Greetings,

During the Summer of 2021, the Freshman Summer Research Institute hosted thirty students - our largest and most diverse cohort of students to date! This year’s cohort included sixteen women, ten Latinx students, and eleven African-American students. During this program year, students participated in cutting-edge research in astrophysics, chemistry, engineering, and neurobiology.

FSRI’s comprehensive program is designed to introduce incoming underrepresented and underserved first-year students to Caltech’s research and math curriculum, culture, academic, and student support services. The orientation and academic support integration ensure an engaged transition from high school to college while building a solid educational foundation.

The Freshman Summer Research Institute works collaboratively with our community and institute partners to create an innovative academic and student success-based program that supports underrepresented students from diverse backgrounds to ensure that they are successful in their academic and personal endeavors.

We thank you for your continued interest and support of this vital program.
The Freshman Summer Research Institute (FSRI) is designed to introduce incoming underrepresented and underserved freshmen students to Caltech’s research and math curriculum, culture and college life, and academic and student support services. The program’s objective is to create a "learning community" for students where they can develop the academic and social skills necessary to achieve academic excellence during their freshman year.

This fully-funded program offers each participant:

- A 5-week summer research assignment
- A 4-week math-intensive course
- A 3-week programming bootcamp
- Room and board on Caltech’s campus
- Group field trips, excursions, and activities
- Opportunities to learn and engage in first-year student programming and Caltech culture

The FSRI five-week residential program attracts highly motivated students from populations traditionally underrepresented in science and mathematics. To determine eligibility, the program looks at various identities, including race/ethnicity, socioeconomic status, and gender identity. We also consider the students’ high school preparation and their previous exposure to math and research.

The 2021 FSRI program had a record number of thirty on-campus student participants:

- 16 Women students
- 11 Black and/or African-American students
- 10 Latinx and/or Hispanic students
- 8 Asian students
- 15 First-generation students
- 21 Pell Eligible students
- 12 Questbridge students
Each FSRI participant is carefully matched with a research mentor. Participants have the opportunity to work on engaging research projects with their mentors and connect with other postdoctoral fellows, graduate students, and undergraduate students who work in Caltech laboratories during the summer. As a member of the Caltech research community, FSRI participants attend group meetings, present their findings, and learn about the ongoing work of their assigned research group. In addition to technical skill-building, the FSRI participants learn essential skills to collaborate in a lab setting and present their research to colleagues and peers.

The 2021 FSRI cohort had a team of twenty-five faculty, postdoctoral scholar, and graduate student research mentors.

- Melany Hunt, Dotty and Dick Hayman Professor of Mechanical Engineering
- Tsui-Fen Chou, Research Professor of Biology and Biological Engineering
- Matthew Graham, Research Professor of Astronomy
- Sarah Reisman, Bren Professor of Chemistry
- Guillaume Blanquart, Professor of Mechanical Engineering
- Adam Blank, Professor of Computing and Mathematical Sciences
- Michael Kuhn, Postdoctoral Scholar Research Associate - Astronomy
- Zoya Vallari, Postdoctoral Scholar Research Associate - Physics
- Shing Chi Leung, Postdoctoral Scholar - Theoretical Astrophysics
- Chelsea Hu, Postdoctoral Scholar, Biology and Biological Engineering
- Elizabeth Qian, von Karman Instructor in Computing and Mathematical Sciences
- Rebeccah Warmack, Postdoctoral Scholar Fellowship - Chemistry
- Kim-Marie Dam, Graduate Student - Biology and Biological Engineering
- Claire Saunders, Graduate Student - Applied Physics and Materials Science
- Corey Husic, Graduate Student - Chemistry and Chemical Engineering
- Anna Overholts, Graduate Student - Chemistry
- Matthew Levine, Graduate Student - Computing and Mathematical Sciences
- Brooke Versaw, Graduate Student - Chemistry and Chemical Engineering
- Mengtong (Tom) Duan, Graduate Student, BioEngineering/Chemical Engineering
- Makayla Betts, Graduate Student - Geobiology
- Tian Zeng, Graduate Student - Chemistry and Chemical Engineering
- Mia de los Reyes, Graduate Student - Astronomy
- Elijah Cole, Graduate Student - Computing & Mathematical Sciences
- Raymond Turro, Graduate Student - Chemistry
- Nathan Jones, Graduate Student - Mechanical Engineering
The students enjoyed collaborating with their mentors and lab groups to learn new skills and techniques in the lab environment. Many of the students found that things do not always go as planned in the research process, and they learned to develop new strategies for problem-solving and new ways of addressing challenges. Others found a clearer sense of direction in the academic fields they may want to pursue. The students had the opportunity to present their findings and share their experiences in the lab while building their presentation skills and answering questions in front of the Caltech community. As a collective, the FSRI participants learned computer programming skills, lab techniques and contributed to research discussions with mentors and lab groups.

