19th Annual

STEM DAY 2026

ALABAMA A&M UNIVERSITY

A.S.C.E.N.D.

ADVANCING STEM COLLABORATION, EDUCATION, & NEW DISCOVERIES

APRIL 9, 2026
THE EVENT CENTER
ALABAMA A&M UNIVERSITY

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Alabama Agricultural & Mechanical University

OFFICE OF THE PRESIDENT

4900 MERIDIAN STREET, NORMAL, ALABAMA 35762

Greetings to the STEM Day 2026 Assembly,

It is a privilege to welcome each of you to the AAMU campus for our annual STEM Day celebration. As we look toward the future, this year's theme, A.S.C.E.N.D. – Advancing STEM Collaboration, Education, & New Discoveries, serves as a powerful reminder of the heights our students and faculty are capable of reaching through dedicated scholarship and inquiry.

At Alabama A&M University, our mission has always been to provide an environment where intellectual curiosity meets transformative action. To ASCEND is to rise above the status quo, and this occurs most effectively when we lean into Collaboration and the rigor of a comprehensive Education. The New Discoveries being presented today are not merely academic exercises; they are the tangible results of a community committed to solving the most pressing challenges of our time.

To our student scholars: your work today represents the vanguard of innovation across every academic discipline. You are demonstrating the leadership and technical mastery that define a Bulldog. I encourage you to use this forum to challenge your assumptions, refine your ideas, and build the professional networks that will sustain your careers long after you graduate.

I also want to extend my deepest gratitude to our corporate partners, alumni, and faculty mentors. Your investment in these students ensures that the legacy of this institution continues to grow.

Let us celebrate the brilliance on display today and remain steadfast in our collective journey to A.S.C.E.N.D. toward a more innovative and equitable world.

Sincerely,

Daniel K. Wims, Ph.D.

President

Alabama Agricultural and Mechanical University

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WEBSITE: WWW.AAMU.EDU

Alabama A&M University

Academic Affairs
108 Patton Hall
Normal, Alabama 36756
(256) 372-5275 Office
(256)372-5278 Fax

April 2, 2026

Dear STEM Day Participants,

On behalf of Alabama A&M University, it is my distinct pleasure to welcome you to **AAMU STEM Day 2026: A.S.C.E.N.D. – Advancing STEM Collaboration, Education, & New Discoveries**. This event reflects our institution's strong commitment to fostering innovation, collaboration, and excellence across science, technology, engineering, mathematics, and related disciplines.

AAMU STEM Day provides a valuable opportunity for students, faculty, industry partners, and community members to come together to share knowledge, explore emerging ideas, and inspire the next generation of STEM leaders. Through engaging presentations, interactive exhibits, and meaningful dialogue, we aim to promote discovery, strengthen partnerships, and highlight the impactful work taking place across our campus.

I extend my sincere appreciation to the organizers, participants, and supporters whose dedication has made this event possible. Your contributions are vital to advancing educational opportunities and supporting innovations that address real-world challenges.

To our students, I encourage you to fully engage in today's experience, build connections, and envision your future in STEM. To our guests and partners, thank you for your continued support and collaboration in advancing our academic mission.

I wish you a productive and inspiring AAMU STEM Day 2026.

Sincerely,

John D. Jones, Ph.D.
Provost and Vice President for Academic Affairs

ALABAMA A&M UNIVERSITY

Office of the Vice President for
Research and Economic Development
4900 Meridian Street
Dawson Building - Room 122
Huntsville, Alabama 35810
Office: (256) 372-7010
majed.dweik@aamu.edu

Advancing STEM Collaboration, Education, & New Discoveries

Dear STEM Day Participants,

As Vice President of Research and Economic Development, I am honored to share our continued commitment to advancing STEM collaboration, education, and discovery in ways that deeply impact Alabama communities, our nation, and our world.

Innovation does not occur in isolation. It thrives at the intersection of disciplines, perspectives, and partnerships. At Alabama A&M University, we are strengthening collaborative networks among faculty, students, industry leaders, and community stakeholders to tackle today's most pressing challenges—from emerging technologies and sustainable systems to equity in agriculture, AI innovation, and workforce development.

We are dedicated to cultivating the next generation of STEM leaders by expanding experiential learning opportunities, and supporting interdisciplinary research training. By equipping students with both technical expertise and critical thinking skills, we prepare them not only to participate in discovery—but to lead it.

Our research enterprise continues to push the boundaries of knowledge. Through innovative projects, strategic partnerships, and a commitment to excellence, we are accelerating discoveries that translate into real-world solutions.

As we look to the future, we invite you to join us in this journey. Together, we can expand opportunities, deepen impact, and shape a more innovative and resilient world through STEM.

Thank you for your partnership and dedication to advancing knowledge and discovery.

Sincerely,
Majed Dweik
Majed El-Dweik, Ph.D. Vice President for Research & Economic Development

ALABAMA A&M UNIVERSITY

Division of Student Affairs and Enrollment Management
P.O. Box 1507
Patton Hall Suite 100
Normal, Alabama 35762
(256) 372-5233 - Office
studentaffairs@aamu.edu - Email

Dear STEM Day Participants,

On behalf of the Division of Student Affairs and Enrollment Management, it is my pleasure to welcome you to STEM Day 2026: A.S.C.E.N.D. — Advancing STEM Collaboration, Education, & New Discoveries.

This special event highlights the innovation, creativity, and dedication of our students, faculty, and partners who are shaping the future through Science, Technology, Engineering, and Mathematics (STEM). STEM Day serves not only as a platform to showcase research and academic excellence, but also as an opportunity to foster collaboration, inspire curiosity, and encourage the next generation of leaders and problem-solvers.

At Alabama A&M University, we are committed to supporting student success both inside and outside the classroom. Events like STEM Day reflect our mission to provide enriching experiences that empower students to grow intellectually, professionally, and personally. I encourage all participants to engage fully, ask questions, share ideas, and take advantage of the many opportunities this event provides.

I extend my sincere appreciation to the organizers, faculty, and staff whose hard work and dedication have made this event possible. To our students, I commend your efforts and achievements—your passion and perseverance are truly inspiring.

Wishing you a successful and rewarding STEM Day 2026.

Yours in The Pursuit of Excellence,

Braque Talley, Ph. D.,
Vice President for Student Affairs and Enrollment Management

Alabama A&M University

3/27/2026

Greetings Bulldogs,

I want to take this opportunity to welcome you all to the 19th Annual Science, Technology, Engineering, and Mathematics (STEM) Day at Alabama Agricultural and Mechanical University (AAMU)! I applaud the outstanding achievement of our student's hard work, which is evident in their engagement in research activities across various STEM disciplines. In the ever-changing, increasingly complex world, it is more important than ever that our students be prepared to apply knowledge and skills to problem-solving, make sense of information, and gather and evaluate evidence to make decisions. These are the skills that students develop when engaging in research. This occasion is also a testament to our students' hard work and aspirations, as well as to their respective faculty mentors in the various STEM disciplines.

We are committed to advancing collaborative work and innovative thinking within our colleges and between our research labs and industry leaders. Hence, this year's STEM Day theme is ***A.S.C.E.N.D. – Advancing STEM Collaboration, Education, & New Discoveries.*** I know you have been well prepared, and I look forward to your presentations.

As we continue to provide advanced educational opportunities to meet your career aspirations, I encourage you, especially graduating seniors, to consider pursuing advanced degrees as part of your preparation to enter the workforce. I extend my best to all STEM Day participants. Remember that regardless of the outcome, you are all winners. Go Bulldogs!

Sincerely,

Tau Kadhi

Tau Kadhi, Ph.D.
Professor
Associate Vice President for Academic Administration and
Dean of Graduate Studies
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College of Agricultural, Life and Natural Science
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Greetings STEM Day 2026 Participants,

On behalf of the Office of Academic Affairs and the College of Agricultural, Life, and Natural Sciences (CALNS), it is a privilege to support and welcome you to STEM Day 2026. This year's theme, A.S.C.E.N.D. – Advancing STEM Collaboration, Education, & New Discoveries, perfectly captures the upward trajectory of our institution and the vital role of scientific inquiry here on "The Hill."

As Associate Vice President and 1890 Research Director, I am consistently inspired by the rigor our students bring to the STEM disciplines. This event is a premier showcase where classroom theory meets real-world application. To ASCEND requires the synergy of Collaboration, the foundation of a transformative Education, and the courage to pursue New Discoveries.

To our student presenters: your dedication today is a testament to your potential as future innovators. I encourage you to use this platform to network, share your findings, and see your work through the eyes of the academic community supporting you. I also want to commend the STEM Day Committee and our faculty for their tireless work in organizing this hallmark event.

Let us celebrate the spirit of inquiry that defines Alabama A&M University. Together, let us continue to ASCEND toward a brighter, more innovative future.

Go Bulldogs!

Sincerely,

Douglas D. LaVergne, Ph.D.
Associate Vice President for Academic Affairs
Interim Dean and 1890 Research Director-CALNS
Alabama Agricultural and Mechanical University

Alabama A&M University

College of Business & Public Affairs
School of Business, Room 309
4900 Meridian Street N
Huntsville, AL 35811-7500
(256) 372-5092

March 31, 2026

Dear Participants,

On behalf of the College of Business & Public Affairs at Alabama A&M University, it is my pleasure to welcome you to STEM Day 2026: A.S.C.E.N.D. – Advancing STEM Collaboration, Education, and New Discoveries.

STEM Day celebrates the creativity, curiosity, and discovery that drive progress in science, technology, engineering, and mathematics. These disciplines are essential to addressing complex challenges, advancing innovation, and improving lives across our communities and beyond.

Events such as this highlight the importance of collaboration across fields and institutions to strengthen STEM education, research, and impact. While scientific and technological excellence remains the foundation of this event, thoughtful connections to business, entrepreneurship, and social sciences help ensure that STEM innovations can be translated into practical solutions, career pathways, and policy initiatives for societal benefit.

The College of Business & Public Affairs is proud to support initiatives that foster collaboration, inspire innovation, and expand access to high-quality learning experiences. I encourage each of you to take advantage of the opportunities offered throughout the day by participating in discussions, presenting your work, networking with peers and professionals, and gaining insight into future STEM careers.

Wishing you a productive, engaging, and inspiring STEM Day 2026.

Sincerely,

Andrea Hawkins, Ph.D.
Interim Dean & Associate Professor of Management

ALABAMA A&M UNIVERSITY®

College of Education, Humanities, and Behavioral Sciences
Office of the Dean
117 Carver Complex North
Normal, Alabama 35762
(256) 372-5500 Office

STEM Day 2026 — A.S.C.E.N.D.

Dear Students, Faculty, Staff, and Esteemed Guests,

On behalf of the College of Education, Humanities and Behavioral Sciences, it is my distinct honor and pleasure to welcome you to STEM Day 2026 — A.S.C.E.N.D. (Advancing STEM Collaboration, Education, & New Discoveries). This exciting event reflects our steadfast commitment to fostering innovation, expanding knowledge, and creating meaningful opportunities in the fields of science, technology, engineering, and mathematics.

STEM Day serves as a dynamic platform where curiosity meets discovery. Through engaging presentations, interactive demonstrations, and collaborative dialogue, we celebrate not only the remarkable advancements within STEM disciplines but also the boundless potential of our students and scholars. The A.S.C.E.N:D. theme underscores our collective mission to advance collaboration, strengthen education, and inspire new discoveries that will shape the future.

As Dean, I am especially proud of the interdisciplinary spirit that defines this event. Within our College, we understand that the future of STEM is enriched by the integration of education, the humanities, and behavioral sciences. These perspectives empower our students to think critically, innovate responsibly, and lead with purpose in an increasingly complex and interconnected world.

I encourage each of you to fully engage in today's activities—ask thoughtful questions, build meaningful connections, and explore new ideas. Whether you are a student embarking on your academic journey, a faculty member guiding and mentoring, or a valued guest supporting our mission, your presence contributes to the success and impact of this important occasion.

Thank you for joining us for STEM Day 2026 — A.S.C.E.N.D. I look forward to the inspiration, collaboration, and discovery that will emerge from this experience.

With warm regards,

Robert Z. Carr Jr.

Dr. Robert Z. Carr, Jr.
Dean, College of Education, Humanities and Behavioral Sciences

Alabama A&M UNIVERSITY

College of Engineering, Technology
& Physical Sciences
Office of the Dean
226 Arthur J. Bond Hall
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Greetings,

On behalf of the College of Engineering, Technology and Physical Sciences (CETPS), I am pleased to welcome you to our annual STEM Day celebration. This year's theme, A.S.C.E.N.D. – Advancing STEM Collaboration, Education, & New Discoveries, perfectly reflects the innovation and technical excellence we strive for every day within our engineering and physical science programs.

At CETPS, we focus on transforming theoretical knowledge into practical solutions. To ASCEND requires the precise integration of Collaboration and Education to reach the summit of New Discoveries. Today, as you present your research in robotics, computer science, physics, and engineering, you are demonstrating the very skills that will define the future of global technology.

To our students: your projects are a testament to your hard work and ingenuity. I encourage you to use this opportunity to engage with industry experts and peers, as these connections are the catalysts for professional growth. I also want to thank the faculty and organizers whose dedication makes this showcase of excellence possible.

Let us celebrate the spirit of technical discovery that thrives at Alabama A&M University. I look forward to seeing how your work today will shape the world of tomorrow.

Sincerely,

ZT Deng, Ph.D.
Dean, College of Engineering, Technology and Physical Sciences
Alabama Agricultural and Mechanical University

College of Engineering, Technology & Physical Sciences

Alabama A&M University

Pyroelectric & Dielectric Materials Laboratory
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The Origination, Value, and Sustainability of STEM Day:

Before there was a STEM Day at Alabama A&M University (AAMU), I had attended numerous science and science education meetings, one of which was called Dynamic Days that considered chaos theory and differential equations. Moreover, I had worked previously at another institution, which at that time hosted an Annual Science Program. As an undergraduate student, I had worked at Argonne National Laboratory as a summer intern and later presented my first science talk at the Southeastern Section Meeting of the American Physical Society, while being a new graduate student. These experiences were all fulfilling, which further caused me to realize the significance of conducting research and sharing it with other individuals. In addition, I had previously organized science programs, and had taken students to government laboratories and to many science and engineering conferences. Although there can be no certainty of how or why it occurred, I believe that during the Fall Semester of 2006, somewhere between thinking about attending the Dynamic Days meetings, of presenting talks and posters at regional and national conferences, of taking students to meetings and government laboratories, of participating in previous Annual Science Programs, and of mentoring students at AAMU, the thought arose in my mind of the need for a yearly event at AAMU to be named "STEM Day."

Initially, not only did I contemplate the thought but also knew I had to tell someone about it. Therefore, I requested a meeting with then Provost Beverly Edmond. In a few days after my request, I arrived at the Provost's office and settled into a chair before the desk where she was seated. In order to buffer or assuage myself against a total rejection, I decided to offer two suggestions hoping that she would accept one, at least, and both if I were very lucky, and while not mentioning it earlier, I had been thinking also of how to deliver science content material better to students and how that process could be improved at AAMU. Thus, after exchanging pleasantries, I told Dr. Edmond that I had two ideas that I thought would benefit or be of value to the entire University. I stated that a need exists for a Center for Teaching and Learning to help early career and retooling faculty members to improve their teaching abilities, and secondly a need exists for an annual event called STEM Day to serve scholarly students and faculty members to illustrate the results of their research and individual studies. After a few other exchanges between us, and a brief moment in reflection, Dr. Edmond did not hesitate before replying that the two ideas were meritorious, so "let's make them happen." Thereby, with that simple statement, the goal was achieved, resulting in no rejection of my suggestions but in two positive outcomes all completed with one effort.

