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UC Riverside Undergraduate Research Journal

Title

2026 Front Matter

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Journal

UC Riverside Undergraduate Research Journal, 20(1)

Publication Date

2026-10-19

DOI

10.5070/RJ5.69844

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VOLUME XX, 2026

UNIVERSITY OF CALIFORNIA, RIVERSIDE

UNDERGRADUATE RESEARCH JOURNAL

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TABLE OF CONTENTS

The Effects of *N*-acetyl Cysteine, Gentamicin, and Ciprofloxacin on Bacterial Biofilm
in vitro in the Presence or Absence of High Oxidative Stress and High Glucose Levels

Samyuktha Vedula and Shayla Nguyen. 11

Does Locus Coeruleus Structure Relate to Associative Memory Related-Activity in Older
Adults?

Riley J. Barrios. 23

Adversity and Visual Working Memory: The Role of Lifetime Adversity When Shaping
Visual Working Memory in Emotional Recall

Carissa Johnson and Rishitha Kona. 33

The Influence of Childhood Parental Support and Irritability on Internalizing Symptoms in
Latina Girls

Rabyana Iqbal and A. Lorena Tafoya. 41

Gaps in Knowledge, Receipt, and Acceptance of Measles, Mumps, Rubella Vaccines in
a National Sample of Emergency Departments

Sahithi Malireddy. 47

The Effects of Cold Smoke on Hummingbird Behavior and Lung Health

Isabelle Rose Loaisiga. 57

UNDERGRADUATE RESEARCH JOURNAL

TABLE OF CONTENTS CONT'D)

Evaluating Acid Activation Parameters of Biochar for Ammonia Adsorption Melina Belen Caraballo.	65
Impact of Fluid Flow on Mechanical Stress and Deformation in Healthy and Senescent Endothelial Cells Keyanna-Milenia (Keys) Pinzon, Kai Lin, Ethan Liu, and Adarsh Mattappally.	73
Evaluating Severity and Long-Term Outcomes in Pediatric Anoxic Brain Injury and Stroke Utilizing TriNetX Christina M. Zhu.	85
Cross-Cultural Communication: Examining Translation Gaps Between Korean and English Elizabeth Park.	93
Chem-AI: Reframing AI-Assisted Research Through Structured, Retrieval-Based Scientific Literature Analysis Kora Dey.	101
20 Years of the <i>UCR Undergraduate Research Journal</i>	110

The *Journal's* Leadership Team would like to extend our heartfelt gratitude to the following people who made this edition possible:

Laksh Athappan and Flicks UCR for capturing the portraits of our Student Editorial Board members and authors,
Katherine Morrisette for assisting with last-minute proofreading,
Liz Teng for finding and contacting 20 years of *Journal* alumni, and
Taylor Petrich for helping troubleshoot InDesign.

We truly would not have been able to do this without you!

Sincerely,
The UGRJ Team

FROM THE CHANCELLOR



At UC Riverside, discovery is a vital part of the university's mission. Faculty research and creative activities deepen understanding, solve complex challenges, and expand possibilities. By advancing treatments for multiple sclerosis, studying planets outside our solar system, developing drought-tolerant plants, or creating artistic works examining AI's impact, UCR researchers are united by a commitment to knowledge in service to the public good.

Mentored by world-class faculty, our students have access to experiential learning opportunities that offer hands-on research and creative scholarship that shape their journey as learners and scholars.

Our research excellence is reflected throughout the pages of the *UCR Undergraduate Research Journal*. In this volume, our students demonstrate the remarkable inquiry taking place at UCR and the promise of a new generation of scholars and leaders prepared to address the challenges of the future. I hope these papers leave

you with a sense of optimism for what these students can contribute to our communities and society, both before and after graduation.

Thank you to the faculty mentors who guide and inspire our students, and congratulations to the students whose work is proudly featured in this issue of the *Journal*.

Sincerely,

A handwritten signature in black ink, which appears to read "S. Hu". The signature is fluid and cursive.

Dr. S. Jack Hu
Chancellor
UC Riverside

FROM THE VICE PROVOST AND DEAN

Two decades ago, the *UCR Undergraduate Research Journal* was established to celebrate the very best faculty-mentored undergraduate research and scholarship at UCR. In that first issue, the Vice Provost of Undergraduate Education, Andrew J. Grosovsky, hoped that “the launch of the *Journal* will help grow what is already a very vibrant undergraduate research environment on our campus, and provide a means to disseminate some of the most exemplary work from our undergraduate students.” Today, as we celebrate 20 years of the *Journal*, it continues to stand as a testament to the enduring spirit of scholarly inquiry that defines the University of California, Riverside.

