

New Public-Private
Partnership to Counter
Opioid Epidemic

Unlocking the
Scientific Mysteries
of Our Universe

Should Advances in
Synthetic Biology
Raise Concerns?

Educating the
Next Generation
of Scientists

THE NATIONAL ACADEMIES

INFOCUS

Fall 2018

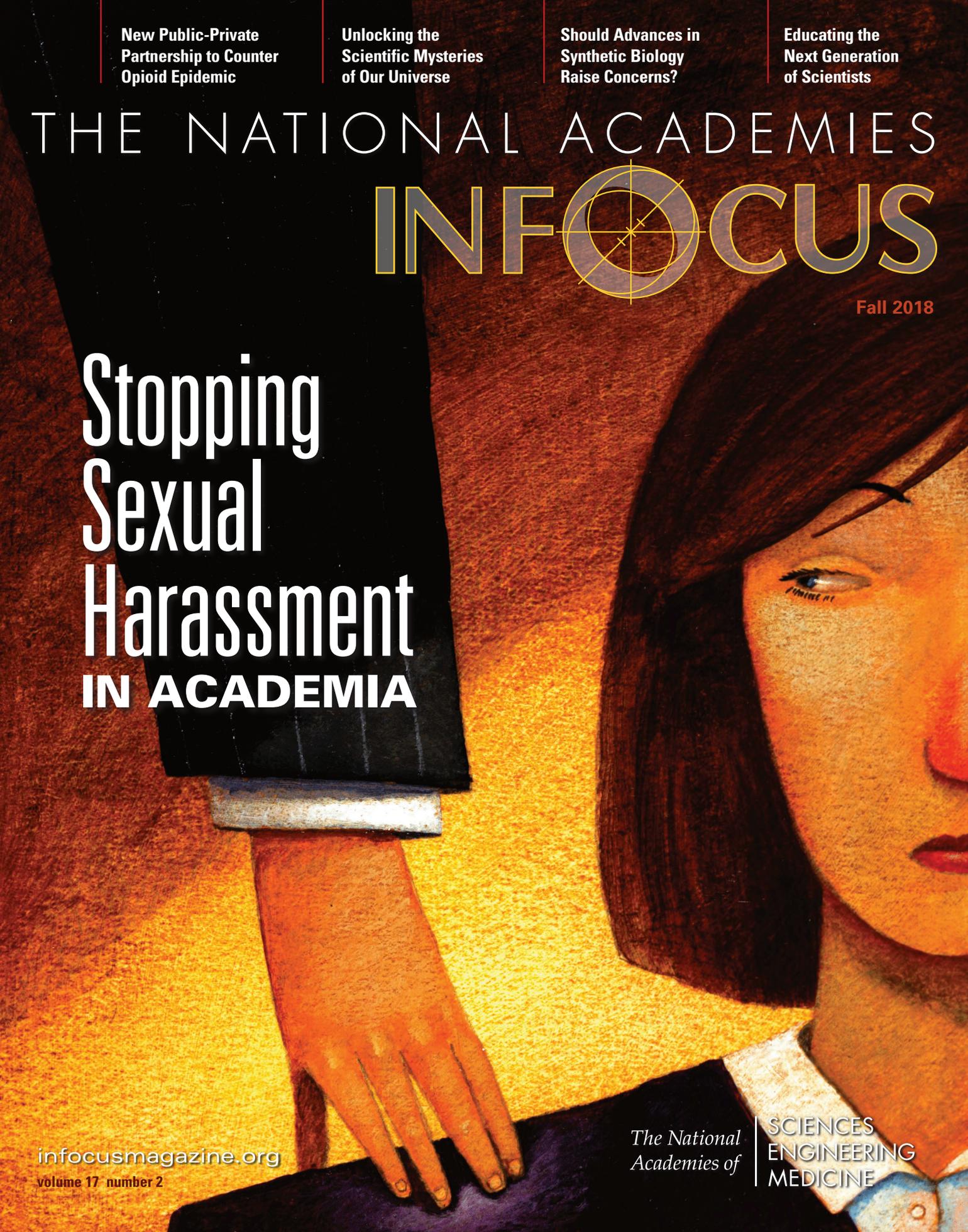
Stopping
Sexual
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IN ACADEMIA

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The National
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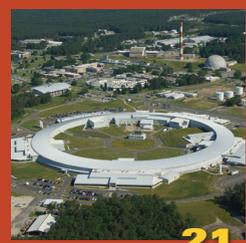
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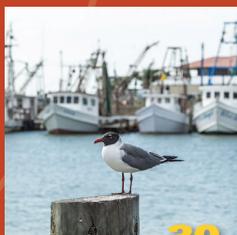
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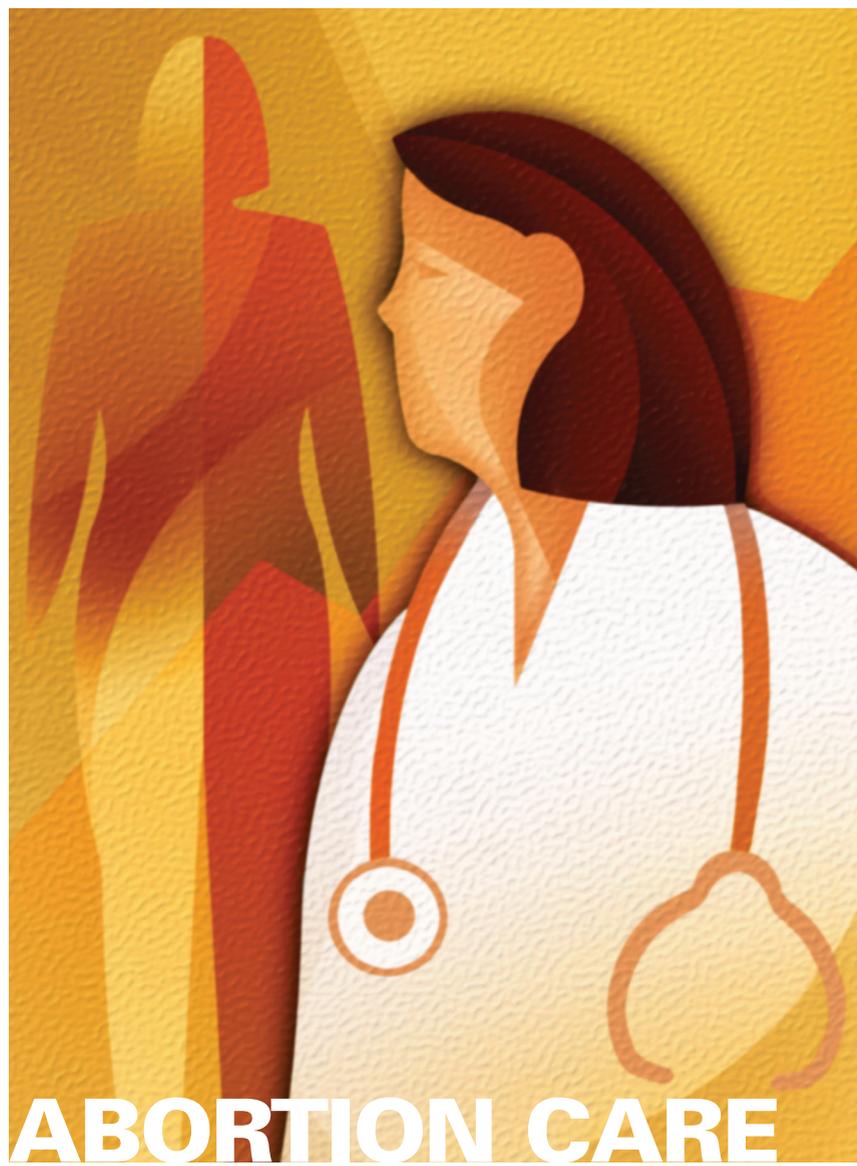
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Since abortion became legal nationwide in 1973, there have been substantial changes to the health care delivery system and medical science. Abortion care practices have changed with the advent of new techniques and technologies, and a great deal of scientific research has been conducted on the safety and quality of abortion services. Between 1980 and 2014, the abortion rate in the U.S. decreased by more than half, from an estimated 29 per 1,000 women of reproductive age to 15 per 1,000. The reason for this decline is not fully understood, but it has been attributed to the increasing use of contraceptives, especially long-acting methods such as intrauterine devices, historic declines in the rate of unintended pregnancy, and increasing numbers of state regulations that limit the availability of otherwise legal abortion services.

