HBCU-UP: DATA SUMMARY REPORT

2025

TENNESSEE STATE UNIVERSITY

CRISPR Workshop Faculty Post-Survey Results

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Acknowledgements

The information provided within this report is summarized according to the author's understanding of data collected for evaluating the NSF HBCU-UP award (#2205542). The opinions, findings, conclusions, and/or recommendations expressed in this report are those of the author and do not necessarily reflect the view of the National Science Foundation.

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INTRODUCTION

The NSF HBCU-UP grant (#2205542), awarded to Dr. Sonali Roy, funded the development of a CRISPR Cas-based-gene-editing technology curriculum. A key objective of the grant is to expand availability of the curriculum by training 10-12 STEM Biology educators at HBCUs through a workshop. To support this outcome, Tennessee State University and the Center for Genome Editing and Recording (CGER) co-organized[1] the 2025 Inaugural CRISPR Course Workshop. The workshop was co-developed by Jonathan Weissman (CGER Center Director), Sonali Roy (TSU Assistant Professor), Maxine Wang (CGER Program Manager), Masami Hazu (CGER Curriculum/Development Lead), and Mandana Sassanfar (Director of Outreach, MIT) to provide college and high school educators an immersive, week-long, hands-on experience in CRISPR technology.

The curriculum was based on the Innovative Genomics Institute's course, and combined lectures, hands-on labs, and discussions to build foundational knowledge, teach practical laboratory skills, explore real-world applications of CRISPR, and showcase effective teaching strategies. The workshop took place in Cambridge, MA, from July 7th to July 11th, with activities held at the Whitehead Institute and MIT's Building 68 (Figure1).Faculty attendees stayed at the Kendall hotel, walking between their daily sessions located at the Whitehead Institute and MIT's Building 68

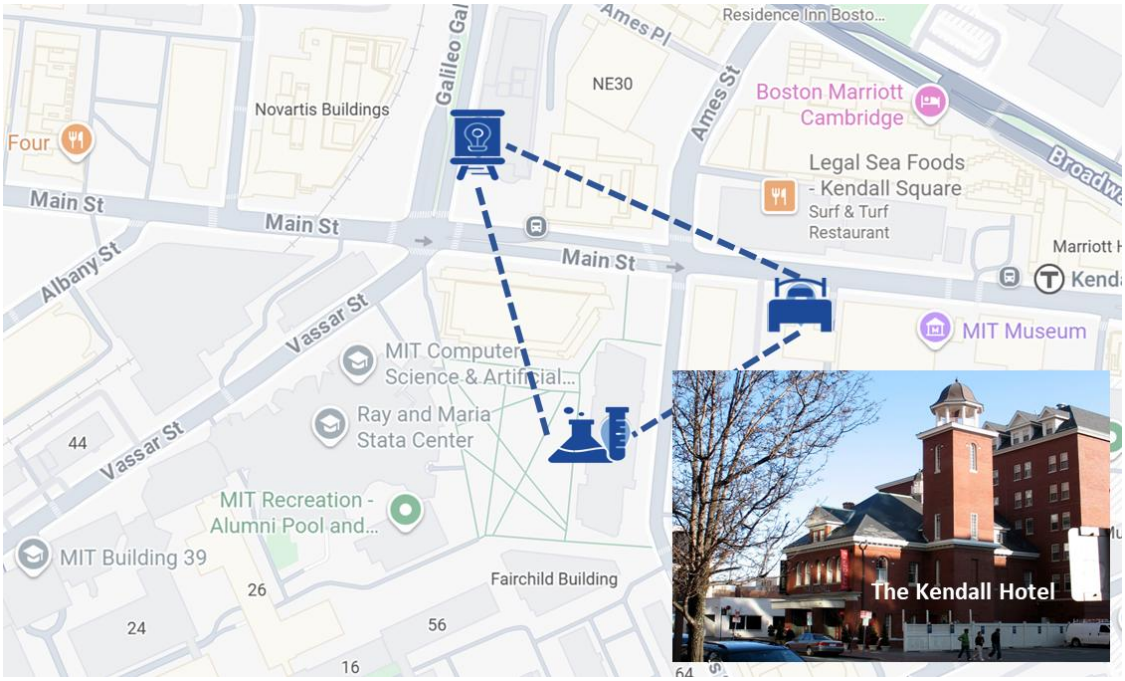
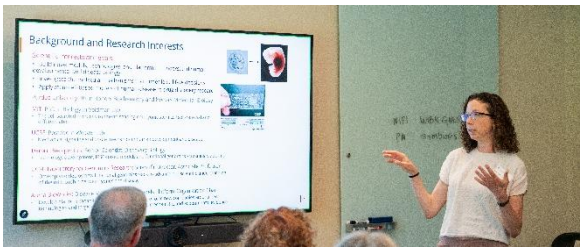


Figure 1. Street map illustrating the key locations for the 2025 Inaugural CRISPR Course Workshop including the Kendall Hotel, the Whitehouse Institute (primary venue for lectures), and MIT Building 68 (where all hands-on lab sessions were held).

[1] Short bios of the organizers and speakers, copied verbatim from the workshop lab manual, are provided in Appendix A.

AGENDA: MONDAY, JULY 07



Introduction to the CRISPR Workshop

Maxine Wang (*Whitehead Institute*);
Sonali Roy (*Tennessee State University*)

The introductory presentation for the 2025 CRISPR Course Workshop was led by workshop organizers Sonali Roy and Maxine Wang. The presentation outlined the workshop's logistics, including seminar locations at the Whitehead Institute and lab sections at MIT Building 68. It also provided information on WiFi access, emergency numbers, and a workshop help-line.

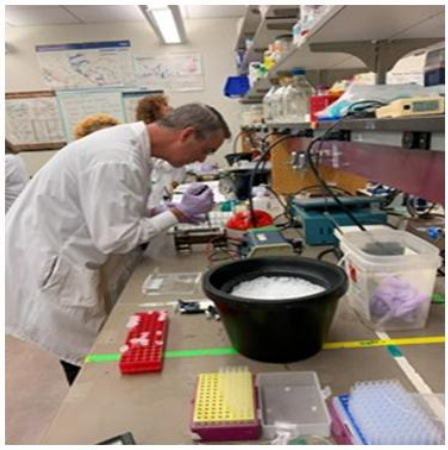
The presentation also featured an overview of the Center for Genome Editing and Recording (CGER) and its partnership with Tennessee State University (TSU). It highlighted a "pipeline for diverse talent," showing a tiered approach from high school students to instructors. Finally, it included a "History of CRISPR" timeline and illustrations of various CRISPR technologies, emphasizing the "CRISPR Revolution".