I departed from the Provost's office and returned to V. M. Chambers Hall knowing of her support to begin STEM Day and an educational center. The Center was established soon after my meeting with her, without my intervention, and near the end of Fall Semester 2006, I called the first STEM Day Organization Meeting; the meeting was held in the Physics Library with Dr. Edmond in attendance. Starting with that meeting, STEM Day had also begun, and all else about this organization since that time has been about its worth and sustainability.

STEM Day has now existed for many years! What a wonderful reality this is for the University to have some of its brightest students to conduct research and present their findings via posters to persons who have an interest in their work. Moreover, I am delighted to have participated in, have observed faculty members mentoring students in this manner, and have seen faculty and staff members taking leadership roles to make each STEM Day a success, all done with the support of the administration of the institution. Finally, it is each of you who will find the worth in STEM Day and help to sustain its existence at AAMU.

Very sincerely yours,

Matthew E. Edwards

Matthew E. Edwards, Ph.D., Professor of Physics
FRM. Dean, School of Arts and Sciences, and Founder of STEM Day

Biography of STEM Day Founder–Dr. Matthew E. Edwards

Employment and Scholarly Activity: Since January 2002, Dr. Edwards has been a Professor of Physics at Alabama A&M University (AAMU) and served as the Dean of the School of Arts and Sciences from 2007 to 2011. Prior to 2002, academic positions he held included associate professorships at Spelman College and Fayetteville State University, and a visiting associate professorship and adjunct faculty position at the University of Pittsburgh, and an assistant professorship at the University of Arkansas at Pine Bluff. He has held summer-faculty-research positions at several Government Labs: the ROME Air Force Research Lab, NASA Langley Research Lab, and the Naval Research Lab. Dr. Edwards is a Condensed Matter physicist with expertise and interests in quantum physics/solitons wave theory, the materials of electrooptics, pyroelectricity, resistivity, and dielectric properties of crystals and nano-particles doped organic thin films, and in STEM Education. Dr. Edwards has more than 50-refereed papers and journal proceedings and has made greater than 55 professional and administrative presentations. He has guided seven students to advanced degrees: four to the Ph.D., and three to the Master's degree, has served on more than 20 dissertation and thesis committees, and has peer-reviewed greater than 25 research manuscripts. Currently, he is guiding two Ph.D.'s and one Master's degree student. Moreover, he sits on the Board of Directors of two science journals and one science education journal and serves on the executive committee of the Alabama Academy of Science.

Formal Training: Dr. Edwards graduated from Central High School in Goldsboro, North Carolina in 1965 and received the Master's and Ph.D. degrees in physics from Howard University, Washington, D.C, in 1975 and 1977, respectively, and received a B.S. degree in engineering physics from North Carolina A&T State University, in 1969. Additional studies included advanced physics courses at the University of North Carolina, Chapel Hill, North Carolina, in 1987, certificate studies at MIT, Boston, Massachusetts, in 2009, and Materials Science studies at the University of Alabama, Sumer 2000.

Honors and Awards: Dr. Edwards has received (1) the award of Fellow of Alabama Academy of Science, March 2022, (2) the award of Interdisciplinary Fellow of the International Institute of Informatics and Systemics (IIIS), July 2019 (3) The William Lesso Memorial Award for Excellence in Physics and Interdisciplinary Communications, July 2018 (4) Session Best Paper Awards, of the Proceedings of the International World Multi-Conference on Systemics, Cybernetics, and Informatics, in three years, July 2013, 2014, and 2016, (5) Top Faculty Award At Online Affordable HBCUs, 2013 & 2014, (6) Nuclear Research Commission (NRC) Faculty Research Participation Program Award, 2011 & 2012, (7) Madison Who's Who Recognition, 2011, (8) American Society for Engineering Education (ASEE) Fellowships, 1996, (9) Received the Noble Achievement Award from NAFEO, 2009, (10) The Special Recognition Award from Science Spectrum Magazine as a Top Minority in Research Science, September 2005, (11) Who's Who in American Colleges and Universities Recognition, 2004, (12) Presidential Award for Excellence in Teaching, from Spelman College, 2001, (13) Outstanding faculty of the year award from the Department of Natural Sciences, Fayetteville State University, 1994, (14) The Award from the National Institutes of Health (NIH)-National Institute of General Medical Sciences, 1991.

Achievements: Dr. Edwards was the Guest Editor of the special issue of the American Journal of Materials Science in 2015. He holds membership in several scientific and scholarly organizations. He has been the PI or Co-PI on more than 20 grants and contracts, totally more than 6.00 million dollars. He founded: (1) the Biomedical Research Program at Fayetteville State University, (2) the Interdisciplinary Center for Health Science and Health Disparities & Materials, at AAMU, and (3) STEM Day at AAMU,

Personal Information: Dr. Edwards's immediate family consists of wife, Glenda Robinson Edwards, a son, Matthew Edwards, Jr., with his significant other Rosalind Combs, two granddaughters, Megan and Misty Edwards, and their mother Shirley Haywood, a daughter, Natasha Hall with her husband Daniel, and two other granddaughters, Kaylie and Alexis Sellers, and Glenda's grandson, and great grandson, Courtland Cutler and Nicholas Cutler, respectively.

Alabama A&M University

Dr. Matthew (Matt) Edwards
Department of Physics, Chemistry and Mathematics
P.O. Box 338
Normal, Alabama 35762
(Office) 256-372-8119
(Cell) 256-337-0340

Dear STEM Day Participants,

As the Founder of STEM Day at Alabama Agricultural and Mechanical University (AAMU), I am honored and privileged to welcome you to the **19th Annual STEM Day Celebration**. Each year, this event offers an important occasion to reflect upon, and showcase the research excellence and innovations demonstrated by our students, faculty, and academic community. Of the twenty years that STEM Day has been in existence, this year's theme, "**A.S.C.E.N.D. Advancing STEM Collaboration, Education, & New Discoveries**" continues to speak to the heart of our mission. It reflects our unwavering commitment to diversity, inclusion, and interdisciplinary collaboration within the STEM disciplines. Such a theme underscores the importance of equipping students and faculty with the resources and opportunities to engage deeply in research, contribute to scientific solutions, and take on leadership roles within and beyond the university setting.

Throughout today's program, you will witness an array of student-led research presentations and scholarly works that exemplify the essence of STEM education, critical inquiry, innovation, and applied learning. STEM Day serves as a reflective space, one that encourages participants to explore the full trajectory of the STEM experience, from foundational education to real-world application. Our goal is that each student leaves this experience with a strengthened belief in their own potential, carrying forward the conviction that "*I can do this too.*" It is in this moment of realization that we witness the beginning of a student's transformation into a scholar and future leader.

This theme also invites us to confront the broader challenges facing our global society, climate change, public health, food security, and energy demands, among others, and to affirm that solutions must include the perspectives and talents of all individuals. It is essential that students from all backgrounds, including women, minorities, persons with disabilities, and immigrants, see themselves as active contributors to the scientific enterprise. This vision, grounded in equity and access, is at the very core of what STEM Day represents.

I congratulate each of you on your participation and encourage you to embrace this opportunity to learn, collaborate, and grow. May your engagement today inspire continued excellence in research and a lifelong commitment to innovation, service, and discovery.

With best regards,

Matthew E. Edwards

Matthew (Matt) Edwards, Ph.D.
Founder of AAMU STEM Day
Professor of Physics
Past President of the Alabama Academy of Science
Former Dean, College of Arts and Sciences
Fellow AAS; Fellow NSBP

STEM DAY 2026
ALABAMA A&M UNIVERSITY

Welcome,

We are pleased to welcome you to the 19th Annual Alabama A&M University STEM Day 2026. Centered on this year's theme, *A.S.C.E.N.D. – Advancing STEM Collaboration, Education, & New Discoveries*, this event reflects our shared commitment to advancing knowledge, strengthening partnerships, and fostering innovation across disciplines.

STEM Day at Alabama A&M University in the Fall of 2006, with the inaugural public event taking place in 2007. Since then, STEM Day has grown into a signature event at Alabama A&M University. Over the years, it has expanded into a university-wide initiative that brings together students, faculty, and partners in a dynamic environment for learning, discovery, and engagement.

STEM Day continues to serve as a platform for collaboration and innovation—connecting ideas, showcasing achievements, and encouraging interdisciplinary approaches to today's challenges. The broad participation across colleges highlights the vital role of collaboration in shaping future solutions.

We sincerely thank all who contributed to organizing and supporting this event. Your dedication makes STEM Day a meaningful and impactful experience each year.

We encourage you to engage fully, connect with others, and explore the many opportunities STEM fields provide. We hope you find this event both enriching and inspiring.

Sincerely,

Yinshu Wu, Ph.D.
Chair, STEM Day 2026

Lisa Dalrymple-McKitt, Ph.D.
Co-Chair, STEM Day 2026

Andrew Pham, Ph.D.
Co-Chair, STEM Day 2026

A.S.C.E.N.D – Advancing STEM Collaboration, Education, & New Discoveries

19th Annual STEM Day 2026 Program

Event Center

April 9, 2026

8:30 – 9:00 AM	Breakfast STEM Day Founding Video & Dr. Edwards	**Matthew Edwards, Ph.D.** Founder, STEM Day
9:00 – 9:15 AM	Welcome & Opening Remarks	**Yinshu Wu, Ph.D.** Chair, STEM Day 2026 **Daniel K. Wims, Ph.D.** President, Alabama A&M University
9:15 – 9:25 AM	Recognition of Dr. Edwards	**Jeanette Jones, Ph.D.** Faculty Senate President, Alabama A&M University
9:25 – 9:40 AM	Welcome Remarks	Greetings on behalf of the Provost **Dr. John Jones** Delivered by **Dr. Douglas LaVergne**, Associate Vice President **Majed El-Dweik, Ph.D.** Vice President of Research & Economic Development, Alabama A&M University **Tiarra Smith** GSESS IV&V Analyst, 4M Research, NASA; Alabama A&M University Alumnae
9:40 – 10:00 AM	Keynote Address	**Erin Lynch, Ph.D., Ed.D., CRA** President, QEM Network
10:00 – 12:00 PM	Undergraduate Poster Presentations Graduate Oral Presentations	Viewing and Judging
3:00 – 6:00 PM	Awards Banquet at the Ernest L. Knight Center	**Lisa Dalrymple-McKitt, Ph.D.** Co-Chair, STEM Day 2026

STEM Day Keynote Speaker

Erin Lynch, Ph.D., Ed.D., CRA

President at QEM NETWORK

Erin Lynch, PhD, Ed.D., CRA is a nationally recognized leader in higher education research enterprise development whose work advances HBCU research capacity, strategic planning, program evaluation, and funding acquisition. With a career spanning K to 12 education through senior university administration, she is known for transforming institutional vision into measurable growth in research competitiveness, infrastructure, and innovation ecosystems.

Dr. Lynch serves as President of the QEM Network in Washington, D.C., where she leads national strategy to strengthen research and innovation across minority serving institutions. As Principal Investigator and Co Principal Investigator, she has led and supported major federal and foundation funded initiatives totaling 28 million dollars in research awards, including 18.8 million dollars as PI or Co PI. Under her leadership, QEM has expanded its national footprint, increased revenue and staffing capacity, strengthened federal partnerships, and aligned its research agenda with emerging policy priorities. A signature achievement of her presidency is the creation of WeHBSeeU TV, a digital media network dedicated to HBCU research and innovation storytelling that elevates the visibility of HBCU scholarship and strengthens public understanding of STEM research through national digital distribution.

Previously, Dr. Lynch served as Associate Provost of Scholarship, Research, and Innovation and Chief Research Officer at Winston Salem State University, where she also held appointments as Dean of the Graduate School and Willie Brasher Endowed Professor of Education. She oversaw a 200 million dollar sponsored programs portfolio that included 11 research centers and more than 90 active awards. During her tenure, research funding increased by 270 percent in two fiscal years, institutional overhead returns grew by more than 122 percent, and contracting timelines were reduced from weeks to fewer than five days. She strengthened research infrastructure, modernized policy frameworks, and enhanced faculty development systems that supported collaborative and community engaged scholarship.

Across her career, Dr. Lynch has acquired 69.7 million dollars in research and sponsored funding and has developed over 1.026 billion dollars in competitive proposals spanning federal agencies, foundations, and state and local partners. An accomplished scholar and national thought leader, she writes and speaks extensively on equity, research investment, innovation strategy, and leadership within the HBCU ecosystem, with scholarship appearing in outlets such as Cell, Peabody Journal of Education, and Issues in Science and Technology. She serves as a national advisor and grant reviewer for multiple National Science Foundation directorates and United States Department of Education programs. Dr. Lynch brings a strategic yet practical perspective grounded in execution. She challenges institutions to align mission with measurable outcomes, to build sustainable research infrastructure, and to position innovation as a driver of economic mobility and national competitiveness.

STEM Day Awards Banquet Emcee

Demetria Green
News Anchor at WAAY 31

Demetria Green anchors WAAY 31's weekday evening newscasts. The Chicago-born journalist is grateful to call Alabama home after 15 years of reporting, writing and editing for print and television media outlets across the country. Demetria is known for her strong investigative skills– she won the Alabama Broadcasters Association Award for "Best News Anchor in Alabama." Demetria spends her free time mentoring young ladies at Huntsville City Schools, serving as an adjunct instructor at Calhoun Community College, a Board Member for EarlyWorks Children’s Museum and Delta Sigma Theta Sorority, Inc member. Her motto is ‘transparency and curiosity will lead you to the truth.’"

STEM Day Awards Banquet Keynote Speaker

LeMonté Green, Ph.D., CISSP

Computer Engineer at DEVCOM Aviation and Missile Center

Dr. LeMonté Green is a nationally recognized Computer Engineer and subject matter expert in cybersecurity. Specifically, he is an expert in software cybersecurity—known as Software Assurance (SwA)—where he excels at shaping strategic policy and leading elite technical teams.

Currently, Dr. Green leads the Software Assurance Center at the U.S. Army's DEVCOM Aviation and Missile Center—the Department of Defense's (DoD) focal point for software cybersecurity. There, he directs a team of more than 25 engineers on a vital mission: to develop policies, assess vulnerabilities, and secure the tactical and enterprise software that protects and enables the American warfighter.

Dr. Green's career is marked by transformative leadership. He has spearheaded a software assurance strategy that set a new benchmark for the entire DoD. As acting Deputy Director of Cybersecurity Engineering for the Missile Defense Agency (MDA), he helped to craft cybersecurity policies impacting and securing the development of the Agency's tactical systems. His diverse experience also includes serving as president of a tech startup and conducting research at top-tier institutions like Los Alamos National Laboratory and The Johns Hopkins University Applied Physics Laboratory.

His work is built on a distinguished academic foundation, beginning with a Bachelor of Science in Electrical Engineering from Tuskegee University (Summa Cum Laude), a Master of Science from North Carolina A&T State University, and culminating in a Ph.D. in Electrical and Computer Engineering from Carnegie Mellon University. A Certified Information Systems Security Professional (CISSP), his contributions have been formally recognized with honors such as being elected an IEEE Senior Member and receiving the IEEE Huntsville Section's Outstanding Engineer award.

