

2021-2022

IMPACT REPORT

Advancing genome engineering to solve humanity's greatest problems

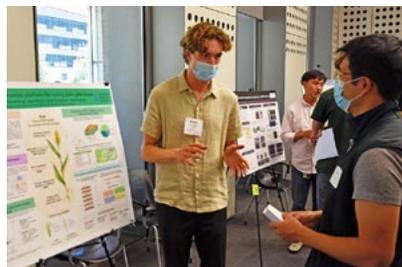


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Photo credits

Dave Savage (p. 4) and Melinda Kliegman (p. 9) by Neil Freese/UC Berkeley
Pam Ronald by Joel Mackendorf/UC Davis (p. 4)
Researchers at CGIAR's International Institute of Tropical Agriculture in Nigeria by Chris de Bode/CGIAR (p. 9)
E. coli bacterium from CDC.gov (p. 9)

LETTER FROM THE EXECUTIVE DIRECTOR

This year marks the 10th anniversary of CRISPR genome editing, a momentous paradigm shift that started right here in Jennifer Doudna's lab at UC Berkeley. The potential of this technology is profound, and just 10 years later, we're already seeing real-world impacts. The IGI is at the epicenter of the CRISPR revolution — and we're just getting started. The first clinical trials using CRISPR are yielding remarkable results, and the number of trials is expanding every year, including a new clinical trial for a genetic immunodeficiency syndrome coming out of IGI research that could lower the barrier for treating many other rare and neglected diseases. The first agricultural products made using CRISPR have recently entered the market. A drought-tolerant rice developed at the IGI is moving into an international field trial and more are on their way.



This is an exciting time to be at the IGI. Our ongoing support for basic research is yielding new genomic tools and approaches, including an entirely new way to study and edit microbiomes and an automated tissue culture facility in our Center for Translational Genomics that will enable massively high throughput editing experiments. We are also continuing to innovate applications in health and agriculture, while adding a new emphasis to our research: climate change. At the IGI, we are committed to using CRISPR to address society's greatest challenges, and climate change is the defining fight of our times. CRISPR is a tool that can help us win this fight by reducing or even eliminating emissions from one of the biggest and most difficult climate problems: the way we grow and produce food.

Our climate research strategy seeks to reduce methane emissions from livestock and rice, create crops adaptable to an increasingly variable climate, and enhance soil fertility on marginal lands all while increasing yields and productivity. One of the first major steps to enact this strategy was made possible with the generous support of a new grant from the Chan Zuckerberg Initiative. We have launched a bold new carbon removal program: a collaborative effort using genomic approaches to enhance the uptake of atmospheric carbon dioxide by crop plants and direct that carbon into stable forms in agricultural soils, where we have lost over 400 gigatons of carbon since the onset of modern agricultural practice.

The focus on real-world impact is a hallmark of IGI programs: we're not satisfied to leave our innovations on the bench. We translate our research into impact through the aid of partner organizations and increasingly by supporting entrepreneurship. The newly launched Women in Enterprising Science (WIES) program is designed to support new ventures from promising scientists, while working to counter gender inequities in biotech. We're extremely excited to launch this program, housed in a brand-new entrepreneurial center at the IGI, and I can't wait to see what the fellows achieve.

None of the innovation at the IGI would be possible with the support of our core staff. As IGI research programs have expanded, we've also grown with new hires in program support, public impact, communications, and facilities — a group who has been very busy renovating our space to maximize lab benches, install new automation, and create beautiful new spaces for research and entrepreneurial fellows. What an amazing year to be part of the IGI!