A new National Academies report provides one of the most comprehensive reviews of the scientific evidence on the safety and quality of abortion care in the U.S. The committee that wrote the report examined the research on the four abortion methods — medication, aspiration, dilation and evacuation (D&E), and induction — and assessed quality of care based on whether it is safe, effective, patient-centered, timely, efficient, and equitable according to well-established standards. Regardless of the method used, serious complications from abortion are rare, and safety and quality are enhanced when the abortion is performed as early in pregnancy as possible. Most abortions in the U.S. are performed early in pregnancy; in 2014, 90 percent occurred by 12 weeks' gestation. Medication and aspiration abortions are the most common methods and, together, account for about 90 percent of all abortions.



ABORTION CARE IN THE UNITED STATES

A Comprehensive Review of Research on Safety and Quality

While legal abortions in the U.S. are safe, the likelihood that women will receive the type of abortion services that best meet their needs varies considerably depending on where they live, due to abortion-specific regulations in many states that create barriers to safe and effective care. These regulations may prohibit qualified providers from performing abortions, misinform women of the risks of the procedures they are considering, require medically unnecessary services, and delay care, the report says. Examples of these policies include mandatory waiting periods, pre-abortion ultrasound requirements, and a separate



While legal abortions in the U.S. are safe, the likelihood that women will receive the type of abortion services that best meet their needs varies considerably depending on where they live.

in-person counseling visit. Some states require abortion providers to provide women with written or verbal information suggesting that abortion increases a woman's risk of breast cancer or mental illness, despite the lack of valid scientific evidence of increased risk.

Availability of services is also a factor. In 2014, 25 states had five or fewer abortion clinics, and five states had only one abortion clinic. In addition, approximately 17 percent of women travel more than 50 miles to obtain an abortion.

In examining the minimum characteristics necessary for clinical facilities to safely perform an abortion, the committee found that the majority of abortions can be provided safely in office-based settings. In 2014, 95 percent of abortions were provided in clinics and other office-based settings. For any outpatient procedure, including abortion, the important safeguards are whether the facility has the appropriate equipment, personnel, and an emergency transfer plan to address complications that might occur. There is no evidence indicating that clinicians who perform abortions require hospital privileges to ensure a safe outcome for the patient. No special equipment or emergency arrangements are required for medication abortions. For other abortion methods, the minimum facility characteristics for providing safe services depend on the appropriate level of sedation.

The committee also reviewed the evidence on what clinical skills are necessary for health care providers to safely perform the various components of abortion care, including pregnancy determination, counseling, gestational age assessment, medication dispensing, procedure performance, patient monitoring, and follow-up assessment and care. It concluded that trained physicians — such as OB-GYNs and family medicine physicians — as well as advanced practice clinicians (APCs) — such as certified nurse-midwives, nurse practitioners, and physician assistants — can safely and



State regulations may prohibit qualified providers from performing abortions, misinform women of the risks of the procedures they are considering, require medically unnecessary services, and delay care.

effectively provide medication and aspiration abortions. Physicians with appropriate training and sufficient experience to maintain requisite surgical skills can provide D&E abortions. Clinicians with training in managing labor and delivery can safely and effectively provide induction abortions.

In its review of abortion's potential long-term health effects, the committee examined the evidence on risk of breast cancer, impact on future childbearing and pregnancy, and mental health effects. Having an abortion does not increase a woman's risk of secondary infertility, pregnancy-related hypertensive disorders, preterm birth, breast cancer, or mental health disorders such as depression, anxiety, or post-traumatic stress disorder.

Access to clinical education and training in abortion care in the U.S. is highly variable at both the undergraduate and graduate levels, the report says. Medical residents and other advanced clinical trainees often have to find abortion training and experience in settings outside of their educational

program. In addition, training opportunities are particularly limited in the Southern and Midwestern states, as well as in rural areas throughout the country.

The committee identified a number of areas that merit further investigation, such as how restrictions on distribution of mifepristone — the only FDA-approved medication for use in medication abortion — affect quality of care; how best to reduce the pain women experience during abortion procedures; and best practices for providing support services to lower-income women.

— *Dana Korsen*

The Safety and Quality of Abortion Care in the United States (2018, 222 pp., ISBN 978-0-309-46818-3) is available from the National Academies Press, tel. 1-800-624-6242; \$60.00 plus \$7.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24950>. The study was co-chaired by Bruce N. Calonge, associate professor of family medicine and epidemiology, School of Medicine and School of Public Health, University of Colorado; and Helene D. Gayle, president and CEO, Chicago Community Trust. The study was sponsored by the Grove Foundation, JPB Foundation, Packard Foundation, Susan Thompson Buffet Foundation, Tara Health Foundation, and the William and Flora Hewlett Foundation.



FOCUS on

The Next Generation of Scientists

The National Academies have long held a particular interest in helping the nation prepare its next generation of scientists, engineers, health care practitioners, and others in the STEM workforce with the best quality education and skills. Several recent reports from the Academies have taken a look at higher education and where opportunities lie for improvement and better outcomes for students and, ultimately, our economy and society.



A New Vision for Graduate Education

Warnings have been sounded for many years that the pathways into science careers are not working as they should. Incentive systems push university faculty to focus on research output to the detriment of teaching and mentoring graduate students. Postdocs spend years in low-paid positions awaiting tenure-track jobs that for many never materialize. While numerous past reports from the National Academies and other institutions have looked at these issues and recommended reforms, little progress has been made.

What is stalling reform efforts, and what can be done to drive real change in ways that support students and early-career scientists? Two recent reports from the National Academies — one focused on graduate education in science, technology, engineering, and mathematics and the other on early-career researchers in biomedical and behavioral sciences — identify the barriers to change and recommend shifts in incentives as one key to overcoming them.

An Ideal Graduate Education

Graduate STEM Education for the 21st Century identifies the characteristics of an ideal graduate education for both master's and Ph.D. students. Students should be able to select their graduate program with the benefit of fully transparent information about viable career pathways and career outcomes of previous students. Programs should give students broad technical literacy coupled with deep specialization in an area of interest. Students should receive multiple opportunities to consider ethical and societal issues associated with their work. They would be encouraged to develop their own project-based learning opportunities as a way to build transferable professional skills. And experiences where students “learn by doing” through activities such as interdisciplinary team projects or internships would balance traditional lectures and coursework.

To make this vision a reality, the graduate education system will need to increase the



What is stalling reform efforts, and what can be done to drive real change in ways that support students and early-career scientists?

value it places on teaching and mentoring, the report says. “A central element of our strategy is to make the graduate education system more student focused while maintaining the central attributes that have made the system the gold standard for the world,” said Alan Leshner, chair of the committee that wrote the report, and chief executive officer emeritus of the American Association for the Advancement of Science.

Faculty behavior must change to achieve a better balance between research output and teaching, and shifting incentives will be crucial to changing that behavior. The current system, primarily governed by the federal and state agencies that support academic research and graduate education, heavily rewards faculty for research output in the form of publications and the number of academic researchers produced. The report calls for these agencies to consider revising funding policies to include incentives for faculty contributions to teaching, mentoring, and supporting diverse, equitable, and inclusive environments. In addition to shifts in funding policies, the report calls on institutions to consider ways in which to include teaching and mentoring performance as important considerations for reappointment, promotion, annual performance review, and tenure decisions. Institutions should also help faculty improve their teaching and mentoring skills by providing training and refresher courses for them.

To help current and prospective students make informed career decisions, graduate

programs should collect and update information on master’s and Ph.D.-level career outcomes and make it easily available to students. Federal and state funding agencies should require institutions that receive support for graduate education to develop policies mandating that these data be collected and made widely available in order to qualify for traineeships, fellowships, and research assistantships.