While his professional accomplishments are vast, Dr. Green is guided by what he cherishes most: his faith, his wife Demetria, and their two children, Madelyn and Porter. Hailing from Anniston, Alabama, as a Life Member of the Omega Psi Phi Fraternity, Incorporated, his commitment to family and community remains the bedrock of his life and work.

Abstract Categories

Undergraduate Abstracts
Biological Sciences
Community & Regional Planning
Electrical Engineering & Computer Science
Food and Animal Sciences
Mechanical & Civil Engineering and Construction Management
Natural Resources & Environmental Sciences
Physics, Chemistry, & Mathematics
Social Work

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Undergraduate Abstracts

Biological Sciences

#1. Neuromuscular Training vs. Athletic Taping on Ankle Sprain Injury Rates in Women's Soccer Players

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Department of Biological Sciences

Ankle sprains are among the most prevalent injuries in sport, accounting for approximately 30% of all injuries in soccer athletes. Individuals who sustain an initial ankle sprain are up to 70% more likely to experience recurrent injury due to chronic ankle instability, decreased balance, and impaired neuromuscular control. Athletic taping is commonly used as a preventative strategy; however, its mechanical support decreases during physical activity and it does not directly address the underlying neuromuscular deficits of ankle strength and stability thats associated with injury recurrence. This study systematically reviews current literature to evaluate the effectiveness of neuromuscular ankle training programs compared with traditional athletic taping for reducing ankle sprain risk in womens soccer athletes. A systematic search of databases including PubMed, Google Scholar, and SPORTDiscus identified 48 articles related to ankle injury prevention, taping, and neuromuscular exercise programs. After applying inclusion and exclusion criteria, five high-quality studies, including randomized controlled trials and systematic reviews, were included for data synthesis. The reviewed studies consistently demonstrated that neuromuscular training programs incorporating balance, strength, and proprioceptive exercises significantly reduce the incidence of ankle sprains. One study reported a reduction in injury rates from 0.74 to 0.25 per 1,000 athlete exposures following the implementation of a structured neuromuscular warm-up program. In contrast, taping alone showed limited long-term effectiveness in preventing ankle sprains. These findings suggest that neuromuscular training programs represent a more effective injury prevention strategy than athletic taping does as a passive method. Implementing structured neuromuscular ankle training programs reduces recurrence rates and improves long-term ankle stability among female soccer athletes. Further research should directly compare taping and neuromuscular training using standardized outcome measures such as ankle range of motion to establish clearer evidence-based guidelines and develop more direct, practical injury prevention strategies for womens soccer athletes.

Keywords: ankle sprains, neuromuscular training, injury prevention, athletic taping, womens soccer athletes

#2. Structural Modeling and Analysis of Proteins Involved in Antibiotic Resistance from Escherichia coli and Salmonella enterica Phages

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Contributing to over one million deaths annually, antibiotic resistance poses a global health concern led by multidrug-resistant bacterial strains that are becoming more widespread in healthcare and environmental settings. Antibiotic resistance spreads rapidly when bacteria transfer their antibiotic resistance genes to phages during infection, and those phages can then transfer those genes to other bacteria they infect. For example, β-lactamase genes, including blaCTX-M-55 and blaCTX-M-27 encode enzymes that degrade β-lactam antibiotics, and are increasingly identified in Escherichia coli and Salmonella enterica resistant strains. This study aims to investigate how JL22 and SJ46 phages, infecting E. coli and Salmonella bacterial hosts, play a significant role in spreading antibiotic resistance genes across various environmental reservoirs. We hypothesized that studying the structural and adaptive mechanisms of the proteins in JL22 and SJ46 phages will help counteract the spread of resistant bacterial strains. Molecular modeling tools were used to predict the protein structures and analyze conserved residues using comparative genomics data. The results from these tools revealed the proteins functions, interactions, and evolutionary relationships among other related species. Overall, this research examines phages that infect E. coli and Salmonella, helping us understand the counterstrategies needed to study the ongoing emergence of antibiotic-resistant strains.
Keywords: Molecular modeling, antibiotic resistance genes, environmental reservoirs

#3. From Wastewater to the Clinic: Comparing CTX-M Antibiotic Resistance Proteins from Phages

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Antibiotic resistance continues to be a serious and growing public health issue, especially among bacteria in the Enterobacteriaceae family. Species such as Enterobacter hormaechei are increasingly associated with hospital-acquired infections and multidrug resistance. One major reason resistance spreads so effectively is because antibiotic resistance genes can move between bacteria, including during infections by bacteriophages. Wastewater systems, including both municipal and hospital sources, contain large populations of bacteria and bacteriophages, making them important environmental reservoirs for these genes. One significant resistance mechanism involves beta-lactamase enzymes, particularly those encoded by the blaCTX-M gene. CTX-M enzymes can inactivate beta-lactam antibiotics such as cephalosporins, reducing treatment effectiveness. While blaCTX-M is commonly identified in clinical Enterobacteriaceae isolates, it has also been detected in bacteriophages found in wastewater. This study uses computational methods to identify and compare CTX-M beta-lactamase proteins from LAU1 and P7. Through sequence analysis and three-dimensional

structural modeling, conserved catalytic residues and active-site features are examined. By comparing these structural characteristics, this project evaluates whether environmental phage-associated enzymes resemble clinically relevant enzymes linked to Enterobacter hormaechei, helping to assess the potential connection between environmental reservoirs and clinical antibiotic resistance.

Keywords: Phages, Antibiotic Resistance Proteins, CTX- M enzymes, Environmental reservoirs

#4. Microbial Diversity on High-Contact Environmental Surfaces: A Culture-Based Analysis Using Selective and Enriched Media

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Microorganisms are ubiquitous in the environment, colonizing surfaces that are frequently touched yet rarely examined for microbial presence. High-contact areas such as stair rails and restroom fixtures can act as reservoirs for diverse bacterial communities, some of which may possess clinical relevance. Culturing microorganisms using agar-based media remains a fundamental technique in medical microbiology, allowing for the isolation, differentiation, and preliminary characterization of bacteria. This study aimed to investigate the presence, diversity, and growth characteristics of environmental bacteria collected from two commonly used surfaces in Carver Hall: a staircase and a toilet surface. Environmental samples were aseptically collected and inoculated onto three types of agar media: Nutrient Agar, Blood Agar, and Mannitol Salt Agar (MSA). Nutrient Agar served as a general-purpose medium to support the growth of a broad range of non-fastidious organisms. Blood Agar, an enriched medium containing red blood cells, facilitated enhanced bacterial growth and enabled the observation of hemolytic activity. Mannitol Salt Agar functioned as both a selective and differential medium; its high salt concentration selectively supports the growth of salt-tolerant organisms, particularly species within the genus Staphylococcus, while the mannitol and phenol red indicator allow differentiation based on mannitol fermentation. Plates were incubated and examined at 48 hours and again after more than 160 hours to assess colony development and changes in morphology over time. Substantial microbial growth was observed across all media types, with variations in colony size, pigmentation, and density depending on the sampled surface and growth medium. Color changes observed on MSA suggested the presence of mannitol-fermenting organisms, while Blood Agar demonstrated varied growth patterns indicative of mixed microbial populations. These findings confirm that frequently contacted environmental surfaces harbor diverse microbial communities and highlight the importance of selective and differential media in microbiological investigation and environmental health assessment.

Keywords: Environmental Microbiology Selective and Differential Media Bacterial Culturing Microbial Diversity Surface Contamination

#5. Attacking Cutibacterium acnes: modeling phage endolysin proteins & their contribution to replication

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Acne affects approximately 85-95% of children and young adults. Understanding how to combat acne-causing Cutibacterium using bacteriophages while also uncovering the structural basis of phage-mediated lysis will allow new forms of treatment and open the doors for further research on endolysin mechanisms and functions. However, there are essential questions that still need to be addressed. Diving deeper into how endolysin enzymes break down bacterial walls from the inside during the lytic cycle and why this is important is one of the questions we can analyze during deep research. We hypothesize that endolysin proteins from Phages KIT08 and Pa615 will show conserved results between their sequences and functions. We examined the endolysins using informatics tools such as sequence alignments, molecular dynamics simulations, and protein modeling to study and compare data about their amino acid sequences and protein structures. This helped us to identify the various structures involved in lysis. Our findings suggested these proteins have similar structures and functions between phages, and they also gave us insights into how to analyze the lytic cycle and identify its usefulness when infecting bacteria like Cutibacterium acnes. We can now apply this in future phage therapy-based studies when identifying the best strategies for treating acne and other bacterial infections.
Keywords: Cutibacterium acne phage therapy

#6. Sequence and Structural Comparison of HIV-1 Env Proteins Across Subtypes K and J

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Human immunodeficiency virus 1 currently affects millions of individuals worldwide and remains a major global health concern due to its high genetic diversity and ongoing transmission. Understanding the structural and functional diversity of viral envelope proteins is essential for advancing knowledge in virology and infectious disease research. However, important questions remain regarding how rare HIV-1 subtypes differ at the molecular level, particularly in the structure and behavior of the envelope glycoprotein responsible for viral entry. We hypothesized that the envelope glycoproteins of HIV-1 subtypes K and J exhibit structural and dynamic differences that may influence the viral entry process. In this study, we examined the structural and evolutionary characteristics of the Env protein from subtypes K and J using computational modeling and sequence analysis. We conducted sequence comparisons, structural prediction, and phylogenetic analysis to evaluate similarities, differences, and potential structural variation between the two subtypes. Our findings indicate that structural differences are present within key regions of the Env protein and further demonstrate variation in predicted protein flexibility and evolutionary relationships.

These results suggest that rare HIV-1 subtypes may possess unique molecular features that influence viral entry and adaptation. Overall, this work contributes to a better understanding of HIV-1 structural diversity and provides a foundation for future research exploring subtype-specific viral mechanisms.
Keywords: HIV-1, Env Protein, Viral Subtypes K1 and J, Phylogenetic Analysis

#7. Comparative Sequences and Modeling of endolysin proteins from Cutibacterium acnes phages

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Acne, a condition where hair follicles are clogged with dead skin cells happens to 90% of teenagers and 10% of all other people. C acnes is known for being rich in sebaceous glands and contribute to acne. Two phages that infect C. acnes (vB_CacS_YGG and phiPA50S) encode endolysin proteins within the bacteria. The function for the endolysin protein is to open a hole within the bacteria after integration and replication inside the bacteria cell so that newly made viral particles can escape the host cells. The objective of this experiment is to investigate the C. acnes phages endolysin proteins through comparative analysis of protein sequences, structure and molecular modeling. The data will be investigated through modeling simulation and analysis of endolysin sequences from two phages. Endolysin proteins from phages (vB_CacS_YGG and phiPA50S) were found to have a similar structure and sequence. This suggests the structure of the endolysin is conserved across these two phages. Ultimately, studying endolysin proteins from C. acnes phages has implications acne treatment.
Keywords: Endolysin, Acne, Protein

#8. Structural Modeling and Functional Characterization of PA15 and PA59 Phage Endolysin Proteins

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The bacterium Cutibacterium acnes, a component of the human skin microbiome, is linked to inflammatory skin diseases, including acne vulgaris. To release newly produced phage particles at the end of the viral replication cycle, bacteriophages that infect C. acnes, rely on endolysin enzymes to break down the bacterial cell wall. It is crucial to understand how these enzymes work, as using phage-derived proteins to target C. acne could offer additional approaches to managing bacterial growth. The structural traits and any distinctions between the endolysin proteins encoded by phages PA15 and PA59 are still unknown, nevertheless. We predicted that conserved structural regions and differences between PA15 and PA59 that could affect phage-mediated bacterial lysis would be revealed using computational structural modeling and energy minimization. To assess folding patterns, hydrogen-bonding

interactions, and overall structural stability, three-dimensional models of both proteins were created and examined before and after optimization. To identify conserved domains and potential catalytic sites, structural comparisons were performed. The findings demonstrated that in both models, energy minimization increased predicted stability and decreased structural strain. Additionally, conserved structural regions and flexible surface areas that may aid in the breakdown of cell walls during phage lysis were identified through comparative analysis. These discoveries advance understanding of the structure of phage endolysins and shed light on how phage-derived enzymes can aid in regulating C. acnes growth.

Keywords: Endolysin Proteins

#9. Investigating the antimicrobial activity of essential oils on MDR foodborne pathogens

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The rise of multi-drug resistant (MDR) foodborne pathogens poses a significant threat to global public health and food safety. As antibiotic efficacy continues to decline, there is growing interest in identifying alternative antimicrobial agents derived from natural sources. This study investigates the antimicrobial effects of selected essential oilsincluding oregano (Origanum vulgare), thyme (Thymus vulgaris), and cinnamon (Cinnamomum verum)against MDR strains of Escherichia coli, Salmonella enterica, and Listeria monocytogenes. The essential oils were evaluated using agar disk diffusion and broth microdilution assays to determine zones of inhibition, minimum inhibitory concentrations (MIC), and minimum bactericidal concentrations (MBC). Preliminary results indicate that all tested essential oils exhibited measurable antimicrobial activity, with oregano and thyme oils showing the most potent inhibitory effects. These findings suggest that essential oils hold promise as potential natural antimicrobials for controlling MDR foodborne pathogens and enhancing food preservation strategies. Further research is warranted to explore their mechanisms of action, synergistic effects, and applicability in food processing systems.

Keywords: Multidrug Resistant Bacteria, Essential Oils, Food borne Pathogens, Antimicrobial Activity

#10. Evaluating the Functional Consequences of HEXA Asp492 Variants in Tay-Sachs Disease

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Tay-Sachs disease (TSD) is a rare autosomal recessive lysosomal storage disorder caused by mutations in the Hexosaminidase subunit alpha (HEXA) gene on chromosome 15, which

is responsible for breaking down GM2 gangliosides. When this enzyme is deficient or dysfunctional, GM2 lipids accumulate in neuronal lysosomes, leading to progressive neurodegeneration. Clinical symptoms can include developmental regression, tremors, seizures, and paralysis, with disease severity ranging from infantile to juvenile and late-onset forms. Several HEXA variants of uncertain significance (VUS) have been identified in patients, and their functional consequences remain unclear. This study investigates the potential impact of three missense variants occurring at Asp492 in the HEXA alpha-subunit: D492G, D492E, and D492H. Variant effects were evaluated using computational prediction tools including PolyPhen-2, SIFT, and the meta-predictor PredictSNP. Structural modeling and molecular dynamics simulations were performed using the YASARA modeling platform based on the human hexosaminidase A crystal structure (PDB:2GJX). PolyPhen-2 and SIFT predicted that D492G and D492E are likely tolerated substitutions, whereas D492H was predicted to be deleterious. PredictSNP supported this result, assigning D492H a moderate-confidence deleterious score of 72%. Residue 492 is located within the C-terminal catalytic domain of HEXA, a region important for maintaining structural stability of the enzyme. Evolutionary conservation analysis using GERP indicated relatively low constraint at this position (score -3.1). Ongoing molecular dynamics simulation comparing wild-type and D492H structures aim to determine whether this substitution alters local structural stability. These findings may help improve interpretation of HEXA variants and support more accurate genetic diagnosis of Tay-Sachs disease.