Brad Ringeisen
Executive Director, Innovative Genomics Institute



IGI BY THE NUMBERS FY 21-22

48 

IGI Principal Investigators

10 

Entrepreneurial Fellows

6 

Research Centers

340 

Publications by IGI PIs

\$49M 

New Gifts

CRISPR TURNS 10



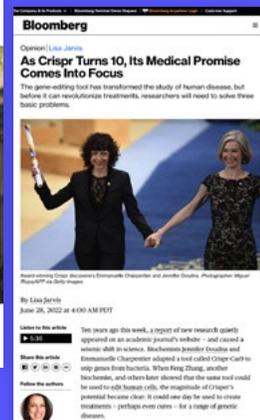
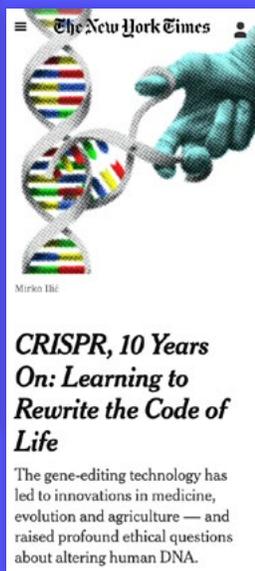
The team behind the original 2012 paper: Emmanuelle Charpentier, Jennifer Doudna, Martin Jinek, Krzysztof Chylinski, and Ines Fonfara. Not photographed: Michael Hauer.

2022 marked a significant anniversary: 10 years since Jennifer Doudna, Emmanuelle Charpentier, and colleagues published the first paper on CRISPR genome editing in *Science*. The IGI was founded just 2 years later, and has been at the epicenter of the development of CRISPR as a tool, and its applications in health and agriculture ever since.

// **The first 10 years were focused on developing CRISPR's capabilities in the lab. The next 10 will be about how we use it to solve real-world problems.**

When the 2012 paper in *Science* was published, there was relatively little reaction right away. That changed quickly as the potential impact became clear. For the full story behind the original paper and where CRISPR research is heading next, [READ MORE >](#)

The CRISPR anniversary was a major media moment for the Institute in 2022. The IGI hosted journalists and film crews throughout the spring and summer, leading to stories in some of the most widely-read news outlets in the world.



CRISPR MEETS CLIMATE CHANGE

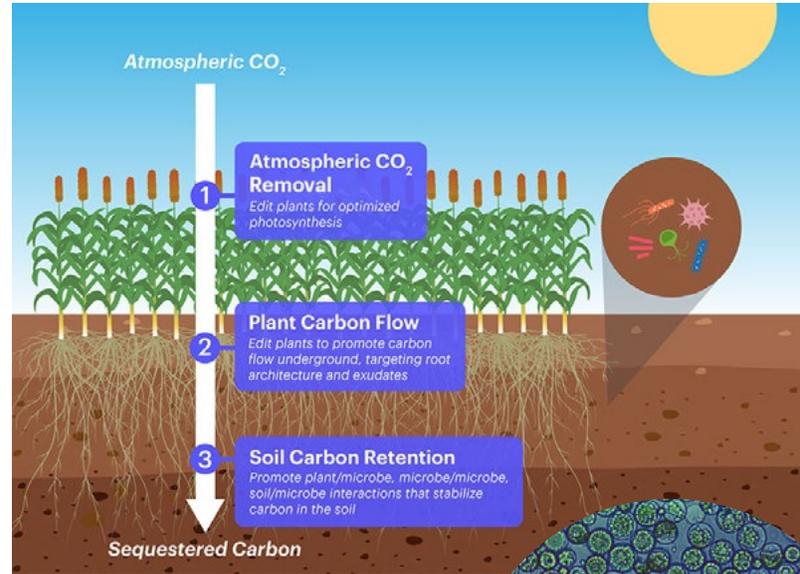


Climate & Sustainable Agriculture

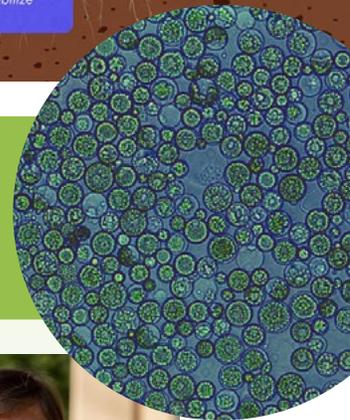
In 2021, the IGI kicked off new projects looking to minimize greenhouse-gas emissions from agriculture. In 2022, IGI researchers took this one step further: we are not just using CRISPR to reduce emissions, but are now harnessing biology to help remove carbon dioxide from the atmosphere.

