. But for other, you know, there are other examples where the form of the, the transformation of the broad uptake was not, not predicted at all, kind of at the onset of the project. So, the Protein Data Bank, for example, PDB, right, this was started decades ago, steady and slow accumulation of protein structures useful for various reasons. But then with the recent emergence of AlphaFold, which heavily relied on the PDB for training, we all of a sudden have this elbow moment, and now the tool is much more broadly useful to the field than PD would've been.

And there are other datasets, I think, where we don't... You know, we could argue about whether it's already hit the elbow or not, but I would say that we don't necessarily know, right, so things like UK Biobank, all of us will hear about a little bit more. I don't think we know yet whether we're at the elbow point or what, what actually kind of the catalytic moment will be. So, another, another kind of high-level point here about innovation and technology and biomedicine, I think we're, we're really bad at predicting the areas of maximal impact. So, when we develop technologies, we often do it for one reason. And then down the line, we find out that, that the, the way it's been primarily impactful has been different than that. So, as an example of this, the, these new sequencing technologies were almost entirely sold around this idea of $1,000 personal genome. And even with these announcements of new technologies and

new upgrades a few weeks ago, where we're now at a $200 personal human genome, that's still the way that we bill it to each other and to the, to the public.

But the truth is that, you know, that the impact of sequencing technologies has been much broader than that. And if anything, personal genomes are a very small part of the story, right? And it's rather, it's, it's kind of become this generic device like a microscope for counting nucleic acids, which has an immense impact in a diversity of fields as one area. And then in the clinical arena, again, we posited it as personal genomes. But in fact, there's been non-invasive prenatal screening and on the, the horizon, non-invasive early detection of cancer that are likely to be far greater area, areas of impact for this, this, this technology. So, yeah, so what's on the cusp? So, what things am I excited about? So, just one example of, of kind of threads of work from our lab and other labs that seem to be coming together that we think kind of might make for one of these elbow moments. So, we have increasingly, you know, CRISPR and prime editing-based technologies to program mutations, genome-wide, that kind of a very scaled fashion.

If you've been following this organoid and embryo field, it's, it's stunning how quickly it's moving. So, a few weeks ago, Magdalena Zernicka-Goetz and Jacob Hanna published these papers describing in vitro synthetic embryo-like models of the mouse that progressed to through gastrulation that, you know, we looked at the data and it's virtually indistinguishable from a bona fide in vivo mouse. And then coupling these perturbations and these sorts of in vitro models with single-cell biology, which has also been taking off, we think that there's rich opportunities for kind of predictive modeling of cells, tissues, and organs in a way that hasn't really been, been impossible before. And so, we're hoping to, to enable some of that. And I'll just close really quickly, I'm a few seconds over. But nurturing disruption, so just a few thoughts here. I think it's important that innovation be nurtured bottom-up rather than top-down. You can create rich ecosystems for driving innovation, but the ideas and the guidance really has to be kind of from the bottom.

I think the role of funding agencies can do you to set moonshot goals as was the case in the 1,000s Genome, $1,000 Genome Project, as well as to host these field-wide competitions like CASP15 leading to AlphaFold. It can't, it can't be managed from the top down, so to speak. And then finally, to make a point about data usability, so it's terrific that we increasingly have widely available or an expectation that we release data at the time that we produce it, but that's not the same as actually making it findable and usable. And so, I think that's an important thing to keep in mind as we go forward. I'll stop there. (AUDIENCE APPLAUDS)

APOORVA MANDAVILLI:

Thank you, Dr Shendure. Our next panelist is Bradley Malin, who is a Professor of Biomedical Informatics at Vanderbilt University Medical Center.

BRADLEY MALIN:

OK. So, let's get started. So, I'm gonna talk a little bit about infrastructure because I think that there have been many changes over the last couple of years that have accelerated what we're doing. So, to start, if I click, click again. I don't know how many times I can click. There we go. OK. So, earlier this year, I was part of this NASEM report that, that came out talking about automated research workflows for accelerated discovery. And there were a couple of things that we talked about in this. One of them was this notion of how to speed up research through automation with the use of data and talk about how you come forward with a model. And then you, you, based on that model, you're gonna apply data to it, and then you're gonna learn a little bit more. And then hopefully, as you cycle over this, you eventually learn new things that you would not have learned otherwise. And you might be able to speed up the entire process of learning. So, things that might have taken you several years, you might be able to do within the context of a day.

And things that we talked about in here was what were all the things that you needed to have on the table to make this work, because it sounds cool automation, right? But it's not necessarily simple to put this out into practice. And so, we had a bunch of case studies that we looked at over the course of a two-year period with funding from the Schmidt Futures Fund. And one of the examples that, that I wanted to, to give you, and I'm sure some of you have heard about is, is the notion of the All of Us program. And All of Us is this initiative to get a million people to provide their medical records, survey information, genomic information, and mobile health information like, like Fitbits, so that anybody in the world can use this data. Sounds like a really noble cause. But then the question becomes how do you do this at scale and how do you speed up the whole process? And so, this was, this was several years in development where, where we built what was called the Researcher Workbench in partnership with, with people at the Broad as well as people at Verily and Google.

And the Researcher Workbench is an environment where we took all the data on these people and then we put it into an environment that's up on the Google Cloud. But more importantly, we created analytic environments that people could work with the data so that... I don't know how many, how many of you would, would remember downloading a dataset, trying to find some place to store it, asking somebody for space to store it, and then starting to try and analyze it. And you get up and running after about, I don't know, two to six months. And so, we brought that down to about two minutes. And so this, this completely for us, it changed the game. And so, the reason why I've been looking at my phone is I wanted to give you numbers that were hot off the press is because as of, as of today, we have 2,460 active researchers. They've created 2,644 workspaces and across 400 different institutions in the US and abroad that, that have entered into agreements with us to come into that environment. And we get asked questions about like, so how do you do this?

And so, in addition to the technology, we also worked on a really rigorous privacy and security component to, to go with this so that we make sure that all the data has been de-identified into an environment so that it's, it's research-ready. And you don't have to go to the IRB because

we've already gone to the IRB for you. So, so what's notable about this beyond what we did? What I just described was that, was that we have made an active effort to try and diversify the data that, that we're dealing with here because there is a history of studying populations that have, what we refer to as, the majority populations that, that have been studied in the past. And so, we have continued to solicit a population that is greater than 50% in underrepresented groups with respect to biomedical research historically. There's been a number of studies that have already come out. And I say this as really intriguing to me because we only put the genomic data out about six months ago. And we're already seeing studies with this data come forward.

And we've seen everything from studies that are more standard with like, like antidepressants looking at autoimmune, but then also really starting to understand aspects that, that you wouldn't have necessarily seen in some historical databases like, like with respect to discrimination or what happens when you're dealing with, with particular subpopulations and particular types of clinical outcomes. And then I wanted to close on a couple of points in that. So, that's just an illustration of what, what you can do once automation is there. And that's not the AI component, that's, that's really automation, that's just research workflow. Now, the AI is, is going to change things. And I want to point out that there have been two large projects that the NIH has recently kicked off that I'm involved with. One is what's called the AIM-AHead program. And this is a, this is $100 million endeavor to, to figure out how to diversify the workforce of people who are developing artificial intelligence and applying artificial intelligence, as well as how do you diversify the datasets.

And as of last week, we just kickstarted 22 pilot projects for, for research across the country including the Pacific Asian Rim. And we have seven different teaching modules that are in the midst of being developed by organizations around the country. The other program that that literally started a couple of weeks ago is what's called the Bridge2AI program. And I'm running the ethics core for this. And this is going to be four large data generation projects focusing on everything from electronic medical records coming out of the ICU to salutogenesis looking at, at type 2 diabetes across the country. And I can go through greater detail on what this is when, when we have more time. But I want you to be aware that, that these projects are coming to the table because this is about how to get data that can be used for artificial intelligence development moving forward out into the public domain, but also diversifying who are the people that are gonna be working with them.

APOORVA MANDAVILLI:

Thank you. (AUDIENCE APPLAUDS) Thank you, Dr Malin. Our final panelist is Kirsten Bibbins-Domingo, who is the Editor-in-Chief of the Journal of the American Medical Association and the JAMA Network. And she's also the Lee Goldman, Endowed Chair and Professor of Medicine and Professor of Epidemiology and Biostatistics at the University of California, San Francisco.

KIRSTEN BIBBINS-DOMINGO:

Great. Well, thank you very much. I'm gonna just dovetail on several nice themes that are emerging from the morning and this afternoon. This morning you learned that, that it matters who participates, whose data is in our genetic databases for the types of risk prediction that are being done. And the greater question I wanna ask is who's participating in our clinical studies, generally? Whose data is in our clinical databases? Whose data is in our genetic and our biological sample databases? And does it match the goals that we have in the US for investing in biomedical sciences in order to improve the health of the US? This is also a consensus report that I, that came out of the National Academies of Science Engineering and Medicine that I chaired also released in May. Let me just lay this groundwork first to say why is it important to have representative research. Well, first, I would argue it's important for good science. We want our scientific findings to be generalizable to to the public.

And when we don't have studies on the populations that are in the US, in particular, I'm focused here, we risk not having generalizable studies. We also know that this hinders innovation. You heard this morning about PCSK9 inhibitors, and studying the broad variation in biological responses and behavioral responses helps us generate new hypotheses, new mechanisms, and opens new lines of research. It's also important for good science because a large fraction of our clinical studies fail because they don't recruit enough people. And when we don't have the infrastructure to recruit all the people who could potentially participate, it's problematic. It's important for access to our new discoveries. We oftentimes approve new drugs, new devices, develop guidelines, very specifically tailored to who was included in the studies. And so, when we narrowly tailor those, we oftentimes deny access to others. Studies are oftentimes also the way in which in cancer, for example, you get access to a new clinical drug.

We talk a lot about community's mistrust of science, and that's the reason they don't participate. But we also saw during COVID that many communities ask, "Well, did you study that vaccine on people like me?" And so, what we have now is, is also trust and lack of trust in actually our, our interventions that we have because we fail to study them. And then finally, it's important for fairness and equity. The people who've been historically excluded from clinical studies are those who also have the worst outcomes in the US. And although biomedical sciences isn't the sole tool that we need to intervene on health equity, it is an important one. And that's what I wanna argue. Let me say that the two key findings from this report were that underrepresented populations are no less likely to participate in clinical research if they're asked. So, it's a common misconception to say, well, people don't trust science. That's why they don't participate. There are issues of trust and of mistrust, but these are not insurmountable barriers.

When we talk to groups that have done this well and are doing this well, what we learned are the general characteristics that, that, that you see across these different types of groups. First of all, these research groups start with equity from the outset. They think about it with intention and agency in the design of the studies. I love the example of the All of Us research

study because they achieved their diverse enrollment because they did it in the first year of their study. I know that from working on their study just in the first year. They build trust, they build partnerships. It's important that these are not transactional one study at a time, but there's something that's long-lasting and spans a whole variety of research studies. They actively remove barriers. They maintain flexibility and how they enroll. And they align resources. It takes resources to do this, but they align their resources to meet their goals. So, the conclusions we had in our report was really to, to say that, unfortunately, when we looked at the data, we have made statements about the importance of diversity in clinical trial participation in clinical research participation for nearly 30 years.

And we've made very little progress, particularly when you look at racial and ethnic minorities, which was the focus of our study. The same is true from many historically excluded groups. And I would argue that the same principles apply to what we found here. This is the responsibility of all of us in a very complex biomedical research ecosystem. All of us doing something more, recognizing that this should be a goal could actually create an environment where we actually achieve this because these are not insurmountable barriers. And by all of us, I mean participants, communities, investigators, the IRBs, industry sponsors, institutions and funders and journals. We spend a lot of time in our report focusing on the federal government for creating an environment that would enable more of this. The federal government funds research, the federal government regulates how participants are protected in in human subjects research, the federal government is the gatekeeper to monetizing new research discoveries through the FDA, and the federal government is the purchaser of research findings through, through insurance programs.

So, the opportunity for all of us doing our part to make this important goal could actually achieve this goal. And then last, I'd like to leave you with what the committee ended this report with. They've made a lot of very strong recommendations, but then ultimately argued that to achieve a more equitable future does entail a paradigm shift. It requires that we move the balance of power from the lofty institutions thinking about how the community comes there to thinking more about the community and the populations in the US being the center and really thinking about how the benefits of science being part and parcel to how we think about community health has benefits both for science and for the health of the US population. Thank you. (AUDIENCE APPLAUDS)

APOORVA MANDAVILLI:

Thank you all very much. You've given us a lot to think about and debate.

APOORVA MANDAVILLI:

Thank you all very much. You've given us a lot to think about and debate. And Dr Deisseroth, I wanna begin with you, but I think all of you probably will have thoughts about all of these

questions. So please feel free to jump in right after they're directed to any one of you. So, Dr Deisseroth, some of your work is very scifi-like, you know, this idea that you just shine a light into the brain, you turn neurons on and off. You make people less shy, less anxious, more sociable, whatever it is. And it makes us somewhat uncomfortable. Right? It's an idea of, we like to think of ourselves as sort of thinking, feeling beings in control of ourselves and shaped by our experience and not just sets of neurons that can be turned on or off by life. So given all that we've been hearing about today, about the mistrust in science and the sort of the way the public sees science these days, how do you think you can talk about your work without making people wanna run in the other direction? (LAUGHTER)

DR DEISSEROTH:

Really important question. I'm the first to say how unsettling it is that we can change essentially, you know, instantaneously how much an animal wants of something and how hard they're willing to work for it for almost anything. Any primary drive, we can, you know, modify perceptions and complex cognitions. And that does raise these ethical and philosophical questions at the most basic level. You know, what what really is the nature of personal responsibility if actions arise, as they indubitably do, from a few blips of activity and a few cells. And this is something that is a longer conversation that we have time for, but to not avoid it is very important also, because these are ways we can actually use this to bring people into science. It's actually it's very interesting. You know, when I teach undergraduates and I show them some of the things that are happening that we can do, first, they are unsettled. They wanna run the other way. And then they, you know, if you take some time and if you, it's almost like not to overuse the psychiatry analogy, but it's a little bit like a therapy session.

If I give enough space and time for the undergraduates to think about it, talk about it, talk to each other, talk to me, then they get really engaged in the prospect. I can see people wanting to come in, wanting to explore fields in new ways. And so giving time, giving space and working with people, acknowledging the disturbing aspects and making clear the opportunities is absolutely critical. And, you know, many other aspects of these questions are very important to consider. You know, what could we modify if we weren't able to do so in human beings? And here, the natural quick answers, you know, you have to treat with caution. You know, we don't want to modify necessarily what people want or how much they want, but those variations are very important. That's critical to who we are as a human family. And a very thoughtful discussion is important around those issues. And as one just one examples is different ways people approach problems, different speeds of cognition. It's not necessarily best to be fastest to the answer or to get to the most efficient solution.

And this is an important point I'd like to stress that we wanna emphasize the diversity of ways that human minds work and to not let this capability that we are developing affect that inclusiveness.

APOORVA MANDAVILLI:

Well, that's fascinating. And Dr Shendure, this is actually very similar to things I wanted to ask you, but yeah, go ahead.

JAY SHENDURE:

So I guess two thoughts. I think my, yeah, I think increasingly, especially with kind of the, you know, Karl's work, early work in the last couple of years, I think I mean kind of like your question that that blurring between science fiction and reality is getting closer and I think I had, you know, dismissed I think concerns about the time horizon on which we you know, I think the Victor's point from the intro that we'll accomplish less than we think we will in the next year. But over the next ten years, we're probably gonna go further than we thought. And I think it's a tough balance because on one hand, I think it's important not to, you know, in terms of how we communicate and discuss this with the public, it's important to, you know, be accurate and not sensationalize. You know, these organoids aren't thinking, you know, that kind of thing, right? On the other hand, you know, you can see paths towards dystopian futures. Right? And I do think it's important to have those discussions proactively and, you know, transparently with some recognition of the fact that, you know, those aren't science fiction anymore.

And we do need to think about it and put in boundaries and all of those things. Right?

APOORVA MANDAVILLI:

Dr Malin and Dr Kirsten Domingo, what about you? I mean, when you think about things like this that have the potential to arouse mistrust in people, that's particularly true for some groups of people. And so how do you make sure that those aren't the people who may actually benefit the most and yet are most afraid to benefit from it because there's so much a history of mistrust there?

KIRSTEN DOMINGO:

Yeah, well, I'll just jump in and say I think that it comes back to some of the things that we talked about in the first panel. I think it is a responsibility for scientists to do good science and then to also understand the context, just like my fellow panelists just mentioned, but then also to ultimately, whether it's through journals or through other lay communication, be able to communicate also the context. And I don't think it's responsible science to just throw our hands back, say, well, we just do the science, we leave the communications to other people because that is just the seeds of all of the miscommunication and allowing other people to control the message. And, you know, I'm not communicating about topics nearly as cool or complexes as my colleagues, but I do communicate oftentimes in the space of active mistrust about issues of importance in public health. And I think that in those, you know, taking the time and meeting people where they are and recognizing that people oftentimes have very clear reason why they have gotten to this point and trying to understand that is part and parcel of helping to do what I think is part of our function, which is to educate ultimately about what a scientific discovery means.

BRADLEY MALIN:

I've been called complex, but I haven't been called cool. (LAUGHTER) Excited about that. So I come from a background of artificial intelligence and so I'll speak from that perspective. And as soon as you say AI, people automatically go hahaha. Right? It's one of those things that we've seen a lot of what can go wrong with that, where if you don't control automation or you don't put checks and balances or you don't put humans in the loop or you don't acknowledge that the data has come from humans to begin with, you run into this risk of perpetuating biases and perpetuating disparities that you knew existed, but now you've really done it at scale. So this is a problem that it only is fixed if you acknowledge that from the outset, the technology isn't necessarily going to address the humanity. And so we've had a really challenging trouble. We've had a hard time really going back to communities to engage with them, to explain to them even what that technology is. And so it's challenging to the point where you need to raise the level of understanding of just what technology is in that regard.

And so that's an investment that I don't think that we realized needed to be made from the outset because first we wanted to say just how do you actually build AI in a way that's actually gonna be useful where you do demonstration projects and people go, Oh, this is worth investing in because you can actually change lives with this. And then you get to that point and now you have to take a step back and you have to go, OK, now everybody needs to understand what we're doing. And that's kind of where we are now, right? We have not really hit the precipice where the technology is ready to be used by everybody all the time. So I think we have a little bit of time to get to the basics, get back to, get everybody some foundational education. And that's where we need to be.

APOORVA MANDAVILLI:

I think this idea of timing, when do you communicate is super important. That's what I'm hearing here over and over. So Dr Malin spoke with AI. Maybe we have a little bit more time, but you know, Dr Shendure, when you were talking about next gen sequencing and neonatal screening, I was thinking, I don't know that the average person really knows that those things are going on or that that's technology that came from their taxpayer dollars. I mean, we've talked about mRNA a bunch of times now, but the main issue, right, was that we didn't communicate that enough. People didn't know that that was actually going on for 20 years.