Breaking Through and Out of the Postdoctoral Rut

After finishing Ph.D. programs, many young biomedical and behavioral scientists go on to postdoctoral positions for further scientific training, and here the current system also falls short — a subject examined in *The Next Generation of Biomedical and Behavioral Sciences Researchers: Breaking Through*. One of the biggest challenges is the gulf between the growing number of young scientists who are qualified for and interested in becoming academic researchers, and the limited number of tenure-track research positions available. Postdocs often pursue training experiences expecting that they will later secure an academic position, rather than pursuing training that helps them compete for a range of careers outside of academia, where the majority will be employed. Those who are able to transition into independent research positions are doing so later: The average age for securing a first major NIH independent grant is 43 years old, compared with 36 years old in 1980.

As with graduate students, postdocs and prospective postdocs need better information to help them make career decisions, the report says. Research institutions should collect, analyze, and disseminate comprehensive data on outcomes, demographics, and career aspirations of doctoral students and postdoctoral researchers in the biomedical and behavioral sciences. To incentivize compliance, NIH should require the collection and publication of this data to qualify for further NIH funding — a requirement that should be phased in over five years.

The report recommends that Congress consider increasing NIH's budget to enable it to more robustly support early-career researchers — for example, by expanding existing awards or creating new competitive awards for postdoctoral and early-career researchers to establish and advance their own independent investigations. It also recommends the creation of more research scientist jobs at universities and research institutes — jobs that would be permanent but non-faculty positions, would provide reasonable salaries and benefits, and would offer an additional career pathway and off-ramp from today's temporary and low-paid postdoctoral fellowships. In addition, after conducting pilot studies to assess the impacts of the policy, NIH should phase in a cap on the number of years of support that postdoctoral researchers can receive from NIH research project grants.

To promote sustained change, the report also urges Congress to establish a Biomedical Research Enterprise Council — a public-private partnership of stakeholders to provide collective guardianship of the research enterprise and address ongoing challenges confronting the next generation



of biomedical and behavioral scientists. The council would function as a forum for sustained coordination, problem-solving, and assessment of progress toward the recommendations in the report.

“Our recommendations seek to put in place the structures and conditions for sustained change — so that the need for episodic reports starts to fall away, replaced instead by ongoing, enduring policy change across the [research] enterprise,” said Ron Daniels, president of Johns Hopkins University, and chair of the committee that wrote the report. — *Sara Frueh*

Graduate STEM Education for the 21st Century (2018, 202 pp., ISBN 978-0-309-47273-9) is available from the National Academies Press, tel. 1-800-624-6242; \$55.00 plus \$7.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/25038>. The study was sponsored by the National Science Foundation, Burroughs Wellcome Fund, Institute of Education Sciences, and Spencer Foundation.

The Next Generation of Biomedical and Behavioral Sciences Researchers: Breaking Through (2018, 192 pp., ISBN 978-0-309-47137-4) is available from the National Academies Press, tel. 1-800-624-6242; \$50.00 plus \$7.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/25008>. The study was sponsored by the U.S. National Institutes of Health and the Bloomberg Philanthropies.

There is limited but promising evidence that a variety of positive learning outcomes are associated with some integrative approaches — including improved written and oral communication skills, content mastery, problem-solving, teamwork skills, ethical decision-making, and the ability to apply knowledge in real-world settings, the report says. Surveys show that these skills are valued both by employers and by higher education institutions.

“Public discourse has increasingly reflected a tension about whether higher education should be focused primarily on developing practical workforce skills or more broadly on fostering an enlightened, engaged citizenry,” said David Skorton, secretary of the Smithsonian Institution, and chair of the Academies’ study committee. “But evidence suggests that integrating the STEM fields with the arts and humanities is linked to learning outcomes that support both of those goals, and that serve students well in many aspects of life.”

While the current evidence base is limited, it is sufficient to recommend that colleges and universities support courses and programs that integrate these fields, the committee concluded. Individual departments and schools, campus-wide teams, and campus-employer collaborators should consider developing and implementing new integrative programs, which should include a strong evaluation component, including longitudinal studies of student outcomes, to measure the effect of these programs on student learning and workforce readiness.

Both graduate and undergraduate programs should consider integrative coursework, the report says. Preparing the next generation of students to solve the increas-

ingly complex problems of the 21st century may necessitate a shift toward integration. Established integrative fields — such as bioethics; sustainability; and science, technology, and society — offer models of successful approaches.



Professional societies in the sciences, humanities, arts, medicine, and engineering have a role to play as well, the report notes. They should work together to build and study integrative pilot programs to support student learning and innovative scholarship at the intersection of disciplines.

— Sara Frueh

The Integration of the Humanities and Arts With Sciences, Engineering, and Medicine: Branches From the Same Tree (2018, 282 pp., ISBN 978-0-309-47061-2) is available from the National Academies Press, tel. 1-800-624-6242; \$70.00 plus \$7.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/24988>. The study was sponsored by the Andrew W. Mellon Foundation, National Endowment for the Humanities, National Endowment for the Arts, and the Scientists and Engineers for the Future Fund of the National Academies’ Presidents’ Committee.

Helping All Children

BETTER PROGRAMS AND SERVICES



A new report from the National Academies of Sciences, Engineering, and Medicine reviews federal, state, and local programs and services that support children with disabilities and their families in a range of areas, such as health care, school-based special education, transition to adulthood, vocational rehabilitation, and community living.

While a variety of services and programs exist, coordination of care within and across service sectors and a focus on achieving specific goals that help prepare these children for adulthood are integral to encouraging healthy growth and development, the report says.

Children with disabilities share many of the same needs, regardless of which health conditions they have; therefore, the committee that wrote the report used a non-disease-specific approach to assessing programs and services designed to improve children's outcomes. The life-course perspective acknowledges that early experiences impact later experiences and long-term outcomes, so it is important that near- and long-term goals are linked to the attainment of desired outcomes and that services are individualized based on an assessment of the child's and family's specific needs. Several other characteristics contribute to the effectiveness of these programs and services, as well, such as engaging children and families in their care, helping them navigate and connect with the array of available supports, and conducting rigorous, systematic evaluation and continuous improvement of services.

A substantial and growing number of children are diagnosed with at least one chronic health condition. Many of these persistent or long-lasting conditions are mild and do not significantly affect a child's ability to develop age-appropriate skills or complete the expected and preferred activities of daily life. However, many others are associated with disabilities that interfere with school, family, or community activities, play or leisure, and routine daily living. And some conditions affect developmental processes and the attainment of functional skills such that the person's disability will be lifelong.

“As a society, we invest a lot in children and youth, and we should make sure those investments also enable children with disabilities to reach their full potential.”

Reach Their Full Potential

FOR CHILDREN WITH DISABILITIES

Various gaps and limitations create barriers to access and uneven quality of services, such as socio-demographic and socio-economic disparities, state variation in the implementation of federal programs, fragmentation of services, insufficient workforce capacity and development, lack of preparedness for transitioning to adult services and programs, and breaks in the continuity of care. The report identifies a number of ways to enhance the provision and quality of programs and services to improve health outcomes and functioning for children with disabilities.

“Service fragmentation places a heavy burden on families of children with disabilities who need access to and coordination of high-quality services,” said committee chair Amy Houtrow, associate professor of physical medicine and rehabilitation and pediatrics, University of Pittsburgh, and vice chair of physical medicine and rehabilitation and chief, Division of Pediatric Rehabilitation Medicine, Children's Hospital of Pittsburgh. “Even the most well-resourced and organized families indicate how daunting it is to navigate the various service sectors to ensure that their children get the care they need to thrive. As a society, we invest a lot in children and youth, and we should make sure those investments also enable children with disabilities to reach their full potential.”

Looking at the evidence base for programs and services aimed at improving outcomes for children with disabilities, the committee noted it is limited because of a number of factors, such as minimal longitudinal data on health and functioning outcomes, a lack of rigorous evaluation



of existing programs and services, and the inability to isolate impacts when children use different programs and services over time as their needs evolve. The committee outlined opportunities to improve the collection and sharing of data and to inform future research efforts on trajectories, outcomes, and interventions, in order to develop innovative and collaborative approaches for promoting healthy growth and development for children with disabilities and supporting their families. — *Dana Korsen*

Opportunities for Improving Programs and Services for Children With Disabilities (2018, 350 pp., ISBN 978-0-309-47224-1) is available from the National Academies Press, tel. 1-800-624-6242; \$75.00 plus \$7.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/25028>. The study was sponsored by the U.S. Social Security Administration.