Keywords: HEXA, Tay-Sachs disease, variant of uncertain significance, molecular modeling

#11. Natural Antimicrobials: Assessing the Effects of Essential Oils on Foodborne Pathogens

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Foodborne pathogens continue to pose a major challenge to public health and food safety worldwide, particularly as antimicrobial resistance becomes increasingly common. As a result, there is growing interest in identifying natural antimicrobial compounds that may help control microbial contamination in food systems. This study evaluates the antibacterial bioactivity of selected plant-derived essential oils against common foodborne pathogens using the agar disk diffusion method. Essential oils including eucalyptus (Eucalyptus globulus), clove (Syzygium aromaticum), lemon (Citrus limon), and tea tree (Melaleuca alternifolia) were tested against bacterial strains such as Escherichia coli, Pseudomonas aeruginosa, Salmonella enterica, and Listeria monocytogenes. Sterile filter paper disks impregnated with essential oils were placed onto agar plates inoculated with each bacterial strain, and zones of inhibition were measured following incubation to determine antimicrobial activity. Preliminary observations suggest that several essential oils demonstrate inhibitory effects against the tested pathogens. These results highlight the potential of plant-derived essential oils

as natural antimicrobial agents that could contribute to improved food safety and alternative pathogen control strategies. Future studies may further examine the effectiveness of these compounds in food preservation systems and explore their mechanisms of antibacterial action.

Keywords: Natural Antimicrobials, Food Safety, Essential Oils, Foodborne Pathogens,

#12. Development of an Education Kit for Cell and Molecular Biology Lab Course

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The goal of this project is to develop an education kit that includes procedures to allow students to understand principles of DNA replication, the role of promoter in the regulation of gene expression, and train students to learn the modern molecular biology techniques used to investigate the molecular processes in a cell. In this project, a red and green fluorescent gene (RFP or GFP) was synthesized, and each was cloned into plasmid pET28(a+), which carries kanamycin resistant gene and a T7 promoter controlling gene expression. The fluorescent gene was then amplified by polymerase chain reaction (PCR), purified and subcloned into pUC18 plasmid, which has an ampicillin resistant gene and a lac promoter controlling gene expression. E. coli DH5α strain was used as host cells to complete the subcloning and transformation experiment. Our results demonstrated that the host E. coli DH5α cells glowed red or green after the subcloning experiment, indicating the expression of the functional RFP and GFP without the addition of any inducers, while the same cells containing pET28(a+)-RFP or -GFP plasmid did not change color. Thus, this integrative kit provides visible evidence for students to appreciate the comprehensive regulation of the central dogma in a cell. It is easy to implement and encourages students to gain knowledge on the complex cellular processes through hands-on experiences and active learning. Students are also able to learn the fundamental skills essential for study of molecule biology and genetics, including PCR, DNA cloning and subcloning, DNA purification, bacterial transformation, plasmid isolation, DNA and protein electrophoresis.

Keywords: Education Kit, DNA replication, Gene Expression

#13. Computational Characterization of HIV-1 Group M Subtype K and L Envelope Glycoprotein Dynamicomes

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HIV currently affects approximately 40.8 million people worldwide as of 2024, with an estimated 630,000 deaths annually. Although most HIV-1 group M infections are caused by common subtypes, rare subtypes such as K and L contribute to viral evolution, recombination, and long-term persistence but remain poorly characterized. We hypothesized

that HIV-1 group M subtypes K and L possess unique structural and dynamic features in the envelope (Env) glycoprotein that influence viral entry and transmission. In this study, we investigated the Env dynamicomes of subtypes K and L using computational structure prediction, phylogenetic analysis, and molecular dynamics simulations. Predicted three-dimensional Env structures were analyzed to assess conformational stability, flexibility, and key receptor-binding regions. Our findings indicate that subtypes K and L display distinct conformational dynamics and structural variability within domains involved in CD4 and co-receptor interactions when compared to more prevalent subtypes. These results suggest that subtype-specific Env dynamics may impact viral entry efficiency and immune recognition. Overall, this work enhances understanding of rare HIV-1 subtype biology and provides a computational framework to support future experimental and therapeutic studies focused on group M subtypes K and L.

Keywords: HIV-1 Env Glycoprotein, Subtypes K L, Molecular Dynamics, Viral Entry

#14. Epigenomic profiling reveals novel intracrine gene targets of parathyroid hormone-related protein (PTHrP) in breast cancer

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Bone is the most common site of distant metastasis in breast cancer, affecting approximately 65-75% of patients with advanced disease. Parathyroid hormone-related protein (PTHrP) is known for its paracrine effects in bone metastasis through activation of its receptor on bone cells. However, breast cancer cells lack functional PTHR1, suggesting an intracrine role for nuclear PTHrP in regulating tumor progression. We hypothesized that PTHrP contains DNA-binding domains within its nuclear localization signal (NLS) or GAP region, enabling direct regulation of gene expression in breast cancer cells. Methods: MCF7 breast cancer cells were transduced with HA-tagged PTHrP or empty vector control. CUTRUN epigenomic profiling was performed using antibodies against HA, H3K4me3 (active promoter control), and IgG (negative control). HA-enriched peaks unique to PTHrP-expressing cells were identified, and overlapping peaks with H3K4me3 marks were selected as candidate gene targets. Quantitative PCR (qPCR) was used to validate gene expression changes, including assessment across PTHrP mutant constructs. Results: CUTRUN identified 1,016 HA-enriched peaks proximal to genes in PTHrP-expressing cells, with 47 overlapping active promoter regions. qPCR confirmed significant regulation of PTHLH, ROR2, and LAMA2 ($p \leq 0.05$), while DCLK1 and PCDH7 results were inconclusive due to variability. These findings suggest that PTHrP directly binds genomic regions and regulates transcription of genes involved in cancer progression. Conclusion: This study provides evidence that PTHrP may function as a transcriptional regulator in breast cancer cells through direct promoter binding. Future work will refine CUTRUN analysis, expand qPCR validation to additional targets, and determine which PTHrP domains are responsible for gene regulation. These findings enhance our understanding of intracrine PTHrP signaling and its potential role in breast cancer metastasis

Keywords: breast cancer, Parathyroid Related hormone protein, bone metastasis, intracrine

#15. Environmental and Social Determinants of Obesity: PFAS Exposure and Neighborhood Disadvantages Among African American Women

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Obesity remains a critical public health challenge in the United States, with non-Hispanic African American Women experiencing the highest and most persistent burden. National surveillance data from NHANES 2017-2018 estimate obesity prevalence at approximately 56.9%, and recent findings from the All of Us Research Program report an age-adjusted prevalence near 59% with a mean BMI of 33.34 kg/m^2. These disparities persist across socioeconomic strata, indicating that structural and environmental determinants, not individual-level factors, drive risk. This study examines the independent and combined effects of per- and polyfluoroalkyl substances (PFAS) and neighborhood socioeconomic disadvantage on obesity among African American Women, using an environmental justice framework. Serum concentrations of PFOS, PFOA, PFHxS, and PFNA were evaluated alongside the Neighborhood Deprivation Index (NDI) to assess cumulative exposure. PFAS, persistent environmental contaminants commonly encountered through drinking water and consumer products, may function as obesogens by disrupting endocrine pathways, including PPARα/PPARγ signaling and thyroid hormone activity. Neighborhood disadvantage further contributes to metabolic risk through limited access to healthy foods, reduced opportunities for physical activity, and chronic psychosocial stress that dysregulates the HPA axis. Results reveal a pronounced cumulative risk pattern: African American Women with elevated PFAS exposure and high neighborhood disadvantage exhibit an obesity prevalence of roughly 70%, compared with approximately 45% among those with low exposure and low disadvantage. These findings underscore that obesity disparities among African American Women reflect a double burden of chemical and social exposures rooted in structural inequity. Effective intervention requires integrated strategies that reduce PFAS contamination while improving neighborhood conditions to mitigate entrenched metabolic health disparities.
Keywords: PFAS, Obesity, African American Women, Environmental Justice, Neighborhood Disadvantage

#16. Determining the Reproductive Outcomes, Antioxidant Potential, and possible Toxicity of Selenium Nanoparticles on Caenorhabditis elegans In Vivo.

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Selenium nanoparticles (SeNPs) have gained attention for their potential biomedical and antioxidant properties, yet their biological effects remain incompletely understood. This study

investigates the antioxidant (Aox) potential, toxicity, and reproductive outcomes of SeNPs in the nematode, Caenorhabditis elegans (C. elegans), a well-established model organism used for toxicological and oxidative stress studies. C. elegans were grown and harvest for use in this experiment. These model organisms were exposed to different concentrations of SeNPs (0.001 - 0.1 g/mL) to assess any acute toxicity and reproductive outcomes compared to control group not treated with Se NPs. Total progeny, egg-laying rates, and developmental abnormalities were assessed to quantified reproductive outcomes. To determine the Aox potential of SeNPs, C. elegans were treated with varying concentrations of hydrogen peroxide (H2O2), before and after treatment of determined concentrations of SeNPs. Antioxidant potential was evaluated through quantification of key detoxifying intracellular enzymes catalase (CAT) and glutathione peroxidase (GPx). Preliminary results indicate low concentrations of SeNPs exhibit negligible toxicity, and organisms exposed to 0.001 and 0.01 g/mL of Se NPs, respectively, show a decrease in progeny, decrease development with a halt at L2 stage, and give rise to aggregation of worms encased in a biofilm matrix. Worms exposed to Se NPs at 0.1 g/mL exhibit a 2-fold increase reproductive success in progeny with multigenerational development. These findings contribute to understanding the dose-dependent biological effects of Se NPs and their implications medicine and environmental safety. Further research is needed to elucidate mechanistic pathways underlying Se NP interactions within biological systems.

Keywords: Selenium nanoparticles, antioxidant potential, reproduction

#17. The Effect of Plant RNA Aid on the Quantity and Integrity of Total RNA Isolated from Soybean Leaves.

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Department of Biological Sciences

Soybean (Glycine max), originally cultivated in China for over 5,000 years, have spread to Japan, Korea, and across Southeast Asia. They are grown commercially for food, animal, feed, biofuel, and industrial fibers. In molecular biology, studying the impact of RNA aid on the quality and quantity of total RNA from soybeans is crucial for applications like next-generation sequencing (NGS) and gene validation. Besides, this study aims to provide hands-on experience with RNA extraction, quality assessment, quantification, and gel electrophoresis. Total RNA was extracted rom four-week-old soybean leaves utilizing different lysis buffer formulations from the Plant Spectrum Total RNA Kit, thereby optimizing the yield and integrity of the RNA obtained. The RNA quality and quantity were evaluated with a Qubit fluorometer and Agarose Gel Electrophoresis 9AGE) to ensure the extracted RNA is suitable for future research application.

Keywords: Plant RNA Aid

#18. The Effects of Cold Plasma on Water Imbibition and Germination of Radish and Spinach Seeds

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Seed germination and early seedling growth are critical stages in crop production. However, poor germination remains a significant challenge in vegetable farming, particularly for small-seeded crops such as radish and spinach. These crops are valued for their high nutritional content and fast growth cycles, yet they often show variability in germination performance as reported in past studies. Cold plasma is an emerging technology that enhances seed germination and plant growth. Cold plasma, the fourth state of matter, is a partially ionized noble gas, composed of reactive species. These reactive particles alter the seed surface, increase permeability, enhance water uptake, and stimulate seed germination processes, ultimately promoting plant growth. In this study, helium gas was used as the source for generating cold plasma.

Keywords: Cold Plasma on Water Imbibition and Germination

#19. Dimorphic effects of environmental enrichment on nicotine-induced behaviors and dopamine signaling in male and female mice

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Substance Use Disorder (SUD) is recognized as a chronic, relapsing condition that carries significant public health consequences. There are striking sex differences observed in both the development and progression of SUD. Specifically, women frequently demonstrate greater vulnerability than men to certain aspects of addiction, such as a faster escalation of substance use, heightened sensitivity to environmental cues, and higher rates of relapse. These differences are thought to arise, in part, from sex-based variations in how reward is processed at the neural circuit level. The mesolimbic dopamine pathwayoriginating in the ventral tegmental area (VTA) and projecting to the nucleus accumbens (NAc)plays a critical role in reward learning. Nicotine, the primary addictive compound in tobacco, alters brain chemistry by acting via nicotinic acetylcholine receptors (nAChRs) within the mesolimbic dopamine pathway, modulating dopamine release in the nucleus accumbens. While many studies have explored this relationship, few directly measure real-time dopamine changes in mice. We hypothesize that enriching the environmental context in which nicotine is administered will differentially impact behavior and underlying neural mechanisms in male and female mice. Specifically, we predict that environmental enrichment will modulate locomotor activity and anxiety-like behaviors in a sex-dependent manner, where males will exhibit greater locomotor activity in response to the testing environment while females will show heightened sensitivity to environmental cues indicative of anxiety. These behavioral outcomes will be associated with distinct patterns of dopamine release within the nucleus

accumbens. This project uses fast-scan cyclic voltammetry (FSCV) to investigate how nicotine exposure affects dopamine release in the nucleus accumbens of mice while also tracking behavioral changes during drug administration. Adult male and naturally cycling female mice will be housed in enriched cages with a novel object and trained in an open field apparatus after receiving subcutaneous nicotine pretreatment at different concentrations. Control groups will include mice that receive saline pretreatment and mice housed without the novel object. Following behavioral testing, FSCV will assess dopamine release dynamics in the NAc.

Keywords: Nicotine, Dopamine signaling, Environmental enrichment, Sex differences, Fast-scan cyclic voltammetry

#20. Importance of Understanding Variations of Rare HIV-1 Env from Subtypes F2 and H

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HIV-1 is a virus that has many different subtypes, but some of the rare ones, such as F2 and H, are not well understood. These rare subtypes matter because they influence how the virus spreads, changes over time, and responds to treatments. To better understand HIV-1 envelope (Env), it is important to learn how these uncommon subtypes differ. It is not fully understood how the Env proteins of F2 and H differ from more common subtypes or how these differences might affect the viruss ability to enter human cells. We predicted that the envelope proteins of F2 and H would show unique structural features that could change how the virus attaches to and infects cells. In this study, we examined the Env proteins from F2 and H using computer-based tools such as YASARA and structural modeling. Results show that F2 and H Env have variation in structure and molecular movement. These differences may affect how the virus attaches to and infects cells. Overall, this work helps improve understanding of HIV-1 diversity and supports future research on how rare subtypes enter cells and evolve over time.