Until the advent of modern agriculture, global soils were a crucial sink for carbon, but in the last 200 years, soils have lost a massive amount of carbon. With an \$11 million commitment from the Chan Zuckerberg Initiative, the IGI aims to use CRISPR genome editing to enhance the natural ability of plants and soil microbes to capture atmospheric carbon and put it into long-term storage deep in the soil. The IGI team combines world-class experts in microbiology, plant genomics, and synthetic biology for this bold new approach.

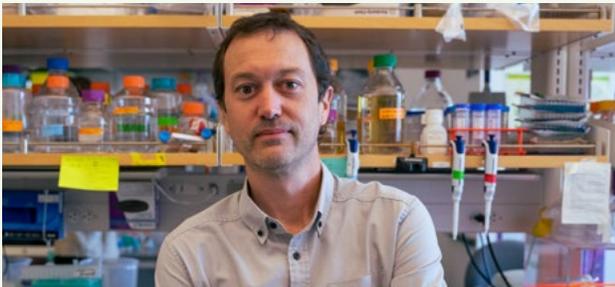
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The Savage lab is developing a new technique to rapidly screen the effects of gene edits on key plant traits using protoplasts, plant cells with the cell wall removed.



Recognition for IGI Researchers Working in Climate & Agriculture



Dave Savage earns prestigious appointment as a Howard Hughes Medical Institute Investigator.

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Pam Ronald wins Wolf Prize in Agriculture, one of the most prestigious awards in the field.

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CRISPR FOR HUMAN HEALTH



Medicine is an area where CRISPR is having an immediate impact. At the IGI, our work on human health starts with discovery of new tools and techniques, and extends all the way to real-world applications. Over the next year, we expect to enroll patients in two clinical trials based on IGI research: one correcting the mutation that causes sickle cell disease, and one that addresses a rare, severe autoimmune condition.

Launching clinical trials is just one measure of the IGI's impact. We are also working on discovering new therapeutic targets for previously untreatable diseases, developing tools to correct imbalances in the microbiome, platform approaches to accelerate CRISPR therapies, and more:

Addressing Severe Immunodeficiency

Combining research and clinical expertise from UCSF and UC Berkeley, a team led by IGI Director of Human Health, Alex Marson, is developing a novel CRISPR therapy for patients with rare genetic immunodeficiency syndromes. This work is moving toward a clinical trial using a new, non-viral approach.

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Refining Cancer Treatment

Using CRISPR-based techniques that turn genes "on" or "off," researchers at IGI and Gladstone Institutes devised a new tool for rapidly discovering genes that play important roles in immune cell biology. The ultimate goal is to advance the growing field of cancer immunotherapies like CAR-T therapy.

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Sickle Cell Therapy 2.0

Sickle Cell Therapy 2.0. Building on the CRISPR-based therapy currently in clinical trials resulting from an IGI/UCSF/UCLA collaboration, IGI is working with the UCLA Broad Stem Cell Research Center to develop a next-generation therapy with enhanced efficiency, safety, cost, and accessibility.

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The newly installed automated tissue culture platform will allow researchers in the Center for Translational Genomics to engineer stem-cell-based disease models at unprecedented scale and speed to facilitate the development of CRISPR-based therapies.

New Capabilities + New People



Alice Reformat — Director of the Center for CRISPR Target Discovery, working to accelerate the treatment and prevention of human disease through interrogation and validation of novel targets.



Dirk Hockemeyer — Associate Professor of Molecular & Cell Biology at UC Berkeley, joined the Center for Translational Genomics (CTG) to use the new automation platform to develop high-throughput methods for developing genomic therapies for rare diseases.



David Nguyen — Assistant Professor of Medicine at UCSF, joined the CTG to develop novel gene-editing technologies for correcting mutations in the immune and blood systems.



Audrey Glynn — Senior Program Manager, Health Portfolio, joined the IGI to provide strategic support across IGI's flagship health projects, including microbiome editing, the Sickle Cell Initiative, and the Affordability Task Force.

COVID & BEYOND

In spring 2020, the IGI quickly built a COVID testing lab from scratch in response to the growing emergency. Since then, the lab has processed over 600,000 tests for the UC Berkeley campus and local community. This new capability — a CLIA-certified clinical lab at the IGI — has spurred us towards new innovation in COVID research and beyond.