Sexual Harassment in Academia



A Change in Culture and Climate Is Needed

Over the past year, the #MeToo movement has spurred a national conversation and drawn attention to the personal and professional harm that sexual harassment causes women. The movement also drew public attention to a National Academies study that had begun under quieter circumstances the year before — an in-depth look at sexual harassment of women in academic science, engineering, and medicine. “When we started, we knew the eyes of the sciences, engineering, and medical communities would be upon us,” said study director Frazier Benya. “What

we didn’t know was that the eyes of the nation would be on this study.”

The study committee’s report, released in June 2018, found that sexual harassment is common in academic sciences, engineering, and medicine — as it is in academia generally. In a survey that the University of Texas conducted among its graduate and undergraduate students, for example, about 20 percent of female science students, more than 25 percent of female engineering students, and more than 40 percent of female medical students experienced sexual harassment from faculty or staff. The Pennsylvania

State University System conducted a similar survey and found similarly high rates of harassment across disciplines. Among faculty, the best available study to date indicated that 58 percent across all disciplines have experienced sexual harassment.

This harassment has serious impacts on women's lives and careers. When women experience sexual harassment in the workplace, their job satisfaction, productivity, and performance decline, their job stress increases, as does their risk of withdrawing from the organization — either by quitting or by becoming less engaged. When students experience sexual harassment, the educational outcomes include greater truancy, dropping classes, receiving lower grades, or dropping out.

One barrier to preventing sexual harassment and its resulting damage is that the most common type of sexual harassment — gender harassment — often goes unrecognized and unaddressed, the report says. When most people think of sexual harassment, they think of unwanted sexual attention or sexual coercion — granting favorable professional or educational treatment on the condition of sexual activity. There is less awareness of gender harassment — behavior that conveys sexist hostility, such as insulting remarks about women, and sexually crude terms that denigrate people based on their gender.

Leaders in academia should pay more attention to gender harassment and enact policies that cover it, the committee recommended. Doing so would also help prevent other types of harassment, since sexual coercion and unwanted sexual attention nearly always occur in environments where gender harassment is already pervasive.

Together We Can Do Better



A National Convocation for Leaders in Academia on Preventing Sexual Harassment

On Nov. 9, 2018, join the National Academies of Sciences, Engineering, and Medicine for a convocation on developing and implementing policies, procedures, and practices to prevent sexual harassment in academia. Building on the recommendations in *Sexual Harassment of Women: Climate, Culture, and Consequences in Academic Sciences, Engineering, and Medicine*, this event will bring together academic leaders, Title IX and diversity officers, ombudsmen, researchers in sexual harassment, and leaders from professional societies, foundations, and federal agencies to discuss strategies and share promising practices. Learn more and register at togetherwecandobetter.eventbrite.com.



Sexual harassment often occurs against a backdrop of generalized incivility and disrespect, and it is less likely to occur when organizational systems and structures support diversity, inclusion, and respect.

Another hurdle is that institutions' policies and practices tend to be overly focused on avoiding legal liability and on symbolic compliance with the law, rather than on actually preventing sexual harassment. As a result, sexual harassment has not significantly decreased, even though policies and practices to address it have been in place for many years.

Given that current policies haven't been effective, the report recommends a new, evidence-based approach to preventing sexual harassment — one that focuses on shifting the culture and climate in academia. Sexual harassment often occurs against a backdrop of generalized incivility

and disrespect, and it is less likely to occur when organizational systems and structures support diversity, inclusion, and respect. Colleges and universities should work to create diverse, inclusive, and respectful environments where these values are integrated into structures, policies, and procedures. Institutions should also take explicit steps to achieve greater gender and racial equity in hiring and promotions — actions that will improve the representation of women at every level. And they should combine anti-harassment efforts with civility promotion programs.

In addition, colleges and universities need to make clear to their communities that those who harass others will be held accountable, the report says. Academic institutions should develop and communicate clear policies on sexual harassment and standards of behavior that include a range of plainly stated and escalating disciplinary consequences for perpetrators found to have violated the policy. And they should provide support for the targets of sexual harassment by conveying that reporting such harassment is an honorable and courageous action, by providing less formal ways of reporting sexual harassment, and by providing targets of harassment with ways to access support services such as health care and legal services. Institutions should also develop ways to prevent retaliation against those who report harassment. — *Sara Frueh*

Sexual Harassment of Women: Climate, Culture, and Consequences in Academic Sciences, Engineering, and Medicine (2018, 312 pp., ISBN 978-0-309-47087-2) is available from the National Academies Press, tel. 1-800-624-6242; \$55.00 plus \$7.50 for single copies; also on the Internet at <www.nap.edu/catalog/24994>. The study was co-chaired by Paula A. Johnson, president of Wellesley College, and Sheila E. Widnall, Institute Professor and Professor of Aeronautics and Astronautics at the Massachusetts Institute of Technology. The study was sponsored by the National Science Foundation, NASA, National Institutes of Health, National Institute of Standards and Technology, National Oceanic and Atmospheric Administration, Burroughs Wellcome Fund, Henry Luce Foundation, and Howard Hughes Medical Institute.



Scientific Progress or Security Threat?

**EXAMINING LEVELS
OF CONCERN
WARRANTED FOR
ADVANCES IN**

**Synthetic
Biology**

Over the past several decades, the ability to re-engineer existing organisms and to potentially create new ones not found in nature has accelerated. Synthetic biology — a field that creates the technologies that enable the design of such novel organisms — is being pursued overwhelmingly for beneficial purposes such as treating diseases, improving agricultural yields, and mitigating pollution. Even though the contributions synthetic biology can make to the society hold great promise, it is also possible to imagine harmful applications that could be used to threaten military personnel and U.S. citizens.

A new report by the National Academies of Sciences, Engineering, and Medicine says synthetic biology does expand the possibility of creating new weapons — including more virulent bacteria and viruses — while decreasing the time required to engineer them. The U.S. Department of Defense should monitor new developments in this emerging scientific and technological field, as some malicious applications of synthetic biology may not seem plausible right now, but they could become achievable with future advances.

“In and of itself, synthetic biology is not harmful,” said Michael Imperiale, Arthur F. Thurnau Professor of Microbiology and Immunology at the University of Michigan and chair of the study’s committee. “The level of concern depends on the specific applications or capabilities that it may enable. The U.S. government should pay close attention to this rapidly progressing field, just as it did to advances in chemistry and physics during the Cold War era.”

In its interim report, the committee created a framework to identify and prioritize areas of concern with the field and to help biodefense analysts as they consider the current and future capabilities. The framework is designed to assess what can be done with biotechnology tools in order to evaluate the dangers that exist, examine the implications of the new tools and capabilities, and understand how numerous technologies compare with and complement one another. In its final report, the committee refined and used this framework to analyze possible capabilities enabled by synthetic biology and the vulnerabilities that may result. The analyses were based on the availability and ease of use of technologies, the challenges of producing an

effective weapon, the expertise and resources required to carry out an attack, and proactive and reactive measures that may be taken to attenuate the effects of an attack.

The committee ranked the synthetic biology capabilities from highest to lowest level of concern. For example, re-creating pathogenic viruses and making existing bacteria more dangerous are some of the relatively higher-level concerns identified in the report, while re-creating known pathogenic bacteria is currently of lower concern compared with most of the other capabilities analyzed.

The report also notes that although many of the traditional approaches of chemical and biological defense will be relevant to synthetic biology-enabled threats, synthetic biology will introduce new challenges. The Defense Department and its partners should continue exploring strategies that can be applied to a wide range of threats now and in the future. The department should also consider evaluating how the public health infrastructure needs to be strengthened to adequately recognize a potential attack.

“It’s impossible to predict when specific enabling developments will occur; the timelines would depend on commercial developments as well as academic research, and even converging technologies that may come from outside this field,” added Imperiale. — *Margaret McCarthy & Riya V. Anandwala*

Biodefense in the Age of Synthetic Biology

(2018, approx. 234 pp., ISBN 978-0-309-46518-2) is available from the National Academies Press, tel. 1-800-624-6242; \$70.00 plus \$7.50 for single copies; also on the Internet at <www.nap.edu/catalog/24890>. The study was sponsored by the U.S. Department of Defense.