Keywords: HIV-1, Subtypes, F2, H, Proteins

#21. Brachypodium distachyon Root Transporters

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Climate change is increasingly impacting the environment, bringing higher temperatures, more extreme weather, reduced water availability, and declining soil quality. Together, these factors make it difficult for plants to grow, particularly for food crops. As a result, food security is an increasing concern worldwide. To address the issue of plant survival in challenging conditions, this experiment focused on the root microbiome and root exudates. The root microbiome is an important part of plant health as the microbiome directly influences

nutrient absorption, growth, and resistance to environmental stressors. Despite its importance, little is known about how plants influence the composition and interact with the root microbiome. A primary force in assembling the root microbiome is root exudates. Root exudation is a process where plants release an array of carbon-rich compounds (amino acids, sugars, and organic acids) into the surrounding soil. These exudates function as nutrients, signaling molecules, or antimicrobial compounds that influence microorganisms in the rhizosphere. This project explores how plant root transporters regulate root metabolites exudation and microbial communities in the model grass, Brachypodium distachyon. This research is centered around a genetics approach with metabolomics and microbiome analysis to study potential transporters that can change root exudates and microbial composition. Additionally, to study underlying mechanisms, a biochemical approach is applied.
Keywords: Plant, transporters, root microbiome, exudation

Community & Regional Planning

#22. Blight to Opportunity: Mapping Brownfields and Socio-Economic Disparities in Alabama Communities

Karter Alexander Woods, Keyshawn Johnson, Camryn Cummings*
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Department of Community & Regional Planning

Brownfields are abandoned or underutilized properties where redevelopment is hindered by the potential presence of hazardous substances or pollutants. This study identified and evaluated brownfield sites across six Alabama countiesCullman, Jackson, Lauderdale, Limestone, Madison, and Sumterto support future remediation and sustainable redevelopment. The objectives were to develop a comprehensive brownfield inventory, assess cleanup and reuse potential, provide data to stakeholders, and analyze socio-economic disparities associated with site distribution. Through a partnership between the Alabama Department of Environmental Management (ADEM) and Alabama AM University, windshield surveys, site prioritization analyses, and Phase I Environmental Site Assessments (ESAs) were conducted. Historical and geological data from the Environmental Risk Information Service (ERIS), along with Geographic Information System (GIS) mapping and Google Earth imagery, were used to visualize sites, population density, and socio-economic indicators. Several brownfield properties with strong redevelopment potential were identified, and Phase I ESAs confirmed multiple sites as eligible for further remediation and revitalization. Analysis revealed that many brownfields are located in socio-economically vulnerable areas, emphasizing the importance of equity-centered redevelopment. Community visioning sessions were also held to enhance public engagement and awareness. This collaboration between ADEM and Alabama AM University demonstrates the effectiveness of academic-government partnerships in addressing environmental disparities while advancing sustainable redevelopment and environmental justice across rural North Alabama.
Keywords: Brownfields, redevelopment, economy, rural

#23. The Cage: Reclaiming Thomas Hall for Student Life, Safety, and Community

*Margaret Brown**
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This project applies the practice of adaptive reuse to transform the abandoned student dormitory, Thomas Hall, into a seven-days-a-week, dual-functioning student space. The Cage would serve as a cozy café during the day for students to study and relax, and act as a late-night workspace for students after hours on weekdays. The practice of adaptive reuse breathes new life into existing structures and land that no longer serve their original purpose by transforming them into spaces that meet modern-day needs. In the case of Alabama AM Universitys campus, The Cage would help address the need for safe student spaces while also bringing new life to a currently vacant dormitory that trespassers frequently enter, creating a potentially dangerous environment for students living in nearby residence halls. This project also looks closely at whether the design would actually work in a real-world setting by using ideas from environmental science, technology, engineering, and math. It considers possible interior layout and floor plan changes, energy-efficient lighting options, and compares the cost of renovating the building versus building something new. Student surveys will also be used to understand what people would actually want from the space and help guide design decisions. From 10 p.m. to 2 a.m., the space would serve as a student nightclub on weekends, and on rotating days, it could host events or meetings for student clubs. The name of this project, The Cage, represents the image of the bold and resilient Bulldog, not one that is confined, but one that owns the space and the fearless energy within it. This project responds to an issue many college campuses across America are facing today: the lack of safe, accessible spaces for late-night student activities throughout the year. Students would have a place to study safely at night while also supporting the school by purchasing snacks, coffee, and tea from the student-run café during weekdays, and enjoying fun, alcohol-free events after dark on Fridays and Saturdays. Unlike other campus spaces owned by outside corporations, this student-centered environment would provide a safe place for studying, socializing, and hosting events—and finally, a space students can truly call their own.
Keywords: Adaptive Reuse, Campus Safety, Sustainable Design, Student Space Design, Student Engagement

Electrical Engineering & Computer Science

#24. Automated Comparative Evaluation of Large Language Models for Cybersecurity Code Generation

*Adeyori Adekunle**
Mentor(s): Dr. Ed Pearson III
Department of Electrical Engineering & Computer Science

Large Language Models (LLMs) are increasingly used for software development, including cybersecurity applications. However, reliability remains a critical concern. This project presents a structured, automated framework for evaluating and comparing three leading LLMs: GPT-4o, Claude-3, and Gemini on their ability to generate executable, functional Python code for real-world cybersecurity tasks. Ten cybersecurity-focused prompts were designed, including AES encryption, RSA key generation, port scan detection, SQL injection testing, XSS payload scanning, log anomaly detection, secure login systems, JWT validation, suspicious file detection, and reverse shell implementation. Each prompt was submitted to all three models through a Python-based evaluation script. The system automatically: Submits prompts to each LLM via API Extracts and cleans generated code Saves outputs as executable Python files Executes code in a controlled environment Logs results as Pass or Fail in structured CSV files Records failure causes (SyntaxError, ModuleNotFoundError, IndentationError, etc.) A ""Pass"" indicates syntactically correct, executable code. A ""Fail"" indicates runtime errors, missing dependencies, formatting issues, or non-executable output Results Summary Out of 10 tasks: Gemini: 6 Pass / 4 Fail GPT-4o: 4 Pass / 6 Fail Claude-3: 2 Pass / 8 Fail Common failure causes included: Syntax errors Missing Python modules Improper indentation File dependency errors The results demonstrate significant variability in model reliability for cybersecurity code generation. Gemini performed best overall in execution reliability, while Claude-3 produced the highest rate of syntax-related failures. Impact This research contributes to data science and applied AI by providing a measurable framework for LLM reliability testing, highlighting execution risks in generative AI for cybersecurity, and introducing a pathway toward automated LLM selection systems. The proposed extension includes a web-based tool that recommends the most reliable LLM for a given prompt based on historical execution performance, reducing time spent correcting hallucinated or non-functional outputs.

Keywords: Large Language Models (LLMs), Cybersecurity, Code Generation, Model Evaluation, Python Automation

#25. How do AI-powered traders behave in low-transparency, high-information-asymmetry markets like penny stocks and does their rationality advantage over humans hold in the presence of manipulation and social media signals?

Amarachi Ezekiel, Segun Oke*
Mentor(s): Dr. Segun Oke
Department of Electrical Engineering & Computer Science

Artificial Intelligence is being integrated into the financial market at such a fast pace as a result many people are interested in understanding how AI-powered traders behave under varying market conditions and the implications of such behavior for financial stability.

Recent experimental evidence by Hansen and Lee (2025) demonstrates that large language model agents exhibit significantly greater rationality and reduced herd behavior compared to human financial professionals in controlled laboratory settings, suggesting that increased AI adoption may contribute to more stable financial markets. However, these findings are derived from idealized experimental conditions characterized by clean binary signals, known probabilities, and the complete absence of manipulative market actors conditions that bear little resemblance to the structural realities of low-transparency markets. While Hansen and Lee (2025) make a significant contribution by demonstrating that AI agents display greater rationality and reduced herd behavior compared to human financial professionals, their findings are constrained by experimental conditions that do not reflect the complexity of real-world financial markets. The study employs clean, binary private signals with fixed and known probabilities, a setting that fundamentally differs from markets characterized by high information asymmetry, scarce public disclosure, and deliberate price manipulation. They acknowledge that their framework does not attempt to simulate a realistic market environment and their experimental design does not consider the influence of social media sentiment, thin trading liquidity, and manipulation strategies such as pump-and-dump schemes, all of which are structural features of penny stock markets. This study extends the experimental framework of Hansen and Lee (2025) by examining how AI-powered traders behave in penny stock markets environments defined by extreme information asymmetry, social media-driven sentiment signals, and deliberate price manipulation. Using historical penny stock price data, Reddit and StockTwits sentiment records, and confirmed pump-and-dump cases drawn from SEC enforcement actions, we construct a series of realistic trading scenarios and present them to multiple large language models as structured prompts. AI trading decisions are evaluated against theoretically rational benchmarks and compared to documented human behavior in equivalent market conditions. Our findings contribute to the rising literature on AI behavior in financial markets and carry direct implications for the regulation and deployment of AI-powered investment tools in low-transparency market environments.

Keywords: Financial market, trading, AI-trading models, herding, penny stocks

#26. Intercept: A Mobile-First AI System for Phishing Detection

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Mentor(s): Dr. Ed Pearson

Department of Electrical Engineering & Computer Science

Intercept is a mobile-first, artificial intelligence-based phishing detection system designed to protect job seekers, students, and employees from socially engineered email attacks before they interact with malicious content. As phishing attacks continue to increase and frequently target individuals through email communication, many traditional security solutions focus primarily on enterprise-level infrastructure rather than protecting individual users directly. This creates a gap in accessible cybersecurity tools for people who frequently check emails on mobile devices, especially in job-seeking scenarios involving recruiter communications and employment offers. Intercept addresses this problem by leveraging a machine learning-based

detection approach using a Random Forest classification model to analyze email characteristics and identify potential phishing threats. The system evaluates multiple features within an email, such as suspicious language patterns, sender information, and structural indicators commonly associated with phishing attempts. By aggregating predictions from multiple decision trees, the Random Forest model improves detection stability and classification accuracy when determining whether a message is legitimate or potentially malicious. The application is designed with a user-centered, mobile-first interface that allows individuals to paste suspicious emails and receive immediate analysis, clear explanations, and actionable recommendations. This approach ensures that users without technical backgrounds can easily interpret the results and make informed decisions about potential threats.

Keywords: Phishing Detection, Artificial Intelligence, Machine Learning

#27. Cost transparency and care navigation using an agentic AI system: the CareLens approach

*Daniel Lambo**

Mentor(s): Dr. Ed Pearson III

Department of Electrical Engineering & Computer Science

Healthcare cost uncertainty is a major barrier to timely medical care in the United States. Many patients delay treatment because they cannot determine the likely cost of care or which healthcare setting is most appropriate. This research presents CareLens, a privacy-first healthcare navigation system designed to improve cost transparency and decision-making before a patient seeks treatment. The platform uses an agentic reasoning architecture that evaluates de-identified symptom descriptions, geographic location, and optional insurance information to recommend appropriate care settingssuch as urgent care versus emergency departmentswhile providing estimated price ranges derived from hospital price-transparency files, CMS datasets, and publicly available insurance coverage data. The system incorporates safety guardrails that prevent diagnostic outputs and focuses exclusively on logistical and financial guidance. CareLens also prioritizes privacy by processing only de-identified inputs and avoiding the storage of protected health information, supporting HIPAA-aware design principles. By presenting understandable cost ranges and nearby care alternatives, the platform aims to reduce delayed treatment, unexpected medical bills, and inefficient healthcare utilization. Importantly, improving access to transparent cost information may disproportionately benefit uninsured and underserved populations who are most affected by healthcare price opacity. Overall, this research explores how AI-assisted healthcare navigation tools can improve patient decision-making and support more equitable access to medical services.

Keywords: AI, Healthcare, Transparency, Estimation, Agentic Systems

#28. Autonomous Multi-Robot Navigation in Constrained 3D Environments via Soft Actor-Critic Reinforcement Learning on Physical QBot Platforms

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Mentor(s): Dr. Yujian Fu
Department of Electrical Engineering & Computer Science

This project presents a reinforcement learning (RL) framework for multi-robot path generation and collision avoidance implemented on physical Quanser QBot platforms. Navigating constrained 3D environments in the real world introduces significant challenges, including sensor noise, asynchronous communication, and the necessity of maintaining physical safety buffers. We address these by formulating the navigation task as a Multi-Agent Markov Decision Process (MMDP), focusing on the deployment of a Soft Actor-Critic (SAC) algorithm to handle continuous action spaces for smooth, precise motion control. Unlike simulation-only studies, our approach prioritizes safe exploration and high sample efficiency to minimize hardware wear while ensuring effective collision avoidance between agents and environmental obstacles. We specifically evaluate the performance of SAC in maintaining a strict 3 cm safety buffer during high-density navigation tasks, comparing its adaptability against Proximal Policy Optimization (PPO) baselines. Experimental results demonstrate that the learned RL policies enable a team of QBots to achieve cooperative, collision-free paths with high success rates and optimized mission completion times. This work highlights the viability of deep reinforcement learning for robust, real-time coordination in physical multi-robot systems.
Keywords: Multi-Agent Reinforcement Learning (MARL), Soft Actor-Critic (SAC), Quanser QBot, Collision Avoidance, Real-World Robotics

#29. Design and Fabrication of a Rotational Biofield Sensor Element

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Mentor(s): Dr. Chance Glenn
Department of Electrical Engineering & Computer Science

This senior design project focuses on developing a rotational biofield sensor capable of detecting extremely weak physiological electromagnetic signals produced by biological processes such as neuronal activity, muscle contraction, and cardiac function. These signals occur at very low magnetic field strengths and are difficult to measure due to environmental noise and signal attenuation. The goal of the project is to design and construct a sensitive electromagnetic sensing system capable of detecting these low-frequency bioelectromagnetic fields without requiring direct contact with the body. The proposed approach uses a rotating coil electromagnetic induction sensor based on Faradays Law and principles from Maxwells Equations. By mechanically rotating the coil, a time-varying magnetic flux is created, increasing the induced voltage and improving sensitivity to weak signals. The project includes electromagnetic modeling, mechanical design, fabrication of multi-turn copper coils, and experimental testing using laboratory measurement equipment. The expected result is a portable and low-cost sensing platform capable of improving detection of weak bioelectromagnetic signals, with potential applications in noninvasive biomedical sensing and research.

Keywords: Bio-electromagnetic, Weak-signals, Noninvasive, Rotational Induction

#30. AppBot: An Interactive Humanoid Platform for Introducing Robotics and Programming

Edwin Smith, Eric Smith, Gabrielle Gray, Jeremiah Swanagan*

Mentor(s): Dr. Chance Glenn

Department of Electrical Engineering & Computer Science

This senior design project is to enhance the current design of a 3D printable humanoid robot. The project focuses on improving both the visual design and functional performance of the existing AppBot platform. The team will first assemble the current robot system to evaluate its mechanical structure, electronic integration, and motion capabilities. Based on this evaluation, the team will brainstorm and implement design improvements to components such as the frame structure, joint mechanisms, and control system. The goal is to develop a refined version of the AppBot that demonstrates improved stability, movement efficiency, and overall usability as an educational robotics platform. The team will validate the proposed improvements through a staged demonstration of the robots mechanical and electronic performance. This includes assembling the 3D-printed components, integrating the Arduino controller, servo driver board, Bluetooth module, and battery system, and programming the system to control the robots articulated joints using servo motors. Performance will be evaluated by testing coordinated movements and repeatable motion sequences uploaded through the smartphone Bluetooth interface. The final outcome will be a documented process showing the design improvements, system integration, and performance testing that demonstrate an enhanced and more reliable humanoid robotics platform.

Keywords: Humanoid robotics, design optimization, system integration, motion control, performance enhancement

#31. Enhanced MIT Coffee Can Radar with Integrated Infrared Imaging for Target Detection and Classification for Experiential Learning Platform

Isaac Anokye, Hidalgo Mudonhi*, Goodwill Kwenda**

Mentor(s): Dr. Delores Baker

Department of Electrical Engineering & Computer Science

This presentation presents an enhanced version of the MIT Coffee Can Radar platform that integrates a software-defined radio (SDR) and an infrared (IR) imaging sensor to create a low-cost, modular learning system for radar and signal processing education. Traditional radar systems used in research environments are often expensive, complex, and difficult for students to access, which limits opportunities for hands-on learning. The proposed system addresses this challenge by modernizing the original Coffee Can Radar architecture while maintaining its low cost and educational accessibility. The redesigned platform replaces several traditional analog radar components with an ADALM-Pluto SDR, allowing flexible waveform generation, digital signal processing, and easier system configuration. In addition

to radar sensing, a See3CAM infrared camera is integrated into the system to provide visual and thermal confirmation of detected targets. The radar subsystem operates using a frequency-modulated continuous-wave (FMCW) architecture to estimate the range and velocity of targets from reflected signals. Radar data is processed using digital dechirping and range-Doppler analysis to detect moving objects within the monitored environment. To complement the radar sensing, the infrared imaging subsystem captures RGB-IR image frames that highlight object features and contrast under infrared illumination. A lightweight sensor-fusion method aligns radar detections with infrared frames via timestamp synchronization and simple gating rules. This approach allows radar detections to be visually confirmed while keeping the system computationally efficient for instructional use. Preliminary testing shows that the system can detect and track moving targets while providing infrared confirmation of those detections. By combining SDR-based radar processing with infrared imaging, the platform provides students with a practical environment to explore radar principles, signal processing, and multi-sensor integration. The system serves as a reproducible educational platform that connects theoretical learning with real-world engineering experimentation.