CRISPR Intro and CRISPR Applications

Laralynne Przybyla (*Arena BioWorks*)

Laralynne Przybyla presented on the use of CRISPR as a tool for drug discovery and disease research. Her career has spanned both academic and industrial settings, with a focus on understanding how tissue mechanics affect development and disease, as well as building cellular models to study human diseases like Alzheimer's and Parkinson's. The core of her presentation was that CRISPR's utility extends far beyond its classic function of cutting DNA. Pryzbyla highlighted the use of deactivated Cas9 (dCas9) to create new applications like CRISPR Interference (CRISPRi), which silences genes, and CRISPR Activation (CRISPRa), which turns them on. Case studies included Frontotemporal Dementia and sickle cell disease, discussing how a CRISPR-based gene therapy called Casgevy works. The speaker argues that many clinical failures are due to a lack of understanding of disease mechanisms and that CRISPR tools in human cell models can accelerate the development of new therapies.

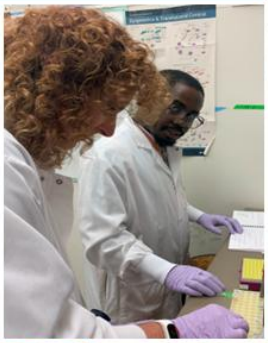


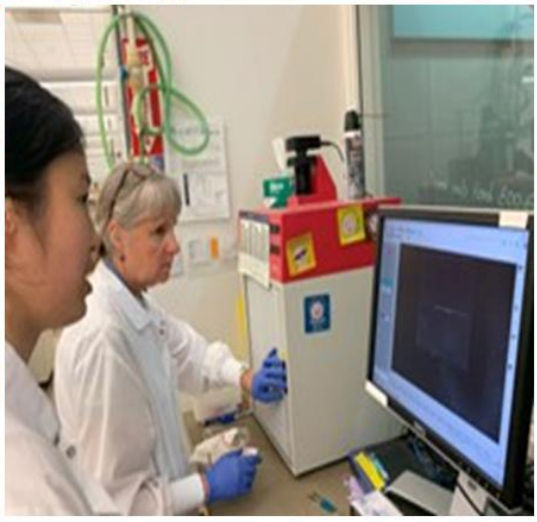



Lab Section - CRISPR Immunity

This lab explores how CRISPR-Cas systems function as a form of adaptive immunity in bacteria. Participants will use *E. coli* engineered to express Cas1 and Cas2 proteins, which acquire viral DNA fragments (spacers) and integrate them into their CRISPR array. The experiment uses PCR and gel electrophoresis to observe this process and identify newly acquired spacers.





Bioinformatics

Sonali Roy (*Tennessee State University*)

Roy's presentation focused on the fundamentals of CRISPR and a practical guide for designing guide RNAs (gRNA) for gene editing in the context of plant biotechnology. The speaker explained that CRISPR is both a location on a bacterial genome and a molecular tool. The presentation defined CRISPR as a form of bacterial adaptive immunity and detailed how Cas proteins and gRNA work together to recognize and cut foreign viral DNA. Key components for using CRISPR as a tool were identified as a Cas enzyme (which requires a PAM site) and a gRNA to direct it. A step-by-step process was outlined for designing gRNA to knock out a gene in plants, using the PDS3 gene in *Arabidopsis thaliana* as a model. This process includes retrieving a gene sequence from the NCBI database, using an electronic lab notebook like Benchling to design and annotate the gRNA, and using an online tool like CRISPR-P to select a guide with high on-target efficiency and low off-target potential. The presenter shared a successful personal experiment where a single gRNA created visually distinct albino *Arabidopsis* plants, demonstrating that students can see the results of their gene editing.

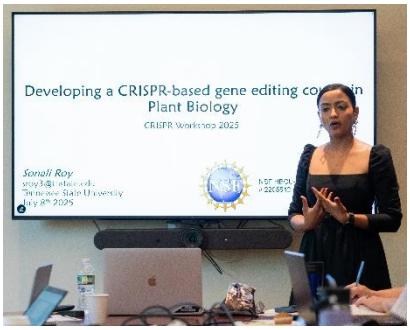
What is Science Communication?

Mary Williams (*American Society of Plant Biology*)

Mary Williams discussed the importance of science communication. She argued that it's crucial for scientists to communicate with the public to inspire the next generation and counter misinformation. She outlined several communication strategies, including using various platforms like social media, telling compelling stories, and making information timely and relevant. She emphasized the importance of being "real" and relatable to build trust with the public, using the "Draw a Scientist" project as an example of how perceptions of scientists can change. Williams highlighted CRISPR as an excellent topic for science communication because of its compelling origin story as a natural bacterial immune system and its wide-ranging applications in both plant and human biology.

Developing a CRISPR-based gene editing course in Plant Biology

Sonali Roy (*Tennessee State University*)



Roy outlined the development of her CRISPR course curriculum for plant sciences, emphasizing the need for a skilled workforce in the growing CRISPR market. The CRISPR course is designed as a 15-week elective for advanced undergraduates and graduate students, with weekly sessions divided between lecture and lab. Roy created the course using a "backward course design" philosophy, defining desired outcomes and using Bloom's Taxonomy to structure learning from basic to higher-level skills. The curriculum includes hands-on labs for designing gRNAs and performing cloning and transformation, and asssessment methods such as electronic lab notebooks, blog posts, and creative assignments like analyzing CRISPR in movies and TV shows. A key goal for students in the course is to produce a basic gene edit that creates a visible phenotype, such as an albino *Arabidopsis* plant. The course also tailors its discussion of ethics to plant research.

Lab Section – Cas9 In Vitro Assay

This section focuses on using the Cas9 enzyme to cut DNA in a test tube. You'll learn how to direct Cas9 to a specific DNA sequence by designing a guide RNA (gRNA). The lab involves creating a Cas9/gRNA complex, introducing target DNA, and then analyzing the resulting DNA fragments using gel electrophoresis to visualize the cleavage.