Tracking an Elusive Greenhouse Gas

TOWARD BETTER ESTIMATES OF METHANE EMISSIONS

Second only to carbon dioxide in its contribution to climbing global temperatures, methane is a potent greenhouse gas that is on the rise. Unlike many other greenhouse gases, methane does not have a single dominant source. It is generated naturally by wetlands, coastal oceans, wildfires, and geologic sources, and many human activities produce the gas as well — such as petroleum and gas systems, livestock and manure management, landfills, and coal mines — and account for an estimated 60 percent of the global methane emissions.

The measurement, monitoring, and estimation of methane emissions caused by human activities inform policy proposals aimed at limiting greenhouse gases. Individual facilities or companies use inventories for corporate sustainability reporting and to make informed invest-

ment and risk decisions. It is also important to monitor methane to protect the health and safety of workers in industries such as coal mining, where high concentrations can lead to dangerous conditions. It is difficult, however, to keep track of this short-lived gas, which migrates readily, combusts easily, oxidizes chemically in the atmosphere, and oxidizes biologically via both aerobic and anaerobic pathways.

A new report from the National Academies says the United States should take bold steps to improve the accuracy of inventories of methane emissions caused by human activities. There are two main approaches to estimate these anthropogenic emissions. The top-down approach uses observations of atmospheric methane concentrations and models that simulate their transport from the source to the observation location. Aircraft, surface, and tower

and satellite remote sensing take these measurements. The bottom-up approach measures emissions at the scale of individual methane emitters, such as natural gas wells, landfills, or cattle farms.

Ideally, top-down and bottom-up approaches can be tested against each



other to obtain an accurate measure of methane emissions, but comparing the two sets of data is challenging because they are collected at different spatial and temporal scales. In some cases, these two methods produce significantly different estimates due to factors such as missing emission sources or problems with atmospheric sampling. The report recommends a national research effort to strengthen and link these two approaches to improve accuracy, better attribute emissions to specific sectors and processes, and detect trends.

In the United States, the Greenhouse Gas Inventory (GHGI) serves as the main source of anthropogenic greenhouse gas emissions information, with emissions reported at national, annual scales using

the bottom-up approach. Currently, however, this inventory cannot be independently tested against top-down measurements due to missing spatial and temporal data.

To complement the GHGI, the report recommends that the U.S. establish and maintain a gridded inventory to combine estimates of the quantity of methane emitted with data about the location and timescale to better characterize and compare inventories and test against top-down emission estimates. This inventory of U.S. methane emissions must be testable using atmospheric observations and updated on a regular basis.

The past two decades have produced significant improvements in methodologies and understanding. To further ensure progress and use of new advances in the science, the report stresses that it is important to keep practices consistent with the best scientific understanding and current engineering practice. An advisory group led by the U.S. Environmental Protection Agency and the National Oceanic and Atmospheric Administration and comprising experts from academia, industry, policymaking and other federal agencies, and nongovernmental organizations should be established to incorporate the latest science into the GHGI and regularly review methane inventory methodologies. — *Jennifer Olson*

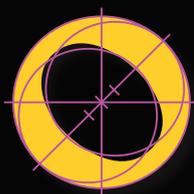
Improving Characterization of Anthropogenic Methane Emissions in the United States

(2018, 250 pp., ISBN 978-0-309-47050-6) is available from the National Academies Press, tel. 1-800-624-6242; \$90.00 plus \$7.50 for single copies; also on the Internet at <www.nap.edu/catalog/24987>. James W.C. White, professor of geological sciences, University of Colorado, Boulder, chaired the study, which was sponsored by the EPA, DOE, NOAA, and NASA.



Unlocking the Scientific Mysteries of Our Universe

THE BENEFITS OF A U.S. ELECTRON-ION COLLIDER



Our understanding of protons and neutrons — the building blocks of an atom — has advanced dramatically in recent years, yet much about their complex nature remains a mystery.

An electron-ion collider (EIC) — a very large particle accelerator — would help deepen our understanding of the atoms that make up all visible matter and could address many compelling scientific questions about the universe, says a new report by the National Academies of Sciences, Engineering, and Medicine. Moreover, such a facility would not only have an impact on

the nation's science- and technology-driven economy but also maintain U.S. leadership in nuclear physics and in collider and accelerator technologies.

In the investigation of quarks and gluons — the tiny particles that bind neutrons and protons — an EIC would reveal fundamental findings about their location, how they move, and how they interact. The accelerator is needed to conclusively answer three profound scientific questions about the universe: the origin of an atom's mass, the role of gluons in nuclei, and the origins of neutrons' and protons' spin — a fundamental property that makes magnetic resonance imaging possible.

An electron-ion collider would help us deepen our understanding of the atoms that make up all visible matter and could address many compelling scientific questions about the universe.

“An EIC would be the most sophisticated and challenging accelerator currently proposed for construction in the U.S. and significantly advance accelerator science, and more specifically collider science and technologies, here and around the world,” said Gordon Baym, co-chair of the Academies’ committee that undertook the study and Center for Advanced Study Professor Emeritus, George and Ann Fisher Distinguished Professor of Engineering Emeritus, and a research professor at the University of Illinois at Urbana-Champaign. “The realization of an EIC is absolutely crucial to maintaining the health of the field of nuclear physics in the U.S. and would open up new areas of scientific investigation.”

A new accelerator facility like the EIC will have capabilities beyond previous electron scattering machines around the world, the report says. High energies and luminosities — the measure of the rate at which particle collisions occur — are required to achieve the fine resolution needed, and to reach such intensities and energy levels requires a collider where beams of electrons smash into beams of protons or heavier ions. Comparing all existing and proposed accelerator facilities around the world, the committee concluded that an EIC with high energy and luminosity, and highly polarized electron and ion beams, would be unique and in a

position to greatly further our understanding of visible matter.

Currently, the Brookhaven National Laboratory (BNL) in Long Island, New York, has a heavy ion collider and the Thomas Jefferson National Accelerator Laboratory (JLab) in Newport News, Virginia, has a heavy electron collider, and both labs have proposed design concepts for an EIC. The EIC is the only high-energy collider being planned for construction in the U.S., and taking advantage of existing facilities would make development of an EIC cost-effective and reduce any associated risks that come with building a large accelerator facility, the report says.

To fully realize the scientific opportunities an EIC would enable, the report also emphasizes the importance of building a theory program to predict and interpret the experimental results within the context of quantum chromodynamics — the theory of strong interaction between quarks and gluons.

“The science that an EIC would achieve is simply unique,” said committee co-chair Ani Aprahamian, Freimann Professor of Experimental Nuclear Physics at the University of Notre Dame, “and [it] would ensure U.S. leadership in nuclear science as well as the accelerator science and technology of colliders around the world.”

— *Riya V. Anandwala*

An Assessment of U.S.-Based Electron-Ion Collider Science (2018, 152 pp., ISBN 978-0-309-47856-4) is available from the National Academies Press, tel. 1-800-624-6242; \$70.00 plus \$7.50 for single copies; also on the Internet at <www.nap.edu/catalog/25171>. The study was sponsored by the U.S. Department of Energy.



THE POTENTIAL BENEFITS OF

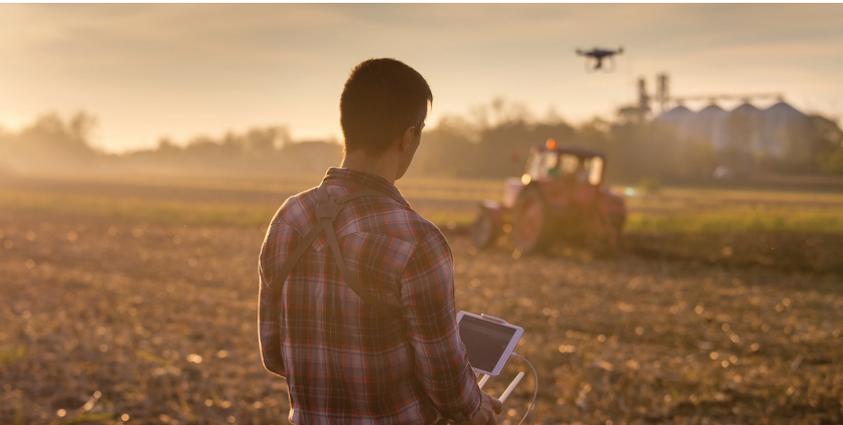
Drone Technology

Earlier this year, a drone designed to spot sharks in the waters off New South Wales, Australia, was used instead to save two swimmers who had been caught in rough water. Lifeguards deployed a drone to drop an inflatable device to the swimmers. In what would usually be a time-consuming and potentially dangerous rescue, the use of the drone quickly and efficiently helped the swimmers. Many examples like this one have brought into focus the potential societal benefits of drones. The last few decades have also seen remarkable advancements in drone technology, making them smaller, faster, cheaper, and more adept to take on a larger role in the nation's airspace.