Mobile Testing

One of the IGI's core beliefs is that the institute should be a good neighbor in the local community. In addition to working with East Bay partners serving first responders, low-income, and unhoused residents, the IGI partnered with Mobility Health to bring mobile COVID-19 diagnostic testing and wrap-around care directly to farm workers in the Salinas Valley. These workers help feed the whole U.S. and have been especially hard hit by COVID-19.

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Supporting CRISPR Therapies

A key challenge for new CRISPR-based therapies is tracking the success of an experimental treatment: there are no pre-existing tests. Researchers in the IGI Clinical Lab are taking on this challenge, creating a suite of diagnostic tools for monitoring the impact of genome-editing therapies in a range of tissue and cell types, starting with sickle cell disease and other blood disorders.

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COVID Breakthroughs

At the start of the COVID-19 pandemic, the IGI raised funds to support 24 rapid research projects. These projects and their spin-offs continue to bear fruit.

New Therapeutic Approach with Broad Applications. UC Berkeley professor Anders Näär and collaborators developed a new inhaled antisense oligonucleotide therapy that blocks COVID infection in the lungs and could be adapted to other RNA viruses.

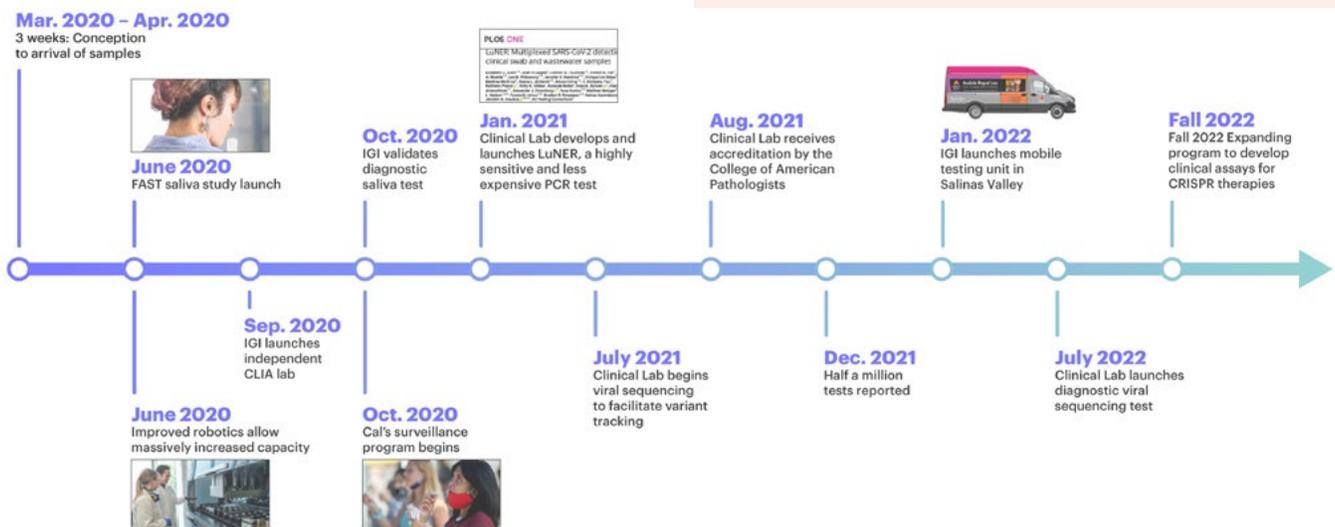
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Studying New Variants Safely. Using an innovative approach developed at the IGI, researchers at UC Berkeley and Gladstone Institutes can quickly and safely test the effects of different mutations in SARS-CoV-2 variants.

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Rapid, Accurate Testing, Anywhere. Rising to the need for innovations in testing for COVID and future pandemics, IGI researchers developed two new rapid point-of-care tests using CRISPR's ability to detect specific genetic sequences.

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ENTREPRENEURSHIP

Bridging the Gender Gap in Biotech

Women are dramatically underrepresented in the biotech space. A 2020 study found that female founders only received 2.3% of biotech venture capital funding. Through the launch of the new **HS Chau Women in Enterprising Science (WIES)** Program, the IGI is supporting budding entrepreneurs whose work involves the development of solutions for some of the world's greatest problems and who strive to develop their ideas commercially for the benefit of the public.