Engineering stable antibody expression using CRISPR/Cas9-mediated gene integration

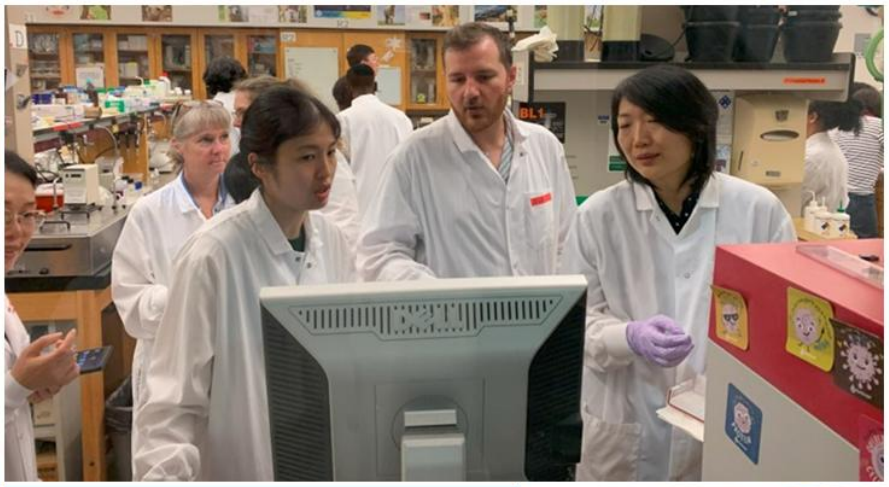
Shelbe Johnson (*Ragon Institute, MIT*)

Shelbe Johnson, an MIT chemical engineering Ph.D. candidate, presented her work on engineering stable antibody expression using CRISPR/Cas9-mediated gene integration. She highlighted CRISPR-Cas9 as a more controlled method for creating stable cell lines that express full antibody genes, which is crucial for accurately comparing the potency of different antibodies. However, she also acknowledged the limitation of CRISPR's low efficiency for integrating large gene segments and discussed her lab's strategies to overcome this, such as adding Cas9 as a pre-made protein and using electroporation. Her research focuses on using high-throughput assays to study antibody function in infectious diseases like influenza, HIV, and SARS-CoV-2.

Improving approaches for altering plant genomes

Mary Gehring (*Whitehead Institute*)

Mary Gehring, a professor at Whitehead Institute, presented on improving approaches for altering plant genomes. She discussed the challenges of traditional plant transformation methods, such as the inefficiency and unpredictability of using *Agrobacterium*. Gehring introduced CRISPR as a tool to address these persistent challenges, allowing for more precise editing compared to older methods. The presenter detailed a specific approach to improve efficiency by designing a guide RNA to cut both the target site and the donor DNA itself, which promotes a more precise repair process called homology-directed repair (HDR). The presentation focused on the broad application of these techniques to address global food security issues and to enable new discoveries in underutilized crops.



Lab Section – Cas9 In Vivo Bacterial Kit

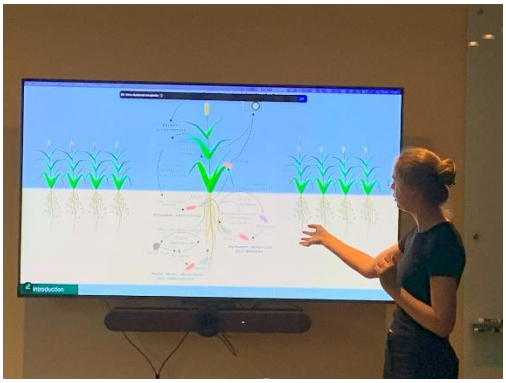
In this lab, you'll move from test tubes to living cells to perform genome editing. Using one of two kits, you'll either insert a gene for a green fluorescent protein (GFP) into *E. coli* to replace a red fluorescent protein (RFP) gene, or insert a stop codon into the *lacz* gene. The goal is to observe a phenotypic change, such as a color change from red to green, or from blue to white, to confirm the successful gene edit.

THURSDAY, JULY 10

CRISPR Technologies: From Bench to Bedside

Wilfredo Garcia-Beltran (Massachusetts General Hospital)

Wilfredo Garcia-Beltran, a physician-scientist, discussed the transformative impact of CRISPR technology across basic science, medicine, and diagnostics. With a background in immunology and clinical pathology, he explained how he uses CRISPR screens to understand the complex interactions between natural killer (NK) cells and cancer cells. Garcia-Beltran highlighted the clinical application of CRISPR in treating sickle cell disease. He concluded his presentation by predicting that CRISPR will also enable faster, more accessible diagnostic tests in the future.



Engineering Plant-Microbe Communication

Alice Boo (*Postdoctoral Researcher*)

Alice Boo presented on engineering plant-microbe communication using synthetic biology. Her work involves using engineered bacteria to sense environmental stimuli and then communicate that information to a plant, which responds with a visible phenotypic change, such as a different color. She explained that this approach is useful because plant engineering is difficult, so they rely on bacteria to perform the complex sensing and computing tasks. She discussed challenges like soil heterogeneity and the need for a more scalable communication system, mentioning a new project that uses peptides to produce a visible purple pigment in the plant.

Whitehead Institute Lab Tour

Lab Section – CRISPR Application Phenotypes

The final section applies CRISPR technology to plant research by focusing on designing and cloning guide RNAs for use in the model plant *Arabidopsis*. Using online tools like CRISPR-P, you'll design gRNAs to target a specific gene, and then use a Golden Gate assembly to clone them for future transformation into plants.

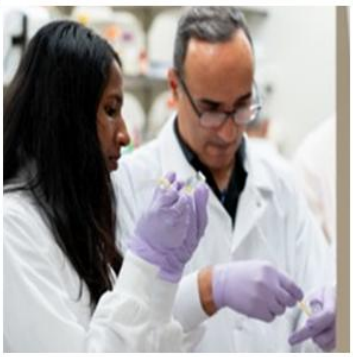


Figure 2. (Top) Photo image of the 2025 CRISPR Workshop organizers and faculty cohort participants. (Bottom) High school teacher participants with speaker Shelbe Johnson.

PARTICIPATION

The workshop brought together a diverse group of participants to engage in hands-on training and discussion. A total of 21 individuals participated, including 8 high school teachers, 11 faculty members from 10 different Historically Black Colleges and Universities (HBCUs), and an additional two attendees from TSU. The primary focus of this report is to detail the experience and impact on the 11 HBCU faculty attendees.

Of the 11 faculty attendees, five were female and six were male. The group's racial and ethnic composition included four Black or African American, six Asian, and one Caucasian participant. The faculty represented a wide range of institutions (e.g., Fayetteville State University, Hampton University, Southern University, Tuskegee University, Winston-Salem State University, Lincoln University, North Carolina State A&T University, Fort Valley State University, Prairie View A&M University, and Spelman College – see Figure 2) and academic disciplines, demonstrating the broad appeal and relevance of the workshop's subject matter.

The academic backgrounds of the faculty were equally diverse, spanning multiple fields, including Animal Science, Plant Genetics, Chemistry/Biochemistry, Biological/Forensic Sciences, Molecular Biology and Agriculture.

Figure 3. Map illustrating locations of participating HBCU's and depicting the collaboration between TSU and Whitehead Institute.