My mentor was amazing and every time we met with him it was a good experience. He truly cares for us and wanted us to succeed in our objective. It was also nice having a fellow FSRI member to do research with. They and I became very close because of that.
2021 RESEARCH PROJECTS

- Abraham Belayneh and Jayden Nyamiaka - Plagiarism Detection
- Aija Washington - Using Micro ED to Capture Intermediate States of Nitrogenase
- America Luna Herrera and Dilichi Nwankwo - How Very Metal Poor Objects Compare to one Another
- Benjamin Lugo - The O’Connell Effect of Eclipsing Binary Stars
- Briana Mercado - Concrete Carbonation Study
- Chi "Cellie" Cap - Neutrino Oscillation
- Darleine Abellard and Alejandra Vazquez-Yanez - Phonon Lineshapes
- Eli Kugelsky and Carlos Olivas - Protection Away from Home
- Favour Okodogbe - Data-Driven Model Reduction
- George Ore - Computer Vision for Land Cover Mapping
- Joshua Archibald and Nohami Elias - Roles of TAXIBP1 & TNIP1 in Selective Autophagy Mediation: A Disease - Relevant Analysis
- Juan Renteria - Infiltration Instabilities in Snowpacks
- Kevin Do - Utilization of Random Forest Machine Learning for Classification of Type 1a Supernova
- Logan Beharry and Stephen Ebaseh-Onofa - Characterizing a Novel Ratio-Tunable Mammalian Polycistronic Expression System
- Maria Azcona Baez - Refining a Thermal Trigger for Polymer Recycling
- Michelle Li and Katherine Xu - Approximating Growth-dependent Dynamics with Effective Models for Synthetic Biological Networks
- Miguel Aparicio - Demystifying Machine Learning
- Patricia Anne Mutia - Observations of bNAb binding to HIV-1 SOSIPs Coated on ELISA Plates
- Ramzi Saber - The Classification & Identification of Isolated Young Star Systems
- Ricardo Garcia - Making a Neural Network from Scratch
- Tessa Pierce - Synthesis of Unnatural Amino Acids
- Wendy Granados Razo - DASA: Feel the Force
- Yi Lin - Conditions Leading to the Preservation of Cells & DNA in Mono Lake, California
The Freshman Summer Research Institute creates an engaging and intellectually rich residential experience for students that extends student learning beyond the classroom and into the everyday lives of our students. The FSRI Residential Life staff, composed of FSRI alums and graduate students, plans and implements weekly programming to help students transition into college life and learn about campus-wide and local resources.

During the 2021 program, the FSRI participants lived in Bechtel Residence, where they established community norms and expectations and developed communication and conflict resolution skills. The students learn independent living skills and are better prepared to live away from home and balance college life.

The 2021 residential experience was exciting and eventful, as students learned how to balance research, math, and personal lives while beginning the transition to college life. The students enjoyed the Resident Teach Assistants evening events that helped them form bonds and learn about each other and Caltech’s culture. In particular, the group enjoyed the excursions off-campus and exploring the Los Angeles area and the social opportunities and time making friends.