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Jenny Hamilton - WIES Fellow

Targeted in-vivo CRISPR delivery technology



Lin Du - WIES Fellow

Biosensors for precise detection of infectious diseases



Navneet Matharu - WIES Fellow

Therapies for diseases caused by gene dosage effects



The Tory Burch Fellowship at the IGI supports scientists whose work focuses on solutions to global problems, while promoting gender equity in the biotech industry.

Veronika Kivenson, the 2022 Tory Burch Fellow, is developing new microbiome-inspired therapeutics, focused on treating heart disease. [LEARN MORE >](#)



New Targets, New Enterprises

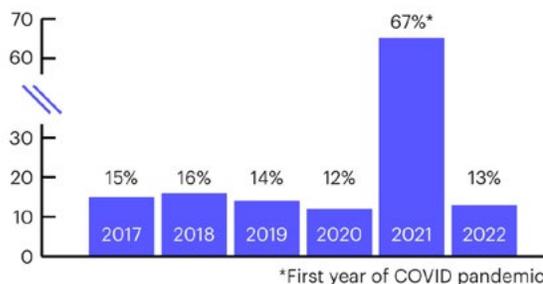
A critical step in developing new CRISPR therapies is finding and validating new targets in the human genome for treating and preventing genetic diseases. With support from Apple Tree Ventures, the IGI supported six projects from researchers at UC Berkeley and UCSF working on disease-related target discovery who are seeking to found companies based on their findings.

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IGI Grows its Portfolio

Worldwide, the University Of California is granted more patents every year than any other university. At UC Berkeley, the IGI is responsible for ~15% of patent applications every year, with a rapidly growing portfolio of innovations with applications in human health, climate and sustainable agriculture, biomanufacturing, and life science research.

IGI Consistently Produces 12-16% of All Invention Disclosures for UC Berkeley



17 New companies founded by IGI associates



1500+ Employees at these companies



\$13.5B Raised

FIELDS: Therapeutics, Diagnostics, Delivery, Agriculture Traits, Gene Editing Tools, Agricultural Waste, Gene Regulation, Cell Therapy, Biomanufacturing

Groundbreaking Discovery Continues at the IGI

Ten years after the development of CRISPR genome editing, IGI researchers continue to expand the genomic toolkit through continued discovery and innovation.

Learning from Viruses

Viruses know how to get into cells — and we can learn from their tricks. IGI researchers in the Doudna lab are using enveloped delivery vehicles (EDVs), particles that recreate the outer shell of a virus but without the virus's genetic material to target specific cells and shuttle CRISPR cargo inside.

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Methane Munchers

The Banfield lab at the IGI recently discovered large DNA elements they are calling Borgs, which appear to reside in methane-eating microbes. Borg DNA contains additional copies of genes needed for breakdown of methane, a key greenhouse gas, and may play an important role in methane metabolism in soils.

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Editing the Microbiome

Communities of microbes that live in the human gut and on the skin play an important role in many diseases. The IGI's new initiative, BiomeForge, supported this year by a \$2.5 million gift from the Shurl & Kay Curci Foundation, is developing tools to both precisely understand the roles these microbes play and edit their genomes. The impact of this work could affect human health at an even greater scale: by addressing the microbial sources of greenhouse gases that contribute to climate change in livestock and soils.

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Spencer Diamond, Ben Rubin, and Brady Cress are collaborating with IGI Founder Jennifer Doudna and IGI Director of Microbiology Jill Banfield on the BiomeForge initiative.



At the IGI, we believe that science should serve the public good. True impact requires incorporating societal, ethical, and environmental considerations into our scientific research. In 2022, we started new ventures aimed at making sure our work can do the most good, for those who need it most.



Melinda Kliegman, IGI Public Impact Director

Tackling the Affordability Crisis

A new IGI task force pulls experts from across research, industry, and government, and is aimed at developing strategies to make genomic medicines affordable.

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Leading on Ethics

The IGI is a central partner to a new campus center for examining the ethical impacts of technological innovations. The Center will connect IGI scientists and the Public Impact team with ethicists, social scientists, and the public for discussions about the potential impacts of scientific discoveries.

