

UNDERGRADUATE RESEARCH JOURNAL

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FROM THE ADMINISTRATION



So far, 2020 has provided an intense study in deviation. As a research university, we made rapid adjustments when COVID-19 swept through the country, disrupting normal operations, upsetting our plans and work in progress. Yet, this year has also given us a lesson in rigor and adaptability. Despite the challenges, our students, faculty, and research teams worked to move forward. And when we couldn't,

we learned from that. In other words, no matter where we turned, we strengthened our skills as researchers. Even in a pandemic, we seized opportunities to bring new learning to light.

You will see in this 14th volume of the UC Riverside Undergraduate Research Journal that our students are delivering truly remarkable work. The published papers this year span the disciplines of Psychology, Biomedical Sciences, Bioengineering, Environmental Sciences, English, Dance, and Ecology. One paper examines how

feelings of shame and guilt impact procrastination. Another studies our respiratory system's response to toxins in organic dust.

Timeless and timely—these examples are but two highlights from this year's journal reminding us that our scholarly pursuits are critical at any time but especially now as we turn to science for help against a viral enemy. At UCR we are stewards of transformation; we create knowledge through student-centered research endeavors, providing the next generation with skills to address tomorrow's challenges.

To all of the students who contributed to this year's Journal, congratulations on your impressive work. I also offer my heartfelt gratitude to the faculty mentors and staff members whose dedication, guidance, and perseverance made these projects possible. All of your efforts inspire pride in our university and hope for the future.

Sincerely,

A handwritten signature in blue ink, which appears to read "Kim A. Wilcox".

Kim A. Wilcox
Chancellor



The Fourteenth Annual UC Riverside Undergraduate Research Journal features some of the very best faculty-mentored undergraduate research and scholarship from America's fastest rising university. The Undergraduate Research Journal adds to the university's impressive 66-year legacy of high-impact research, which fully integrates with the undergraduate student engagement experience.

In many ways, UC Riverside represents the university of tomorrow. Our inclusive culture, world-renowned faculty, and rigorous and future-focused environment produces young researchers who are prepared to tackle the dynamic challenges that face not only California's Inland Empire, but the world at large. The students whose work is presented in the journal are enriching the environmental, economic, social, and cultural future of California, the nation, and the world.

Congratulations to each of the scholars featured in this journal as this is the culmination of a lengthy process of discovery filled with excitement, frustration, and anticipation. Thank you to our students, faculty, and staff who made the publication of the Undergraduate Research Journal possible. In particular, I would like to acknowledge the Student Editorial Board for leading the peer-review process, the Faculty Advisory Board for its consultation and advice, and Gladis Herrera-Berkowitz for her role in bringing this journal to fruition.

I hope you enjoy and are enriched by the discoveries revealed in this year's Undergraduate Research Journal.

Wishing you all the best,

A handwritten signature in blue ink, which appears to read "Jennifer Brown".

Jennifer Brown, Ph.,D.
Vice Provost and Dean of Undergraduate Education

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Phuong-Anh Do
Editor in Chief
Biology

It is with great pleasure that we present UC Riverside's 14th Edition of the Undergraduate Research Journal. It has been an honor to work alongside talented individuals across disciplines and backgrounds, all of whom have contributed to the success of the Journal. Congratulations to the authors, Student Editorial Board, and Faculty Advisory Board — your diligence, dedication, and efforts towards the editing process have ensured the quality and success of the Journal. The research presented in this Journal represents the creative culture and academic achievements of the UCR student body and contributes to the legacy of excellence within UCR's undergraduate research. We are proud and extremely humbled to have been part of an outstanding team that has made this year's Journal a success.

Sincerely,

Phuong-Anh Do & Catherine Seo, *Co-Editors-in-Chief*



Catherine Seo
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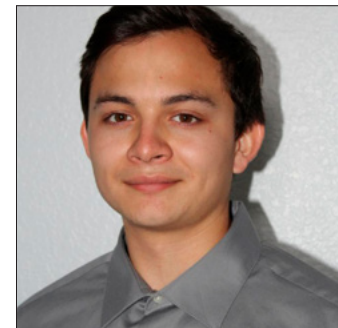
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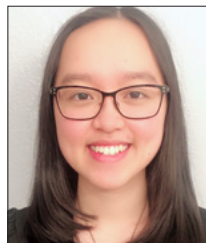
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Since UCR's Undergraduate Research Journal started, it has published over 150 scholarly articles across many fields. These papers represent the commitment of our undergraduate students to performing independent research as part of their undergraduate experience. The Undergraduate Research Journal thus fills a critical need. More often than not, undergraduate research forms part of a larger work with many

contributors, which can mean a dilution of the student's contributions as well as a longer time between completing the work and publication. With the Undergraduate Research Journal, our students can publish their work and get first-author credit. They can publish before the end of the academic year, and gain the experience of seeing their manuscript go through a peer-review and

publication process just like a standard research journal. When the paper becomes a part of a student's professional experience, it contributes to their record of scholarly achievement. The Journal submission and review process is run by undergraduates who form the Student Editorial Board, working with members of the Faculty Advisory Board. The preparation of this issue has been especially challenging because students and faculty have been able to meet only virtually. We owe a debt of gratitude to the students for their professionalism and dedication for the review and preparation of the articles in this issue. We are also grateful for the participation of the members of the Faculty Advisory Board in guiding the reviewers. If you are interested in publishing your undergraduate research at UCR, consider submission to our next issue!

Prof. Morris F. Maduro
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ABOUT THE COVER



Amanda Xaypraseuth

Amanda is a fourth year Bioengineering major who enjoys balancing her time between science and the arts. Throughout her time at UCR, she has participated in ASUCR's Marketing Committee, served as the Bourns College of Engineering Day's Graphic Designer, and created graphics for various organizations and friends. Currently, she's dedicating her time towards developing an online women's magazine and exercising her interest in Product Design to further develop her design skills.

THE PATH OF LEAST RESISTANCE

Located near Page, Arizona, this crescent-shaped meander is better known as Horseshoe Bend. As I approached this spectacle, the Type A in me gave up the fight for constant control of the situation and succumbed to the grandeur of the scene. I pondered and took a long stare at what was in front of me when I remembered how this greatness was created — like how I would navigate my life moving forward — by following the path of least resistance.