JAY SHENDURE:

That was the fastest adopted tests in the history of molecular tests. Right? It was overnight. When you have a kid, you have a kid two years later, totally different testing regime, you know. So yeah, have a lot of communication about it.

APOORVA MANDAVILLI:

But how do you, I mean, so is that something that people should know? And you talked about the sort of long process to getting to a technology and getting to an innovation. And when in

that long process do you start to communicate? I imagine you don't wanna over promise, but you also don't wanna take people by surprise.

JAY SHENDURE:

I don't know. I don't have a good answer to that. Honestly, I wish I did. I mean, just thinking about RNA, you know, RNA vaccines and that, like, I don't think the public would have been that interested four years ago. Right? In the nuances of RNA modification and that kind of thing. Right? The way they are now. So it's a hard thing to know. But I think, you know, minimally, when you can see that you're at that transformational moment, I think at a bare minimum, I think that's where there's some obligation to be very proactive about it. But it would be nice if we had ways of getting ahead of the curve, so to speak.

APOORVA MANDAVILLI:

In cace of the RNA vaccines with the time have been as soon as we knew that those vaccines were coming like a year from now. And so we should start talking about them now, normalize them and talk about them as. Is that the time or is it as Dr Malin was saying, even before that, we should start to think about the technology still maturing and getting to a point where it's useful?

JAY SHENDURE:

I think, I mean, we can second guess, right? But I think that maybe the broader point here is that we just need a more general education of the public about the things that we do in the lab and what to worry about and what not to worry about. And I think that you don't know when the next big things are to come from, right? So if you had a more general understanding that was more elevated, I think that would you know, in many ways, the current moment is an opportunity to do that right, because I think there is heightened interest in, you know, many of these things from the pandemic.

BRADLEY MALIN:

Can I say two things here. One, you have a challenge on your hand and that you can't get people excited to learn unless you can give them something tangible. And so just trying to teach people science or trying to teach them technology without giving them something to latch on to, is not going to work for most people. A lot of people are very visual thinkers, they're very tactile thinkers. And so if you can't give them something that they can relate to out of the gate, you're lost. The second issue, though, because this comes back to when do you engage with people, is that when you have that, you have to translate the terms into something that's easier for people to digest. Because the majority, I hate to say it, the majority of people in the world could not tell you what RNA is. OK? And so you say RNA vaccine, they might know what a vaccine is, they're not going necessarily know what the difference is between RNA and DNA. Same thing with like automation. If you ask somebody like what's artificial intelligence?

A lot of people will look at you and go, Google. And you're like, no, Google is not necessarily artificial intelligence. And then they go, Alexa. You're like, Oh, OK. So that's the conversation we're having, right? But now you have an in, right? Now you have something that people have had experience with in their life. You're like, OK, so now imagine Alexa at your bedside, right. Now imagine Alexa making a decision about where this suture is going to go within the body. You know, now you can have something where there's this discussion. But if you come in too early, it's really challenging to get people to really think about what you're offering to them.

KIRSTEN DOMINGO:

I think we're having the conversation which is very focused on the very specifics of a new discovery or new technology. A lot of this is just about creating a general basic science literacy and a sort of basic narrative about what it means to have people in science and medicine engaging in a range of research. I mean, I liked the comment this morning that the mRNA vaccines came overnight, but no, they didn't. They came on ten years of research. And there's a way in which I think when we communicate only the boom and bust of a new discovery, it misses the fact that we have lots of people engaged in this wonderful enterprise in science and medicine that we could probably communicate a little bit more of the mundane, or at least the fact that there's a lot going on that's working to improve health. And that at least would lay the groundwork for what we're talking about.

APOORVA MANDAVILLI:

I want to talk about what happens to once you have these technologies in place. And, you know, I was going through the airport recently and they immediately knew who I was. I didn't have to talk to anybody. I didn't have to do fingerprints, nothing. And on the one hand, great, you can get through really quickly. But on the other hand, OK, so now the government knows what I look like, exactly. And I think, you know, when the commercial companies get a hold of that kind of data, you know, there's all these clear and all these other companies just waiting. So what happens when those companies get a hold of it? Is that our future? Is there anything we can do to prevent it? And should we even bother to?

BRADLEY MALIN:

We can have a long conversation this. (LAUGHTER) So there is a fundamental trade off between, if you're talking about data, there is a fundamental tradeoff between the utility that you get out of that data, and the potential intrusiveness that it has on not just an individual, but the group that that individual or perhaps some population that that individual represents. And at the end of the day, that's a societal discussion. Now, where do you strike the balance between the two of them? And I think that we've seen over time the pendulum swings in that, you know, when something bad happens, people are willing to give up their data for anything. So if you have like a pandemic on your hand, easy to collect data, super easy to collect data. Now, here we are several years later. And what we're starting to see is everybody saying we need more data sharing. It's like but it's not as imminent at the moment. And so it's not as easy

to actually share data at the moment. And we're kind of like starting to swing back a little bit towards where we were before.

So in this respect, there has to be not just a discussion about what are the tradeoffs, but you have to make it easy to make that decision. So once you're in a closed situation with data sharing, people don't wanna, where they currently have like my data set, I'm gonna analyze it and then damn that journal if they're asking me for a copy of it, I don't want to give them to it. Right? You have to make it easy for them to make that decision, to push the data out the door. And you don't necessarily have to have it where the data has to be completely public for everybody in the world to inspect. But you have to make it usable and you have to make it available when the time is right. And that's the important part. Like, what is that timing? Right? So if I had a data set where I had like fully identified information on everybody and it was like a population of HIV positive individuals, that's not necessarily a data set that most people feel comfortable putting out into the public domain. But I may study it and then there needs to be an opportunity to give other people to come in and study it as well.

But I'm gonna have to have the right checks and balances in place to do so. What exactly those are, that's a longer discussion.

APOORVA MANDAVILLI:

But it's a very important discussion when we're talking about, for example, now women being penalized for getting an abortion. But that data is just available from these health trackers. Dr Deisseroth, I wanna pull you in here, too. I mean, your technology seems to me to have particular potential for misuse. So really, I'm trying to think about, like, what happens when commercial interests get in the way of some of these things, these developments that we're talking about that have potential for benefit?

DR DEISSEROTH:

Yeah. You know, psychiatry has been, in medicine has been at the forefront of many of these issues with, you know, personal health issues that may be very sensitive, that could affect employment, that could affect opportunities more broadly. And what's really interesting is now we're seeing as neuroscience progresses, psychiatry is now, I think, being asked to play a broader role in some sense interpreting normal or adaptive variations and human capabilities, whether cognitive abilities or others. And this extends to, you know, the normal typical ranges of how human beings vary and then how it verges into the pathological when you get to even disturbing things like sociopathy. And so, you know, this field has a lot to say in principle for the public to the public. But it has to be done extremely carefully because as exciting as the advances are that we're making, we also don't quite know nearly enough to play the role that society seems to be asking of us now. And, so this is the challenge we're facing is how do we give give the public as they deserve and need a flavor of how far the science has come, how exciting it is, how the insights into ourselves and the history of the human family, how fast and powerfully they've progressed.

And at the same time interjects this note of caution that we can't provide necessarily all the answers or even most of the answers that people would want right now. And here we, you know, we have the science communication is so critical. Those of us who reach out to the public, we have to stay, we have to stick to the truth. We have to make sure there's no wiggle room there that we do not verge beyond what is absolutely known and true. The public deserves to know the truth. And they're also smart and they tend to know as well, you know, as they should when they're getting the straight talk. But then at the same time, you know the appetite that they have is so great for this scientific truth. It's probably greater than many of us realize. We all wish when we see some scientific communication being done, we wish it probably could be done better. But we have to support ourselves as a scientific and medical community to those who are doing it right to help them, support them, amplify them.

And so this mix of excitement and caution is what is the path we need to take. And I think that's what we're trying to do.

APOORVA MANDAVILLI:

So your work, Dr Deisseroth, and you talked about how it brought together chemistry, engineering, all these different disciplines. And I think we've been, a lot of the things we've been talking about takes a lot of different disciplines to come together. And how do you reward those? I've been hearing for years that academia doesn't know how to reward these kinds of collaborations, and yet a lot of the money is for those kinds of collaborations now. And how do you balance that with sort of individual investigator driven innovation bottom up, as Dr Shendure was talking about?

DR DEISSEROTH:

We've been working hard on amplifying the credit for broad multi-person teams to making sure that people are recognized as two or three or four or five people who are jointly equally involved in a discovery or an effort and doing everything we can to make sure, both within the scientific community and outside, that that sort of shared or joint credit and, you know, appreciation is shared. So that's one big, very critical step because you have people you know, you have a chemist, you've got a doctor, you've got a biologist, you have an engineer. And these four types of people bring incredibly different perspectives, each essential. And none of them is subsidiary. And this is something we all can do as a scientific and medical community is work hard to make sure that that such shared contributions are equally appreciated.

APOORVA MANDAVILLI:

Dr Shendure, and your thoughts?

JAY SHENDURE:

Yeah. So I'll agree with everything Karl said, but just kind of one more thought. I do think, you know, collaborations are great, but I think there's also, it is increasingly the case that you see

I'm sure this is the case in your lab too, Karl, that trainees who are, you know, equally comfortable in R studio in Python as they are at the bench. Completely, you know, hybrid. Right? And I think you can't beat that. That's worth more than a collaboration, right? Having that duality in a single person or a single mind and I'm sure in other sorts of combinations of fields as well. And it does, you know, bringing it back to kind of this being the medicine academy like it does, you know, some of the thoughts raised earlier, it doesn't make me I do have this persistent concern that there are many aspects in science where I think interdisciplinary individuals are becoming more common to a great effect. But as a point, I think raised earlier today, you know, as medicine, medical education seems to becoming more clinical, that that interdisciplinary physician scientist I think is ironically, you know, less common than maybe 20 or 30 years ago.

APOORVA MANDAVILLI:

Kirsten Doming, what are you saying from the publication perspective? Are you seeing more of the innovation that he's talking about, or do you see stills of the group think?

KIRSTEN DOMINGO:

Yeah, I think that as journals, I think probably the biggest journals in the respective fields have gotten there because they have a history. And with that history oftentimes can come with it, not being aware of all of the new things that are on the horizon. I think the responsibility for journals is to stay as fresh as the research is staying, to be able to catch the best research that comes into a journal, to have the people who can evaluate it, to be able to put it, to be able to vet it through peer review and to put it in context. With regards to these aspects of sort of multidisciplinary teams, it's amazing how each of our different disciplines have their own traditions on how they publish and what a publication looks like in one field versus another field. And I think that is sort of a challenge for multidisciplinary teams. And I think it's the responsibility of the Academy to help these types of teams be able to articulate a publication in this journal means this. And I think we've tried to do that I know at UCSF to recognize contributions on teams as a part of the promotion process to allow investigators to give more narrative about their specific contributions.

Their contributions might be new code or something else to value those types of things. And I think that we have to understand that there are many things that contribute to what makes really extraordinary discoveries like this and then figure out how the Academy can value that and understand that for an individual.

APOORVA MANDAVILLI:

I actually want to switch gears and talk about racial equity, but I think people can start lining up for questions. I'll go to them as soon as I'm done asking this question. So you've talked about all of us and how successful that was and mindful recruitment and all of that is great if you have people in place to do the recruiting. But this morning we heard about how there is

underrepresentation of black scientists, for example. And I think in fiscal year 2021, 2.6% of NIH applications were from black scientists. So, you know, if the pipeline is broken, can you actually fix what's at the end?

KIRSTEN DOMINGO:

Yeah, it's a great question. It has sort of, I would say, multiple areas that I would respond. So one is that the fact of only 2.6% of black scientists is a travesty that needs to be corrected. It is not directly, it is related to the representation we want in clinical studies. But I would say the responsibility to diversify our clinical studies is a responsibility of all of us. It's not the responsibility of the 2.6% black scientist. And we want those 2.6% of black scientists, hopefully more, to be engaged in every type of research, not necessarily only research that's related to a population with which they might identify. And so I think we have to solve, we have to recognize that both are issues. They are related, but they're not the same issues. And I do think that we have to tackle both. I will say that I think fundamentally, just like I believe that we make new discoveries when we explore the broad variation of human biology and human behavior and human response. I think we also learn more by having a diverse workforce that thinks about questions in different ways.

APOORVA MANDAVILLI:

Anybody else wanna jump in here? Otherwise we're gonna go to questions. OK, so we'll start taking questions. But again, I would please like to remind you that these should be questions. And I'm a journalist, so I don't really feel as many qualms about cutting people off. (LAUGHTER) We'll start over here.

JOHN WHITE:

Hi. I'm John White from Philadelphia. An actual question. I'm wondering if you can help sort of reconcile on the one hand, the long lead time for discoveries and the sometimes unpredictable applications of those discoveries with the notion of community engagement and community consultation. When and how should that be part of the process? Is it only sort of when we get to late stage translational clinical trial kinds of things, or is there a way to plug in community voices at much earlier points in terms of the broader issues of scientific discovery? Thanks.

BRADLEY MALIN:

Way earlier. I'm serious. I mean like so right now, I would say the majority of scientific investigation is done within the scientific community, and it's not done in partnership with the communities that it can potentially have an implication for. And this is a problem because it takes, it actually moves the science and the technology development in the direction that is under the control solely of the scientists who are doing it. And that's great from the perspective of innovation for innovation, it's not great from the perspective of designing something in an ergonomic manner that's appropriate for society. And so one of the things that I think we recognized a long time ago at Vanderbilt was that, you know, community advisory boards were

critical in the creation of our bio repository that we use in combination with our medical records for research purposes. And actually, Jeff could probably speak about this better than I can historically, but this was something that and we have embedded even before we began doing research.

And this was, you know, there were questions about what research should be done, even? You know, like what populations should be studied? Do we have blind spots in the development of the technology that we're building? I think if you don't have, give the opportunity for the populations that are gonna be impacted to have a seat at the table, you'll never know what could have happened from the outset.

JAY SHENDURE:

It's a little bit there. There are I mean, just, you know, I think your question kind of applied to clinically facing topics, but there are, you know, for example, on stem cell research, there are approval committees that are university based where there is we said our university, there is some community representation. Right? So even in a space that is not necessarily directly leading to trials or things like that, just getting input from the community on whether they're comfortable with the rationale and the specifics or the kinds of experiments we're proposing.

FLORA WINSTON:

Hi. Flora Winston from the Children's Hospital of Philadelphia and University of Pennsylvania. Very interesting panel and wish we had much longer to talk about it. I was thinking a lot about the question was, when do we talk to the public? And because these are really very challenging topics, what I think is missing is the influencers of the public. When do we talk to the influencers of the public? When do we talk to the people who make decisions for that public? So I think about IRBs, I think about so many others, and what is the way that we can start to have consistent language jargon across the fields so that we better understand what technologists are talking about? I'm a pediatrician, engineer, so I understand that divide in language. But really, I think we're missing something here. And I want you to think about who are the people that the public turn to and are we talking to them because they're not coming necessarily to I don't know the news all the time. They're coming to social media, they're coming to their families.

They're talking to their pastor or somebody else.

KIRSTEN DOMINGO:

Yeah, I'll jump in and say so I agree with you. And I think when you look at the groups that do this well, they're not talking study by study. They're talking about sort of partnerships with community organizations, community leaders that are sort of longer term, where there is both the one on one, but there's a lot of translation right across the. So and you know, for us at UCSF, this was a lot that happened during COVID, which was really about partnering with these community organizations to then together think about, well, what studies and what care

delivery. And so that wasn't about every single community member. It was partnering with other trusted institutions within the community together, then setting the agenda for what was gonna happen. So I agree with you. But it does require this sort of sustained view of what you're doing. It's not that you assemble this for like one study like.

SPEAKER:

I'm (UNKNOWN) from S General Hospital. I really appreciate all the conversation here. Really good to hear also about how to engage the community in terms of the capacity building, the co-creation, co-developing our research agenda and all the work that you are all doing. One of the things that come to mind when we think about the bench to bedside approach and why we want to enhance diversity in our research studies, well, the problem that we encounter is that even if people want to participate in the research study, when that goes into the bedside for treatment, their insurance will not cover. You're wondering, they don't have access to the treatments or therapies that are developed from that innovation. It's always difficult for them to reconcile. Why participate in a research trial when I may not see a downstream benefit to your point where people need to see something tangible? So you're wondering in your experience, if you can give us some tips on how to navigate reconciling this in the community that you're involved in in your research?

KIRSTEN DOMINGO:

I totally agree with you. We make recommendations in the report about how CMS, Medicare and Medicaid could create incentives, how they could engage more community practices and safety net hospitals in research. That is something that I think would help in diversifying, but also it creates access in many cases to new discoveries. But ultimately, we live in an environment where we have a large fraction of the population that is still uninsured, that still doesn't have access to all of the technologies. And that is the broader context within which we're talking about discovery. So I totally agree that is remains the challenge.

SPEAKER:

(UNKNOWN) from Johns Hopkins. Some years ago, I was a leader of a clinical trials network sponsored by the NIH in the US and Canada. And I learned that in Canada, you cannot identify patients or subjects by either appearance of race or self-identification of race. So what do we do to achieve diversity in clinical trials in the absence of an ability to utilize or document race as likely to occur in admission to universities?

KIRSTEN DOMINGO:

Yeah, that's a good question. So I think what the committee, when we looked at this question, we were interested in using self-identified race as would be the standard. I would say that it and to think about other variables that can help us think about diversity across different dimensions, language access, regional access, we were very interested in rural access for things. So I think there are a number of dimensions that you could think about across the broad range

of science that's funded and conducted in the US. What you would wanna know to ensure that it's available to people and that the discoveries are based on the range of people. I think with race it is important that identifying self-reported race and ethnicity, race and ethnicity as a social construct is, why should that lead you to make different biological discoveries? I'm often asked. Is there a danger in redefining biological concepts of race by saying, this is our goal? And I think that we as a committee came down very strongly on underscoring that race is a social construct, but that the entire, that based on principles of fairness and principles just on sort of broadly speaking, the broad ways in which we are all going to contribute to biological diversity, that it's important to do this.

Race is in some ways a poor proxy to do that in that self-identified race. But it's probably the best we have. And you're right, we're in a dynamic environment where that might not be what we have in the future.

BRADLEY MALIN:

So you have a short game and a long game here. So the short game is there are barriers that are put up with respect to what information can be collected or are permitted for use for an investigation. So it's not just in the US and Canada that you've run into these problems. We've seen similar things with clinical trials that have run through certain European countries as well. So France is the exact same situation, which begs the question of, so what do you do in the short game? Short game, you may look at other variables, fine. But I think that in the long game, which is really where we need to be thinking about this, is why are we in this situation as we are? What happened within society to bring us to that point? And then try to work backwards from there to figure out how do we address that issue? Is it a matter of trust? Is it a matter of a penalization for something that happened in the past? And if so, is it something that could be addressed? I think each of the countries, each of the populations in which this has happened there are, has been handled in different ways.