However, the Federal Aviation Administration's overly cautious approach to safety risk assessments tends to overestimate

the likelihood and severity of risks from drones, says a new report from the National Academies of Sciences, Engineering, and Medicine. The "fear of making a mistake" drives a risk-averse culture at the FAA regarding drones, despite the unmanned aircraft systems (UASs) not posing a direct threat to humans in the same way as their manned counterparts. Even with their potential safety benefits, drones have been prevented from entering the airspace because of the FAA's safety risk approach, which was developed over many years for traditional aircraft. The report outlines several recommendations to optimize drones' advantages and allow for their expanded use in the future.

"FAA needs to accelerate its move away from the 'one size fits all' philosophy for UAS operations," said George Ligler, proprietor of GTL Associates and chair of



The “fear of making a mistake” drives a risk-averse culture at the FAA regarding drones, despite the unmanned aircraft systems not posing a direct threat to humans in the same way as their manned counterparts.

the study committee. “The FAA’s current methods for safety and risk management certainly ensure safety within the manned aircraft sector, but UASs present new and unique challenges and opportunities, which make it important for the agency to take a broader view on risk analysis.”

For safety risk assessments, the report says, the FAA should approach requests for operations approval with an attitude of “How can we approve this?” The FAA does not currently have the same depth and breadth of specific expertise for drone operations as it does for manned ones, making it difficult to properly assess and manage the safety risks associated with them.

The report also urges the FAA to interpret the threshold of risk that the public is likely to accept for small drones in the same context as other levels of publicly accepted risks for activities such as traveling by car or walking across the street. Not only would a shifted approach help to integrate common small-sized drones, but it would also establish safety standards for UASs beyond those defined in current safety regulations.

Establishing standard guidelines and certification processes in a timely manner would also benefit the FAA, the drone industry, and society, the report says. Current risk assessment methodologies need to evolve toward using quantitative and empirical data when certifying drone operation instead of the presently used qualitative and subjective risk analysis, which complicates the regulation process and stifles the potential use of drones in valuable ways.

Drone technology has advanced greatly over the years and continues to grow at a notable pace. The report argues that having the FAA carry on its risk assessment processes without evolving to acknowledge the potential benefits of drone activities would curb innovation and prevent the many ways drones can help people.

— *Andrew Robinson*

Assessing the Risks of Integrating Unmanned Aircraft Systems into the National Airspace System (2018, approx. 76 pp., ISBN 978-0-309-47750-5) is available from the National Academies Press, tel. 1-800-624-6242; \$45.00 plus \$7.50 for single copies; also on the Internet at <www.nap.edu/catalog/25143>. The study was sponsored by the Federal Aviation Administration.

National Academy of Medicine Launches Public-Private Partnership to Counter Opioid Epidemic

In recognition of the need for a national coordinated and collective response to the epidemic of opioid addiction in the U.S., the National Academy of Medicine (NAM), in partnership with the Aspen Institute, launched a public-private partnership made up of more than 35 organizations representing government, health systems, associations and provider groups, health education and accrediting institutions, pharmacies, payers, industry, nonprofits, and academia. This partnership — the NAM Action Collaborative on Countering the U.S. Opioid Epidemic — is committed to establishing shared priorities, identifying unmet needs, and developing and disseminating evidence-based, multi-sector solutions to reduce rates of opioid misuse and improve outcomes for individuals, families, and communities affected by addiction.

Since 1999, the number of opioid-related deaths — from both prescription opioids and illegal drugs including heroin, fentanyl, and carfentanil — has quadrupled. Driven in large part by the opioid epidemic, drug overdose is the leading cause of accidental death in the U.S., resulting in 170 deaths every day. Addiction and overdose not only destroy individual lives, but erode the health and prosperity of entire families and communities. The economic toll is significant; according to Altarum, the cost of the opioid crisis is estimated to have exceeded \$1 trillion from 2001 to 2017, and is projected to cost an additional \$500 billion by 2020.

“Since it was declared a public health emergency in October 2017, so many

organizations are working around the clock to reverse the opioid epidemic, yet progress has been slow,” said Victor J.

Dzau, NAM president and chair of the collaborative. “The problem is clearly not absence of will, but insufficient alignment and coordination across sectors. The complex drivers of the opioid epidemic make it impossible for any single organization or professional sector to make a significant impact on its own. This one-of-a-kind public-private partnership will bring stakeholders from government, academia, the health care industry, health education, and communities impacted by addiction under the same roof to build collective solutions and accelerate the pace of progress.”

Collaborative members will establish goals and working groups to develop collective strategies in priority areas identified at the first meeting on July 27, such as education and training; prescribing guidelines and evidence standards; treatment and community approaches; communication, culture, and stigma; and research and data. Future activities will include meetings and workshops, expert publications, public engagement strategies, and the development of an information hub to share knowledge and best practices, among other efforts. — *Dana Korsen*



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SOLUTIONS**

For more information, visit www.nam.edu/opioidcollaborative.



An **American** Crisis

The Growing Absence of Black Men in Medicine and Science

Black men are increasingly underrepresented in medical schools and in the medical profession. Although black Americans comprise approximately 13 percent of the population, they make up less than 7 percent of medical students and less than 3 percent of practicing physicians. Moreover, according to the Association of American Medical Colleges, though the proportion of black students in medical schools has increased in the past several decades, the gains are entirely attributable to advances among black women. For example, only 515 black or African-American men matriculated to medical school in 2014 compared with 542 in 1978.

The National Academies of Sciences, Engineering, and Medicine and the W. Montague Cobb/NMA Health Institute jointly convened a workshop in November 2017 that explored the factors contributing to the low representation of black men in the medical profession; current strategies to support entry and passage through educational and career transition points; and how medical schools, philanthropies, and government can support these strategies. In coordination with the release of a summary of the presentations and discussions from that workshop, the National Academies held a briefing with members of the Congressional Black Caucus and staff on May 18, 2018, moderated by Cato Laurencin, University Professor, Van Dusen Distinguished

Professor of Orthopedic Surgery, and director of the Raymond and Beverly Sackler Center at University of Connecticut, who chaired the planning committee for the workshop and is a member of both the National Academy of Engineering and the National Academy of Medicine.

“We contend that the absence of black males in medical schools represents an American crisis that threatens efforts to effectively address health care disparities, and of course, we know that diversity and excellence are intertwined, so this threatens excellence in terms of clinical care,” said Laurencin in his opening remarks.

Other speakers were NAM President Victor J. Dzau, who gave an overview of how these trends threaten the quality of the U.S. health system and underscored NAM’s commitment to supporting strategies to address this topic, as well as Randall Morgan, executive director of the W. Montague Cobb/NMA Health Institute, who summarized the November workshop’s discussions related to the past and current history of black men in medicine and the challenges they encountered along the way.