Relevance and Prior Engagement with CRISPR

Prior to attending the workshop, the faculty members' engagement with CRISPR technology varied, with many actively incorporating it into their research and teaching. Several attendees had extensive and sustained experience with CRISPR, with some having used the technology since its early development in 2012. Faculty's experience with CRISPR includes application across a variety of fields, including plant and animal science, cancer research, and addiction studies.

Beyond active research, many participants were already integrating CRISPR into their curricula. Several attendees had incorporated gene editing labs or were supervising undergraduate and graduate students in CRISPR-based research projects. While some participants had not yet used CRISPR extensively, they recognized its significant relevance. Several faculty members saw its value for applications like analyzing soil microbes, while others acknowledged the need to expose students to "more trendy" industry technologies. The overall consensus was that CRISPR is a crucial, modern tool with broad applications across various scientific fields.

DATA COLLECTION

This report summarizes the quantitative and qualitative data gathered through observations from attending the 5-day workshop, faculty pitches given on the final day of the workshop, semi-structured, short interviews with faculty attendees, and an electronic post-survey administered to participants at the conclusion of the workshop.

FINDINGS

Faculty Curriculum Development Pitches

Participants in the workshop were tasked with developing a curriculum pitch for how they might integrate CRISPR into an existing course or create a new one at their home institution. The pitches were presented to workshop participants and organizers and covered learning outcomes, teaching strategies, and assessment methods. Table 1 provides a detailed overview of the curriculum pitches given by the college faculty participants. Common themes across the pitches were the development of new courses or modules, a strong emphasis on hands-on lab work, and addressing the ethical implications of the technology.

Table 1. *Overview of Faculty Curriculum Pitches*

Pitch	Pitch 1: A Low-Cost Course Curriculum at an HBCU	Pitch 2: Integrating into Existing Courses with Service Learning	Pitch 3: A Two-Credit Undergraduate Elective Course	Pitch 4: A Semester-long Course at 1890 Institutions
Course Type	A new, stand-alone CRISPR-based course; can be a module within an existing class if needed.	Integrating CRISPR into existing courses (e.g., genetics, genome science) and a service-learning project.	A new, two-credit elective course for undergraduate seniors, expandable to graduate level.	A full, 15-week, three-credit course for upper-level undergraduates.
Learning Outcomes	Students will be able to design sgRNA, explore CRISPR applications in various industries, and understand ethical and regulatory issues.	Students will develop skills in genomic DNA analysis, scientific communication (using a comic app), and teamwork through a service-learning project.	Students will gain foundational CRISPR knowledge and hands-on lab experience with in vitro and in vivo assays.	Students will learn CRISPR-Cas9 editing, molecular biology fundamentals, and apply their knowledge to real-world problems.
Curriculum /Content	Structured modules covering an introduction to CRISPR, sgRNA design, cloning, molecular techniques, and ethical considerations.	An ambitious service-learning project involving a tree inventory on campus using DNA barcoding and CRISPR analysis of the tree microbiome.	Foundational CRISPR knowledge, a bioinformatics module, an in vitro cleavage assay, and an in vivo genome editing assay (blue/white screening).	A 15-week curriculum including molecular biology basics, CRISPR mechanisms, bioinformatics, in vitro and in vivo labs, and a debate on ethical implications.
Assessment	Lab assessments using electronic notebooks, lectures evaluated through assignments, quizzes, and class participation.	Scientific communication through a comic book app and a final project, with a focus on teamwork.	Not specified in detail, but implied through hands-on labs and a final paper on various applications of the technology.	A final project where students design a CRISPR-based solution to a real-world problem, with peer review and a presentation.
Major Challenges	Funding for lab kits and obtaining institutional support for a new course.	Feasibility and the ambitious nature of the service-learning project, along with a time-sensitive budget.	Funding for expensive lab kits and a lack of faculty time and instructional support staff.	Funding and institutional support.

Faculty Interviews

During the last two days of the workshop, 10 of the 11 faculty members were interviewed during free time between workshop activities. Using a semi-structured interview format, faculty members were prompted with open-ended questions to a) understand current use of CRISPR or gene-editing techniques in their teaching and research, b) explore how the workshop might influence curriculum development and research, c) discuss the feasibility and timing of incorporating CRISPR into existing or new courses, d) understand involvement with undergraduate and graduate student researchers and applicability of CRISPR to their research projects, e) understand use of specific tools and resources (such as electronic lab notebooks and bioinformatics databases), and f) identify perceived barriers to implementation as well as determine what ongoing support would be most valuable.

Faculty members were asked for verbal consent to record their responses using an audio recorder. The audio recordings were then uploaded into Otter.AI to create transcriptions that could be used to employ thematic analysis to identify themes, patterns, and insights from faculty members responses.

Key themes that emerged, included:

Curriculum Development: The majority of faculty members expressed a strong desire to either integrate CRISPR into existing courses or create new, dedicated elective courses. They often cited the need for a lengthy approval process, particularly at state institutions.

Resource Constraints: A significant and recurring barrier was the lack of financial resources for equipment, kits, and supplies. Several faculty members emphasized the need for funding to purchase CRISPR kits, which can be expensive.

Student Engagement: Most faculty members actively involve both undergraduate and graduate students in their research. The interviews revealed a strong commitment to providing students with practical, hands-on experiences to prepare them for careers in industry and graduate programs.

Technology Adoption: There was a mixed use of lab notebooks. While some faculty still relied on traditional paper notebooks, many recognized the value of electronic notebooks like Benchling for real-time data recording and improved data management.

Collaboration: Participants highlighted the value of collaboration, both with other faculty from the workshop and with researchers at nearby institutions, as a way to share resources and expertise.

Post-Survey

A total of 13 workshop attendees, 11 faculty recruited from HBCUs plus 2 additional attendees from TSU were invited to complete a post-survey about their experiences with the workshop. A total of 7 (54%) attendees completed the post-survey. For the purposes of this report, all attendee's data are included in analyses.

Expectation to integrate concepts and techniques learned during the CRISPR workshop into faculty teaching activities (e.g., courses, lab sessions, student projects):

Examples for how faculty envision integrating CRISPR material into their teaching activities:

- Course and lab
- I will integrate the labs into my CRISPR course.
- courses
- Student research discussions and lab training opportunities
- I plan to incorporate CRISPR technique in my independent research course for undergraduate students. I also plan to develop a new course to discuss advancement in biotechnology, including CRISPR.
- Course-Plant Biology and Biotechnology/BIOL432

Expectation to apply the knowledge and skills acquired from this CRISPR workshop to faculty current or future research projects:

Examples for how faculty envision integrating CRISPR material into

- I'm planning to write a teaching research project type of proposal so undergraduate and graduate students will be able to participate the research work.
- I will integrate the labs (in vitro cleavage assay and in vivo editing assays) into my CRISPR course.
- Downregulation of genes
- Reviewing Soil Microbiota for determination of soil health
- My lab already identified several transcription factors that are potential regulators of endosperm development. I am planning to create CRISPR knockout to study the function of these candidate genes.
- I already apply CRISPR in my research!