And I suspect that what's happened, if you were to solve it in France, for instance, you would not solve it in Canada. And so this is something that requires a longer investigation into how do you go about building back the trust that would allow you to get that information and reuse it? Sorry. That's just my perspective.

SPEAKER:

Hi. (UNKNOWN) the University of Iowa. I had a sort of a philosophical question, actually. About the elbow that you talked about, probably Jay. And that comes from two things. One is Thomas Kuhn and his idea of sort of a set of paradigms that constrain our ability to accept new ideas, even when the data tells us that that's what's happening. And also the RNA vaccines and the work that was done in the mid to late '80s by Caitlin Grieco, which people just didn't believe, you could put these things on cells and they would work. And they had a lot of work to do to develop that. But that was a lot of work done, really going uphill. So I wonder how much of this

delay of getting up the elbow is really a conceptual challenge for us, for the scientists in our inability to accept these new ideas and these new approaches?

JAY SHENDURE:

Yeah, it's a great point, I think. I mean, maybe this connects to kind of another point I didn't get a chance to make, I think. I mean, historically, I think this kind of free-ended technology exploration for its own sake, so to speak, has probably been less appreciated or funded than it might otherwise be. I think that at least I've seen in my career so far. I felt like that has changed to some degree. But, you know, like for every one of these threads that leads to an elbow, there's 100 threads that didn't. Right? And it's just a maze of exploration where you're just trying ideas and trying to make better educated guesses about which way to go. And I don't think any of that is very predictable at the get go. It's a pretty empirical science of this kind of, you know, low amplitude tech (UNKNOWN). Right? So I guess it's a long way of saying, I see your point. I do think to some degree it's a cultural problem in science, but I the best way we can solve that is simply supporting more basic science and tech that for its own sake, without worrying too much about where it's going.

Right.

APOORVA MANDAVILLI:

You have only about a minute left. But Dr Deisseroth, I want to give you the last word on this. Oh, you're muted.

DR DEISSEROTH:

I don't think.

APOORVA MANDAVILLI:

Now we can hear you.

DR DEISSEROTH:

I'll just in the last words sort of way, I'll just say that, you know, people care about people more than anything, more than ideas even. And this is something scientists and doctors don't know as well as politicians. Politicians always start with a human story. They start with a human being. They tell about the challenges and they build a bridge from there to possible solutions. I think that's what gets us from these early moments, helps us build public trust, helps us bridge, you know, through the long development to get to the elbow. Let's tell human stories when we talk to the public.

APOORVA MANDAVILLI:

Great note for a journalist to hear. (APPLAUSE) So that's actually a great note to end the panel on. Let's thank all of our panelists. We really put them on the spot to explain exactly when and

how to communicate new technology. (LAUGHTER) But I think you all did an amazing job. So thank you very much. (APPLAUSE)

SPEAKER:

Have mic on, please. Thanks. Thank you the panel two for such great remarks and for a great discussion. And thanks to the audience. Now, just as we did after the first panel, we have a question for you. As you see in the instructions on the screen, just scan, the easiest thing to do is scan the QR code with your camera or you can go to the website, the slido.com, and use your computer or smartphone when you're in, when you're prompted for the event code, again, it's NAM2022. And the question is how convinced are you that scientific breakthroughs and changing paradigms in the conduct of research described today or elsewhere will lead to major paradigm shifts that really dedefine science and innovation in this decade? We'll give you a minute. I could hum the Jeopardy song, but there we go. Maybe you can pop up some results. Well, I'm gonna do it low tech. It looks like about 40% of us said they were, said we were, gave us a four. And about 30% of us were fully convinced. So the audience was split between kind of halfway between one and five, four and five in terms of being totally convinced.

So that's pretty good. Thank you.

Panel 3: Shaping the Path Forward: From Disruption to Transformation

SPEAKER:

Let's move to panel three. The name of this panel is shaping the path forward from disruption to transformation. And our final session is going to be moderated by Mariette DiChristina, the dean of the College of Administrative of Communication at Boston University and a nationally recognized science journalist. Previously she was editor in chief at Scientific American and the first woman to head Scientific American since its founding in 1845. There, she led the editorial team to receive the coveted National Magazine Award for General Excellence. Please join me in welcoming Mariette DiChristina and the panel three panelists.

MARIETTE DICHRISTINA:

I want to thank you for that truly lovely introduction. I was sitting here thinking, since we're using the terms of social media now that I was having a squel moment with all the wonderful expertise and insights in this room. So, it's my real pleasure to introduce a wonderful panel of experts to conclude this part of the series of our discussions today. I'm going to share the name of super briefly. And then as we've been doing with the other panels, I'll introduce them with a little bit more. So, to my far right, your far left is Dr Sangeeta Bhatia. Welcome. And Dr Leslie Vosshall, lovely to see you. Dr Keith Yamamotov and Eleanor by Mark. Nice to see you today and thank you so much. So, you know, I think I was reflecting on the lessons we've been getting

today and quite a number of them are sort of reflected refract off each other. And I hope we'll continue to build on that as this third panel gets a chance to reflect on the rest of the day so far. We've heard about disrupting challenges in the scientific enterprise, including diversity in multiple ways in research, science, communication, recruiting and retaining folks and, you know, developing different ways of thinking about science.

We've heard about changing the game, emergent science and technology areas. And our third panel will continue the forward looking perspective and will highlight how we address those challenges going forward as we move toward transformation. And I might impose a little bit on our panelists after we hear their remarks for how do we get those first steps in place? Because it occurs to me that largely we've been talking at a very high level. But, you know, and that's important. In the last, we just heard a commenter say, it's good to have a short term and longer term gain. We do need to do that at all times, thinking shorter and longer. And a bit later, we'll have a conversation. Then again, we'll turn to questions and answers and the questions in the room. The questions are for the audience to ask. The answers come from the speakers and I really appreciate your asking those questions with a little up sound at the end, as Alan Leshner (INAUDIBLE) used to say. So, first, let me please turn to Dr Sangeeta Bhatia who is John and Dorothy Wilson, Professor of Health Sciences and Technology and of Electrical Engineering at the Massachusetts Institute of Technology.

Over to you.

DR SANGEETA BHATIA:

OK. Hi, everybody. It's great to see you. So, I think as as physicians, many of us learn by case study. So, I thought I'd give you a case study today of an example of convergence science. So, convergence being the intersection of life sciences, physical sciences and engineering. I myself am a physician and an engineer by training. And so the case study I'd like to give you is one in Nano medicine. So, just to kind of orient you. Nanotechnology is kind of the world under 100 nanometers. And it's a set of technologies that have emerged at the nanoscale. So, human hair is 100 microns. These are a thousand times smaller. And we really have two different sets of technologies that have emerged in nanotechnology. On the left you see a semiconductor microchip. So, the kind that's in your smartphone. Most of your smartphones has 8 billion transistors with five nanometer features. We call this top down fabrication, the ability to pattern materials with light at that resolution. On the right of your screen, you see another set of technologies that have emerged from the world of chemistry and material science.

And here we make ensembles of molecules and atoms to make nanoscale materials like gold and lipid materials and carbon nanotubes. And what's amazing about these materials at this scale is they have actually distinct properties than their macroscopic counterparts. They are different colors. They have different electronic properties, magnetic properties and even biological trafficking properties. So, this is an amazing tool kit to sort of spur medical innovation. And in our country, a large emphasis on the intersection of nanotechnology and

medicine has come from longstanding investments that the NIH made through the National Cancer Institute on spurring cancer advances. And what was amazing about that is that when COVID came along, you may or may not recognize that nanotechnology was actually one of the unsung heroes of the COVID-19 pandemic. So, the surveillance that we did for viral variance was a nanotechnology enabled point of care diagnostics. The color change on that paper strip was nanotechnology enabled.

And of course, we've been talking about RNA vaccines which are packaged in lipid nanoparticles which had already been worked out to be manufactured at scale with their four component parts. So, in fact, these longstanding investments in cancer and nanomedicine actually enabled our our country and the world to pivot so quickly to be able to address an urgent crisis. And what that looks like over time is these individual threads of research really starting for their own goals. So, the miniaturization really the goal there has been to speed computation and nucleic acid therapeutics have their own goals. And if you sort of layer on to that stem cell research, cancer biology, genomics and the emergence of artificial intelligence. What's really very exciting is that these are converging. They are coming together in the last decade to address, really, we hope, grand challenges in many fields. In cancer, we've been focused on early detection, enabling immunotherapy, addressing metastatic disease and cancer diagnosis and treatment in resource in poor settings.

But as I hope you've seen that these longstanding investments actually can enable pivoting for for new opportunities and challenges as they emerge. So, in sort of case study format, I wanted to get really specific about what does convergence research look like. It's not just a colorful diagram on the slide. What does it look like on the ground? And I thought I'd give you an example of my little microenvironment where I do research. So, I sit in the middle of Cambridge in a building. It's an NCI designated cancer institute that's called the Koch Institute for Integrative Cancer Research. And it was built when Susan Hockfield was our president and the inaugural director was Tyler Jacks. And every floor of the building has half cancer biologists and half engineers that I'll call cancer curious. And there are six such floors in the building, and we're all focused on grand challenges in cancer. There are 700 researchers in the building but that is actually too big of a community with which to have deep, long formal conversations and safe innovation.

And so the way that plays out is we have micro communities even within this structure. And I show you there is the six individual engineers who are in the cancer nanomedicine center that we have within this building. And there are many such micro communities in our building. And then we physically sit in a larger ecosystem, which is really important for enabling and accelerating the delivery of discoveries from the bench to the bedside. And that has to do with adjacent institutes. So, the Broad Institute, the Schwarzman College of Computing. And then also local industry and biotech startups, pharmaceutical companies and importantly, investors. Now, the impact of this kind of community can be measured in many ways and discoveries and publications and trainings and medicines. But just one metric that I'd like to show you. This is a

little bit, at least drawing to me and fascinating is over the last 15 or so years, 100 companies have come out of this particular building. So, this format of innovation and convergence I think is really very ripe to be replicated and many places around the country.

And of course, there are other such centers focused on other diseases. And I hope you leave this panel today thinking about a future of convergence science and what it can do for some of the problems that you're focused on. And I'm happy to talk about some of the enablers as we go.

MARIETTE DICHRISTINA:

Now, I'd like to welcome Dr Leslie B. Vosshall who's vice President and Chief Scientific Officer, Howard Hughes Medical Institute. And Robin Chalmers, News Stein Professor and head of the Laboratory of Neuro Genetics and Behavior at the Rockefeller University.

DR LESLIE B. VOSSHALL:

Thank you. I want to bring this back to a question that was posed earlier this morning by Neil Hansford which is who is doing the science? So, earlier today, we elected new members of the National Academy of Sciences. 50% of them are women. Right. So, who is doing the science outside of the National Academy of Medicine? It's not 50% women. As we heard a few minutes ago, just under 3% of black Americans receive our wands. There's a huge disconnect between the demographics of the United States and the people who are actually doing the science. This has been discussed endlessly for decades. We've been wringing your hands for decades to try to figure out why is this. And so part of the panel's idea was to bring some transformational ideas to figure out how we can address it. There's no easy fix. Many of us have been thinking about it. And so I want to give you the case study of a 30 year old postdoc who have a two year old that needs to go to daycare. You've just started on a natural funded postdoctoral fellowship and your salary is $54,835.

Right. You don't have health insurance. You don't have retirement contributions. So, you're 30 years old. You're an adult and you're trying to live on $54,000. You may be historically underrepresented in science and going into a laboratory where you are the only person in your demographic and you're encountering a hostile environment. And so I think none of us should be wondering, why are we not getting postdoc applications? Why are our postdocs leaving to go to private sector positions? And I would say, on the one hand, we need to pay postdocs a living wage. And I think that this is common for all of us. I think postdocs are unionizing rapidly. So, I think we have to have some conversation very quickly, that it's not acceptable to pay somebody with an advanced degree or $54,000. There has to be some mechanism within our profession to pay people. According to their credentials. So, that's the first thing. I also think that we owe it to our trustees to have an environment that is more welcoming.

And so this is where it comes down to my new job at the Howard Hughes Medical Institute, that our vision for where we get to 50% women in science and African-American and Hispanic

scientists proportional with where they are, is to make happy and inclusive, equitable labs. Sounds kind of hokey. Sounds kind of girl scary. I was a Girl Scout but the idea is the way that we've been making these investments is with the Hand of our Fellows program, which gives postdocs four years of support and we explicitly recruit them because they're underrepresented in science. So, the women of racial and ethnic representation are underrepresented in science. We give them eight years of support. Right. So, they're selected. They're given eight years of stable funding when they set up their labs and they're very aggressively recruited because we have a huge diversity problem. They then recruit women and minorities to their labs because we want to be part of a group that is diverse. And as has been said many times today, diverse people do diverse science.

We're launching another program which kind of turns up the temperature a little bit more. So, the Freeman Hrabowski Scholars program, named in honor of the great Freeman Hrabowski who has figured out how to educate and graduate and populate the world with incredible black scientists, engineers and physicians. And so then we're giving these folks ten years of support. And the way you become a Freeman scholar is that you care about your people. You care about a diverse lab, you make a welcoming environment, you pay them a living wage. And so we think that if by selecting 30 of these scholars this year and then over the next ten years, 150 scholars each have on average 20 people in their lab. And they're getting professional development to be able to encourage people to have a happy lab that we're going to have some generative ability to bring people into science that represent the demographics of the country. And so that I'm just going to stop there. So, the answers are pay people a living wage, get people, get Lab has the help that they need to recruit diverse people and make the labs happy that we currently have this generational shift.

Those of you who have labs, millennials and Gen Z, they're not like us. Right. They're just not like us. They expect more. They expect more from the environment. And I don't think that we have really confronted this, that we need to adapt how we interact with our trainees to meet them where they are. And so with that, I'm going to turn it back to our (INAUDIBLE).

MARIETTE DICHRISTINA:

A third speaker is Dr Keith Yamamotov who is Vice Chancellor for Science Policy and Strategy, University of California at San Francisco, UCSF Precision Medicine and Professor Cellular and Molecular Pharmacology at UCSF.

DR KEITH YAMAMOTOV:

Isn't it great? They're not like us. What a relief. So, our marching orders as Dr Leslie said on this panel, was to bring forward policies that could drive transformation in our current enterprise and the environment. Now, like the other speakers, I have 6 minutes. So, that should be no problem in standing up, let's say three transformative changes and discussing them. So, let's let's try it. I'm going to raise them in the context of science and technology writ large rather than traditional biomedical sciences. Just to underscore what we've already heard from

Sangeeta and from Carl Viswanath in the last panel about the importance and power of transdisciplinary science. So, here we go. Number one of three, focus federal science and technology efforts on existential societal threats. The government should be launching multiagency, multi-sector science and technology initiatives that address major societal challenges. Together with Mary Wooley, who's here and Sue Patrick and Bill Novelli.

I have the honor of co-chairing the Science and Technology Action Committee which is an ad hoc collective of two dozen leaders across academia, industry of the non-profit sector and government. And actually includes Marcia McNutt, Victor Zal and Harvey Fineberg. So, the presidencies of the Academy is well represented. In 2020, that group stood up for such societal challenge areas all of which you will recognize directly impact health. So, public health and health care, of course, but environment and climate change, energy production, utilization and storage and food and water security are big issues that need science and technology to be in transformative ways to be able to move forward. Now, don't get me wrong, this is not a call to abandon basic science. For all four of those challenges, ongoing knowledge discovery is going to be continuously the feedstock of ideas for development of impactful applications. So, continued steady funding increases in support of basic science agree with everything that we heard from (INAUDIBLE) this morning.

But now linked to abundant new funding for challenged, specific, coordinated, multi-agency, multi-sector initiatives. Number two, award high levels of public funds. Public funds for science and technology, to the private sector, to companies. Wow. The U.S. science policy framework, as you all know, was really set in 1945 by Vannevar Bush in the Endless Frontiers report that he wrote for President Roosevelt. The federal government, he said, should support basic research and the training of the next generation of scientists in our universities and medical schools. And after that, the private sector would take over, driven by the profit motive to take those basic discoveries and turn them into things, products, drugs and so forth. Well, that hand-off doesn't actually work or at least it works too slowly as seen by the decades long, three decades long gap between fundamental discovery and the final approval by the FDA of a new drug as really documented in a beautiful paper by Mark Fishman in 2018.

So, one can imagine three broad conditions where companies would be bestowed taxpayer dollars at scale. This is what we're talking a lot of money here. First, de-risking that is resources to create important new technologies that are burdened by substantial uncertainty by long development timelines, by perceptions of small markets. These are issues that the risk averse quarterly report conscious industries really can't take on. Second, public need. As in novel antimicrobials, pandemic preparedness, climate change mitigation, things of that sort. And third, economic and national security. Here, recent passage of the Chips in Science Act indicates that there is some consciousness in response to that third notion. Number three, ensure that science and technology benefits all. Complex social justice and equity issues are embedded in all emerging technologies. But these issues have not been considered strongly by many of the stakeholders in the technology lifecycle. This is not a new problem.

Many of you know of the inequities in COVID-19 triage and therapy decisions suffered by people of color due to systematic measurement errors by a 40 year old technology plus oximetry. And the inequities continue to emerge in the development and use of new technologies introduced at every stage along the technology lifecycle. These inequities selectively disadvantage specific racial and ethnic groups, gender and objects, accused groups, or those that are disabled in poverty or living in rural locations. It's heartening that President Biden issued an executive order on his first day in office promoting government wide attention to equity. In general, however, science and technology enterprises need a system that encourages funders, developers, regulators and other stakeholders in both the public and private sector that prioritizes equity. In hopes of addressing that, the National Academy of Medicine has stood up a consensus report committee which I'm honored to co-chair with (INAUDIBLE) that's been charged with developing a federally coordinated, multi-agency, multi-sector governance framework founded on core ethical principles with a focus on equity extending from conception to post-market for emerging science and technology in health and medicine.

So, let's be done to revolutionize our enterprise. These are just three ideas focused on societal challenges. But public funds for science and technology have scaled into the private sector and elevate equity to ensure that science and technology benefits all.

MARIETTE DICHRISTINA:

Well done getting that all to 6 minutes. Now, I'm delighted to turn to Elena Viboch, (INAUDIBLE) Elena, excuse me, because we have talked about a lot of the elements of commercialization but we haven't really talked about how that how that happens from the company perspective. So, from General Catalyst, please go ahead.