Keywords: See3CAM, Software Defined Radio, Infrared Imaging, FMCW Radar, Hands-On Engineering Education

#32. iPhone Audio Amplification

Tyler Mason, Timothy Mack, William Hudson

Mentor(s): Dr. Xiao

Department of Electrical Engineering & Computer Science

This first phase of our project focused on taking a weak smartphone audio signal and boosting it with a discrete multi-stage BJT amplifier. We originally tried a simple two-transistor design, but it did not hold up once we tested real speaker loads using only a five-volt supply. After working through early problems, we shifted to a more structured analog layout that uses a differential pair at the input, a current mirror, a main gain transistor, and an emitter follower. This gave us the stability and predictable gain that the basic design could not provide. Several challenges helped us understand the circuit on a deeper level. One example was the one-hundred-ohm resistor that we placed in series with the speaker. It completely killed the output signal, and we had to revisit the load calculations to fix the issue. We also discovered that feeding the audio signal into the wrong base pulled the bias network down. Once we moved the input to the correct node of the differential pair, the circuit behaved the way the theory said it should. LTspice was a major part of this phase. It helped us check bias points, current sharing, and the small signal behavior of the amplifier. After correcting the main issues, the simulation finally showed clean and usable amplification from a typical smartphone output. We also added internal test points so that we can measure the important nodes once the hardware is built during the next phase. To keep the project grounded in real engineering practice, we followed several IEEE standards. These guided how we approached grounding, waveform measurement, and how test points should be organized for hardware debugging. This will help us when the circuit is moved onto a PCB. Overall, this stage of

the project produced a working schematic and a verified design that is ready for PCB layout, hardware fabrication, and testing in the second part of the course.
Keywords: Smartphone Audio Amplification, Multi-Stage BJT Audio Amplifier Design , Analog Signal Amplification

#33. AI and Autonomous Vehicle Research

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Department of Electrical Engineering & Computer Science

Autonomous navigation in multi-platform environments remains a central challenge in robotics, particularly when systems must operate reliably across simulation and real-world conditions. This project focuses on the development of leader-follower navigation algorithms for drones, mobile robots, and autonomous vehicles using Robot Operating System (ROS), Gazebo, and hardware platforms including QDrone, QBot, Arduino, Raspberry Pi, and autonomous car systems. The research integrates artificial intelligence and robotics to enable coordinated motion, adaptive decision-making, object detection, obstacle avoidance, and path planning in dynamic environments. The work emphasizes both simulation-based development and sim-to-real transfer, addressing the common gap between controlled virtual testing and physical deployment. Navigation behaviors were designed and tested in Gazebo before being implemented on hardware to evaluate performance under real-time constraints. Python and C++ were used to program intelligent control pipelines that supported perception, localization, and cooperative movement among aerial, ground, and vehicular agents. Special attention was given to multi-agent coordination, where leader-follower strategies improved group navigation efficiency and system responsiveness. Results demonstrate improved reliability in real-time navigation tasks, with enhanced path planning accuracy, obstacle avoidance capability, and coordination consistency across multiple robotic platforms. By optimizing sim-to-real performance, this research contributes to the advancement of scalable autonomous systems that can be deployed in practical applications such as surveillance, search and rescue, smart transportation, and collaborative robotics. Overall, the project highlights the value of integrating AI-driven control with robotics middleware to build adaptable and robust autonomous platforms.
Keywords: AI, Autonomous vehicle, AGI

#34. Fabrication and Characterization of the Thin Film Solid State Li-Ion Batteries

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Mentor(s): Dr. Satilmis Budak, Dr. Zhigang Xiao
Department of Electrical Engineering & Computer Science

Solid-state lithium-ion batteries are generally recognized as the emerging battery technology of choice for electronic devices that require the storage of electrical energy, which must

provide greater safety, thinness, and compactness compared to the conventional lithium-ion battery that utilizes a liquid electrolyte. This is unlike the standard lithium-ion battery that contains a liquid electrolyte, which can lead to more leakages and other burning dangers when the battery is mishandled under conditions of excessive heat. The advantages of the new battery technology are great benefits to the emerging battery technology, as the chances of leakage under the new battery are reduced, while there are fewer chances of battery burning when mishandled. The project was specifically focused on forming a strong fabrication and measurement process for the materials for a thin-film solid-state lithium-ion battery and, further, studying using this process the effect of low-temperature annealing on the electrical transport of these materials. The battery materials, which were included in the research for this project as specifically applicable to a solid-state lithium-ion battery, were LiCoO_2 as the cathode, LiPON as the solid electrolyte, Sn as the anode, and a stack of these materials as a single entity in a film format placed on silicon substrates utilizing electron beam evaporation as the means of creating these materials in film configurations. Electron beam evaporation was chosen because this process allows for the precise creation of these films and configurations and utilizes the smaller scale that must be used in the development of these films as the basis for the eventual development of these cells in a film format. The films then underwent annealing at 50^oC, 100^oC, and 150^oC for one hour each and an unannealed set as a reference point for the effect of annealing as opposed to the film process used to create these films themselves. To evaluate how annealing affected transport behavior, the project used a Van der Pauw measurement system to extract key electrical parameters: resistivity, sheet resistance, mobility, carrier density, and Hall coefficient. These measurements were complemented by current-voltage (I-V) characterization for each individual film and for the multilayer stack. Findings will be presented during the meeting.

Keywords: Solid-state Batteries, Thin-film Materials, Lithium-Ions

#35. N-Type and P-Type Semiconductor Filaments for FDM-Printed Electronics

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Mentor(s): Dr. Chance Glenn

Department of Electrical Engineering & Computer Science

This senior design project develops two functional composite filamentsone n-type and one p-typethat enable early-stage 3D printing of semiconductor elements and devices on a standard 1.75 mm multi-filament FDM printer. The filaments will be produced by embedding micro-powders derived from doped semiconductor wafers into printable polymer matrices and extruding them into diameter-controlled filament suitable for reliable feeding and extrusion. Prior work has verified that dopant type is retained after wafer grinding, shifting the primary engineering emphasis from whether doping survives to whether the composite filament can be manufactured, printed, and used to demonstrate device-level electrical behavior. Students will validate performance through a staged demonstration: (1) printing simple n-type and p-type elements and measuring I-V characteristics with extracted resistivity; (2) fabricating diodes and demonstrating repeatable rectifying I-V behavior; and (3) fabricating

transistor test structures and demonstrating three-terminal control with measured output and transfer characteristics. The final outcome will be a documented, repeatable process for filament fabrication and printing, along with measured electrical datasets and prototype device demonstrations that establish a platform for future printed-junction electronics.
Keywords: 3D printing, Semiconductor, FDM Printing

#36. Design and Simulation of Microwave Subsystems

Shanice Gray, Matthew Williams*, Keonna Peterson**
Mentor(s): Dr. Shujun Yang
Department of Electrical Engineering & Computer Science

The purpose of this senior design project is to design and simulate several microwave subsystems used in RF and microwave applications. Microwave/RF circuits behave differently from low frequency AC circuits. At low frequencies, the signal wavelength is much larger than the size of the circuit conductor, so a single wire can carry the signal. The voltage and current remain constant along the wire. However, at microwave frequencies(above 1 GHz), the signal wavelength becomes comparable to, or smaller than the size of the conductor. In cases like this, signals must be treated as traveling waves and must be transmitted through transmission lines such as coaxial cables and microstrip structures. As a result, Microwave/RF circuits require different structures and design methods than low frequency AC circuits. In this project, microwave subsystems including microstrip transmission lines, coplanar waveguides, and microstrip band-stop filters were designed and simulated to examine their performances.
Keywords: Microwave Systems, Microstrip Transmission Lines, Coplanar Waveguide (CPW), Bandstop Filters

#37. Building a Scaled Autonomous Vehicle Using the Quanser QCar2

Mercy Akinyemi, Yujian Fu**
Mentor(s): Dr. Yujian Fu
Department of Electrical Engineering & Computer Science

This project focuses on developing an autonomous vehicle platform using the Quanser QCar2 to simulate real-world driving scenarios in a controlled environment. The QCar2 is equipped with a comprehensive sensor suite including a 384-point LiDAR, CSI cameras, and an Intel RealSense RGB-D sensor, enabling it to perceive its surroundings and navigate a structured driving map. The platform serves as a scaled autonomous driving testbed, allowing real-world evaluation of perception, control, and learning algorithms similar to those used in full-scale self-driving vehicles. Current system capabilities include closed-loop speed control using motor tachometer feedback, LiDAR-based obstacle detection with dual-threshold emergency stopping (1.5 m safety zone and 0.5 m emergency zone), and vision-based lane following. Lane detection is implemented using HSV color space thresholding with region-of-interest cropping for yellow lane detection, followed by contour analysis and moment-based center-of-mass calculation for lane positioning. Vehicle steering and motion are regulated

using Proportional Integral (PI) control strategies. This system follows a perception-control architecture where visual and LiDAR sensors provide environmental perception, computer vision algorithms estimate lane position, and control strategies regulate steering and vehicle motion. These behaviors are currently implemented using rule-based methods with obstacle avoidance that analyzes left and right space availability for steering decisions. A key objective of this project is transitioning toward more intelligent navigation through the integration of Deep Learning and Reinforcement Learning. By collecting sensor data and analyzing vehicle responses under different driving conditions, this work aims to develop learning-based navigation strategies that allow the vehicle to adapt to dynamic environments while maintaining safety and reliability.

Keywords: Autonomous Vehicles, Computer Vision, LiDAR Sensing, Reinforcement Learning, Autonomous Navigation

#38. Semina: AI-Driven Intrusion Detection in SCADA/ICS Environments for Water Utilities

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Mentor(s): Dr. Ed Pearson, Rahmat Herron

Department of Electrical Engineering & Computer Science

Semina is an AI-powered intrusion detection system (IDS) engineered specifically for the unique constraints of small and public water utilities. Utilizing a machine-learning based anomaly detection engine powered by a Random Forest model, the system achieves a 99.1% AUC by training on 145 operational and security features. A core functionality of Semina is its ability to fuse Operational Technology (OT) data from physical infrastructure, such as pump levels, pressure junctions, and water quality metrics (pH, turbidity, and chlorine), with Information Technology (IT) telemetry, including firewall logs and remote access patterns. This data fusion enables more accurate, context-aware detection of cyber-physical threats, equipment failures, and potential contamination. Designed for reliability in rural or low-connectivity environments, Semina runs locally on dedicated hardware to ensure continuous real-time monitoring. It brings advanced threat detection to utilities that often lack dedicated cybersecurity resources, delivering practical, enterprise level protection tailored to the realities of public water systems.

Keywords: Intrusion Detection System, SCADA/ICS Security, Machine Learning, Cybersecurity

#39. CS Advisor

*Prashant Banjade**

Mentor(s): Dr. Yujian Fu

Department of Electrical Engineering & Computer Science

Academic advising plays a crucial role in helping students successfully navigate their degree programs; however, many advisors still rely on manual processes to track academic progress

and recommend courses. This project presents the development of the CS Advisor System, a web-based platform designed to assist professors and academic advisors at Alabama AM University in efficiently monitoring student progress and generating informed course recommendations. Requirement gathering was conducted through discussions with professors who currently advise students manually by referencing the undergraduate bulletin each semester. This process was identified as repetitive and time-consuming, requiring advisors to individually analyze each student's academic history to determine course eligibility and progression. These findings motivated the development of an automated solution that streamlines the advising workflow. The system was developed using React for the frontend and Node.js with Express for the backend, supported by a PostgreSQL database managed through Prisma ORM. An agile and iterative development approach was used, allowing features to evolve as advising requirements became more clearly defined. At the core of the system is a rule-based recommendation engine that analyzes completed coursework, grades, classification standing, and concentration to determine eligible courses, identify missed requirements from previous semesters, and suggest appropriate courses for upcoming terms. Course eligibility is determined by evaluating prerequisite completion, minimum grade thresholds, and classification requirements. The platform provides advisors with a centralized dashboard to review student academic records, identify unmet degree requirements, and receive tailored course recommendations. By automating a previously manual process, the CS Advisor System reduces administrative workload, minimizes advising errors, and supports more efficient academic planning.

Keywords: Academic Advising Systems, Course Recommendation System, Degree Progress Tracking, Web-Based Education Platform, Rule-Based Decision System

#40. Login Anomaly Detection Application (CampusShield)

Samone Oigbokie, Jeffery Dulaney*, Darius Johnson*, Nia Burnett*, Aiden Henderson*, Taylor Hall**

Mentor(s): Mr. Rahmat Herron, Dr. Ed Pearson

Department of Electrical Engineering & Computer Science

As organizations increasingly rely on digital systems and cloud-based services, protecting user accounts from unauthorized access has become a critical cybersecurity challenge. Traditional authentication mechanisms, such as passwords alone, are often insufficient to detect suspicious activity such as credential theft, brute-force attacks, or compromised account usage. This project presents the development of a login anomaly-detection application that uses machine learning and behavioral analysis to identify unusual login behavior. The application analyzes authentication data, including login time, IP address, geographic location, device type, and number of failed login attempts to establish patterns of normal user activity. A synthetic dataset of login events is used to simulate both normal and suspicious login scenarios. Using these labeled examples, a machine learning classification model is trained to distinguish between normal and potentially malicious login attempts. To support real-time monitoring, the system includes an interactive user interface that allows administrators to view login activity, risk scores, and flagged anomalies through a dashboard. The interface

provides visual alerts and summaries of suspicious login attempts, enabling faster identification of potential threats. This application demonstrates how machine learning, combined with an intuitive monitoring interface, can enhance security by detecting abnormal login behavior and enabling proactive threat response.

Keywords: Cybersecurity, Wi-Fi Security, Login Anomaly Detection, Machine Learning, Network Security

#41. Characterization of Radiation-Induced Defects in InAs for Space-Based Infrared Detectors

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Mentor(s): Dr. Claudiu Muntele, Dr. Jonathan Lassiter, Dr. Satilmis Budak
Department of Electrical Engineering & Computer Science

Ion irradiation in infrared detectors degrades performance by generating atomic-scale defects that impact electrical and structural properties. This work aims to characterize irradiation-induced defects in InAs and related materials through a combination of experimental techniques and modeling to establish damage equivalence among various ion species found in radiation environments, such as space. We will investigate the effects of bombardment with protons, C, and Si. We used SRIM, a Monte Carlo modeling package, to simulate the accumulation of damage in these materials for the purposes of guiding ion bombardment experiments and interpreting characterization results. Targeting fluences in the range of 10 9 -10 ions/cmtypical for III-V deviceswe emphasize materials characterization before and after irradiation. Fourier Transform Infrared (FTIR) Spectroscopy and Raman Spectroscopy are used to analyze the energetics of induced defects, with Raman being particularly sensitive to pre- existing and irradiation-induced defects. Additional techniques, including X-ray Photoelectron Spectroscopy (XPS) for elemental and chemical state analysis and ion channeling, will further clarify structural changes. By examining defect formation, charge trapping, and localized strain effects, this study provides insights into how irradiation impacts carrier mobility and conductivity in InAs, contributing to the broader understanding of semiconductor radiation effects. SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525.