Additional examples for how faculty anticipate using CRISPR?

- Outreach and mentor students
- Outreach
- A scientific workshop of potential research applications
- I am also planning to develop 1-credit colloquial course intended for freshmen, all majors. The goal is to introduce the concept of new technologies and discuss their impact on the society. A simpler version of this course could be used in my outreach activity (I volunteer with Atlanta Science Festival every year to do K12 classroom visits).
- No

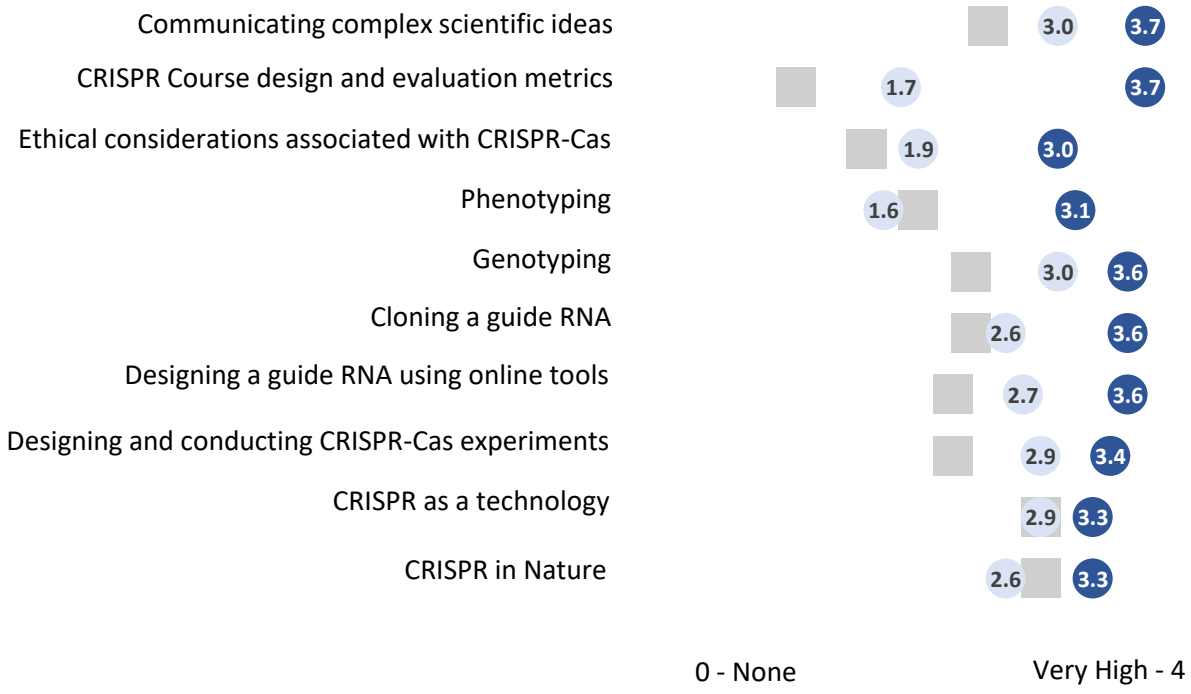


Figure 4. Dumbbell chart illustrating change in self-reported comfort levels among participants of the CRISPR Course Workshop using retrospective ratings of 0 (*None or extremely little comfort*) to 4 (*Very high amount of comfort*) **before (●)** and **now (●).** The grey ■ are used to indicate level of familiarity using a scale of 0 (*Not familiar*) and 4 (*Extremely familiar*) for 7 participants who completed a pre-survey.

Need additional training on CRISPR:

Additional training on CRISPR that would be beneficial to faculty:

- Development a long-term collaboration with other researchers and put together a workshop or summer training program for undergraduate student. Advanced application of CRISPR technology.
- It would be helpful to design a lab on the new developments in CRISPR. Perhaps learn how to design an experiment with dCas9 or Cas13
- I would have liked to spend more time learning about the background of CRISPR. I really feel that I understand labs and activities better after understanding why I'm doing them beforehand.
- The workshop was great; however, basics were not explained clearly. I am ok with it, but we need to know our audiences.

Need additional training to teach CRISPR:

Additional training to teach CRISPR that would be beneficial to faculty:

- It would be very beneficial to learn about the latest developments in CRISPR. The CRISPR field is more than a decade old now. So, most scientists already know a lot about Cas9. It would be very beneficial to learn more about the other Cas proteins and the different Cas mutants.

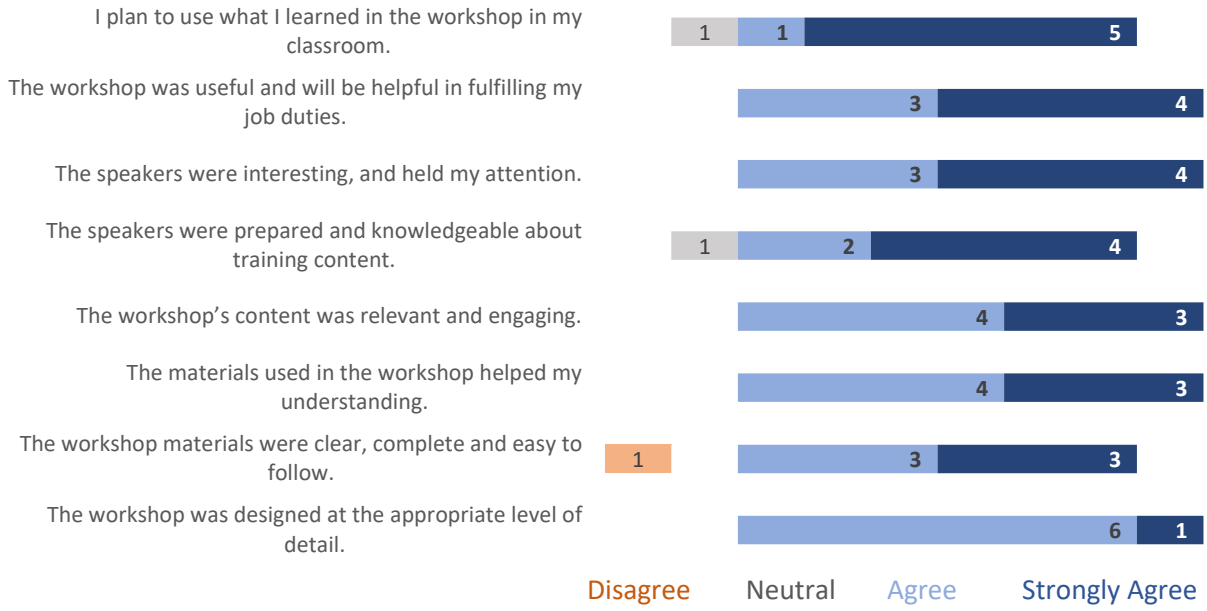


Figure 5. Agreement ratings to statements about the overall 2025 Inaugural CRISPR Workshop.