ELENA VIBOCH:

Hi, I'm Elena Viboch and I'm so honored to be here at the National Academy of Medicine where it all starts, where it all happens. And I thought of some things to talk about. But before I go into what I planned, I just want to recognize Leslie's point, just so, so important. So, I'm a part of an investing partnership and we invest in science and technology. And 40% of our partnership and leadership team identifies as not white. We're not nearly as far along with women, we are working on it. I'm trying to recruit and we have a truly happy and friendly environment. I joined a year ago. The firm is 20 years old and it is unbelievable how welcoming it is and what a difference that makes in the environment. So, I just wanted to pick up on that and how important it is. OK. So, what did I actually plan to talk about? I'm going to give a bit of background about General Catalyst, talk about our investing philosophy around responsible innovation. And talk about investing in life sciences which is what I spend most of my time doing.

So, the National Academy of Medicine, its mission speaks to advancing science, accelerating health equity, and building a healthier future for everyone. And General Catalyst has a lot of

overlap with that mission. So, as a venture fund, we focus on investing in powerful, positive change that endures. And from the inception, we've been strongest at early stage investing. That's the core of what we do. And responsible innovation is our unique angle of how we do it. I would encourage everyone to check out responsible innovation labs, of which we're a founding member. And I won't spend time talking through the seven pillars but inclusive prosperity is one of them. So, when we look at how we invest, we think about enduring companies. Those are companies that have society's permission to keep existing. And so if we start working with a company, we ask, what impact will this have at scale? And we help design companies for both growth and good. And this isn't philanthropy. This is a business imperative because we think these are the only companies that society will allow to exist.

We have a three pronged thesis in health care, particularly. So, we focus on investing in companies that can transform the health care system from a sick care system to a health care system, that's the first. The second is bending the cost curve. And the third is expanding health, access and equity. So, that hits on a lot of the themes that have come up earlier today. We also want to invest in companies that transform the health care system. You know, the title of the panel includes the word disruption. We actively avoid that. We want to work with the health system to deliver better care that's more accessible to people. And one of the ways we do that is by working with health system leaders. So, Mark Harrison, former CEO or current CEO, soon to be former of Intermountain Health. We work with Ron Paulus, who is the former CEO of Mission Health. Steve Klasko from Jefferson. And some of our investments I hope will also resonate with this. So, Livongo was created in General Catalyst office and it was really formed out of a premise that started in academic medicine which was population health.

And at the time people didn't think it would translate especially not into a profit imperative because in our fee for service medical system, doing things that help diabetic patients take better care of themselves. Very unclear whether there's any fee for service value in that. It's more interactions of the health care system, drives more costs so you might think. So, what Livongo did is prove through clinical studies that this concept could be implemented in the real world, showing a 22% reduction in cost for diabetic patients and a one year RY (INAUDIBLE). And they actually got it adopted. Livongo went public, was eventually acquired for 18 and a half billion dollars by Teladoc. Proving that there is a real commercial value in doing what's best for patients and then bending the cost curve. I want to switch a little bit. I had more examples but I didn't budget time well. So, I want to switch a little bit to what I spend most of my time doing which is investing in life sciences. So, the vast majority of what we do in life sciences builds on work that is done in academia, that is led by people who are trained in academia.

I've never met a college dropout biotech startup that succeeded. Don't quote me on this. But, you know, generally people who have the best impact tend to have extensive academic training. And so what I do really relies on people like you. And I invest across therapeutics, diagnostics and research tools. And some of the key themes we're pursuing are investing at the intersection of compute and biology. I'm sure this group knows well. Harnessing nature's

machinery, investing in research tools and clinical trial technology and infrastructure. And on the clinical trial side that really ties to some of the earlier panels conversation. So, a couple of our investments that you'll hear about in the press soon, they haven't announced yet, are focused on clinical trial technology infrastructure that expand clinical research as a care option. So, how can you give people the opportunity, not the obligation to access clinical research? Another investment that we did in the theme of computationally enabled drug discovery is we recently led the Series B Financing of Odyssey Therapeutics.

Gary Glick start out in academia for many years. He is a chemist and his team has developed a novel chemistry platform that they're using to develop drugs for cancer and autoimmune disease and they have eight programs underway. Maybe the last example I'll give is really at the intersection of academia and investing. We just led the Series B Financing of control therapeutics. And it was founded by Dr Shana Kelly. This is her fourth company and she is in academia leading a lab and finds the time to work so deeply with companies translating her discoveries around her technology which can identify circulating tumor reactive lymphocytes. So, I know I'm over time, I'll wrap up. We need you and we need academic discoveries to fuel our investing and we need clinicians to help us understand where the true unmet medical needs that drive what we're trying to do. So, thank you.

MARIETTE DICHRISTINA:

So, I always love it when we can get a little bit engaged with these panels too. So I'm gonna first remind everybody, please do feel free. I'm gonna ask questions of individuals, but I'd love to hear other panelist contributions because there are a lot of themes here that are sort of mingling with each other, and it'll be great to tease those out. But Dr. Bhatia, I'd like to start with you. I love the storytelling, you know, that you did with this specific case example and now people on the floor together and how many and how that works. What are some ways we can start with that if we don't, if we're, you know, it's great to co-create when you're together, how are some ways that people can get started in any environment?

SANGEETA BHATIA :

Yeah, that's a great question, and thank you for it. I am, one thing I ran out of time for was that last slide of things that one can do. And one thing I think it's really important to do is what we call intentional teaming. And you can do this at any level. You can do this in medicine, you can do this if you run a lab and that is to bring people just around the table into your lab meeting as part of the invention process. So, I always have MD-PhD students or medical fellows in the room. I have a diverse lab in terms of women around the table, and I represent minorities. But I think you need to make a safe space for people to actually not know the answer and not know the jargon and be able to bat ideas around. And then I think it's also important in the intentional teaming to have some bilingual individuals who can help translate because a lot of

us are speaking different languages. So, I think that's something that anybody in this room could do tomorrow in any of their sort of creation activities as to more intentional teaming.

MARIETTE DICHRISTINA:

Your thoughts. Anybody would like to share about that? Where I go on.

LESLIE VOSSAHALL:

I think it's absolutely true that if you're, the word silo came up before, maybe not so that if you're, if you stay in your lab and stay in your lane, you'll miss out on the opportunities to bump into other ideas so I'm gonna use this intentional teaming. (LAUGHS) That's a great idea.

MARIETTE DICHRISTINA:

Dr. Vossahall I'd like to pick up with you as well just the next step so I love the idea. And as somebody with millennials and Gen Zs in my, you know, my children, I know they are different. How do we help make them happy? What are some of the steps we can take?

LESLIE VOSSAHALL:

I think that when, I'm 57 years old, when I was a graduate student, there was no discussion of mentoring or climate. You came into the lab and you did your work and there just wasn't any discussion of that. I think that this generation doesn't find that to be acceptable. So, they want to be heard, they want to be taken care of, they want culturally aware mentoring, and if I don't give it to them, they will leave academic science. I think it's pretty clear. I think it's like a pretty clear direct path that they have high expectations for the environment in which they live. And so, I do have a couple ideas to throw out there that I mean, there's many, many mentoring, the mentor programs the University of Wisconsin has seamer, has an incredible mentoring program that teaches people don't send an email at 2:00 AM with angry feedback on the thesis. Just don't do that. It's not helpful. (LAUGHTER) Don't text them, call me. Don't do that because they freak out. Just simple ways to be human. Another thing (LAUGHTER) is the anonymous lab survey, which I stole from my colleague Vanessa Rotella, which is an online Google form where people can tell you what's working and tell you what's not working, tell you things that are very sensitive that they would never say out loud.

And I do that every year we collect all the feedback and then I just work through it of, OK, I will not email you at 2:00 in the morning anymore with bad feedback on your thesis. I won't do this. Like most of it is directed against me, which is fully appropriate. Or it will surface some problems in the lab that I haven't been aware of. And so, every year I can rebalance the climate and fix problems that exist. And so, then I have the hope of retaining these brilliant scientists in the lab.

SANGEETA BHATIA :

Also, they want snacks. They want snacks. (LAUGHTER)

MARIETTE DICHRISTINA:

I mean, who isn't thinking about snacks?

LESLIE VOSSAHALL:

I have like a $500 a month snack budget. Very high snack, Lacroix snaps. It's the only, (CROSSTALK)

ELENA VIBOCH:

Snacks are very important. (LAUGHTER)

MARIETTE DICHRISTINA:

Keith.

KEITH YAMAMOTO:

So, I like all of that Leslie but I would add one more thing that I think is fundamental about the way that academia is working. And that is that we squelch the kind of fundamental reason that young people decide to go and do science. And that is that they imagine that they can make some amazing discovery that will have a big impact. And so, they say this is great, you know, science should be really what I want to do. And they get into maybe the undergraduate level, but certainly in graduate school and they're told by their mentors, all of us wise people, not to try to do anything too bold, to pick a thesis project that will be short of work sure to generate papers. Alright. And OK, that's great. So you kind of hold back and then you apply for a post-doc fellowship and we tell them, "Now, don't go crazy, you know, just kind of do something that's gonna be highly feasible that the funding panels will like. So do that." Same thing when you apply for a job. Write your job proposal. Write, try to get tenure into your position.

And it turns out that we never in academia tell the scientists who are so hungry to do something amazing, now's the time to really do it. Right. See what this little machine will do if you put the gas pedal on the floor. We don't do it. Instead, we hold them back. And I think that they get this message of careerism and publishing in the right places, publishing the right number of papers. Right? And, you know, don't step outside of the parent standing paradigm of the day because you won't get invited to meetings and you won't be invited to write a review article. And so, they look at that and say, well, this is what I wanted to do, something wild and crazy, but I'm not allowed to do it. So they don't stay in the business. So, I think all the things you said are exactly right.

LESLIE VOSSAHALL:

I agree. Never tell your students to not be crazy. You have to tell them to be bold. So, if you're doing that, don't do that.

KEITH YAMAMOTO:

Right.

LESLIE VOSSAHALL:

You're not doing that. (LAUGHTER)

SANGEETA BHATIA :

We have something, I think, along those lines Keith, which is we tell the students to spend 20% of their time tinkering,

KEITH YAMAMOTO:

Yeah.

SANGEETA BHATIA :

And we say, you know, as long as you're not hurting yourself like they call them submarine projects. And yeah, it's tough to remember, like why you love science, to be curious, just to wonder what happens if, like I take risks.

KEITH YAMAMOTO:

Right. I think all of the things are great but I think that the endeavor overall tends not to do that tends to hold people back.

MARIETTE DICHRISTINA:

I was just reflecting on how, you know, change is kind of hard and working across is kind of hard and it takes the time and space to do that. And I love it that you'd tell them 20% or that you, you know, encourage them to go big and go bold. Now, so speaking of big and bold, Dr. Yamamoto, I wanna come back to your points (LAUGHS) about trying to propose or not trying to proposing federal cooperation across a couple of dozen, you know, science and tech agencies and extending into the private sector. That's pretty bold. You know, those agencies are not necessarily known for their, you know, collaboration across. So how do you start to build productive bridges there?

KEITH YAMAMOTO:

Yeah, that's a, it's a key question. And this science and technology action committee that I referred to proposed planting a coordination function, a resource coordination function in the OSTP, and then, we'll Alondra Nelson's coming up to your neck, so she'll be happy to hear this. That would be charged with having a coordinator or coordination group for each of those existential threats I talked about within the OSTP, whose job it would be to wake up every morning thinking about how to bring together the efforts across these agency boundaries that would move forward in each of those four areas. And so, they then issue a challenge to that collective of these agencies and says come back to us with an idea about how in a cooperative

way you could really move on this problem. And if we like what you say, we've got money for you. Because the way that the federal budgeting system works sets these agencies against each other in competition and the way that they respond to that. And so, each of these direct agency heads has to go to the Hill every year and defend themselves and say, "Don't forget to give me my agency money.

I need more." And if you stop it, then all of this magnificent work we're doing will stop because no one else across the government is doing it. Why? Because they're not talking to each other. They're competing. They're setting up computer systems that don't interface and so forth. It's a major problem. So how to overcome that is to then provide resources to them to say, if you come back with a good plan, we'll give you a bunch of money that is over and above your current budget so you don't have to spend only your money to be able to move it forward. So think we need incentivization to really be able to drive that kind of cooperation. I think the will is there and the realization for what can be gained by the cooperation is there but because of the way that federal budgeting is done, they're really constrained to work together.

MARIETTE DICHRISTINA:

And I'd also like to follow up on the idea of giving private sector companies this funding. What are some ways we could go about thinking about that or rewarding it?

KEITH YAMAMOTO:

Yeah, you can see all sorts of risks involved in dropping a bunch of public money on specific companies. And, but I think there are pathways for doing it. And again, competitive bidding on contracts, you know, this is something the government has done for a long time. But other new models, some that are embedded in the DARPA ARPA approaches of building teams that include of investigators from specific companies or even whole companies themselves working in collaboration with academic and government scientists. And so, the DARPA ARPA program managers go out and recruit specific individuals or companies or programs to be able to work together on a problem that they stand up. So that's one approach. If you look at the new biotechnology in my manufacturing executive order that just rolled out a few weeks ago, you'll see in their efforts to build novel ways to build public-private partnerships that recruit companies or start or help startup companies that can actually move on a specific problem in collaboration, again, with academic and government scientists.

So, I think there are models for being able to do that that won't run afoul of the kinds of conflicts that are pretty easy to imagine otherwise.

MARIETTE DICHRISTINA:

But I'd like to follow up with you. Find out how did that strike you? You know, as somebody who, I'm not asking you to speak for the entire world of companies and how they might respond, but do some of these approaches seem productive to you or what would you add to them?

ELENA VIBOCH:

Well, I think when we think about investing, we want to see a company that can have impact at scale. So, if it's a therapeutics company, we're looking for a novel technology platform that can discover drugs that couldn't be discovered any other way. And so, you could see opportunities to fund, say, a company with a therapeutic discovery platform, you know, for example, that's applied to cancer and autoimmune diseases, saying, "Hey, we'd like to fund you to work on tropical diseases." which, you know, as investors, we know the economic incentive just isn't there unless you can get the cost of goods way down. It's tricky. So there's opportunities to take platform companies that have a commercial incentive and also have them apply their technology to areas that wouldn't necessarily be attractive for development.

MARIETTE DICHRISTINA:

I'd like to give you the opportunity. You said you had a couple of other examples that you didn't get to mention. Is there anything you wanted, (CROSSTALK)

ELENA VIBOCH:

Oh, OK. Yeah. Well, yeah, sure. I'll take all the time. (LAUGHS) No. Yeah. Well, I think, you know, we're talking about responsible innovation, the other company I didn't mention is devoted health, and it really fits more into the clinical side here, which you were talking about earlier, which is how do you meet people where they are? How do you meet patients where they are? And it's a medicare advantage plan that's technology-enabled. So really similar to Livongo just earlier in its journey of using technology to identify people and drive interventions at the right time in a way that's really people-centric. So I think, you know, on the last panel mentioned, like how do you design science and technology for people that fits into the physician workflow and fits into their lives and their workflow? It turns out it relies a lot on nurses and technology that can extend nurses. But if you want to help low-income people, underrepresented minorities, people who live in rural places, you need to close that last cure gap of actually getting it to them, which is where nurses and technology and new models of care can really fit in.

MARIETTE DICHRISTINA:

And just one other quick follow-up. I'm sorry to pick on you, but you mentioned you need folks in the room, right, when you're running out of time.

ELENA VIBOCH:

Yes.

MARIETTE DICHRISTINA:

Is there anything that they should be thinking about specifically?

ELENA VIBOCH:

Yeah, well, I mean, I think for this room, there's probably some of you who practice, some of you who don't. On the research side, what we need is those big ideas. We need ways to bring really transformative technology forward. So, if you work on diagnostics, we need technology that has clinical utility and decision impact that actually changes how physicians and doctors behave. And then it needs to have a medical economic impact after that. If you work on research tools, it needs to enable researchers to unlock a big question in biology that they couldn't answer any other way, like 10X genomics for single cell. Think about a huge swath of biology and a tool that can answer a big question. So those are the things we need is technology focused on enabling research, technology focused on helping people, and technology helping us make better medicines.

MARIETTE DICHRISTINA:

Thank you very much. So I'd like to take the opportunity, since we are the third panel, to reflect a little bit, both on this conversation and earlier today. And by the way, I promise I will come to the folks at the mics in just a few minutes. Now, what as you think about the challenges we've talked about so many of them and the opportunities, we've also talked about them, you know, what really resonated with you today and what's really still worrying you? I'd love to hear from each of you on that. And you could flip it if you wanna do the negative one first.

ELENA VIBOCH:

I can go first because it's short. Everyone in this room should get a Gen Z mentor. (LAUGHTER) Ask them to be your mentor.

KEITH YAMAMOTO:

I think that broadening the scope of the scientific community. And by that, I really, I am focusing on the kind of comments that we heard in the last panel about the imperative of community outreach and community involvement in what we do as scientists. And not at the end, you know, when basically you're in a postmarket survey of how well something is working. But at the beginning and letting the public, not letting the public in on what we're doing, but helping them to feel like they are part owners of the enterprise and that their involvement, their data, and their interest, and their feedback on the way that we're working is really important. And not again, not just at the clinical trial stage where we're trying to coax data out of them. But instead in really letting them know what it is that we are thinking about doing and getting their feedback about the wisdom of the questions that we're trying to ask and the ways that we're trying to ask them. And if we don't, I think if we don't do that, we'll continue to be at risk for doing things that cross the line in terms of ethics and equity that we're talking about or that just put lots of resources into approaches that are, at the end of the day not going to be productive.

So, let's have a bigger scientific environment that includes people that don't write that now, and don't think of themselves as scientists at all.

MARIETTE DICHRISTINA:

I love the idea of a bigger, more inclusive environment.

LESLIE VOSSAHALL:

Does seem like inclusion is the word of the day. I think including more of every demographic in American science is key for us to keep innovating. I was struck by the data about how lopsided all of our genetic databases are. All our patient databases are so lopsided that increasingly it's gonna be a huge problem. So, anything that could be done to solve that, that feels like an incredibly urgent and pressing problem to solve that.

SANGEETA BHATIA :

Yeah, I wanted to, it's a worry and an opportunity, I guess. I wanted to pick up on a comment that Keith made about, you know, the endless frontier and Ben Bush, and the investment, and the model that we invest academics with discovery, and then industry will pick up and make products. And how we know now that at least a startup ecosystem is an important part of that sort of branch of taking inventions from academics to turn them into products so that they can grow up enough. They can become investable, and keep growing. And the data that I showed from MIT the thing, the worry that I didn't show on that side is that women and minorities have been left out of that in huge numbers. So we calculated that there would have been 40 missing companies at MIT. The same study has been done at Stanford. And I suspect if you did the math anywhere in the country and in the world, that women and minorities are being left out of that. So that's a worry. I think it's a huge opportunity. We and others have been doing some experiments to try and hack that and engage those folks.