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Reducing Global Hunger

A five-year partnership with CGIAR, the world's leading international agricultural research consortium, aims to use CRISPR to improve productivity and climate resiliency of farmers in low- and middle-income countries. The ultimate goal is to improve the wellbeing and livelihoods of individuals in some of the world's poorest communities.

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Training Global Scientists

The IGI is partnering with the African Orphan Crops Consortium, the Seed Biotechnology Center at UC Davis, and the International Institute of Tropical Agriculture, to host a new course on CRISPR genome editing in agriculture in Kenya. The goal is to empower over 80 African scientists to implement genome-editing technologies to fast-track engineering in vital food crops.

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Guiding Big Policy for Small Organisms

Along with the U.S. Department of Agriculture (USDA) and Phytobiomes Alliance, the IGI organized a workshop on genetically-engineered microorganisms, entitled "The Future of Microbial Biotechnology: From Research to Regulation" to help inform regulatory policy on this important but mostly unaddressed topic in the US and around the world.

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OUTREACH & EDUCATION

At IGI, we strive to create a STEM future that is more diverse, welcoming, and inclusive. Our education and outreach work is aimed at supporting a more diverse pipeline of STEM students and researchers, with efforts from local to global in scope.

Agrobacterium

Tipo de bacteria del suelo que puede transferir sus propios genes a las células vegetales e integrarse en sus genomas. A menudo, se usa como una forma de agregar nuevos genes a las plantas de cultivos.

Alelo

Una de varias versiones posibles de un gen. Cada uno contiene una variante distinta en su secuencia de ADN. Por ejemplo, un “alelo perjudicial” es un tipo de gen que puede llevar a una enfermedad.

Expanding our Languages

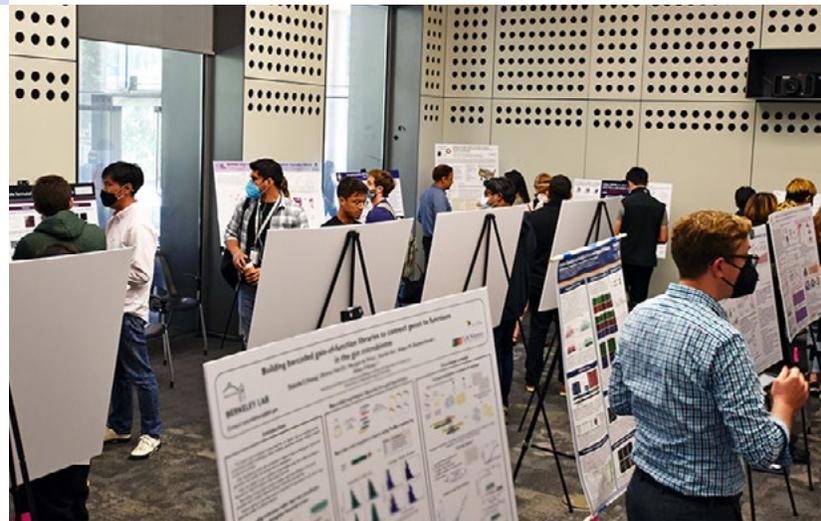
Over the past year, the IGI added full translation in Spanish and Chinese to all of our website pages and released an expanded version of our Illustrated CRISPR Glossary in both English and Spanish.

[EXPLORE THE GLOSSARY >](#)

IGI Opens its Doors

In March 2020, all IGI events moved online. We kept our weekly seminar series running by Zoom, which opened up them to a new global audience. But as an institute fueled by collaboration that cuts across fields, we missed the energy and serendipity that comes from live events. In July, the IGI hosted its first live poster session in over two years. 200 people came out to learn about the research underway at the IGI from 30 presenters covering human health, sustainable agriculture, climate change, the COVID-19 pandemic, and beyond.