Comments related to your ratings of workshop satisfaction.

- Outstanding planning and implementation of the training workshop
- I would have appreciated the introduction to CRISPR background and microbiology information being provided before the workshop, as well as at the beginning of the workshop, as a refresher.

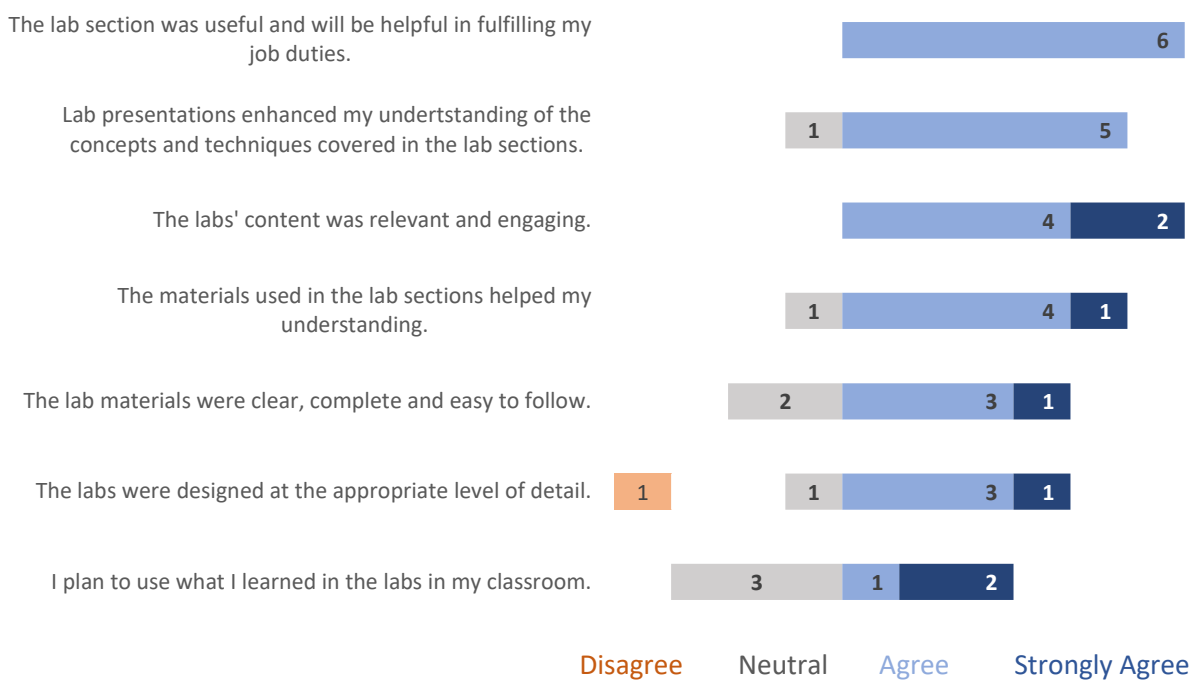


Figure 6. Agreement ratings to statements about the lab components of the 2025 Inaugural CRISPR Workshop.

Satisfaction with the workshop and its lab components was high, with most participants rating their experience as 'Satisfied' or 'Very satisfied'. The most useful aspects of the workshop were engaging with other faculty and teachers, hearing from experts, and the diversity of speakers and topics. The hands-on experience and detailed lab manual were considered most useful aspects of the lab section.

Participants offered several suggestions to improve future workshops, including:

Pre-Workshop Materials: Providing background reading or materials before the workshop would enable participants to have a deeper understanding and come prepared with questions.

Clarity of Instructions: Clearer instructions and expectations for labs, including a review of cleanup rules and expected experimental results, would reduce confusion.

Speaker Presentations: Speakers should be encouraged to present their research to a less expert audience, especially given the involvement of high school teachers.

Duration: One week was considered too short, with a recommendation for a two-week program to allow for adequate lab planning.

Count of Satisfied or Very Satisfied	Seminar Presentations
6 out of **6**	Introduction to the CRISPR Workshop (Maxine Wang, Whitehead Institute; Sonali Roy, Tennessee State University
4 out of **6** (2 neutral)	CRISPR Intro and CRISPR Applications (Laralynne Przybyla, Arena BioWorks)
6 out of **6**	Launching Pilot CRISPR Course at TSU (Sonali Roy, Tennessee State University)
6 out of **6**	Science Communications (Mary Williams, American Society of Plant Biology)
6 out of **6**	Lab Section - Bioinformatics (Sonali Roy, Tennessee State University)
5 out of **6** (1 neutral)	Engineering Stable Antibody Expression Using CRISPR/Cas9-Mediated Gene Integration (Shelbe Johnson, Massachusetts Institute of Technology)
5 out of **6** (1 neutral)	Plant Epigenetics (Mary Gehrig, Whitehead Institute)
4 out of **6** (2 neutral)	CRISPR-Cas9 Technology: From Bacterial Immune Systems to Genome Engineering (Wilfredo Garcia-Beltran, Massachusetts General Hospital)
4 out of **6** (2 neutral)	Synthetic Microbe-to-Plant Communication Channel to Monitor the Soil Quality (Alice Boo, Massachusetts Institute of Technology) **Comment included:** Could have used less data.
6 out of **6**	Faculty pitches **Comment included:** Loved they all had their own innovative methods for establishing programming.

Count of Satisfied or Very Satisfied	Lab Sections
7 out of **7**	Monday - CRISPR Immunity
6 out of **7**	Tuesday - Cas9 in Vitro Assay
6 out of **7**	Wednesday - Cas9 In Vivio Bacteria Kit
7 out of **7**	Thursday - CRISPR Application Phenotypes

Most useful aspect of the workshop:

- Engaging with faculty and high school teachers.
- Hearing talks by experts in the field and curriculum pitches.
- Single guide RNA design by Dr, Sonali Roy
- Just learning more about all the laboratory, background and innovation that CRISPR has to offer.
- Exposure to a diverse range of speakers (both in career stage and area of expertise) and topics (both research and teaching, as well as outreach)
- 1. Interaction with a diverse body of people. 2. Detailed lab manual. 3. Promise to share CRISPR reagents, but for how long?