And I think they're really hiding in plain sight. There's a whole lot of innovation and new medicines that we can accelerate to the clinic.

MARIETTE DICHRISTINA:

And the other thing that I wanted to ask before we go to the audience questions and we talked a lot today, not yet at this panel so much about communication, about the challenges of polarization, misinformation, disinformation. If as you've been thinking about these problems, what are some of the ways folks can engage productively to make sure that communication surrounding efforts such as convergence, inclusivity, crossing the boundaries of different disciplines and different agencies? How can we do that in a productive way? We heard a lot about the problems. What are some other ways? And we heard some great ideas for solutions.

LESLIE VOSSAHALL:

I'm gonna turn it back to Gen Z. And so, Gen Z and the millennials in my lab are incredibly engaged with education and trying to bring science to kindergartners, middle school students, high school students. And so, they're this army of fired-up scientists that are well trained and capable of, and again, incredibly passionate. And so, we should help them do this. They're also huge users of Twitter and other social media, which I think is also coming, that we have to be better at using social media to communicate the good message, the right message, get information out to people.

SANGEETA BHATIA :

I agree with that. I also think that social media can be great for amplifying role models. You know, it used to be hard to see people that were doing science, but I think we can take an opportunity there. I know actually, there's a lot of science on TikTok (LAUGHS) that you might find hard to believe, but it's true. It's true.

ELENA VIBOCH:

Getting with empathy is really important and assuming positive intent. So from the research community. Assuming that the investors want to cross the valley of death, we just need your help to do it, you know, assuming positive intent. I think social media goes a long way. Bob Wachter is my favorite person on Twitter. I don't know if anyone else follows him. San Francisco Doctor, nobody, nobody. OK. Thank you. He is an amazing communicator. Yeah, COVID pioneer. I think he really had a huge impact, at least in the West Coast. Yeah.

KEITH YAMAMOTO:

Oh, I think that's true. And so, I think what we've heard in what all of you understand well is that there's huge urgency to working on this problem of communicating clearly what it is that we do. Even at the, you know, not even, at the fundamental level of people beginning to have a greater respect for the importance of evidence in forming their conclusions about problems. So, I say that it's the lead into something that you would probably object to otherwise, and that is, that I think we also need to go all the way back to K-12 or pre-K-16 education and rethink the way that we do our training. That capitalizes on what I was talking about earlier, the capitalizes on the fact that human beings are innate scientists, right? Kids drive their parents crazy by always asking how and why. And instead, our education system says, memorize all the bones in the body. That's science. Well, I don't think so. And I think that takes the kind of fun and edge and excitement out of that kind of thinking.

So, it's not just whether these people end up being scientists, but instead that they begin to assimilate this notion that evidence, problem-solving through experimentation and gathering of evidence and drawing conclusions that then proceed to the next step is an important way of thinking about problems in their lives overall. And so, I think going back and rethinking the way we do our training is important. But it's not to say that there aren't things that we need to be doing today at the same time.

MARIETTE DICHRISTINA:

I think we heard of thinking shorter term and longer term a few times a day and you know, it bears effort. So, I'd love to turn to a few of the questions from the audience. Please make them brief if you can. Please let us know who you are. with the gentleman on my right, your left.

ROBERT KAPLAN:

I'm Bob Kaplan from Stanford University. And my question is, is part of the problem that we've been talking about all day, that our academic publication system is broken? And let me give you just a brief justification for my question. You know, 50 or 60 years ago, most academic publication was done by university presses in professional societies. But then private industry came along and said, well, we'll take this off your hands for you. You know, there's a lot of expense, and printing, and binding, and warehousing, and so forth, but most of those expenses are now gone. And if you look at a company like Elsevier, they reported a profit margin of about 35% two years ago. And to put that in perspective, that's a way more than Google and Amazon and about five times the profit margin off of fossil fuel companies. So, I'm just curious, when I hear from young people and editors, they say the system's really broken. And editors are telling me that they're going 15 to 20 deep to find two reviews.

And the biggest complaint I get from younger fellows and graduate students is they just can't afford these open-access fees. So, is there a better way? And did giving this over to private industry, was that the right idea?

LESLIE VOSSAHALL:

It was not a good idea. And I agree with you. It's a huge problem. And I'll, I guess I'll speak in half of my colleagues at HHMI that maybe the future is gonna be something where everybody preprints. So I'll, all discoveries are shared immediately on something like bio archive and then there's a post-publication peer review mechanism by which experts peer review those things that require further scrutiny, where we then find a place for the journals somewhere in this ecosystem to help curate and review. But that as scientists, we pull the power back to us so that we own it, we own the copyright, we decide when to share it. And I think that's the only this is the only way that we're gonna be able to improve all of the problems. They've called out the false incentives, the billions of dollars that we spend giving to these publishers, the paywalls, the false prestige, the brand journal names that are confused with quality. So it's so many layers of problems that would be solved by immediate open sharing and layered upon it peer review.

KEITH YAMAMOTO:

I completely agree. I think that huge damage has been done by the big corporate publishers. That is affecting our training and the progression of people's careers. And, but I'm encouraged that there are models out there, experiments being done by HHMI, by eLife, by plus, by science that are, that I think can begin to stand up on approaches for the scientific community, begin to

stand up approaches for being able to communicate their work that can be independent of what the big publishers are doing. So, you know, I don't think that we should set as a goal to put Elsevier and Springer Nature out of business. But if instead, we can actually create models that scientific community understands begins to serve them, right, and that they actually own this process, that publication of our work is a part of the experiment, right? If we don't publish our work, it's exactly the same as not doing the experiment. Alright. So why shouldn't we be able to take back that element of our experiments? And I think that there are some experiments that are being done now that can move in that direction.

MARIETTE DICHRISTINA:

Thanks for the question. Clearly struck a chord.

STEVE GOODMAN:

I am Steve Goodman. Unfortunately, I'm not diversifying institutions from Stanford. So, I'm an epidemiologist and I asked, compared to what? And we can make academic medicine better, much better. But we have to look at what the new generation is looking for as alternatives. And I'm glad that Sangeeta mentioned startups. I mean, a lot of them are looking at an alternative career because they can fail and they can do big exciting things and they can be translated to make big impact. And if they fail with that idea, they move on to another startup. And that same risk-taking is not incentivized in academia, where it gets so bad that they have to have done the experiment already to get funded, to have a grant that gets funded and they're not allowed to fail. So, the conservatism is basically enforced and we're not looking at the multitude of really exciting alternative careers right now where they think that they can get rewarded both scientifically and economically in a different way. And of course, the venture capitalists look at portfolios of risk and they don't care if nine fail, one succeeds.

That's a successful portfolio. But that doesn't work for an individual scientist where every grant must succeed to get funded. So that's why they do it first. So, how do we capture this risk model to make academic medicine both more science, more exciting, risk-taking, and rewarding, and stable at the same time?

LESLIE VOSSAHALL:

I think you need to have longer. You can't have a 3 to 5-year grant cycle that's based on a specific project.

STEVE GOODMAN:

Exactly.

LESLIE VOSSAHALL:

So HHMI we fund people in our projects and it's like a long runway so that you have a long time to play before you have to explain what you've been doing. And so, and other NIH is also

experimenting with this, the Pioneer Award, the new Innovator award that gives you like a longer runway and more generous funding. So I think if we can get away from these little incremental project-based grants so people can play and experiment and innovate, that seems to be, that is a proven formula. And CZI has also placed these long-term bets on risk so that very much like, it's like venture investing in basic science by giving people no questions asked support for long periods of time.

KEITH YAMAMOTO:

Those experiments are really important. But, you know, it's as you know HHMI really started this, and CZI and others have continued it with investigators working within the big academic structures. But it's still problematic because failure in academia is a major problem. (LAUGHS) Whereas, you know, failure in Silicon Valley is another day at the office, (LAUGHTER) right?

ELENA VIBOCH:

I wanna say that for the record, we try to help every single company succeed. (LAUGHTER) And we believe in every single one of them, which is also give them the freedom to try hard things. But we should let the other side come.

MARIETTE DICHRISTINA:

Back to this side of the room.

MEREDITH NILES:

Thank you very much, Meredith Niles. I'm an associate professor at the University of Vermont and also one of the emerging leaders here today. And I was really well, first of all, I'm a millennial, so there's a few of us in the room you could talk to. I don't know about Gen Z, but as a millennial, I'm actually also running my own lab, right? So we're not just working in labs. Many of us are all now starting our own labs and having those succeed. And I was really struck by Leslie's point that, you know, 30 years ago, 25 years ago, the mentorship that it takes to retain diverse people in science didn't really happen. And those questions and things that people want to hear today and the conversations they wanna have didn't happen. And that's because it takes a lot of time and effort, that kind of mentorship. And we also know that women and people of color are also much more likely to take on some of those roles. So, I guess my question is, especially as it relates to Kiss Cam about careerism, there's a mismatch between what we know it takes to be a good mentor, to retain people, to provide that kind of mentorship, and what's actually sort of valued in the system and what's the solution there?

LESLIE VOSSAHALL:

And I guess we have to say that it matters how you do the science, that if you have a lab that's happy and people are supported, science will be better. So, I think we just have to believe that and we have to encourage people. The funders have to encourage people that there are simple instruments like a lab climate survey. If your lab is unhappy, fix it. Maybe the funders should be

concerned that the lab is unhappy, have them fix it, and so that we value mentoring because the outcome will be a happy lab. Happy labs are more productive, less, you know, less internal competition, less fighting, less stress, fewer people dropping out. That has to have a benefit. And it shouldn't fall only on, everybody should care about this. This should not be an issue for women. Everybody should be caring about this because it does improve the quality of the science. Thank you for being you. I'm sure you're a great mentor.

MARIETTE DICHRISTINA:

I think we might have time for one more over to the side.

SHARI BARKIN:

Great. Thank you. Hi, Sherri Barkin, Virginia Commonwealth University Children's Hospital of Richmond, formerly of Vanderbilt, shout out to Jeff Bolser. I wanted to just build on these questions because we have tension. How is it that we continue in robust scientific discovery that also responds to agile, ever-changing worlds? How can we make sure that we're building the long game while responding to the short game with shorter and shorter cycles and differing expectations? And the question is, what would it actually look like for us to redesign academic medicine so that it could be multi-sectoral? It could be co-creation. It could be capacity building and we could finance it and sustain it. What would that take?

ELENA VIBOCH:

That's a big question for a minute and a half. (LAUGHTER)

MARIETTE DICHRISTINA:

Anybody want to go for it?

LESLIE VOSSAHALL:

I believe in you.

MARIETTE DICHRISTINA:

Solve everything, please.

KEITH YAMAMOTO:

No, it's a great question. And I think that, you know, building a multi-sector enterprise is gonna take a multi-sector effort that all of the players are gonna have to be thinking and working together to try to solve these problems, identifying where the soft spot, the weak spots are, the problematic spots, and then bearing down on them specifically. So none of the things that we've talked about individually up here or in the previous panels will work in isolation. But in fact, together, I think that they can actually begin to make progress. And one of the real values of this gathering is that not only this people who have been on this end of the stage, but

everyone else out there who's thinking about these problems from different angles of approach and from different environments can begin to see that, in fact, that they can take on this major problem as individuals or individual institutions because there's knowing they can't solve it by themselves. But thank God there's other people in this room and in your communities that if we're working together, can really begin to make progress.

So, it's basically a social problem. Social problems take enterprise, a very broad enterprise to be able to take them on. But I think that I'm encouraged that with this discussion and others like it, that we can actually begin to move on this.

MARIETTE DICHRISTINA:

So, I'd love to keep going. I think hopefully will. A little bit later, we'll probably need to wrap. I mean, I heard a lot of lessons. I'm gonna put them in three buckets, but we could argue about the buckets. I mean, we heard about being intentional. First and foremost, I really love that working together to support things, focusing on big questions, and then putting the support in place, co-locating people. There are lots of ways we could be intentional. We talked about incentives. We talked about incentives for funding collaboration. We talked about funding people in our projects. We talk about looking for ways to solve problems that could be solved any other way. And we talked about probably for me, this one really rang home, having the time and space that it takes to work collaboratively. We kind of ended on that note to meet people where they are, to get better at things like social media, to cultivate our millennial and Gen Z mentors together, and to get comfortable long and short of being a bit uncomfortable at times.

And with that, I hope you'll really join me in thanking the panelists for a really wonderful.

SPEAKER:

So, before we run away, we'd like to pose one final question and thank you to the panel and to our wonderful moderator. Thank you. Take a picture, go to slido.com, and remember, it's NAM2022. And then you're gonna see the question, which is how convinced are you that the solutions offered will be implemented at scale and will catalyze a transformation of science and innovation in this decade? Give it a, give it a, we'll give it a second. Maybe we'll get lucky and it'll come up on the screen this time. Alright. Well, people are a little skeptical. I think that's probably, I think somewhere in the middle, wish I wish we had more fours and fives and ones and twos, but that's probably a pretty good sense of the audience. So, thank you for participating in this little experiment with Slido. So thank you once and for all to all of the moderators and panelists for such a rich discussion today on how we can transform the scientific enterprise. I'm certain that many of your comments today will stay with us and will motivate our actions for many years to come.

So, final round of applause. Thank you.

President's Forum: Transforming the Future: Perspectives from Scientific and Institutional Leaders

SPEAKER:

(AUDIENCE APPLAUDS). So, so now we're gonna turn to the final session of the annual meeting, the President's Forum, which will be led and moderated by Victor Dzau, the President of the National Academy of Medicine, National Academy of Medicine. And please join me in welcoming Victor and the President's Forum panelists to the stage. (AUDIENCE APPLAUDS)

VICTOR J DZAU:

OK. We've had long day, lots of great issues to discuss. Now, when I saw the last poll data, I said to Francis, we need to convert three to a five. And that's what these leaders are gonna help us do. (LAUGH). So, I'll just summarize very quickly. I think we clearly heard phenomenal progress in science, health and technology had lots of challenges. So, there's a sense of excitement and also a sense of concern. And you heard the last few panels' discussion is about science is moving really amazing speed, other current models of research, training, and funding, are they keeping up with those changes? There's a whole discussion on the need to have much better communication to the public, much more diversity in the research enterprise and the engagement public and issue of trust. So, I think the question that was earlier said would be, OK, who is participating in research? And who's being... who are, who are the ones doing research? And of course, the whole issue about need for convergence science and young scientists giving them stable support.

I think you've heard all these things, so I'm not gonna repeat them. But we have with us are the scientific institution leaders. They (UNKNOWN) movers and shakers. So, I thought I'll come up and ask them, OK, what we gonna do about this? How can we change these things? As the last poll said, "Well, we know some, come, we can do this." So, OK. So, I will introduce them individually as I ask them to give their five-minute thinking. But I think the important issue is that the last group talk about some pathway forward. One is, OK, you know, we need to think about convergence that science cannot remain in silos in separate disciplines. More important, it's not just multidisciplinary. It's actually forming teams together to solve a complex problem. Yeah. My team report said that the NA, the National Academies report has said that. Leslie Vosshall talked about long-term stable support, paying a living wage for researchers and allowing them to build a diverse team. Keith had a whole set of ideas, which are really important.

He says, well, funding should be focused on societal threats in addition to investigating the issue of research. And that we should bring industry in and review wisdom to actually invest more in areas that's needed. And of course, the issue of equity and ultimately suicidal medication. And then we heard about responsible innovation lab, how to invest. I think the most interesting issues for me, the keynote, because Mariana Mazzucato talked about needing for a new social contract. So, it goes back to the discussion of Elena Viboch, right? OK. We

invest in basic research. Then when, in fact, opportunities come with handover to private sector and the market. What she said is that we need intentionality. That is understanding as we invest 42 billion of NIH research, how do we make sure that the fruits of our labor is actually realized back in the public sector? Right. So, the whole idea of market-driven, you know, development of research versus in fact a good social public good. So, those are the things I heard.

So, OK, with me, they're some of them, as I said, leaders in shakers of science and institution from government, from scientific journals, from university, and of course from philanthropy. So, I asked them to come and talk to us about their point of view. Let me just, therefore, begin to ask my Francis Collins, who certainly does not need an introduction. But Francis is the former director of NIH and the former science advisor to President Biden. Each one of you have five minutes. Francis, for you to tell us about your perspective on these areas, convergence science, science funding, and of course, where the future of science is going.

FRANCIS COLLINS:

Well, thanks, Victor. And good afternoon to everybody. It's a privilege to be on a panel with such distinguished panelists and with Victor as our moderator. And I hope we can maybe chart some new pathways forward here in terms of where our whole enterprise of biomedical research is going. I've listened to the last couple of panels and I think there were a lot of great points have been brought up, although I'm gonna be a little more optimistic than some of the panelists that have preceded me, because let's look at where we are here in terms of things that have gone right. We have in the course of the last seven years, seen the support for biomedical research go up by 50%. Thanks to strong support from both parties in both houses of the Congress and strong administrative support right now from President Biden leads us to believe that we are on a path to be able to continue that trajectory. So, this is a much more favorable situation than we were experiencing back in 2015. And we ought to be sure to be sending roses and chocolates to all those members of the Congress who made this happen so that we aren't here wringing our hands about the lowest-ever success rates, which is what we were doing during sequester in 2013.

So, that's, that's a good thing. But, you know, that's just funding. What about the science? Again, I am stunned in a positive way by the remarkable things that are now possible scientifically, that people in this room and others not in this room are doing. And they've been touched on by some of the presentations already. Such things as doing single cell biology combined with the ability to do epigenomics, to do CRISPR, to modify and identify the function of every gene, put that together with stem cell biology. My own research lab routinely now taking 400 different stem cell lines, differentiating them into beta cells that make insulin, and figuring out which genes have the most significant effect on what happens in as a way of getting an insight into type 2 diabetes. I could not have imagined doing that five or six years ago, but now there you are. And all of the things that are happening with the basic science of

the brain, the brain initiative now, giving us that kind of information, the way in which cancer has moved forward.

And we're talking about serious tests of multi-cancer early detection to see whether that really does change outcomes and what's the best way to do that so that we know for sure that that very exciting technology is actually going to improve people's lives, something that the president is very much interested in seeing happen as one of the components of the Cancer Moonshot. And we heard about all of us the opportunity to have a cohort of a million people who are pre-consented for contact to do follow-on studies and highly diverse and motivated to be part of research. That's an amazing platform that is only just now beginning to emerge in an exciting way. And for me as a geneticist, the fact that our genetic efforts is now not just about diagnosis, but about therapy in more and more situations, and particularly the opportunity maybe if we do everything right in the next decade to figure out how to do effective and safe in vivo gene editing. If you have the right way to distribute your editing apparatus to the right cells, why could we not go after those 1,000s of genetic diseases where we know the specific DNA misspelling and we don't at the present time have anything to offer that almost sounds scalable?