Keywords: Ion irradiation, InAs semiconductors, radiation damage, SRIM simulation

#42. PhishGuard: AI-Powered Phishing Detection for Students and Everyday Users

Goodluck Badewole, Ibrahim Bello*, Gabriel Chambers*, Asia Harris*, Amber Jamison*, Taylor Pippins**
Mentor(s): Dr. Ed Pearson
Department of Electrical Engineering & Computer Science

As phishing attacks continue to evolve, students and everyday email users remain frequent targets of scams disguised as job offers, delivery notifications, and account alerts. These attacks often lead to identity theft, financial loss, and compromised personal information.

Many existing security tools are designed for enterprise environments and can be overly complex, technical, or overwhelming for individual users. Our project addresses this gap by proposing PhishGuard, an AI-powered phishing detection prototype focused on simplicity, clarity, and user understanding. This solution aligns with the Network Security focus area of AI-Based Phishing Detection, which emphasizes the use of NLP and deep learning to detect phishing emails, websites, and social engineering attempts. PhishGuard is designed to analyze email content and behavioral patterns using artificial intelligence techniques. The system aims to identify suspicious language, impersonation attempts, malicious links, and other forms of social engineering while providing clear explanations for why an email may be risky. By emphasizing explainable alerts and beginner-friendly setup, the prototype seeks to reduce alert fatigue and empower users to make informed decisions about potential threats. This project demonstrates how AI can be leveraged to enhance everyday cybersecurity in an accessible and user-focused way. PhishGuard highlights the potential for AI-driven tools to support safer email practices without requiring advanced technical knowledge. Future development would include user testing, dataset expansion, and refinement of the detection model to improve accuracy and usability.
Keywords: AI, Phishing, Cybersecurity

#43. Artificial Intelligence in Education: A Systematic Review of Methodologies and Their Impact on Learning Outcomes (2015–2025)

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This paper examines the evolution of Artificial Intelligence (AI) and its growing role in education between 2015 and 2025. It discusses key AI methodologies, including machine learning and deep learning, and explains how these technologies have enabled systems to analyze large datasets and improve decision-making. The study also explores the application of AI in education through tools such as adaptive learning platforms, intelligent tutoring systems, and predictive analytics, which support personalized learning and improved instructional outcomes. Additionally, the paper highlights challenges associated with AI adoption, including data privacy, bias, and ethical considerations. Overall, the study provides an overview of recent AI developments and their impact on modern educational practices.
Keywords: Adaptive Learning, Machine Learning, Artificial Intelligence in Education

#44. Fabrication and Characterization of Thin Film Multilayer Thermoelectric Devices

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Mentor(s): Dr. Satilmis Budak, Dr. Zhigang Xiao
Department of Electrical Engineering & Computer Science

The objective of this project is to use nano-engineering and nanofabrication to develop nanostructured thermoelectric materials for application in high-efficiency thermoelectric power

generators and solid-state micro cooling devices. Multi-nano-layered super-lattice thin films of Bi2Te3/Sb2Te3 were grown using ultra-high vacuum-based deposition methods for achieving a high thermoelectric figure of merit, ZT. To significantly increase the ZT value, the values of the Seebeck coefficient and electrical conductivity should increase while the thermal conductivity should decrease for the efficient thermoelectric generators and thermoelectric coolers. Bi2Te3/Sb2Te3 multilayer thermoelectric devices were fabricated and these samples addition to the previous single layers of Bi2Te3 and Sb2Te3 samples were characterized. The planned characterization techniques listed as: Seebeck Coefficient, Thermal Conductivity, four probe Hall effect measurements, SEM/EDS, XPS/Raman, I-V Characterizations, Impedance Measurements. After the characterizations are performed, the nanofabrication of the thermoelectric devices will be performed using the best recipe for the high efficient thermoelectric devices. The findings will be shared during Stem Day.
Keywords: Thermoelectric Devices, Semiconductor Characteristics, Seebeck Measurements Van Der Pauw Measurements.

#45. The Art of Search: Algorithms That Power Discovery

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The Art of Search, also known as the Algorithm Showcase, is an interactive learning tool that demonstrates complex search and pathfinding algorithms such as Breadth-First Search (BFS), Depth-First Search (DFS), Iterative Deepening Depth-First Search (IDDFS), A* Search, Simulated Annealing, and Genetic Algorithms. The program visualizes how each algorithm explores a search space, allowing users to observe differences in the processes they use, their efficiency, and their effectiveness in finding solutions. While some algorithms may guarantee optimal paths, others prioritize speed or adaptability, making this comparison extremely valuable for understanding their real-world applications. Developed in Java, the application uses JPanels to create a graphical user interface (GUI) that improves usability and accessibility. Users can also modify obstacle placement, adjust the speed of algorithm execution, and customize the starting position, goal location, and size of the search grid. These features help to provide an hands-on learning experience that not only encourages experimentation but also leads to a deeper understanding. The tool is designed to remain intuitive and accessible, even for users with very limited technical experience. Ultimately, it serves as both a teaching aid and a demonstration of how algorithmic strategies can be applied to real-world problems.
Keywords: Computer Science, Search Algorithms, Education

Food and Animal Sciences

#46. Bioactive and Antioxidant Properties of Capsicum annuum L. (Bird's Eye Chili): A Promising Functional Food Ingredient

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Capsicum annuum L. (Birds eye chili) is a pungent spice rich in capsaicinoids, phenolics, and flavonoids, recognized for its health-promoting properties. The present study investigates influence of solvent polarity on extraction efficiency and antioxidant potential of Birds eye chili. Extracts were prepared using 80% ethanol and distilled water and were evaluated for total phenolic content (TPC), total flavonoid content (TFC), and antioxidant capacity using DPPH (2,2- diphenyl-1-picrylhydrazyl), FRAP (Ferric reducing antioxidant potential), nitric oxide radical scavenging (NORS), and Trolox equivalent antioxidant capacity (TEAC) assays. The aqueous extract exhibited markedly higher TPC (791.59 mg gallic acid equivalents (GAE)/100 g) and TFC (213.72 mg quercetin equivalents (QE)/100 g) compared to ethanolic extract (471.5 mg GAE/100 g and 126.55 mg QE/100 g), suggesting that a polar solvent is more efficient in extracting phenolic and flavonoid compounds. In contrast, ethanol extract demonstrated stronger DPPH radical scavenging activity (66.52%) compared to aqueous extract (44.99%), indicating that ethanol may extract non-polar antioxidants with higher radical-quenching efficiency. FRAP values further supported enhanced reducing power of aqueous extract (172.21 mM Fe (II)/100g) compared to ethanolic extract (77.01 mM Fe (II)/100g). The results of this study show that Capsicum annuum L., has a high phenolic and flavonoid content that provides high antioxidant activity, suggesting that it could be used as a functional food ingredient. Its bioactive profile indicates that it may be effective in reducing diseases linked to oxidative stress, which will need more in vivo and bioavailability studies in future for nutraceutical applications.
Keywords: Antioxidant, Bioactive, Capsicum

#47. Hematologic Adaptations Associated with Lactation in Rabbits

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Rabbits are widely used for production and research, as well as companion animals. Evaluating physiological changes in rabbits during lactation and the post-weaning period is important for accurately interpreting hematologic values and evaluating maternal health. This research was conducted as part of course-based undergraduate research training. The objective was to assess changes in hematologic parameters associated with lactation by examining white blood cell differentials, erythrocyte indices, and platelet characteristics during the lactation period and after weaning. Adult female rabbits (n = 5) and their litters were monitored for five weeks (3 weeks lactation). Blood samples were collected from the marginal ear vein during lactation and again after weaning, and hematologic values were analyzed using an automated hematology analyzer. Data were analyzed using SAS. Physiological stage (lactation vs. post-weaning) was included as a fixed effect, and differences were considered

significant at $P \leq 0.05$ and a tendency at $0.05 < P \leq 0.10$. Lactation stage did not affect total white blood cells. However, lymphocyte counts tended to increase from lactation to post-weaning (1.13 vs. 2.18 × 10^9/L; P = 0.07), while the neutrophil-to-lymphocyte ratio tended to decrease (3.38 vs. 1.62; P = 0.10). Red blood cell counts (5.02 vs. 6.11 012/L; P = 0.06) and hematocrit (29.67 vs. 35.97 %; P = 0.09) tended to increase after weaning. Platelet distribution width decreased significantly from lactation to post-weaning for both PDW-CV (30.40 vs. 27.78 %; P = 0.002) and PDW-SD (7.90 vs. 6.45 fL; P = 0.003). These findings suggest that hematological variables, particularly lymphocytes, red blood cells, hematocrit, and platelet distribution are valuable parameters to quantify physiological adaptations to lactation in doe rabbits.

Keywords: Rabbit does, lactation, weaning, hematology

#48. Potential of Jujube (Ziziphus jujuba) as a Feedstuff for Livestock

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Jujube (Ziziphus jujuba), is a drought-tolerant fruit tree that has increasing potential as an alternative feedstock for livestock production. The objective of this study was to evaluate the nutrient composition and antioxidants in jujube fruit, leaves, and seeds. The plant parts were oven dried and used for proximate analysis using AOAC methods, the phenolic and flavonoid content were also determined using official methods. The data were analyzed using generalized linear method in SAS and tukey posthoc test to separate significant means. Results show that all the parts of jujube have moderate level of protein, fat and fiber with a significant level of phenolic and flavonoids which contributes to its antioxidant status. Conclusively, utilizing jujube leaves, pulp, seeds, and fruit offers further opportunities to reduce agricultural waste while supporting livestock nutrition. These by-products often contain antioxidants that may enhance rumen microbial activity, improve digestibility, and potentially promote animal health.

Keywords: Feedstuff, Jujube, Livestock.

#49. Exploring the Functional and Sustainable Potential of Classic and Shiitake Mushrooms as Natural Antioxidant Sources

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Mushrooms are increasingly recognized as sustainable sources of bioactive compounds with potent antioxidants and health-promoting properties. This study evaluated and compared the polyphenolic content and antioxidant potential of two edible mushroom varieties Classic (Agaricus bisporus) and Shiitake (Lentinula edodes) using two solvents, 80% ethanol and distilled water. Total phenolic content (TPC), total flavonoid content (TFC), and antioxidant

activities were analyzed using Ferric Reducing Antioxidant Power (FRAP), 2,2-diphenyl-1-picrylhydrazyl (DPPH), Nitric Oxide Radical Scavenging (NORS), and Trolox Equivalent Antioxidant Capacity (TEAC) assays. Shiitake extracts exhibited slightly higher phenolic content than Classic mushrooms, with TPC values of 532 mg GAE/100 g (ethanolic) and 476 mg GAE/100 g (aqueous) compared to Classic mushrooms (516.52 mg GAE/100 g and 401.32 mg GAE/100 g). Classic mushrooms had higher TFC in aqueous extracts (35.12 mg QE/100 g) than in ethanolic (24.28 mg QE/100 g), whereas Shiitake had opposite trend, showing 283.04 mg QE/100 g (aqueous) and 105.2 mg QE/100 g (ethanolic). FRAP values were higher in Classic ethanolic extracts (132 mM Fe (II)/100g) compared to Shiitake aqueous extracts (98.85 mM Fe (II)/100g), while DPPH scavenging activity was markedly higher in ethanolic extracts of both mushrooms 85.28% (Classic) and 86.86% (Shiitake) than their aqueous counterparts. Overall, Both Classic and Shiitake mushrooms exhibit rich phenolic and flavonoid content, contributing to strong antioxidant potential. Ethanol extracts showed higher bioactive recovery, emphasizing solvent polaritys role. Mushroom cultivation also supports sustainability by utilizing agro-waste in eco-friendly systems. Inhibitory effects of Mushrooms on selected enzymes make it suitable for monotherapy or in combination with other therapies to prevent chronic disorders. Future studies should optimize growth and environmental conditions to enhance bioactive yields and functional food potential.

Keywords: forestry waste, sustainability, mushroom

#50. Performance and Metabolic Responses of Rabbit Does During Lactation and Post-Weaning

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Mentor(s): Dr. Miriam Garcia

Department of Food and Animal Sciences

Rabbits are widely present in the United States, both in production systems and as companion animals. Understanding rabbit physiology is important for explaining biological responses during demanding stages such as lactation. This research was conducted as part of course-based undergraduate research training. The objective of this study was to evaluate performance and metabolic responses to lactation by assessing body weight, feed intake, plasma glucose, and plasma nitrite concentrations during lactation and post-weaning. Adult female rabbits (n = 5) and their litters were monitored for five weeks (3 weeks lactation). Feed intake and doe body weight were recorded weekly, and litter body weight was recorded until weaning. Blood samples were collected from the marginal ear vein during lactation and post-weaning to determine plasma glucose and nitrite concentrations using enzymatic assays. Data was analyzed using SAS. Physiological stage (lactation vs. post-weaning) was included as a fixed effect, and number of kits and days in lactation were included as covariates for glucose and nitrite, for intake and weight; week was the only fixed effect. Differences were considered significant at $P \leq 0.05$ and a tendency at $0.05 < P \leq 0.10$. Doe body weight tended to change across weeks (P = 0.06), increasing slightly during lactation but not during post-weaning. Litter body weight increased significantly with weight ($P < 0.01$), rising from 0.41 kg in week 0 to 1.48 kg by week 3. Weekly feed intake remained relatively constant (P =

0.84). Plasma nitrite concentrations decreased significantly from lactation to post-weaning (21.7 vs.13.3 μM; P = 0.04), while plasma glucose concentrations did not differ between stages (134.8 vs. 116.6 mg/dL; P = 0.42). In conclusion, does support increasing litter growth without body weight loss, suggesting adequate metabolic responses during lactation were sufficient to meet maternal and litter demands.
Keywords: Rabbit does, lactation, body weight

#51. A USDA Capacity Building Grant for Workforce Development: Utilizing Animal Feed Concentrates to Optimize Dairy Cattle Milk Production: Phase I

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With one billion tons of animal feed produced worldwide annually, the feed industry needs individuals who understand feed formulation. The AAMU National Dairy Challenge Team Virtual Training Session and Literature review, including journal articles, books, and North American Intercollegiate Dairy Challenge Resources, has been used to provide students with up to date-information on utilizing grains and other concentrate feed ingredients used in feeding animals used to produce food. In the cattle industry, concentrates ingredients are fed to raise the energy level of the ration for dairy cattle and to compensate for any other deficiencies that remain beyond those provided by the forage portion of the ration. Various energy sources can be used in diet formulation, although corn is the major dietary ingredient. The three basic groups for concentrate are cereal grains, protein sources, and by-product feeds. The feed type and the manner of preparation influence how the dairy cow uses these ingredients. The objective is finding the balance of energy, protein, and micronutrients that best complement the forage ration. Animal feed processing and formulation are challenge. A key technological advancement that the feed industry and producers are using in formulation of animal feed is the integration of computational models and artificial intelligence to determine accurate amounts of ingredients used to manufacture animal feed. MIXIT is one for several feed formulation programs that will be utilized in training AAMU students on identifying feed ingredients for use in manufacturing animal diets that could be fed to reduce feed costs, improve feed efficiency, and enhance animal performance. The software is used by the feed industry to determine animal rations and vitamins and minerals premixes based on the ingredients and nutrients that is required by animals.
Keywords: Capacity Building, Workforce Development, Feed Concentrates, Dairy Cattle

#52. UV Pulsed Light and Dehydration as Processing Strategies to Enhance the Nutritional and Physicochemical Attributes of High Protein Mushroom Crisps

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The growing demand for sustainable, nutrient-dense, plant-based snack foods highlights the need for innovative protein alternatives to conventional animal-based products. Edible mushrooms are a promising solution due to their high-quality protein content, bioactive compounds, and low environmental footprint.; However, limited research exists on how advanced processing methods affect their nutritional and physicochemical properties when developed into crisp snack products. This study investigates the impact of UV/-pulsed light exposure combined with osmotic dehydration, and drying techniques on the nutritional composition and physicochemical characteristics of high-protein mushroom crisp being developed. Selected mushroom varieties, including oyster, shiitake, and lions mane, are processed using controlled UV-pulsed light treatments followed by dehydration methods such as freeze drying. Nutritional analyses evaluate vitamin D_2 formation, vitamin C retention, protein content, and antioxidant capacity, while physicochemical assessments include texture, color, moisture content, and water activity. Instrumental texture analysis and color measurements are used to relate processing conditions to crispness and visual quality. The results of this research are expected to identify optimal processing parameters that enhance vitamin D_2 content and antioxidant activity while maintaining desirable texture and sensory attributes. Findings from this study will support the development of functional, protein-rich mushroom crisps and contribute to sustainable snack innovation by demonstrating how non-thermal light treatments and dehydration technologies can improve the nutritional value of mushroom-based foods.