The students published in the *Journal* have spent countless hours in labs, community settings, archives, and field sites, navigating the complexities of the research process—from the initial spark of a hypothesis to the rigorous demands of peer review.

Reflecting on 20 Years of Impact:

A Culture of Mentorship: None of this would be possible without our distinguished faculty. Their commitment to guiding the next generation of scholars ensures that UCR remains a powerhouse of transformative undergraduate experiences.

Interdisciplinary Perspectives: True to the mission of our institution, this issue spans a range of disciplines—from the arts and humanities to the physical and social sciences—reminding us that innovation often happens at the intersection of different ideas.

Launching Careers: For many of our alumni featured in previous volumes, the *Journal* was the starting point for careers in academia, industry, and public service.

As we look forward to the next twenty years, let us continue to champion the pursuit of truth and the bold exploration of the unknown. Under the mentorship of our faculty, our rising student scholars and researchers will continue to embark on new research and creative activities that will solve problems, tell stories, and strengthen our society and world for generations to follow. Thank you to all of the students, staff, and faculty who have supported the *Journal* during the last 20 years and congratulations on another transformative and illuminating issue!

Sincerely,



Dr. Louie F. Rodriguez
Vice Provost and Dean,
Division of Undergraduate Education
Professor of Education
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We are proud to present the 20th edition of the *UCR Undergraduate Research Journal*. Two decades of the *Journal* represent more than a number. They represent twenty years of undergraduates choosing to ask difficult questions and contribute original knowledge to their fields. This milestone belongs to every student, editor, and mentor who has shaped the journal into what it is today. This edition carries that legacy forward. The research within these pages spans disciplines and methodologies, but a common thread runs through each article: intellectual courage. These authors did not settle for easy answers. They pursued problems that demanded rigor, creativity, and persistence, and the result is a volume we believe stands among the strongest in the *Journal's* history.

A publication of this caliber is never the work of authors alone. Our Student Editorial Board and Faculty Advisory Board brought sharp critical eyes and genuine care to every manuscript. Their feedback elevates each piece, and their commitment to the process transforms individual papers into a cohesive scholarly volume. We are deeply grateful for their time and expertise.

As we mark twenty years of the *Journal*, we find ourselves looking ahead as much as looking back. The next twenty years of undergraduate scholarship at UCR will be shaped by students who apply their intellectual curiosity to do meaningful work. If this edition inspires even one reader to pursue a question they cannot let go of, it will have done its job. It has been our privilege to serve as Co-Editors-in-Chief for this milestone edition. We hope it honors the two decades of scholarship that preceded us and encourages even more scholarly success to come.

Sincerely,
Sreenidhi Surineni and Nandini Mannem,
Co-Editors-in-Chief



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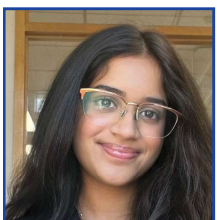
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Why do we do research? The obvious answer is that the results of the research have value: research helps us understand the universe and our place in it, learn from the past, and prepare for the future. But there's another benefit of research that's worth considering as we celebrate the 20th issue of the *UCR Undergraduate Research Journal*: the value of research for the researcher. Undergraduate research can be a transformative experience for a student. I'm amazed by how many professors I know who credit their own undergraduate research experience for launching their careers (I'm one of them—thank you Dr. Chambers for welcoming me into your lab at the University of Tennessee 30 years ago!). And even if you go into a career outside of research, the skills that undergraduate research cultivates—how to be observant, analyze data and evidence, draw conclusions, persevere through setbacks, and communicate effectively—are extremely valuable in any field. It's immensely satisfying to read this special issue of the *Journal* and see the incredible things that 20 years' worth of student researchers and editors have accomplished since their time at UCR. You're an inspiration to our current and future students and a reminder of the importance of undergraduate research.

My sincere thanks to the members of the *Journal's* Student Editorial Board who guided the submitted articles through review and publication, the Faculty Advisory Board members who assisted the students in the peer review process, and Jennifer Kavetsky for the million things she does to make the *Journal* happen each year. We're also grateful for the support of Gladis Herrera-Berkowitz, the CUREL team, and Vice Provost and Dean of Undergraduate Education Dr. Louie Rodriguez. A special thank-you goes to Liz Teng for tracking down and interviewing many of our authors and editors from the last 20 years. And to the undergraduate researchers whose work is featured in this issue, congratulations! We look forward to hearing great things when we check in with you 20 years from now!