If we can do that for a few diseases, why not do it for a lot more? So, all of those things make me feel pretty bullish about where we are, even as we're sitting here in the National Academy worrying about the things that are not going well. And there's plenty of those. Our diversity issue clearly has been emphasized as well. It should be in the course of the whole day. I don't know that we quite heard about some of the experiments that are underway that actually sound sort of promising in that regard. And I would point to the BUILD Initiative, the National Mentoring Research Network, the first program of doing cohort recruitment of underrepresented scientists, which seems to be a way to do not only good recruitment, but retention. Those things haven't, maybe gotten quite as much attention as experiments, 'cause that's, that's how we're gonna get past wringing our hands into something better. Similarly, as far as how we do the funding to capture all of the talent that's out there, I don't think we've heard today just a number of lessons that we might have gleaned from COVID beyond the amazing lesson of a vaccine, two of them getting approved in 11 months, but also the way in which we pulled sectors together, the therapeutic part of that, the active public-private partnership, 20 companies, the FDA, the NIH, and multiple philanthropies all working together to ultimately test 29 compounds in rigorous controlled trials to see if they actually provided benefit.

Most of them didn't, but you needed to know that too. And six of them did. And that was unprecedented. And then finally, there's ARPA-H which got touched on briefly by Keith Yamamoto. And I think this audience should be excited to watch this as a new model. This is taking the DARPA's approach of how do you take really big risks on projects, which if they succeed are gonna have really big benefits. And you bring in program managers who have fire in the belly, you give them three years to do something dramatic. And yes, Keith, you fund

companies to do this too, because many times the partners you need for those projects are gonna be small businesses. Put that together and see what you can achieve with rigorous milestones and a willingness to pull the plug on the projects that aren't working. And you expect at least half of them will be of that sort. We haven't quite had that opportunity before. And everybody should be excited about figuring out how to use it. And now with Renee Wegrzyn having been appointed just two weeks ago as a new director with all of her DARPA experience, this is gonna be fun to watch.

OK. Now for me. (AUDIENCE LAUGHS) (AUDIENCE APPLAUDS)

VICTOR J DZAU:

You have just got them all excited. (LAUGHS) It's great. But I'll ask you some tough questions later. Cori Bargmann, an outstanding researcher, professor at the Rockefeller University and being the first head of the Chan Zuckerberg Initiative. So, Cori, you have an inside look at science philanthropy. Tell us a little bit about your experience and I'll have some other questions for you, but give you a five minutes.

CORI BARGMANN:

So, after Francis's victory lap here, (LAUGH) I'm gonna talk a little bit about how the philanthropy ecosystem can supplement and kind of add to the federal system. So, when I was a starting assistant professor at UCSF, Bruce Alberts said to me, "With new resources, you can do new things." And I think that's the key to philanthropy is that you're allowed to try to do new things. You're allowed to try to, you're allowed to, like a startup or like a venture capital or try a bunch of things and see which ones work out. And you can try and ask where the holes are in the existing systems and work on those. And so, to give an example that I think we are partway through now, and we will continue to be through, I think 5, 6, 7 years ago, we didn't really know how to use tech and technology in the non-commercial sector in science and in medicine, even though it was already clear that it was having a tremendous effect of the commercial sector. And how do we go about using that? The tools on that side were not that useful.

There were a lot of people trying to do everything in their own domain not successfully. And so, it did require the "convergence approach" of bringing together people from tech, people from experimental science, people from medicine who knew what the questions are, people could address the issues together. And that was something that you could try out several things in a philanthropic setting and see which ones felt like they were gonna have the most value. And the Chan Zuckerberg Initiative did this, but other, other philanthropies have worked in that area as well. Historically, the Gordon and Betty Moore Foundation and the Sloan Foundation worked on areas in data science trying to figure out how to build those up. And more recently groups like the Schmidt, Schmidt Foundation. So, you know, how do you get these people together? A lot of this comes to the point that Jay Shendure mentioned about sort of the long elbow of developing technologies. How do you get people to... How do you go from the initial invention,

which we're really good at supporting in basic science to the commercialization, which also they're a good mechanism to, but whether there's a lot of, a lot of work to be done in the middle.

So, you have to kind of go through cycles. And the one that's close to my heart is single-cell biology, because to me, that is the tool that needed to exist between genetic risk factors, which we've gotten so much of from genome project and human beings, and what cells and tissues are affected, we needed the parts list of the human body, we need to know what the cells were and what genes were active in each cell, and how genetic risk affected them. Well, the technology, the experimental technology was immature and needed to start over. You needed doctors to tell you how to go about finding the right tissues in the right conditions. And you actually turns out needed a whole different kind of, sort of statistical and analytical tools distinct from the things that were existing at the time. And so, all of those groups sort of had a chance to work together and sort of building that up with some wrong starts and bringing different people in with something that felt like a good job for a philanthropy to do.

It's now something that seems pretty robust. I think its promise is not done yet. But even then you can still see where there's gonna be a need for a philanthropic or a public input. So, how is all this data gonna get integrated and harmonized and served up so that everyone can use it? That's not something a company is gonna do for you. That's something that we still have to build out. And I think these are all areas where sort of building new tools out is kind of something that, that philanthropy can help to do and can enjoy doing. And I would say another example of a tool that I think of as in some ways as a philanthropic tool is AlphaFold. Google developed that for its own purposes, ultimately hoping to make money in medicine, but they donated it back to the scientific community recognizing that it was built on the back of the protein structural database. And now, it is essentially a resource for all of us to use. And even though I'm not sure they would "call that" a philanthropic act, I think it really was.

And the last thing I wanna say about philanthropy is that I think we're, we're entering a period of experimentation around what kinds of scientific institutions we have. So, we've had kind of a monoculture in academia, where a particular kind of model with a training lab and a lab head and trainees. And we're starting to experiment with different institutions that maybe go away from a pure training model into more of a scientist model. And I think that addresses some of the things people are talking about with postdocs and livable wages and retirement benefits. So, if you look at some of the institutions that are strongly supported by philanthropy now, like the Broad Institute and the Allen Institute and Janelia, Howard Hughes's campus and a bunch of new institutes that are spinning up in California now, they are built much more around the idea of working together on big projects for 10 or 15 years and then having something that comes out of that that can then be shared with the community.

And I think particularly the ones that have like the Allen Institute generated resources that are broadly used with the community are having a really big impact and are seeing added value not just as one more place with internal funding, but as a place that's, that's delivering something

unique to the scientific community that's helping to build it out. It's like the next... It's the current incarnation of what Bell Labs was in a different way with a different form of funding, but with that idea of long-term, different model shared resources. And I'll stop there.

SPEAKER:

Terrific. Great. (AUDIENCE APPLAUDS)

VICTOR J DZAU:

So far, really uplifting messages. (AUDIENCE LAUGHS) Do you buy it? (AUDIENCE LAUGHS) It's very exciting, truly, both great stuff. Alondra Nelson, the Deputy Director of OSTP and the former Acting Director of OSTP. Alondra is so well known for her work in the social science area. But I think people want to hear both your point of view about OSTP, right? What does it do? How does it drive policy changes? And how would we actually, as she said, bring together all the different agencies to work, but also your perspective on the issue of diversity, equity, et cetera?

ALONDRA NELSON:

Right. Yep. Well, thank you for the opportunity to be here, Victor, with this August company and with my running partner of the last seven and a half months, Francis Collins, it was, talk about a great experiment. We have had, we just had a thrill working together on behalf of the nation and the president to, to sort of lead and organized science and technology policy. It was a real pleasure. So, I am, you know, I think it's OK to be cautiously optimistic. I think those of us who are researchers, we try things, we fail, we try again, our hypothesis is wrong and just wrong, and we go back. And so, I think that disposition, I feel very comfortable in the space of, of the cautious optimism that keeps us going in our work. And this is what my researcher had on, but also allows us to be critical of the work and where we need to go. So, I wanna just give folks an overview of the last 18 months because it's been quite breathtaking, certainly from inside the White House about, particularly around areas of science and technology policy, policy that has everything to do with healthier futures and with medicine.

I wanna take us back to January 20th, 2021, President Biden, Vice President Harris issue an executive order on equity that says that equity is going to be the sort of lens and driver of all of the policy of this administration. In that same week, two days later, there was an executive order on scientific integrity. So, several of the first utterances of the Biden-Harris administration are about the importance of equity and important, about the importance of science, evidence-based policymaking and scientific integrity and the work that we were beginning to do as an administration. And I think that is quite profound. And that was really us on the starting block. When the, when the, when the gun went off, that was, those were the, the kind of foundations that we move forward with. More recently, as many as you know, there's been historic legislation and issues around the science and technology enterprise. So, there's been a legislation like the PACT Act, which is making, expanding healthcare possibilities for veterans.

There's of course been the Inflation Reduction Act, which has a lot of investments for energy innovation and energy technology. But I want this community to know in particular is also very importantly reducing healthcare costs and investing in R&D that has bearing on making us all healthier. And of course, there is the CHIPS and Science Act, which is in part moving forward with semiconductor R&D and innovation. But it also is particularly the section B of that, of that law, the end science part is is a vision statement about what a science and technology ecosystem should look like and be. And it says that we should be investing not only on the COST, but in R&D, education, human capacity throughout the country that we should pay particular attention to tribal colleges and universities that we should be thinking about what are called emerging institutions, HBCUs and the like. So, it is a strategy for the future of S&T in our country that is really expansive. I've heard a bit of the last panel, there's a piece of CHIPS and Science that's also about engaging non-expert communities in the work of science.

Dr Yamamoto talked about this a little bit in the last panel. And that's really, you know, how do we show our work? How do we get the larger American community to trust science, to trust government, and to be engaged in that work and to understand that? I think those of us, particularly who are teachers in this room, that the work of discovery is for all of us, and that there's a particular CZI or UCSF or Stanford or Michigan pursuit. But there's also a way in which if we want to truly engage an American public and a community and a global society, that is increasingly driven by science and technology in which we need to take them as partners in that work and understand that there is a level at which they can be partners in that work. So, the great thing about being at OSTP, the Office of Science and Technology Policy, is that we get to help coordinate and drive and galvanize the nation sectors, and also the US government around that work. And you should know from the perspective of government that people are tremendously excited to have this opportunity, of course, to have the funding some of which has yet to be appropriated that to be able to, to do this work and move forward this transformative vision to make it into to action.

Clearly, a huge part of this is going to be the equity piece and the piece of it that is really about as we say at OSTP, driving equity to change and transform the S&T community, but also taking equity as a kind of one of the missions. So, we think about our big challenges, climate change, the pandemic. I think equity is also a challenge to which S&T approaches po... You know, can be put to as well. So, it's both equity for S&T, equity and S&T is a way to think about it. This legislation, much of it really leans in, puts the thumb on the scale about having a more equitable S&T enterprise and what that can and should mean. And then I would say also at OSTP, as many of you know, we've been working, you know, the portfolio typically includes, you know, making investments and providing leadership around the STEM ecosystem. And certainly, we are working on issues of STEM equity, everything from graduate training and fellowships, talking with colleagues at NSF and NIH about that, but also working in the community science and citizen science space and thinking about issues of access to science and the sort of products of S&T that are federally funded.

VICTOR J DZAU:

Thank you. (INAUDIBLE) (AUDIENCE APPLAUDS) Alondra and Francis, I need to thank you on behalf of the Academy for the great public service you guys have done.

SPEAKER:

Amen.

VICTOR J DZAU:

Clap. (AUDIENCE APPLAUDS) Alright, hold on. Someone said, "Is our academic publication system broken?" Are you on the hot seat? (LAUGHS) So, tell us about your experience now as editor of science, editor in chief of science, and the future of the publication.

HOLDEN THORP:

Yeah, well, it's great to be here in an environment where people are so up upbeat about scientific publishing. (AUDIENCE LAUGHS) Yeah. I'm so excited. Oh, no, look, I'm actually optimistic that we can work this out. But the most important thing (LAUGHS) to do that is for everybody in this room who hasn't read Alondra's memo and who doesn't, hasn't read the editorial by my boss Sudip Parikh and our publisher Bill Moran and the great Shirley Malcom. If you haven't read those, you need to go read them right away, because this whole thing has a lot of very important implications for a lot of the things about the welfare of the scientific community that was discussed in the last panel. So, the first part is about open access. And what has happened in open access in the last ten years is a lot of things with a lot of unintended consequences have been implemented while most of us were paying attention to other things. And the most important of those is creating an ecosystem of open-access journals that are funded with APCs, article processing charges which is a great scheme for Elsevier and Springer to get money from indirect costs through the libraries and money from direct costs for the APCs, which is nice work if you can get it.

And you don't see them complaining about this open access thing because they're laughing all the way to the bank. And Richard Horton had a great piece in The Lancet about it. I have no idea what the corporate overlords at Elsevier who are his employers thought of his piece. But I would also encourage you to read that. The second piece of it is the open data. So, (LAUGHS) the word open sounds good. It always sounds great. Alright. So, now, you've got this open access. Oh, and there's one other thing about open access that you need to, to inform yourself about, which is when you get a CC BY license, if you know what that is, it's something you click "I agree" when you publish an open access paper, you ought to go read that license, because one of the things that says in there is that anybody who wants to can take your paper and change it and resell it. Now, we tried to get instead of CC BY something called CC-BY-NC-ND, which would stop people from doing that. But during this period of unintended consequences when there were the open access advocates, let's call 'em, we're driving all of this, they didn't want that limitation.

But that's a profound thing too. Then you have the open data. Now, of course, we all want all the data to be posted somewhere so that everybody can redo the analysis and redo the experiments and compare their data to the data that's posted. That's a really good thing. But who's gonna control those data? Who's gonna pay to maintain them? Who's gonna make sure that they actually match what's in the paper? And once, you know, again, if the commercial publishers can get the papers that they can change and resell and get the data, which they can do anything they want to, then you've basically taken science and made it into Facebook. Alright. So, you know, I would just, and I think, you know, our experience when we rolled, when the Holdren memo came along, when I was a chancellor which we rolled out and it worked, and it was all, it was, it all came out fine. But when we started rolling out, the investigators had no idea what we were talking about. Right. So, the most important thing that everybody can do, and I believe if they do this, that we can succeed, is to go understand all of this as, as well as you can, because people in this room, most of you may not like paying the APCs, but most of you have labs that are capitalized in a way where you can pay them.

You can get your papers into outstanding journals. But there are lots of people who don't have those advantages, who are gonna be affected by that. And we owe it to all of them to make sure that we are doing the best we can. Science has a solution to this that we hope it's gonna work. It's detailed in (UNKNOWN) editorial, which I encourage you all to read. We're kind of taking a leap of faith that the community's gonna go with us on this. But I think if we all actually think about what's going on, then we can come up with a way to do this that will address a lot of the challenges that have been raised. It won't happen overnight, but there are good places that we can go with all this.

VICTOR J DZAU:

I'd like to come back to some of these issues later, but let me go to Marc Tessier-Lavigne. Marc, I know you've got your board of trustees meetings, so thank you for being with join us. Marc, as you know, is the President of Stanford University, one of the leading research universities. So, Marc, really, in many ways, the future rests in the universities, and all these things are converging on, what are you educating? What's your pipeline? How do we research? And the question about organizational research in the future. So, say a few words about what your thoughts are.

MARC TESSIER-LAVIGNE:

Great. Well, thank you, Victor, and thank you so much for the opportunity to participate. I'm sure. Sorry, I couldn't be there in, in person. I just want to start by echoing some of the enthusiasm and guarded optimism we heard from other panelists. I really think that the life sciences are poised to, to really redefine human health in the 21st century in the same way that innovations in physics define the 20th century. And universities have an important role and responsibility to help usher that in, in collaboration with all the others who are there on the panel today. At the most fundamental level, obviously, our role is several fold, first to support

individual brilliant researchers do their, their best work. And I think universities have a special responsibility to enable research that's just fueled by sheer curiosity that as we know can reveal profound insights and lead us in exciting directions, and often are the sources in unpredictable way of the most transformative advances. I think we have a special obligation.

It is more difficult for the private sector, for example, to, to undertake that kind of work. At the same time, I do think we have an obligation to apply knowledge to tackle urgent problems. People often want to pit basic research against application. I like to talk about the power of, and research universities like Stanford and so many of our, our peers across the country have to support fundamental research, but also the intentional application of research to tackle great problems in, in the case of this panel of medicine of course, and they work hand in glove. Fundamental knowledge is the essential underpinning of any attempted application. But the process of translating knowledge we know, will open up new questions and new areas of discovery. It's really a virtuous cycle between the two. And our third important role is, of course, to train the future leaders in, in biomedicine. And here, I just wanna underscore the a theme that we, we've heard throughout the day and also on this panel already, that expanding access to create opportunities for students from all backgrounds and especially underrepresented backgrounds, is a really urgent priority for all of us, and especially for us in universities.

We also believe that it's important when we train future leaders in biomedicine to ensure that students engage meaningfully with ethics and civic responsibility during their university years, which we're trying to tackle through a curricular changes at the university as well. I'd like to make just two sets of comments about the structural organization of universities, because I think what I've set up till now is not, not very controversial. But I think it's all a question of how do you pull all of this together in an intentional way. And the way that we thought about it at Stanford, and I think is, is reflects what's being done at many universities, is really to, to have a three-pronged approach. The first is we need to continue to have departmental structures where scientists can go deep within individual disciplines. But then we need to supplement that with mechanisms to break down the silos, to create the interdisciplinary environment that's been emphasized today, which we do systematically through interdisciplinary institutes.

So, in the case of medicine, we have departments from biochemistry through to chemical biology and everything in between. But we also have interdisciplinary institutes that bring together different disciplines within medicine and the biosciences, but also beyond that one of the ones I'll just mentioned here is our ChEM-H Institute which stands for Chemistry, Engineering and Medicine for Human Health that brings together our chemists with our engineers, with our biomedical scientists. It's directed by Carolyn Bertozzi, who we were thrilled to celebrate two weeks ago when she received the Nobel Prize in chemistry. That's one of many institutes we have to break down barriers within the life sciences and beyond to bring people together from different disciplines. So, disciplines, disciplinary departments, I think of them as verticals, interdisciplinary institutes, horizontals. And then the third part that we think is very

important of what we call accelerators, others will have different names that are infrastructure resources, expert assistance to enable our researchers to take their ideas and to go more seamlessly from idea to impact.

We know, of course, in biomedicine about the valley of death and going from a theory in the lab to an FDA-approved medicine. And we believe that universities can help move us more seamlessly along that continuum, especially in the early stages and going from an idea to, for how to make a drug that could tackle a particular poorly treated disease, to making a drug prototype. And we provide our faculty with the infrastructure on a competitive basis to be able to go from idea to drug prototype and to test their idea. We think it's important for universities to have that kind of mechanism because so often great ideas just lie fallow and they don't get picked up. There are lots of great ideas. And it's very hard for people on the outside to know which ones to go after. I saw this, I was working in the private sector for a number of years myself in biotech. There were just so many ideas coming at us. It was often difficult to know, just based on the idea, having a drug prototype really accelerates the conversation.