Suggestions to improve overall workshop experience:

- Assign more reading before each lab. Pre post lab self quizzes will help.
- Additional background information about the labs would have been helpful. At times, we were asked to answer critical thinking questions without having sufficient context to respond meaningfully. In several cases, we were also unsure how to interpret our experimental results due to missing information—such as expected PCR product sizes. Clearer instructions overall would have improved the experience. For instance, on the final lab day (Thursday), my group cleaned our workspace as we had done previously, but it became apparent that the expectations were different. It would have been helpful if the instructors had clearly communicated their expectations regarding how the lab should be cleaned and how materials should be organized and stored. The lack of explicit guidance contributed to some confusion, and the instructor's visible frustration during the process left some of us feeling uncomfortable and undervalued.
- One week is too short for the program. It should be longer, at least 2 weeks, so that the labs can be adequately planned.
- Provide background reading on CRISPR before the training. This will enable participants to gain a deeper understanding of the topic, as well as provide an opportunity for them to raise questions for discussion.
- Just from my own perspective (I spend lots of time in the lab already), the lab portion could be shortened (remove the hands-on portion). I think my learning outcome would be the same by just going over the procedure on paper and then looking at the demo gels and plates.
- Please select speakers who will talk about their research in a way as if they are talking to almost non-expert, given that high school teachers were involved. 2. More group activities maybe

Most useful aspect of the lab section:

- The lab manual
- Biorad assay
- Hands-on experience in the laboratory increases understanding of topics discussed.
- Seeing the demo plate and expected gel images help me understand the concept better.

Suggestions to improve overall lab section experience:

- More interactive activities would help.
- More background
- 4 days of lab is too short for the program

- Go over the concept of LabAids and BioRad kit before the respective labs, or just assign reading materials / videos before the lab.

Additional comments:

- Just from my experience of teaching undergrad labs, it would be helpful to go over the cleanup rules before the lab (either before every lab or post the rules and expectations at the bench).

CONCLUSION

The 2025 Inaugural CRISPR Course Workshop was highly successful in training a diverse group of HBCU faculty. The workshop successfully achieved its core goals of providing foundational knowledge, practical skills, and curriculum development strategies related to CRISPR technology. The curriculum pitches demonstrated a strong desire among faculty to integrate CRISPR into their teaching. Interview and survey data confirmed this intention, highlighting faculty's commitment to preparing students for careers in the life sciences.

A key takeaway is the need for continued support to address the identified barriers to implementation, primarily the lack of funding for lab equipment and supplies. While the workshop was a significant step, faculty could use sustained support to successfully develop and implement new CRISPR curricula.

RECOMMENDATIONS

Based on the findings, the following recommendations are proposed to support best practices for future workshop implementation:

Provide Pre-Workshop Materials: To enhance participant understanding and engagement, distribute background reading, videos, or pre-quizzes on CRISPR fundamentals before the workshop begins. This will ensure all attendees, regardless of their prior experience, can engage in higher-level discussions and understand the purpose of lab activities.

Enhance Lab Instruction and Materials: Consider adding expected results (e.g., PCR product sizes) to the lab manual and explaining the "why" behind each step. Clearly communicate cleanup procedures at the start of each lab to reduce confusion and improve the overall lab experience.

Tailor Presentations for Diverse Audiences: Encourage speakers to present their research in a way that is accessible to both experts and non-experts. Repeating questions from the audience will also improve clarity for everyone.

Develop a Follow-Up Support System: Faculty indicated a willingness for ongoing development and collaboration opportunities. Ongoing collaboration could include information for securing funding and institutional support, shared resources, or a collaborative platform to facilitate long-term partnerships between institutions.

In addition, to improve the clarity and impact of presentations at future workshops, presenters should be mindful of several key factors related to their positioning, volume, and the use of audio.

Presenter Position: Presenters should be conscious of their placement relative to the audience and the presentation screen(s). It is recommended that they consider their position with respect to "audience angles and access to viewing entirety of a presentation" to ensure that everyone in the room can see the presentation materials clearly.
Audio Quality: Presenters should maintain an adequate volume to be heard by all attendees. If answering questions from the audience, presenters should "repeat questions back to audience" so that everyone, including those who may not have heard the initial question, can understand the context of the answer.

Noise Level: Presenters should be aware of the "noise level" in the room, as this can affect how well they are heard.

Appendices

Appendix A: Organizer and Speaker BIOS

Organizers[2]

Jonathan Weissman
CGER Director; HHMI Investigator; Professor of Biology, MIT; Member of Whitehead Institute

Jonathan Weissman earned his bachelor's degree in physics from Harvard College in 1988, graduating summa cum laude. He next took on a PhD in physics from MIT, where he studied under biochemist Peter S. Kim, and from 1993-1996 he completed a postdoctoral fellowship at Yale in the lab of Arthur Horwich. For the past 24 years he has held faculty positions in the Departments of Cell and Molecular Pharmacology and Biochemistry & Biophysics at the University of California, San Francisco, until joining Whitehead Institute in 2020. He also co-leads the Laboratory for Genomic Research, funded by GlaxoSmithKline, to drive development of CRISPR-based therapeutics.

Sonali Roy
Assistant Professor, TSU

Sonali Roy is an Assistant Professor in the College of Agriculture at Tennessee State University in Nashville. She earned her Ph.D. from the John Innes Centre, UK, where she studied auxin regulation in root nodule and arbuscular mycorrhizal symbiosis. Her postdoctoral research at the Noble Research
Institute in Oklahoma led to the discovery of peptide hormone families involved in macronutrient signaling and nodule development.
Since 2018, Sonali has incorporated CRISPR-Cas9 technologies into her research program using Medicago truncatula to functionally dissect regulatory genes involved in legume root development and nitrogen-fixing symbioses. Her lab combines
gene editing, transcriptomics, and peptide signaling assays to explore the molecular mechanisms underlying legume microbe interactions. She currently leads two federally funded research projects focused on applying CRISPR-based approaches in legumes and holds a teaching grant supporting CRISPR pedagogy in undergraduate classrooms. Sonali is also committed to scientific communication and serves as a Reviewing Editor at The Plant Cell (2017–2019).

[2] Bios were copied verbatim from the 2025 Inaugural CRISPR Course Workshop manual, unless otherwise specified.