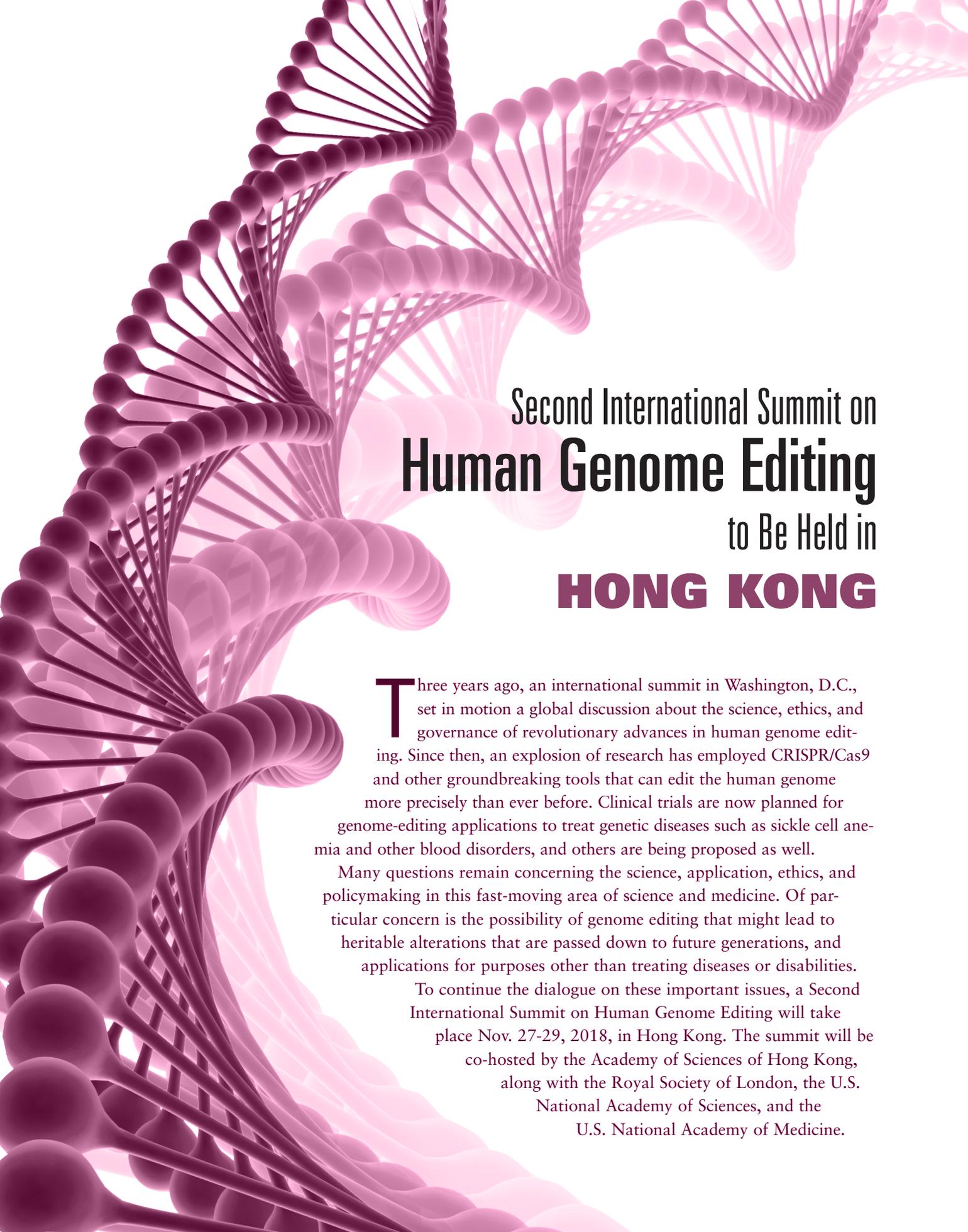
“As I thought about this particular effort to address the absence of black men in medicine and science, I could not help but to reflect on approximately 53 years ago when I came to Washington as a medical student at Howard University,” Morgan said. “The factors that I think led to my success are illustrative of some of the things we’ve lost over the last 50 years and that we must regain, as well as increasing other types of innovations that are much more timely. It is in the nation’s best interest that we report to the legislative branch of our government in general, and specifically, to

the members of the Congressional Black Caucus, that we have studied this problem in great depth and are ready for multi-level action endeavors to solve this problem.”

In addition, NAM member Vivian Pinn, senior scientist emerita at the Fogarty International Center and former director of the Office of Research on Women’s Health in the National Institutes of Health, outlined innovative and exploratory strategies to support entry and passage through educational and career transition points discussed at the workshop. Pinn focused on the importance of having comprehensive “wraparound” programs to address the socio-economic and socio-emotional circumstances of black boys and men from childhood through graduate education as well as strengthening the medical education pipeline by cross-promoting medicine and the sciences within, for example through youth athletic and drama or arts programs.

The members of Congress in attendance, including Rep. Bobby Scott (Va.), Rep. Barbara Lee (Calif.), Rep. G.K. Butterfield (N.C.), and Rep. Eddie Bernice Johnson (Texas), discussed how they envision carrying this issue forward to bring about progress in reversing this trend. — *Dana Korsen*

An American Crisis: The Growing Absence of Black Men in Medicine and Science — Proceedings of a Joint Workshop (2018, 170 pp., ISBN 978-0-309-47690-4) is available from the National Academies Press, tel. 1-800-624-6242; \$50.00 plus \$7.50 shipping for single copies; also on the Internet at <www.nap.edu/catalog/25130>. The workshop was sponsored the Aetna Foundation, Burroughs Wellcome Fund, W. Montague Cobb Institute/NMA Health Institute, Kavli Foundation, National Academy of Medicine, National Institutes of Health, and the Robert Wood Johnson Foundation.



Second International Summit on Human Genome Editing to Be Held in **HONG KONG**

Three years ago, an international summit in Washington, D.C., set in motion a global discussion about the science, ethics, and governance of revolutionary advances in human genome editing. Since then, an explosion of research has employed CRISPR/Cas9 and other groundbreaking tools that can edit the human genome more precisely than ever before. Clinical trials are now planned for genome-editing applications to treat genetic diseases such as sickle cell anemia and other blood disorders, and others are being proposed as well.

Many questions remain concerning the science, application, ethics, and policymaking in this fast-moving area of science and medicine. Of particular concern is the possibility of genome editing that might lead to heritable alterations that are passed down to future generations, and applications for purposes other than treating diseases or disabilities.

To continue the dialogue on these important issues, a Second International Summit on Human Genome Editing will take place Nov. 27-29, 2018, in Hong Kong. The summit will be co-hosted by the Academy of Sciences of Hong Kong, along with the Royal Society of London, the U.S. National Academy of Sciences, and the U.S. National Academy of Medicine.



“Research on human genome editing is moving apace, but there are still many topics that require deeper exploration, including the potential benefits and risks inherent in this research and in possible clinical applications,” said Lap-Chee Tsui, president of the Academy of Sciences of Hong Kong. “We are pleased to host this second summit in Hong Kong, and we look forward to welcoming participants from around the world to continue this critical international discussion.”

“Human genome editing offers much promise for treating or curing devastating genetic diseases, but we have an important responsibility to continue to examine the ethical and societal implications, especially with potential clinical applications just on the horizon,” said Venki Ramakrishnan, president of the Royal Society. “As a co-host of both international summits, we are committed to providing a global forum for consideration of these issues.”

U.S. National Academy of Sciences President Marcia McNutt and U.S. National Academy of Medicine President Victor J. Dzau echoed these sentiments. “We are honored to join our international counterparts in fulfilling our pledge to continue this essential dialogue,” they said. “Given the profound societal implications from the application of these widely available genome-editing tools, diverse stakeholders need to draft ethical guidelines to ensure positive outcomes.”

An international, multidisciplinary program committee has been appointed to plan the November summit, which will be held in the Lee Shau Kee Lecture Centre at the University of Hong Kong. The program committee, which includes representatives

from eight nations, is being chaired by Nobel laureate David Baltimore, president emeritus and Robert Andrews Millikan Professor of Biology, California Institute of Technology, Pasadena.

The summit will bring together a broad range of stakeholders — including researchers, ethicists, policymakers, clinicians, patient and disability groups, and representatives from science and medical academies and organizations worldwide — to examine issues such as:

scientific advances that have been made since the 2015 summit;

progress in the study of non-heritable genome editing to treat diseases;

the state of the science for genome editing in germline cells and the potential for clinical applications;

efforts to address technical challenges identified at the 2015 summit;

prospects for developing international regulatory frameworks;

ethical and societal issues surrounding the pursuit of human genome-editing applications; and

efforts to engage the public.