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CRISPR Education for All

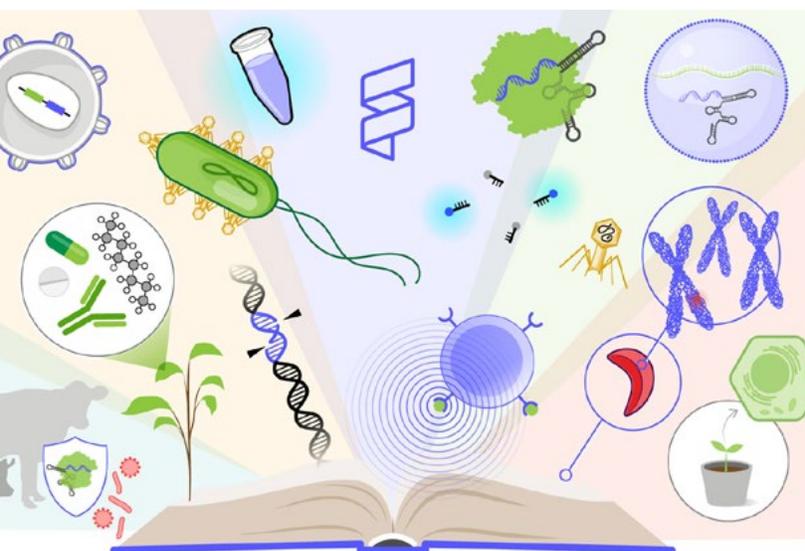
In addition to our research, a core goal of the IGI is to contribute to the scientific community through education, sharing resources, and guiding the ethical use of CRISPR and genomic technologies. Over the past year, we launched two new, totally free resources for people looking to learn (and teach) about genome editing:

[CRISPR MADE SIMPLE >](#)

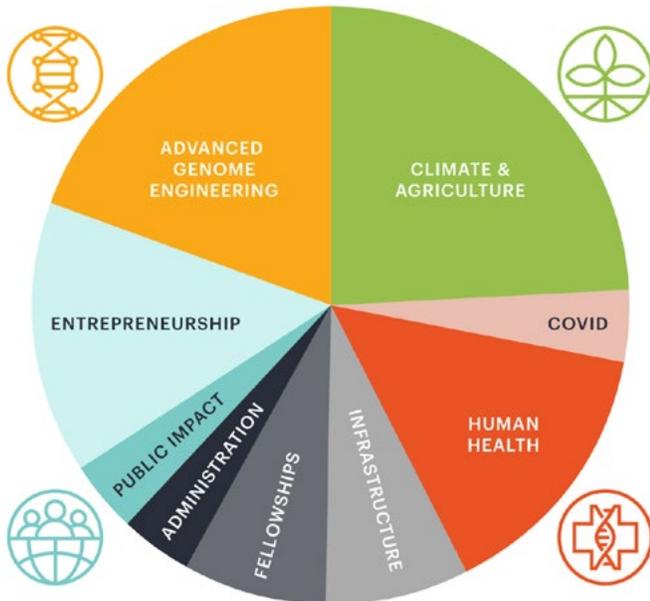
A basic primer on genome editing for younger learners and anyone starting from scratch

[CRISPRPEDIA >](#)

A richly illustrated, textbook-style resource that explains all things CRISPR



A GROWING INSTITUTE



Areas Supported by Gifts to the IGI

Growth Through Gifts

The IGI's continued growth and broad portfolio of research projects is made possible through the generous support of philanthropic organizations and individuals.

New gifts to the IGI supported the launch of the HS Chau Women in Enterprising Science program; funded new research into carbon capture, microbiome editing, and diagnostics; and enabled the construction of new, cutting-edge laboratory facilities and a space for our entrepreneurial fellows. Overall, the IGI raised \$49 million in new funding over the 2021–2022 fiscal year, supporting the full breadth of our work.

Pardon Our Dust — We're Renovating!

As the IGI grows, we are investing in new facilities that expand the unique capabilities of the institute and further our mission to bring genomic innovations from the bench to the clinic and the field. Over the past year, we broke ground on a new entrepreneurial hub with office and lab space for the WIES program fellows (photo below), a state-of-the-art automation facility for the Center for Translational Genomics, and new laboratory spaces for IGI investigators working on rare diseases and microbiome editing. There is only so much growth we can achieve inside our current building: We are also planning for a new facility to support our future growth!





innovativegenomics.org