So, we think this three-part structure of departments, interdisciplinary institutes and accelerators is for us, how we're organizing ourselves to be intentional. We're applying that in medicine as I've described. I might add, we've just created a new school, the first new school at Stanford in 70 years focused on sustainability. And within that new school, we have disciplinary departments that span the natural sciences, engineering, and the social sciences and humanities. On the one hand, we have interdisciplinary institutes focused on energy, environment and sustainable societies, and we have an accelerator. So, I really believe those three parts are essential if we're going to be able to go further faster in generating new knowledge and then applying it for the benefit of humanity. One last point here, I've talked about the university as a self-contained unit, of course, we're not. Our connections with other parts of the ecosystem are so important. We've heard the role of government, of philanthropy, the private sector today.

And it's very important for universities also to be structured to enable that deep connectivity to occur. We applaud, for example, the creation of ARPA-H. And we're really excited about being able to engage in the kind of large-scale, very audacious a team science that will be enabled by that. We have to facilitate that for our scholars. Cori Bargmann mentioned a number of philanthropic models. And there, it's so important for universities to be very open to new ways of doing things. We think back, you know, 40 years ago when HHMI was being established, I think it was a very different model. It took people a while to accommodate. And we see the power of that, that model. Today, we see other institutes coming up. And the people who start those institutes are doing experiments. They wanna do things slightly differently. I think often in academia, we say, well, if you don't do it exactly this way, then we can't proceed. I think we have to have the opposite attitude. Let's work with you to figure out how we can work together and seamlessly integrate well respecting the needs of your institute and the needs of the university as well.

So, being intentional about those different dimensions within the university and intentional about engaging the external world, I think is gonna be necessary if we wanna realize the full potential of the biomedical revolution that is ahead of us.

VICTOR J DZAU:

Thank you very much indeed. (AUDIENCE APPLAUDS) Now, you know that Marc, you are at Stanford, and everybody recognized that Stanford is talent-rich and resource-rich sitting in a very unique space. I think the other university president may have somewhat different perspective.

VICTOR J DZAU:

But let me come back to this question that Bhatia, Sangeeta Bhatia raised, about convergence, if in fact the concept of convergence is accepted by many of us, we do know that there's a lot of misalignment in trying to go forward with the convergence model. In fact, you had a conference we had here.

FRANCIS COLLINS:

I remember.

VICTOR J DZAU:

A couple of years ago on this whole issue. To begin with, if you look at funding, convergence across different diseases, different discipline, like to have Francis think about that answer promotion. And most of us are discipline driven, you talk about departments and how, in fact, there are people who have a career, how do you get recognized for your work and how do you get promoted? What are the incentives that are included together? I think I would love to hear from this panel their thoughts about if convergence is the way to go, maybe it's not the only way to go. How do we do our system altogether? Francis, going to start with you.

FRANCIS COLLINS:

Oh, it has to be the way to go if you want to make progress. You want the tools, the technologies, the talents of the people who have the best chance of advancing a really bold initiative to all be there together and designing and then implementing a plan. I think about the brain Initiative is a good example of this. We're really gonna try to understand how this most complex structure in the known universe works. Those 86 billion neurons between your ears and all of the other things that support them. We would not get very far if we just brought together the usual crowd of senior neuroscientists and said, figure it out. And if you look at what's happened with that initiative now, seven years along the last two or three cycles of new opportunities for people to come and join, the dominant discipline that has been coming on board are the engineers. And that's a good thing. In fact, that's one of the reasons we see so

much remarkable progress. And again, it's been great working with CCI on this inquiry, I think would probably also reflect on just how critical that project has needed these kinds of convergence opportunities for different experts to come together.

So I think scientifically, we have to do this. Certainly, though, our support structures and particularly things like promotion and rewarding systems aren't quite so quick at adjusting to the way in which science is going forward. And every academic center has their approach to this. And some have moved quickly and some frankly need to move more quickly or they're gonna find themselves in a circumstance where their faculty don't get the chance to be part of some of these remarkable team efforts because they're afraid they're going to be dishonored as a result. There's no reason that that should continue at this point. Our promotion and tenure processes, there's really no excuse at this point for them to be doing what they did 20 years ago.

VICTOR J DZAU:

But Francis, I think we hear from a lot of investigators when they have a new idea is not one of the ICs, one disease areas or whatever. And they say, where do we apply this to? It's difficult to get funding when you cross disciplines. So when you go convergence, you're discussing more like a strategic approach to a scientific theme. But what about ground-up, bottom-up ideas? How do they get this kind of funding? In fact, the review committees are structured around ICs.

FRANCIS COLLINS:

Well, you're right about that. And NIH has its own sort of traditions that aren't necessarily well aligned with the direction that science is going. I don't know how much people have been paying attention to the revisitation of the study section, organizational structure. It is massively different now than it was ten or 15 years ago, and that is certainly caused a lot of people to get pretty upset because there were certainly some cul de sacs of disciplines that were not really catching up as much as they might be with new opportunities. And those basically aren't serving us well. So many more of the study sections now have the kind of convergence feel to it, and certainly, a place like NIGMS sees this as part of their DNA that they really do have to figure out ways to support this. The other thing that Elias Zerhouni came up with when he was NIH director, that has been a wonderful place for these bold projects that don't fit neatly within one IC is the Common Fund and now the Common Fund with $600 million a year, projects can come in, but they can't stay more than ten years.

Look at the output of that and you all see some of the most exciting science that's happened in this last decade. Because it is interdisciplinary, it is bold, It is the kind of thing that is gonna take a team. It needs to be well-designed and executed and monitored, but it needs to put its data out there for everybody to use. But it's pretty dramatic to see how that's played out. Cori your thoughts? Probably in your, at least, in Chan Zuckerberg. That's what you're doing in some way, right? But what do you see in private philanthropy and then your own experience as a university researcher about this whole facilitating convergence?

CORI BARGMANN:

So just to say a couple things, the first is that this was one of the gaps, but with the exception of something like the brain initiative or the Genome Institute, we did identify as something where we could make a difference. So, if people weren't wrong... people weren't wrong to raise it. But I want to mention something else, which is this idea of like, people can't work together and we can't have multi-author papers. Like this is something that academics are doing to ourselves, specifically that biomedical scientists are doing to ourselves. And if you look in the fields of physics, so, in trying to explore some of these things about single-cell biology and requiring people to collaborate. We talk to the people like Maria Super and other people, Fabiola at CERN, and like ask like, how do people in physics make it? And it's like there is a structure. Everyone knows how it works. You're a junior person. You've got a letter written for you by the leadership of CERN that says what you contributed to this project uniquely, even if the off, even if the paper had 250 authors on it, and it's not like they write you a letter that's part of your package that goes out to other people.

The physics community respects that collaboration, and I know of institutions. I know UCSF, the Chancellor sent someone to every promotion committee. When people say, Oh, I don't know, second to last author, they're instructed to say UCSF believes in collaboration. And we can do this ourselves. We have to spend some extra time figuring out what you actually did compared to other 249 authors. But, if what you end up finding is the Higgs boson, that's like really important, even divided by 250. So, yeah, we can do this and there are examples out there. Yeah.

VICTOR J DZAU:

Alondra, particularly when I think about a topic, something you and I work together on emerging technology signs. There's so many other piece that need to come together, right? As you said, social science, equity, all this stuff. How do you package all this? What do you see in this whole convergence side of things?

ALONDRA NELSON:

I see we have a big challenge facing us, but it's also tremendously exciting. I mean, as a sociologist who thinks about systems, it's clear that there are not only misalignments, but they're just kind of structural changes. Some of them are about new research institutions. Some of them are about, you know, to Mark's point, I like to think about the different velocities at which faculty can work. So some people want to just work in a department and some want to as he was laying out work across centers and others do not. And so I think that a system that's really humming across the S&T enterprise allows people, institutions, organizations to work at their different velocities. And that includes actually getting out of the incentive structures, dare I say it, of individual universities themselves. Which are competing for donors and philanthropy dollars. I mean, I think the OSTP perspective here is a bit kind of 30,000 feet looking at the ecosystem. And I think with our wonderful new leader, Arthur Prabhakar, who very much thinks

from a kind of systems design perspective, like what does it mean to have universities working together?

The incentives that particularly around donors are missing line there as well. And so that is a kind of at a macro level, part of the system systemic problem, I think that we face as well. You know, I would say if Ponch was here, he would want me to say, of course, NSF has been working in a convergence accelerator space for a very long time. They've been working for a few years now. They've been working in that space in a way that hasn't transformed how NSF does its work. So I think that we can and government look to spaces of innovation like ARPA H and also to the new Technology Innovation and Partnerships Directorate that's being stood up at NIH, at NSF, that's kind of really taking seriously misaligned incentives, creating new kinds of collaborations as ways in which government is trying to think through that. And then I would say in the space of science and technology policy, there needs to be and this goes to the kind of ethics piece and the equity piece and some of the work that we were doing with CEST, this Committee for Emerging Science, Technology and Innovation here at the National Academies, conversations across the ecosystem from the beginning to innovation to scale around social issues and implications, that needs to really be baked into how we increasingly think about our work.

So as we're working to create a system of convergence, that part of that conversation increasingly needs to be, you know, what are how do we get a society ready for that? You know, I mean, one of the takeaways from the COVID-19 vaccine was that we didn't have time to sort of introduce it to communities, to bring them on as partners, to bring them along. And one of the gambits that we're doing at OSTP, which is this blueprint for an AI Bill of Rights is sort of saying let's slow down just a little bit and let's bring technologists doctors who are using automated systems, Americans who are engaging with systems and real estate in the workplace to sort of think about how we want these to work in our life and to begin to have a conversation before automated systems really become in toto. You know, talk about convergence converge, this kind of singularity across our society. I'm just kidding here. How do we begin to have that conversation earlier on? And so I think the convergence for me is really about including in that conversation.

Just to sum up my slightly kind of all over the place, how we think across institutions, how do we think across universities, how do we think upstream and the kind of innovation ecosystem and how do we include issues of equity and trust in science and government as part of that conversation?

VICTOR J DZAU:

Absolutely correct. Holden I mean...

HOLDEN THORP:

Yeah, well, I think yeah. So we see some interesting implications of this because one of the things that people complain about, journals like ours, if they're not complaining about the costs and how long it takes is how much stuff you have to have to get a science paper. If it's a clinical thing you've got to have the animal data and you've got to have the case chemistry and you've got to have the engineering and all these things, and you've got to cram it all in 3,000 words and terabytes of supporting information. And this convergence idea, as Alondra is saying, if you're breaking out of your field, it has the potential to make it very daunting to get all of these things done at once. And, you know, the thing we see and this gets to Cori's part, that we have the power to change this if we want to. The reviewers ask for all that stuff. Now, of course, we have some influence and we shouldn't try to broker it down so that it's not quite as daunting. But as a community, we've kind of decided that if you're going to publish this big convergence paper in science and nature, it's got to have all this stuff in it.

Yeah, well, why don't we just decide you don't have to do that? It ought to be OK to say, I got this part, I got the chemistry part, I got the clinical part, I got the animal part, whatever. I got the engineering, whatever it is, so that we're not putting this enormous burden on particularly young investigators coming up trying to do this, which then feeds into the problems with tenure and promotion and all the other things that are being discussed here. So, again, that gets back to kind of what I was saying earlier, which is, and you're doing this by having this meeting. We got to get off of our own bicycle every once in a and talk about how we can come together to solve some of these probwhile lems.

VICTOR J DZAU:

I'll come back to that for sure. Yeah. Mark, We talk about promotions and others. So tell me a little bit about what you're doing. How can, in fact, with the current structure, like it or not, we're still disciplined about mental structure. How do you work on the promotions issue?

MARK:

For the maybe I can mention the promotions, but also the incentives to get people together. I think everybody recognizes that we need a better way of rewarding, you know, the kind of scientific activity that we want to encourage people to do cross boundaries. At the same time, we do ask of our faculty to make a mark in their own disciplines. And I do think that over the years, what we've seen is more flexibility on the part of the promotions committees. And as they've... as we've encouraged interdisciplinary work generally at the university to consider that with a more of an open mind. I think it's part of culture change that goes hand in glove with interdisciplinary work becoming more of a mainstay in the university. And so maybe I can just comment on that briefly. I mentioned how one of the ways we've been doing this is by creating interdisciplinary institutes. To Cori's point, you then have to really work hard to make them work to really break down the barriers. And certainly one of the ways to do that is by putting together resources that not only encourage interdisciplinary research, but are only available for interdisciplinary interactions.

And let me give an example. We have an institute, one of our first interdisciplinary institutes called Bio-X, headed by Carla Shatz. Many of you will know that brings together physics, engineering, medicine, biology. And they have programs where they have fellowships for graduate students, but they're only available if the graduate student has two mentors in two different schools, in engineering, and in biology or medicine, for example. It turns out that there are a lot of students and faculty are interested in taking advantage of that. And then once the connections are made between those faculty members, that they persist even after the student graduates. So we have to work on culture change within the university. We've been doing this by essentially providing a lot of carrots to encourage people to work together and people take them up and people do work together, and that then feeds into how people are evaluated as well. So those two things have to go hand in glove.

VICTOR J DZAU:

Thank you. And always herd cats, but you can move their food. I think that's what he said.

MARK:

Yes. That's very well put.

VICTOR J DZAU:

I do want to caution, Mark, that you have such great leadership and also resources. Not all of us can easily do what you do. And so the real question is how we make facilitate this through external mechanism as opposed to internal. But I...

MARK:

(UNKNOWN) victor, if I may say. That's where foundations, philanthropy on the one hand, and NIH on the other can play the same game. They can make resources available that are only available for interdisciplinary types of studies. And I think you will find that people will go in that direction.

ALONDRA NELSON:

I just, yeah, jump in here a little bit halfway in my like former dean, which is to say what I meant by the velocities thing earlier was part of it takes resources our work... research requires resources. But to your point about lesser-resourced organizations, I mean, there is a... there are ways to re-imagine what it means to be a faculty member. And what I meant by velocity is that if someone wants to is a medievalist and wants to drill down on with that is that the university should create... can create structures to make people so the people are working at the height of their powers and that looks different for different researchers. And sometimes that will take a lot of money and fiscal resources, and sometimes it'll just take us getting out of our own way. You know, in the space of...

VICTOR J DZAU:

Putting the right people together and yes, yeah.

ALONDRA NELSON:

People together getting out of people's way. I mean, one of the more sort of humbling insights, when I did a... worked on a strategic plan for social science was one of the things many of the faculty said was like, can we have office? YCan we have classrooms where we can move more of the desks? So, I mean, I just think that like, what people wanna do often in their research and in their in their teaching sometimes takes a lot of money, but sometimes it takes imagination. And us being able to think about these 800-year-old institutions and how they might do the work differently.

VICTOR J DZAU:

Fair enough. Lastly, I mean, Cori, I'm thinking about what's the future of science philanthropy? In other words, what do you think it should look like if we're gonna transform the biomedical enterprise?

CORI BARGMANN:

I think the future is here and I would say that if I could tell you what the future should look like, then that wouldn't be the right role for philanthropy, probably. You don't want to be trapped in your own success. You don't wanna keep doing exactly what you've been doing. You wanna be open to the new opportunities. And I thought about this a lot at the Chan Zuckerberg Initiative. It was an incredibly generous gift from Mark Zuckerberg and Priscilla Chan to start this philanthropy. And it represented 1% of the NIH budget. It was not gonna replace. We cannot as a society give up our commitment to federally funded scientific research. It is you know, that is gonna be the heart of what happens no matter what. And so these are gonna be experiments around the edges, ideas that develop where once we do figure out how to use computation and machine learning and open source software in science more, then there will be other mechanisms to fund it that can go mainstream or whatever. But it's not a long-term.

I don't think viewing it as sort of a long-term investment is necessarily the right way to think about it. That said, Howard Hughes is doing great on the basic model of the Hughes investigators, but notice that they're not just saying, well, if we have more funds now, we're just gonna have more Hughes investigators, they are trying to do new things. They are doing the new experiments. And I think that's the value of these systems that, you know...

VICTOR J DZAU:

So if you think about the drivers of science innovation, there is government funding, there is philanthropy, and there's the private sector. How do we bring these pieces together to be more coordinated and more strategic?

FRANCIS COLLINS:

I think. Yeah, I think that's a really great opportunity that has not been fully harvested. We've talked about ARPA H as a new model where there may be an opportunity there to mount projects which are going to have more direct interactions between academic investigators and people in the private sector, maybe, especially by small businesses that have a technology that brought together with an academic idea could really go somewhere. But we also in the last seven years or so, have seen models for interactions with the private sector that have worked pretty well. But I'm not sure they're as well known about. And I'm particularly thinking of the Accelerating Medicines Partnership AMP, which got started by a general recognition in both private and public sectors that there are some pretty fundamental questions that everybody wants answers to. Like really what are the next generation of potential drug targets for Alzheimer's disease and diabetes that might emerge from what we're learning from genomics in single-cell biology?

And it was a little tough to get people to recognize that that could be really pretty competitive, but ultimately they did. And so those projects, seven of them now diabetes, Alzheimer's disease, rheumatoid arthritis, Parkinson's disease, one on cancer immunotherapy and on gene therapy for rare diseases even, the newest one of these and on heart disease. All of these have come together in a way that brings really impressive scientists from both sectors around the same table to design the project. And they get to know each other. And sometimes they're sort of surprised. The academics, like all these people in the private sector, they just want to make money. And the people in the private sector, all these academics, they just wanna publish papers. They don't care if anything really important happens. Well, both of those are wrong. And you find that out pretty quickly and just look at that track record. This was also a circumstance where it had to be skin in the game. So the public sector contribute half the money.

Most of that from NIH and the private sector contributed, the other half from pharma budgets. So people had to really care about the result. This wasn't one of those things where you did a nice thing and then went off and the leadership stayed closely connected. We could do more of that. There's lots of other situations like that, pre-competitive opportunities where the talent is not just in one sector, let's get it together and do those things.

VICTOR J DZAU:

I think would be fabulous because take one area. Climate change and human health and equity, right? I mean, we're now looking at trying to get NIH more funding for this area across institutes. There's private sector, but I think the kind of research is not scaled enough at this point. In fact, looking at cross-sectoral agricultural research and health and climate and others, there's not an easy place to go to. I mean, think about these big issues. They are, in fact, still funded in different silos. Alondra, any thoughts?

ALONDRA NELSON:

No, I think that's right. I was also thinking, you know, about the sign behind us that says the health science. And so I was going to where you went, Victor, which, that are are, you know, problems that are not that laboratory science is not very hard and can be very thorny, but that the complexity of problems around climate and around the health sciences and public health, I think make the convergence equation a lot harder because we are talking often about.

VICTOR J DZAU:

Are very much needed.