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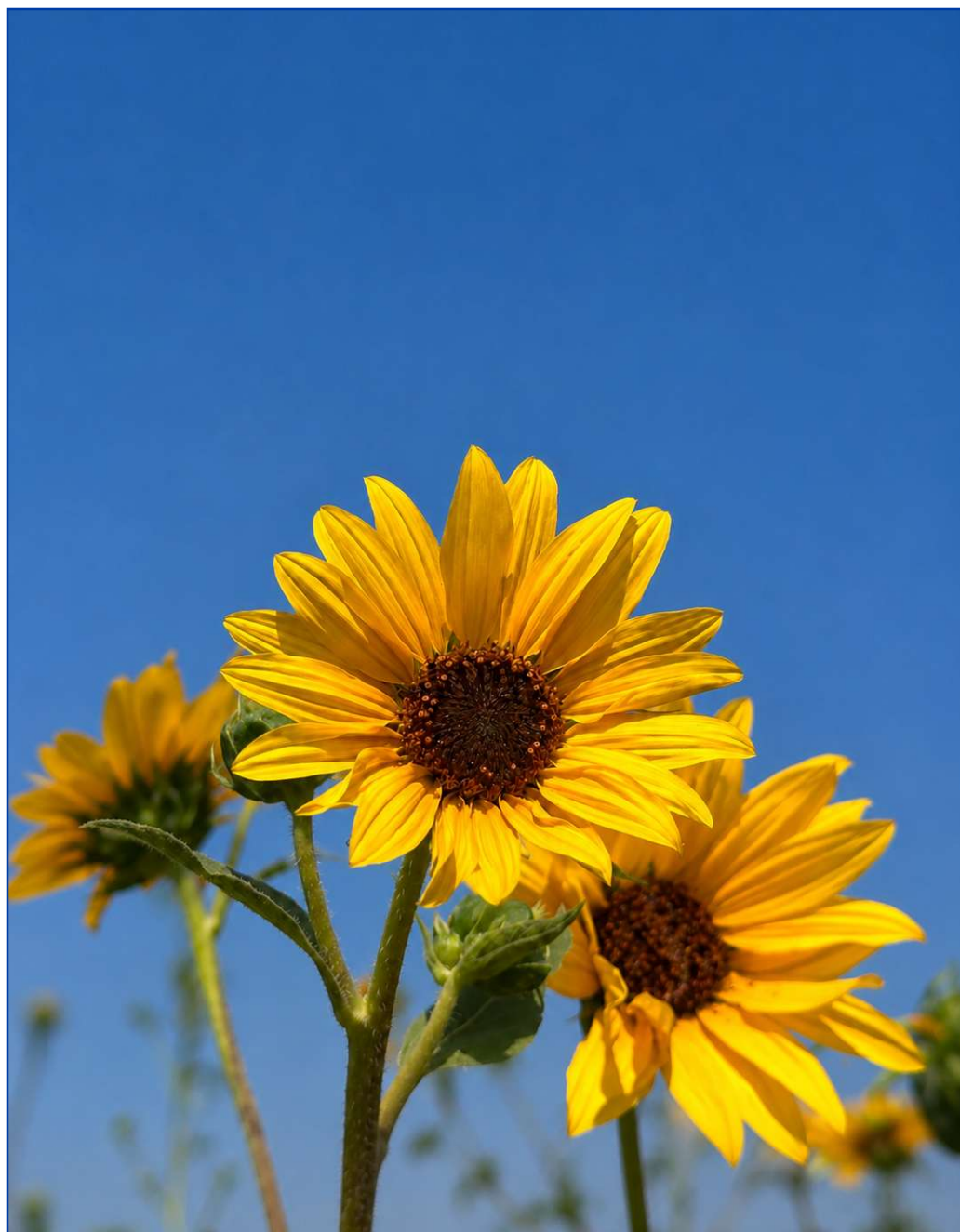


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ABOUT THE COVER



This photograph was taken at UC Riverside Agricultural Operations Center as part of my work with Dr. Ostevik. Our work examines phenotypic and genotypic variation across diverse sunflower populations, with a particular focus on traits associated with drought resilience and local adaptation. One of our recent projects examined drought stress and sunflower moth herbivory across multiple wild sunflower populations to better understand how environmental stress and insect interactions vary among populations.



Omeid Majd

Omeid Majd conducts research in the Ostevik Lab, investigating drought adaptation and insect herbivory in *Helianthus annuus*. He also serves as a copy editor for the *UCR Undergraduate Research Journal* and as a Pre-Health Ambassador with the Pre-Professional Advising Center (PPAC). He is a scholar in the California Alliance for Maximizing Potential (CAMP), an NSF-funded program, and his Honors capstone research examines the impact of interdisciplinary experiences on STEM student development. After graduation, he will pursue a Master of Science in Biomedical Sciences at the UCR School of Medicine before applying to M.D.-Ph.D. programs.