Maxine Wang
CGER Program Manager

Maxine Wang received her BS in Molecular Environmental Biology from UC Berkeley and is now an HS Chau Scholar at Caltech. Maxine has developed a strong background in strategic organizational development, scientific outreach, and scientific program management. Her experience spans research and leadership roles within both academia and industry, where she has managed large-scale, multidisciplinary genomics collaboration and led educational initiatives to promote diversity in STEM. Maxine's expertise has enabled her to foster impactful collaborations between a wide-range of teams, ensuring that innovative technologies like CRISPR are accessible and relevant to a broad scientific community. She is dedicated to empowering underrepresented minorities and building inclusive scientific networks through hands-on education and strategic partnership-building.

Masami Hazu
CGER Curriculum; Development Lead

Masami Hazu earned her Ph.D. in Molecular Biology from the California Institute of Technology, where her research focused on the molecular mechanisms of membrane protein biogenesis. She holds a BSc from Nagoya University in Japan and an MSc from the University of Sheffield in the UK. Masami's international academic journey has shaped her commitment to fostering inclusive and accessible STEM education. At Caltech, she led multiple initiatives to support diversity and mentorship, including chairing her department's women's group for three years and co-founding both the DEI Representatives program and the Diversity in BBE group. She is passionate about scientific outreach and mentorship, and continues to advocate for equity in science through community engagement.

Mandana Sassanfar
Senior Lecturer; Director of Outreach, MIT

Mandana Sassanfar holds a BS and MS in Biochemistry from the University Pierre and Marie Curie, Paris VI, and a PhD in Biochemistry from Cornell University. After completing her postdoctoral work at the Harvard School of Public Health and the Massachusetts General Hospital, she spent several years working in industry and teaching at Harvard College before joining MIT in 2002. Mandana spearheads a number of outreach activities primarily for low income students and those from institutions with limited research opportunities.
She supervises multiple summer programs, organizes field trips to MIT, teaches a number of lab courses, and coordinates training opportunities for high school science teachers. In 2012, she became a Fellow of the American Association for the Advancement of Science and the Massachusetts Academy of Sciences, and earned the Dean's Education & Advising Award from the MIT School of Science. She was also the President of the National Association of Academies of Science between 2011 and 2013.

Speakers

Laralynne Przybyla
Disease Mechanisms and Models Team Lead, Arena Bioworks

Laralynne Pryzbyla leads the Disease Mechanisms and Models Team at Arena BioWorks to integrate human genetics, disease-relevant models, and high-throughput screening assays with a goal of uncovering the mechanisms of human disease to identify opportunities for therapeutic intervention. Prior to this role, Dr. Przybyla was an Associate Professor at UCSF and the UC Scientifc Director at the Laboratory for Genomics Research, a joint industry academia hybrid institute between UCSF, UC Berkeley, and GSK. She obtained her PhD in Biology from MIT and has experience leading technology development teams across both academia and industry to accelerate development of novel therapeutics across disease areas including neurodegenerative disease, autoimmune disorders, oncology, cardiovascular disease, and kidney disease.

Mary Williams
Features Editor at American Society of Plant Biologists

Mary Williams studied Biochemistry at Berkeley (BA) and Plant Molecular Biology at Rockefeller (PhD). She did a postdoc at Berkeley with Ian Sussex, and then spent 14 years as a Biology Professor at Harvey Mudd College in Claremont, California. In 2009 she started working at the American Society of Plant Biologists as Features Editor of the journal Plant Cell and the developer of Teaching Tools in Plant Biology. Her passion lies in making it a little bit easier for students of all ages to understand plants and plant science research.

Shelbe Johnson
Chemical Engineering PhD candidate, MIT

Shelbe Johnson received her Bachelor's degree from Georgia Institute of Technology. She is currently a NSF graduate research fellow in Brandon DeKosky's Lab at the Ragon Institute of MGH, MIT, and Harvard. She is particularly passionate about developing and using new technologies to improve human health across the globe. One of her projects involves leveraging CRISPR-Cas9 to engineer stable antibody expression.

Mary Gehring
HHMI Investigator; David Baltimore Chair; Whitehead Institute; Professor of Biology and Biological Engineering, MIT

Mary Gehring began her scientific career at Williams College, earned her doctorate from University of California Berkeley in 2005, and continued her studies as a postdoctoral researcher with Steven Henikof at the Fred Hutchinson Cancer Research Center. Gehring came to Whitehead Institute in 2010 and was named the Thomas D. and Virginia W. Cabot Career Development Professor by MIT in 2011. In 2020 she was named the Landon T. Clay Career Development Chair at Whitehead Institute. In 2023, Gehring was named the Inaugural David Baltimore Chair in Biomedical Research. In 2024, she was selected as an Investigator of the Howard Hughes Medical Institute.

Alice Boo
Postdoctoral Scholar, MIT

Alice Boo is a Postdoctoral Associate in Professor Chris Voigt's lab in the Department of Biological Engineering at MIT. She completed both her MEng in Biomedical Engineering in 2017 and her Ph.D. in Synthetic Biology in 2022 from Imperial College London. In the lab, she is engineering a synthetic microbe-to-plant communication channel to monitor the soil quality of agricultural crops. She is passionate about all forms of communication, especially visual communication and graphic design, and helping people communicate their research through visuals. Outside the lab, Alice can be found working on eclectic sets of projects from painting to woodworking or gardening.

Wilfredo Garcia-Beltran
(*Ragon Institute of Mass General, MIT, & Harvard*)

Dr. Garcia-Beltran is originally from Puerto Rico, where he obtained a bachelor's in Chemistry from the University of Puerto Rico-Rio Piedras in 2010. He subsequently entered into a cross-institutional MD/PhD program where he received his PhD degree in Immunology from Harvard University and his medical degree from Harvard Medical School and Massachusetts Institute of Technology (MIT) in 2018. He pursued clinical specialty training in Clinical Pathology with sub-specialty training in Transfusion Medicine at Massachusetts General Hospital (MGH), and carried out post-doctoral research in NK-cell biology and cellular therapies as well as immune responses to SARS-CoV-2 infection and vaccines. He is currently leading his own laboratory as a Clinician-Scientist Fellow at Ragon Institute of Mass General, MIT, and Harvard.[3]

[3] Bio copied from https://ragoninstitute.org/lab/garcia-beltran/.

Appendix B: Icon and Image Attribution

Workshop photos. Images of the workshop were taken by either the evaluator and/or CGER staff.
Organizer and speaker headshots. Images were taken from images publicly available online.

Other Photo/Image Attribution.

Map created in google maps with icons added from the Noun Project.
The Kendal Hotel, Peter E. https://www.flickr.com/photos/pmeimon/4421776902/, **CC BY-NC-SA 2.0**