Communication and teamwork work hand-in-hand. We aren’t expected to agree with someone else fully, but everyone must be respected in order to collaborate effectively.
I really liked when we went to Universal and to the Huntington gardens. We were able to see a lot of the area that's within a good drive and it made me feel more at home.

As part of the program, the FSRI participants attend group excursions highlighting Pasadena and the Los Angeles area during the weekends of the program. From hiking and biking to trips to the beach and museums, the five-week residential experience provides meaningful and fun activities to engage the students' diverse interests. These excursions allow FSRI participants to become familiar with the Pasadena area, cultural events, and community resources.

The 2021 FSRI Excursions included:
- Getty Villa and Santa Monica Beach Trip
- *Hamilton* at the Pantages Theater
- Exploration at Huntington Library
- Knott's Berry Farm and Universal Studios Theme Parks
- Explore Pasadena evening events
The FSRI participants attended math classes and evening math workshops that have been aligned with Caltech's first-year math program. The FSRI Mathematics curriculum is specifically designed to take advantage of an intensive summer setting while preparing the FSRI student for research and the transition into Caltech's math curriculum. The four week-long modules for the FSRI Math course are: Set Theory & Logic; Differential & Integral Calculus; Linear Algebra; and Ordinary Differential Equations.

These topics were chosen to prepare students for the mathematics they may see in their summer research experiences and for much of the rigorous topics taught in the first two years of Caltech's required mathematics sequence. Based on previous assessments, statistically, FSRI students perform significantly better than their matched counterparts in first-year math scores. This success can be directly attributed to the preparation, exposure, and training during their intensive summer course. Instructionally, the course is designed as a hybrid lecture/workshop model.

The lecture presents basic definitions and concepts, and students work in small group settings to complete their homework assignments and problem sets. Students have a mix of computational and proof-based assignments, exposing them to the type of coursework they will be engaging in during their first quarter at Caltech. Beyond merely constructive correct solutions, students are required to present their solutions orally in a way that demonstrates their content knowledge.

The FSRI participants have direct exposure to the expectations of how Caltech defines academic rigor and math readiness. Students get their first glimpse of college midterms and finals, as well as receiving test scores and feedback from a college professor and teaching assistants. The students learn how to communicate better and ask clarifying questions to the lecturer and see the value of proof-based math through collaboration. Throughout the summer, these students found themselves learning math skills and concepts that they did not learn in high school in group settings instead of independently solving problems.

The math workshops were extremely helpful and raised my standard for what a math class should look like. I felt that I learned the most in math workshops and math office hours. Math office hours emphasized the importance of asking questions and TAs in general to me.
Professor Justin Bois, a Caltech teaching professor of biology and biological engineering, developed a three-week computer programming boot camp in the Python language for the FSRI cohort. The FSRI programming boot camp provided an intensive, hands-on, pragmatic introduction to computer programming. FSRI students learned basic concepts, such as data types, control structures, string processing, functions, input/output, etc., while writing code applied to scientific problems and research areas.

The programming boot camp ran two hours a day, four days a week, for three weeks during the five-week FSRI experience. Before starting boot camp, students attended a troubleshooting session to address installation issues and an introductory lesson to meet the programming team: postdoctoral scholar Hiedi Klumpe, graduate student Sophie Miller, and three FSRI alumni teaching assistants. The programming boot camp teaching assistants held office hours Monday and Friday evenings to engage students in the lesson information and complete exercises.

The programming boot camp gave the FSRI student participants a jump-start on their computer science education and contributed to data-heavy research projects. At the end of the course, the FSRI students were better able to write code and analyze and plot data.

I loved how FSRI opened doors to knowledge and connections that I would never have been able to get before.
72% of students felt that the FSRI program enhanced their interest and skill in STEM.

89% of students would recommend FSRI to future incoming freshman student.

94% of students attended office hours during the FSRI experience.

89% of students felt that they had clearly defined and accessible FSRI research experiences.

89% of students felt that receiving Math 0 before starting fall term was helpful.
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