Those unable to attend in person will be able to view the summit via live video webcast. For more information, visit national-academies.org/gene-editing/2nd_summit/index.htm. — *Molly Galvin*

Building COMMUNITY RESILIENCE

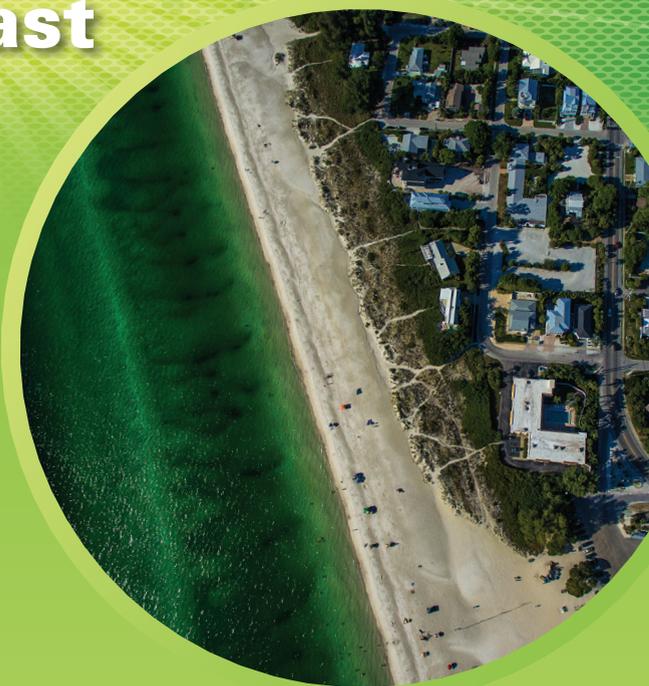


Along the Gulf Coast

The Gulf Research Program (GRP) of the National Academies has served to enhance offshore energy safety, human health, and environmental resources since 2010, following the *Deepwater Horizon* disaster. Among a range of other activities, the program provides grants with the aim of generating long-term benefits for the Gulf of Mexico region, which in turn benefits the nation. In July, GRP announced a \$10 million grant opportunity specifically targeted at enhancing coastal community resilience, enabling residents of the Gulf coast to better prepare and plan for, absorb, recover from, and adapt to stressors from acute and longer-term adverse events.

“Building resilience is a complex challenge, particularly in the coastal Gulf of Mexico region, which faces a multitude of compounding stressors associated with climate change, severe weather, and chronic impacts of environmental degradation,” said Laura Windecker, an associate program officer for the GRP.

To help bridge the gap between the knowledge and practice of community resilience, GRP seeks out research that increases understanding of how community social, health, and economic systems interact and influence



a community’s capacity to thrive, and that provides actionable information and strategies that can be used to implement well-informed policies to enhance resilience.

There is no “one-size-fits-all” solution for building community resilience. By examining the subject in new and interesting ways, the Gulf Research Program is able to create a fuller picture of what works and what does not in resilience-building policies and programs. — *Kacey Templin*

Learn more about these and other activities of the Gulf Research Program at www.nationalacademies.org/gulf.

Pilot Initiative to Identify

NEW VOICES

in Science, Engineering, and Health

The National Academies of Sciences, Engineering, and Medicine are organizing a new initiative to identify exceptional, early-career leaders in the fields of sciences, engineering, and medicine. Through “New Voices in Sciences, Engineering, and Medicine,” they will work to expand the diversity of expertise brought to the Academies’ advisory and convening activities.

Sponsored by the Gordon and Betty Moore Foundation, the initiative selected an initial group of 18 early-career leaders and a senior advisory committee who will meet over a two-year period to discuss important challenges in science, engineering, and medicine. Participants will have the opportunity to attend international events on science policy and communicate and engage with a larger group of young leaders from diverse groups and backgrounds.

The first group of participants is:

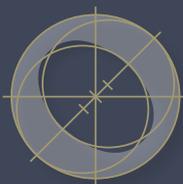
- Olujimi Ajijola** – University of California, Los Angeles
- Joel Baumgart** – University of Virginia
- Asmeret Asefaw Berhe** – University of California, Merced
- Michelle Birkett** – Northwestern University
- Orianna Bretschger** – Aquacycl LLC
- Frances Colón** – Jasperi Consulting
- Tyrone Grandison** – Data-Driven Institute
- Faisal Hossain** – University of Washington
- Colleen Iversen** – Oak Ridge National Laboratory
- Yunyao Li** – IBM Research
- Yan Liu** – University of Southern California
- Ali Nouri** – Federation of American Scientists
- Cynthia Reinhart-King** – Vanderbilt University
- Abhishek Roy** – The Dow Chemical Co.
- Alison Sheets-Singer** – Nike Inc.
- Patricia Silveyra** – University of North Carolina, Chapel Hill
- Lauren Stewart** – Georgia Institute of Technology
- Amos Winter** – Massachusetts Institute of Technology

As part of their participation, each group member will provide a written personal perspective and evaluation of his or her experience, as well as suggestions for future activities. — *Kacey Templin*

Learn more about the initiative at
<www.nationalacademies.org/newvoices>.



NAS Honors 2017 American Nobel Laureates

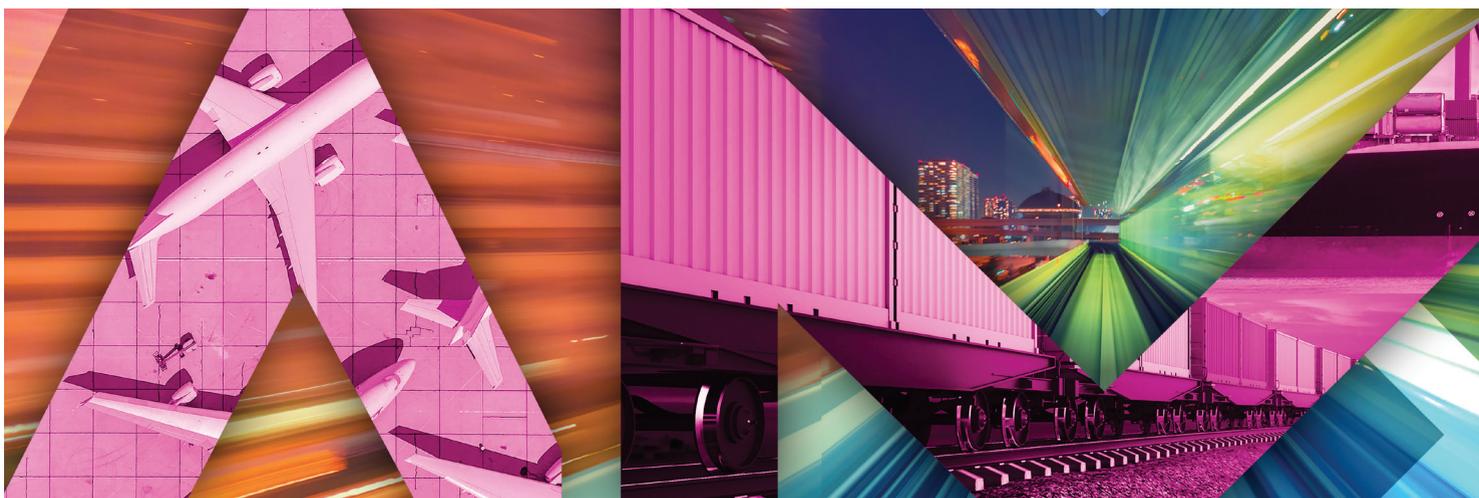


In April 18, 2018, the National Academy of Sciences hosted a reception in the Mansfield Room at the U.S. Capitol to recognize 2017 Nobel Prize winners from the United States. The event is traditionally held at the White House prior to the Nobel award ceremony and is intended to be a celebration of the accomplishments of the laureates. Nobel laureates from 2017 and previous years, as well as scientific leaders, philanthropists, and members of Congress attended the event, as well as the three presidents of the National Academies. Of the eight American Nobel laureates in 2017, five were able to attend the event — Barry Barish, Michael Rosbash, Kip Thorne, Michael Young, and Joachim Frank. Senators Lamar Alexander (R-Tenn.) and Christopher Coons (D-Del.) and National Academy of Sciences President Marcia McNutt gave remarks at the beginning of the reception. The event provided an opportunity to engage and strengthen relationships among legislators and the scientific community.

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