ALONDRA NELSON:

Very much needed, like urgently needed. And I think that would be my answer to the future question. And so point taken about the 250 authors and how do we get other scientific fields or physical sciences to think about that? But, how do we get environmental scientists you do one or two in, you know, off papers or humanities and social sciences to work in that space at all? And I think around the conversation, around incentives that that is part of the challenge. And I do think that what I'm encouraged by in this administration is that the president has a big vision for the future of the nation that is that says that climate change is an important priority in mitigating. And adapting to that is one that we should all be working on. And so there is a way in which there's space for all folks in the research community to sort of find a place at that table. And so I think that and this is the part of me that's been in government for almost two years, I think, and I'm thinking also about Professor Mazzucato's work like the Mission Orientation matters.

And I think how you align people or realign the incentives in part is with a strong vision and a kind of mission orientation for the work that allows them to get out of their own ways across silos.

HOLDEN THORP:

Yeah, and I think I'm sorry, just one way to connect a lot of the things that have been said. I mean, we're always focused on doing more and making it bigger. You (UNKNOWN) Mark about how much money Stanford has, and it's awesome that Francis got us more money for the NIH. Nobody ever did it any better. But that just made people compete more to try to get more. And the problems that we're talking about are really hard and you can't necessarily solve them by just making your labs bigger and bigger and building more neuroscience buildings and having more postdocs. I mean, it's time to stop and think about what we really want to accomplish. And I mean, Francis had a perfectly logical scheme to try to help young investigators get more funding by taking just an ever so slightly slight amount of money from the highly funded investigators.

FRANCIS COLLINS:

Yeah, I remember that.

HOLDEN THORP:

Yes. And I didn't sign the letter from WashU, but my medical school colleagues were very mad at you for doing that because I agreed with you. And we can't seem to come to agreement about how we're going to distribute all this stuff. And in addition to all the equity problems that creates, it also makes it hard to solve the kind of problems that Alondra is talking about.

VICTOR J DZAU:

So I do want to ask you, all of you, the question about the future, but I wanna open up the floor for, I'm sure, many questions for all speakers. But as you think about this, I'm gonna ask you. Let's just say ten years from now, now ten years from now, what would it look like and what would you like it to look like if you had the ability to intervene and design it correctly for the biomedical enterprise? So that's what I would like. And so, OK, let's take some questions then, please.

SPEAKER:

I wanted to follow up, Anna Graca. I'm at the Bird Institute, the Brigham, a Harvard Medical School. And for full disclosure, NIH funded CCI funded and an associate data for science advance.

VICTOR J DZAU:

I think you're doing alright.

SPEAKER:

All my disclosures. I wanted to revisit this issue of the young scientists, and I especially wanted to focus on young physician-scientists. And Dr Collins had commissioned a report back in 2014 about the workforce and the dwindling numbers. And at that time, we had found in that report decreased entry. We train a lot of MD PhD students, but they don't follow on to careers. We have attrition. And also the report said that there was a higher percentage of physician-scientists who are over 65, 70 and so were at higher risk when they retire, that basically our pipeline will be left extremely leaky. And so the question is, if we agree that it's part of our future enterprise, we need physician-scientists to be a part of the teams that, you know, make all of this happen. What are our answers to this problem? And I think it also builds on what Holden is saying about, you know, all young scientists and sort of where do they get the funding to grow their own labs in this new environment?

FRANCIS COLLINS:

Yeah, it's an incredibly important question. And people have been writing editorials about physician-scientists as an endangered species going back at least 30 years. I wrote one of those myself and longer.

VICTOR J DZAU:

But it's true.

HOLDEN THORP:

If you wanna send us another one. We'd love to see it.

FRANCIS COLLINS:

And it was bad when they started writing these editorials. And it's worse now. And you can see that trajectory. If it doesn't change somehow, it's headed to zero. And even the physician-scientists who are out there doing research, many of them don't have the projected time to be able to be as competitive as you would want them to, given the skills and the training they have had. As far as early-stage investigators, I think a lot has been done to try to prioritize their applications to NIH. And I don't know if you've watched those numbers, but they've more than doubled the sort of first-time applicant getting an R1 was maybe 600 back in 2015, and it's now 13 or 1400 by basically making that a priority. If you're a first-time investigator, you get a priority score in the top 25%. You should be funded regardless of which institute and what their payline currently is. And I think all the ICs have pretty much decided just to do that. And that applies, of course, also to physician-scientists, to MD PhDs.

But we're losing them along the way. And I think that may be something that NIH has some role to play in. But it's really an indictment, I'm sorry to say, of our academic medical centers that those same individuals are called upon to do other things, which involves potentially a lot of patient care time. And I don't know, I'm kind of old-fashioned. If you're going to be a credible physician, scientist, researcher, and you're spending less than two-thirds of your time on the research part, it's gonna be really hard to be able to be up there competing with all those folks who are spending a lot of their time in the lab and you're not. So our institutions have got to figure out ways to protect the time of those talented folks, or we can't blame them for deciding that this is not a credible pathway for them. And there's a financial issues which we all know about the terrible costs of loans that need to be repaid, a loan repayment programs getting better but not good enough. So I'm citing all the problems that you're very familiar with and NIH can do some things there, but I'm gonna sort of call out all the academic medical centers.

You've got to help us here, because otherwise, we do not have the workforce we need for the future. And we certainly don't have the diverse workforce we need for the future either. So a big problem. Thank you for bringing it up. Come on, y'all, let's fix this now. You're supposed to fix it.

VICTOR J DZAU:

Oh, Mark.

MARK:

Maybe I can just add two things that Francis identified many of the problems there is the issue of on-ramp for physicians. You know, MD, PhD is one route. And of course, there are issues around that. But in the past, many more MDs would then go on to do research. And certainly, the experience before I came to Stanford at Rockefeller, we had a program for physicians to do research and found that only foreigners would do it. And the root of the problem was that they had no debts, whereas American MDs did. When a loan forgiveness program was introduced as part of the fellowship program, suddenly the American applicants increased. So we do to Francis's point have to remove the obstacles that are that get in the way. Many physicians would like to be able to devote themselves to research. We have to make that possible for them.

VICTOR J DZAU:

Absolutely right. Cori.

CORI BARGMANN:

I was just gonna say the same that Mark just said and that it's the same point that (UNKNOWN) made this morning. I think making it possible for physicians particularly to have a reasonable salary and debt forgiveness would be the equivalent of public service in getting them into science. If they're crazy enough to want to do research after doing their fellowship, we should really disappoint them.

AUDIENCE:

(APPLAUSE)

VICTOR J DZAU:

I'd like to give you some thoughts on this issue. I wrote a paper with Lance about redefining academic medicine. And the question is, most of us think of physical sciences in the model of Francis. Are you an MD equal?

FRANCIS COLLINS:

No.

VICTOR J DZAU:

Francis, myself, and others who bench translators, researchers and do clinical work. But in fact, if you think about where science is going, also the issue of community work, the issue of data science that in fact is possible for physicians to do more science and the concept of what they do in clinical work. So we do have to redefine with physician-scientists. If you count the numbers and to look at how to support those individuals. We're gonna make a huge difference in the use of data science and others in the issue of improving equity, health care, etc. Some thoughts. OK, Sam.

SAM SILVERSTEIN:

Sam Silverstein, Columbia University. You've given us a brilliant and optimistic view of how we can work together to accomplish what we all know needs to be done. Yet more than a third of this country is distrustful of government and distrustful of science, and would not accept the idea that government is part of the solution but is part of the problem. We need some marching orders from you as a community about how we can communicate what our view of the future is and why it's the right view of the future and how we ought to get there. You've defined the problem and given us practical solutions, but they only are solutions that are enactable as Francis pointed out. If the government or one of you pointed out that the government is got the funds to do the big piece of the job because it can't come from private foundations, there just isn't enough private money to do it. So tell us. What should we all be doing? What should we all be saying? And how should you think we ought to behave in order to bring the future that you're hoping to have to flourish it?

VICTOR J DZAU:

I'm gonna start with Holden.

HOLDEN THORP:

Yeah, well, I've written a lot of columns about this, including one pretty provocative one that dropped on Friday and got a lot of commentary in the Wall Street Journal this morning, which whenever the Wall Street Journal editorial page drags me, I know I'm doing my job. Unfortunately, Francis and Tony got whacked this morning, too.

FRANCIS COLLINS:

Yeah, we got it.

HOLDEN THORP:

So I feel bad because it's my fault, but so, my whole shtick about this is we got to get a lot better at communicating with each other. Because if you look at the whole history of misinformation. You can go all the way back to Galileo, but you can certainly go to the Scopes trial. Tobacco, ozone, climate change, acid rain, strategic defense. There's always been some people in our community who have enabled misinformation by disagreeing with the scientific consensus without running their disagreements through the scientific process. So and we've certainly seen a lot of this in. Mark, you have a lot of these guys I'm sorry to single you out. You know, who... Many of them are outside the field. They disagree with things and then they tweet and have press conferences and they go on podcasts. And it's fun to blame Tucker Carlson and Joe Rogan. But if they're quoting people from our own community, shouldn't we straighten that out first? I mean, out here in the hall are pictures of people who did that, too.

And as Leslie Vasile says, it's a dude wall, so why not take a few of those down anyway? And so if our own people are the ones enabling the misinformation, then I mean, I know there's not an

easy solution to this. But really, that's the problem before, because we've always had politicians, we had William Jennings Bryan and we had Ronald Reagan with the just strategic defense and Edward Teller. Yeah, I mean, that's always been there. And so if we want people to believe what we have to say, then that's getting our own act together is job one. And then the second thing, which I think I've heard almost everybody in this panel say, and many of you as well, is we've just done a lousy job of explaining to people that science is a process, not a set of facts that fall out of the sky in a textbook, and that the disagreements that we have and the back and forth and the revisions and all of that, that is what we do. And so if we don't explain that to people and we always want to be the person who stands at the podium, who has the answer, instead of saying, Well, this is the process, then we're also giving the misinformation people at all, because they see our back and forth and revising our estimates and all this stuff as us not knowing what we're doing, when actually that is what we're doing and it has been for hundreds of years.

VICTOR J DZAU:

So I'm aware that American Board internal medicine is attempting to and of succeeding or not that that any of their members certified. Because there's certification that clearly polls misinformation that's damaging. They can remove their membership. Now, you can imagine the reaction of members, but it is they talking about doing this. And I do think that we have to take some ownership in making sure that, in fact, what we as a profession, what we say are based on facts. And we are if it's not based on facts or maybe you actually really do true disinformation, that could be actions to be taken.

SPEAKER:

So would let me just add, then, what would this information be a medical school produced to teach abortion? And should that medical school continue to be an accredited medical school that showed obstetrician and gynecologist who trained and had medical schools and hospitals that refused to train them in abortion? Should they be more than satisfied?

VICTOR J DZAU:

No question. Deserves a lot more consideration on this issue. I don't think this panel have....

HOLDEN THORP:

254 (UNKNOWN)

VICTOR J DZAU:

Alondra, yeah Alondra.

FRANCIS COLLINS:

Can I just add one other thing about the communication issue? I think what Holden has said is right that we did a poor job with COVID and probably with other things explaining that science is provisional, that you do the best you can with the data you have in front of you. And you should say at that very moment, and this could well change when we have information as soon as tomorrow. But we're doing the best we can with what we have in front of us. That should have been said all the time during COVID.

HOLDEN THORP:

We've learned that, well,

FRANCIS COLLINS:

I'm. Guilty of that as well as others. But I do think more positively, I don't think this is gonna be solved by better government communication, although it could be a lot better and it could use social media instead of talking heads on cable news, which probably doesn't convince a whole lot of people to change their minds. We could use certainly that more Tik Tok and less CNN might have been a good idea to try to get the information to the people who are still open to changing their minds. But why don't we have this is just a thought idea. Why don't we have a way of activating our entire scientific community to become part of this communication process? Lesley was talking about encourage your students in the lab to take this on and be promoters of accurate information, but do so in a formalized right. Let's form a science communication core and ask every graduate student and every postdoc if they want to join and provide some kind of resource and support so that they have that kind of information and don't get caught completely without some kind of grounding.

If somebody is asking a tough question that just came out of nowhere and not make this just, oh, well, we'll hope it'll work if we send you all out there, actually provide some kind of framework.

VICTOR J DZAU:

I think should be part of a scientific training. Right altogether. Oh, there you go. We can ask. Sorry, one last question.

FRANCIS COLLINS:

He deserves a chance. Yeah.

MARK:

I just wanted I listening to Sam's question that started this. I wonder, though, Sam was asking, you know, the concern was expressed of how do we maintain public support for our enterprise? And I think what was just discussed is part of it. But I do want to say something a little bit more hopeful, which is we do a lot of polling ourselves in public opinion, as does the AAU, the Association of American Universities. We see a lot of data on what drives unfavorable

impressions of higher education and research universities and what drives favorable impressions. And it's important to recognize that people can have an unfavorable impression for one reason. For example, the people are concerned about the cost of universities, the cost of attendance or access. And they... and certainly a large segment of our society is concerned about issues of free speech on campus, for example. But it turns out that the favorables often dominate those unfavorables even in the minds of individuals. And the biggest driver of favorable impressions of research universities and we can extend that beyond that is innovation and especially innovation in the life sciences and medicine.

The public at large understands that our enterprise generates life-saving therapies and cures that will have impact for them, and they may have a dislike for one or other aspect of the enterprise. But overall, the impression the favorables override the unfavorables. And so what's important in our communications is to focus on the good that we're doing for society. I think that's job one.

VICTOR J DZAU:

I think that was emphasized in the earlier session. Elena, I want you ask the last question.

ELENA:

Thank you, panel members. Wonderful presentation. I'm Elena from the (UNKNOWN) from the University of California, San Francisco. I'm a pediatrician by training and I can't help when I listen to the presentations we've had this panel and previous panels. We talk about silos. We talk about the need for more interdisciplinary intra-specialty work. And I feel that there's an opportunity to take more of a life course approach to many of these issues, whether it's cancer, rheumatoid arthritis. Dr Collins, you raised the other priorities. To my ear, we talk a lot about from the adult spectrum, but we don't think about how the whole life courses at integrated. So I would suggest that one way to revolutionize the medical and health sciences might be to incorporate not only inequity lens and everything that we do, but a life course perspective as well. Thank you.

VICTOR J DZAU:

Thank you. I want to end by asking each one of you just to one

AUDIENCE:

(APPLAUSE)

VICTOR J DZAU:

This time we're supposed to be transforming the future from your perspective. So maybe in two sentences for each. What do you see we need to do for the future and what we would like? Should it look like, say, ten years from now? Francis. Two sentences. I'll give you three.

FRANCIS COLLINS:

As I started out, I think the scientific opportunities in the next decade are absolutely breathtaking. If we can do what we need to do to support the talents to come in and work in these fields, whether it's neuroscience or whether it's figuring out how to treat all of those currently untreatable conditions caused by DNA mutations and even cure them, or whether it's understanding enough about cancer that we can no longer worry when you get a stage four diagnosis because we have a cure for that too, we should, in the next ten years, be able to make accomplishments that will absolutely dwarf what we've been able to do up until now. This is the golden era.

VICTOR J DZAU:

Very optimistic. Yes, Cori.

CORI BARGMANN:

I'm gonna speak a little out of my officially assigned role here and say that what I wanna see in ten years is real progress in neurodegenerative disease and mental health based on brain science. And I think that is realistically in view. I think, when the war on cancer was declared in the 1970, people were like, oh, the war on cancer, you know, it ended and we lost, yand then over decades just sort of just became like a disciplined attack and decrease in cancer mortality basically 1% a year over like 25 years. Really impressive. And I'd like to see the same thing happening in. And some of these other areas that. And I think that's possible. I think neuroscience is 20 years behind, but it's time to start.

VICTOR J DZAU:

Great. Alondra.

ALONDRA NELSON:

For me, ten years and pulling on some of the threads of the conversation. Something like S&T. Enterprise Convergence. Like everybody in this room, everyone on this panel has a piece of making the sort of larger enterprise better. And we're gonna need everyone in this room and their different capabilities, their different sectors to make that possible. And ten years, I wanna imagine an S&T enterprise system that includes and benefits all people. And I'm talking about everything from welders to Nobel laureates. And I think that we need to begin to think about to the life course perspective. K-12 education to new innovative research institutions is how we think about the S&T Enterprise. I want to the question about public trust. I think we need to have and a decade a space that has a lot more public accountability and like some humility and just honesty that we are often doing research and doing policy in a context of low trust. And that's like we can't... we can even, we can hark back to the halcyon days where we had high trust or we can actually sort of make policy and lead institutions in the space that we have, which is a kind of humility around the low trust.

Lastly, I want us to imagine in a kind of anticipatory, thoughtful S&T policy space that is anticipating implications that might come, that is bringing the American public on board as partners in the work that we're doing, including all of the American public, wherever they sit, demographically, wherever they sit, and the kind of spectrum of equity across our nation.

VICTOR J DZAU:

So thank you very, Holden.

HOLDEN THORP:

Yeah, I think the most important thing is that we've got to examine everything that we've been doing and be willing to think about how it plays out outside of our world and what we can change inside of our world to make a difference in that. And it's so easy. And certainly, I was guilty of it when I was a young faculty member and right up until I went into administration to just focus on the metrics that I had to achieve. But the problem with that is that, we come to these things and we talk a lot about a lot of big ideas, but then we go back and do what we were doing before and we don't change anything. And so I think a lot of things are possible, and I'm very optimistic about it, but only if we're willing to change some things that have... seem like they're immutable, but they're not. It's up to us.

VICTOR J DZAU:

Mark.

MARK:

Ten years from now, I'd like to see that we have made huge strides in this problem, this problem of access of students from all backgrounds and particularly underrepresented backgrounds into the medical sciences and life sciences that we made great strides in the culture change that's necessary for us to realize the potential of the convergence of all these disciplines where we've broken down the of the silos effectively, where we've also become much more skilled at rapidly applying knowledge, I still think is the valley of death that we talk about is a solvable problem if we put our minds to it. And I think it's a solvable problem in the next decade. And lastly, we haven't touched about this very much in our particular panel that's been mentioned earlier in the day. I think we focused a lot on our country, but strengthening international bonds at a time of globalization and rising tensions and making sure that we engage with the rest of the world. Human health is a is a universal problem, we have to work together to solve it.

And I'd like to see us look back ten years from now and say we made great strides also in strengthening connections with countries and scholars and scientists around the world.

VICTOR J DZAU:

Well, thank you very much indeed.

AUDIENCE:

(APPLAUSE)

VICTOR J DZAU:

I want to thank our panelists for the really great closing thoughts. They should be leaders in science and institution and we have... they are certainly carving a pathway forward for the next ten years. So thank you.

AUDIENCE:

(APPLAUSE)

VICTOR J DZAU:

Alright, Good. Thank you. Thank you.