Keywords: Pulsed light processing, UV treatment, Osmotic dehydration, Functional snack foods, Vitamin D_2 enrichment

#53. Downregulation of Mitochondrial Metabolism as a Driver for Fetal Adaptation to Maternal Nutrient Restriction During Gestation in Bos taurus

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Nutritional stress in Bos taurus occurs when nutrient intake is inadequate or imbalanced, disrupting essential metabolic processes and growth. Such deficiencies are common in cow-calf operations and can have lasting impacts on fetal development. This study aimed to identify cellular pathways influenced by maternal nutrient restriction during gestation. Thirty-six fetuses were examined from dams receiving either a restricted (RES) or adequate (ADQ) diet from day 160 to 240 of gestation. At day 240, dams underwent Cesarean section for fetal removal and tissue collection. Liver samples were sequenced using Illumina platforms and analyzed with DESeq2 ($|log2FC| \geq 1$, Padj $\leq$ 0.05). A total of 2,327 genes were differentially expressed between groups-1,106 upregulated and 1,221 downregulated in RES

vs. ADQ fetuses. KEGG pathway analysis revealed significant downregulation in four mitochondrial metabolic pathways: oxidative phosphorylation (53 genes, 52 downregulated; Padj $< 5.07e-10$), thermogenesis (69 genes, 59 downregulated; Padj $< 8.08e-9$), non-alcoholic fatty liver disease (42 genes, 40 downregulated; Padj $< 5.18e-6$), and ribosome (76 genes, all downregulated; Padj $< 6.68e-9$).These findings indicate that fetal adaptations to maternal nutrient restriction are associated with suppressed mitochondrial metabolism, suggesting a shift toward energy conservation to sustain essential biological functions under limited nutrient conditions. Funded by NIFA CBG 2021-38821-34599.

Keywords: Mitochondrial Metabolism, Nutrient Restriction, Fetal Programming

#54. Development of a Value-Added Venison Sausage Using Quinoa as a Functional Ingredient

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Department of Food and Animal Sciences

Venison sausage is an alternative, healthier option to traditional meat products, without compromising flavor, combining traditional methods with modern nutrition in a convenient way. This study explores the use of quinoa in venison sausage recipes as a fat alternative. Venison is considered a healthy muscle food source due to its higher protein content, lower intramuscular fat, and cholesterol content when compared to beef or pork. However, fat may be considered necessary for the satisfactory development of desired characteristics, particularly related to texture, juiciness, and flavor. Quinoa seeds are a rich source of unsaturated fats, dietary fiber, complex carbohydrates, minerals, and bioactive compounds, including carotenoids, vitamin C, and polyphenols, which may be used as functional ingredients to replace fat in meat products such as dry-cured sausages and burgers. The study includes four treatment groups: control, quinoa, tallow, and quinoa plus tallow. Physicochemical properties, including moisture content, pH, water-holding capacity, texture profile analysis, and color, were measured for all treatment groups. Results showed that the control group had the highest pH (6.45), whereas the tallow group had the lowest (6.03). Similarly, water activity was highest in the control groups (0.903), compared to the tallow groups (0.874), which may influence shelf-life. In addition, the quinoa plus tallow retained more moisture than the control, indicating a greater water-binding capacity. Colorimetric analysis revealed that the tallow and quinoa plus tallow treatments resulted in considerably lighter external surfaces (L* 26.61) with increased redness (a* 11.12) compared to the control (L* 23.07, a* 9.4). Interior color assessments revealed that all treatments maintained similar lightness values, with tallow formulations demonstrating superior color stability. The study findings conclude that smart formulation changes can significantly improve the quality, moisture retention, and visual appeal of venison sausage which should increase overall acceptability and healthier choices for consumers.

Keywords: venison, protein, sausage, quinoa, functional foods

#55. Effects of Selected Processing Methods on Phytochemical Content and Antioxidant Capacity of Tiger Nut (Cyperus esculentus)

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Tiger nut is the edible tuber of Cyperus esculentus L., a perennial sedge plant native to North Africa and widely cultivated today in Spain and West Africa for its nutritional and functional properties. Tiger nuts contain bioactive compounds, including polyphenols (phenolic acids and flavonoids) and are rich in fiber/resistant starch, associated with antioxidant activity. Common processing techniques such as boiling, blanching, roasting, drying, and fermentation can leach, degrade, transform, or liberate phenolics and generate Maillard reaction-derived antioxidants. However, comparative research in tiger nuts remains limited and few studies connect chemical composition changes to functional outcomes. Aim was to evaluate the effect of commonly used processing methods on the phytochemical content and antioxidant capacity of tiger nuts. 80% ethanol (ET) extracts of processed tiger nuts were prepared using standard protocol. Phytochemical content was determined using total flavonoid content (TFC) and total phenolic content (TPC) assays. Antioxidant potential was determined using 2,2-diphenyl-1-picrylhydrazyl (DPPH) and Ferric Reducing Antioxidant Potential (FRAP) assays. TFC (7.51-13.42 mg C.E./100g DW), DPPH % inhibition ($μg/mL) (23.95%-71.69%) and FRAP (23.71-37.62 mM F.E. (II)/100g DW) were highest in the roasted samples, while TPC (733.33-1596.61mg G.A.E./100g DW) was highest in the blanched samples. Significance of this research is to determine the effect of common processing methods on tiger nut bioactive retention and antioxidant capacity, thereby identifying processing conditions that optimize functional quality for industrial processing and formulation of tiger nut-based foods and beverages.

Keywords: Tiger Nuts, Processing, Antioxidants, Phytochemicals

#56. Transition stress: An Unavoidable Stressful in Livestock industry

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Transportation Stress: An Unavoidable Stressor in Livestock Industry Myana Chenier, August Ragland and Nathaniel Ogunkunle Abstract Transportation is an essential component of modern livestock production systems, enabling the movement of animals from farms to markets, feedlots, and slaughterhouses. However, it represents one of the most significant and unavoidable stressors affecting livestock welfare and productivity. This study evaluated the impact of transportation on the physiological and antioxidant status of beef cattle. Twenty (20) Black Angus heifers were randomly allotted to either control (CON: loaded and unloaded from the trailer without transportation) or transport(TRAN: transported for 150 miles), with 10 animals per group. Vital parameters and blood samples were collected at three time points: baseline (prior to transportation), immediately after transportation and 24 hours post-transportation. Plasma was extracted from the blood samples and analyzed using enzyme linked immunosorbent assay to determine the concentrations of biomarkers of oxidative stress. Data were analyzed using mixed model procedure in SAS 9.4. There was weight loss or shrink in the animals after transportation regardless of the transportation duration. Vital parameters increased after transportation but returned to normal levels within 24 hours. The transported animals had lower antioxidant capacity with elevated lipid peroxidation and lower antioxidant enzymes when compared to the control group. In conclusion, transportation cannot be completely eliminated from livestock production systems, its negative effects can be minimized through improved management practices.

Keywords: Translation , stress, livestock

#57. Effects of Dehulled Hempseed Products on Sheep Monocyte-Derived Macrophages Immune Function and Metabolism

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Department of Food and Animal Sciences

Hempseed products contain bioactive compounds that may influence immune responses in small ruminants, but their effects on immune function is not well understood. The objective was to evaluate the effects of dehulled hempseed (HS) and hempseed meal (HSM) extracts on immune and metabolic responses of sheep monocyte-derived macrophages (MDM). MDM were derived from peripheral blood mononuclear cells isolated from blood collected from six mature ewes and differentiated by culturing adherent monocytes for 7 days prior to treatment. Cells were treated with HS or HSM extracts at three doses (100, 500, and 2,500 μg/mL). MDM functional activity was evaluated through phagocytosis and oxidative burst using fluorescence-based assays. Glucose concentration and nitric oxide production were measured in the spent media using enzymatic assays. Data were analyzed using SAS, comparisons with the control were conducted using Dunnetts test, and effects of product (HS vs. HSM), dose, and their interaction were evaluated. Differences were considered significant at $P \leq 0.05$ and a tendency at 0.05

Keywords: hempseed, macrophages, immune function, sheep

#58. Functional and Antioxidant Potential of Adansonia digitata (Baobab) Powder.

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Adansonia digitata (Baobab) is a nutrient-dense fruit recognized for its rich phytochemical composition and health-promoting properties. This study evaluated the antioxidant potential and bioactive compound content of Baobab powder extracted using two solvents80% ethanol and distilled waterto explore its functional food applications. Total phenolic content (TPC), total flavonoid content (TFC), and antioxidant activities were assessed using DPPH (2,2- diphenyl-1-picrylhydrazyl), FRAP (Ferric reducing antioxidant potential), nitric oxide

radical scavenging (NORS), and Trolox equivalent antioxidant capacity (TEAC) assays. The ethanolic extract exhibited higher phenolic (589 mg GAE/100 g) and flavonoid (294.79 mg QE/100 g) contents compared to the aqueous extract (580 mg GAE/100 g and 184.17 mg QE/100 g, respectively). Correspondingly, the ethanolic extract demonstrated superior antioxidant activity across multiple assays, with DPPH radical scavenging (81.92%) and FRAP reducing power (105.74 mM Fe (II)/100g) exceeding those of the aqueous extract (51.69% and 93.13 mM Fe (II)/100g). These findings indicate that Baobab powder is a potent natural source of polyphenolic and flavonoid compounds with strong antioxidant capacity, supporting its potential as a functional food ingredient. The higher efficacy of ethanol extraction suggests that solvent polarity influences bioactive recovery and antioxidant performance. Overall, Baobab demonstrates promising utility in the development of nutraceuticals, functional formulations, and innovative functional food products aimed at combating oxidative stress and promoting metabolic health.

Keywords: Baobab, Functional food, Antioxidant, Metabolizing Enzymes

#59. Effect of Printing Temperature on the Physical Properties of Soy Protein Isolate-Enriched Cookie Dough for 3D-Printing

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Mentor(s): Dr. Lamin Kassama

Department of Food and Animal Sciences

This study examined the effects of processing temperature on soy protein isolate (SPI)-enriched cookie dough for 3D food printing, modeled after a traditional vanilla wafer cookie. The objective of this research was to determine whether SPI could be incorporated into a sweet baked product while maintaining desirable quality attributes such as color and texture. Three formulations were evaluated to assess the influence of SPI substitution, including a control formulation containing 100% flour, a formulation containing 50% flour and 50% SPI, and a formulation containing 100% SPI. The dough samples were extruded using a 3D food printer to create consistent shapes and structures, and the printed cookies were subsequently baked in a conventional oven to simulate traditional baking conditions. Two printing temperatures, 25C and 50C, were tested to determine their effects on the dough's physical properties and the final baked product. Color analysis was conducted before and after baking to assess changes in product appearance, while texture profile analysis (TPA) was conducted using a texture analyzer. Each formulation and temperature condition was tested in triplicate to ensure the reliability and consistency of the results. The statistical analysis was conducted using SAS 9.4 using a 95% confidence interval. The results indicated that both printing temperature and formulation influenced the color and texture of the cookies after baking. Overall, the results demonstrate the potential to incorporate soy protein isolation into 3D-printed cookie formulations while maintaining characteristics comparable to those of a traditional vanilla wafer cookie.

Keywords: 3D food printing, soy protein isolate, processing temperature, cookie formulation, color analysis, texture analysis, protein-enriched foods

Mechanical & Civil Engineering and Construction Management

#60. Cadmium Zinc Telluride (CZT) Radiation Detector

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Mentor(s): Dr. Jonathan Lassiter, Dr.Rodney Pinder

Department of Mechanical & Civil Engineering and Construction Management

Radiation detection is an essential tool for environmental monitoring, nuclear safety, homeland security, and medical research. Many traditional gamma-ray detection systems rely on scintillation detectors paired with photomultiplier tubes. While effective, these systems can be large, costly, and difficult to deploy in portable field applications. This project investigates the design and development of a portable Cadmium Zinc Telluride (CZT) semiconductor gamma-ray detection system intended to improve portability while maintaining high measurement accuracy. CZT semiconductor materials directly convert incoming gamma radiation into electrical signals, eliminating the need for bulky optical components or cryogenic cooling systems commonly required in other detector technologies. The proposed detector integrates a CZT crystal, signal pre-amplification electronics, and a single-board computer used for data acquisition and analysis. The system is capable of performing real-time pulse height and count-rate measurements. Experimental validation included inspection and preparation of the CZT crystal, surface polishing to improve charge collection efficiency, and analysis of current-voltage (I-V) characteristics to verify detector functionality. Calibration and testing procedures were conducted in accordance with ASTM and IEC engineering standards to ensure measurement reliability, electromagnetic compatibility, and operational safety. The system was designed to achieve an energy resolution of $\leq 2.5\%$ Full Width at Half Maximum (FWHM) at 662 keV while maintaining a handheld device weight of less than three pounds. Preliminary results demonstrate that CZT-based detectors can offer improved portability and strong energy resolution compared to many conventional scintillator-based systems. The development of compact radiation detection devices has important applications in environmental monitoring, nuclear safeguards, and rapid-response radiation assessment in field environments.

Keywords: Cadmium Zinc Telluride (CZT), Gamma-Ray Detection, Semiconductor Radiation Detector, Energy Resolution, Portable Radiation Monitoring

#61. MotorSports Engineering and Rover (HERC) Competition

Carlie Seibert , Samuel Johnson *, Joshua Stricklen, Joel Friedman, Daniel Jones**

Mentor(s): Dr. Chan

Department of Mechanical & Civil Engineering and Construction Management

Through our participation in the Rover and FSAE competitions, we have developed valuable engineering and technical skills. These experiences allowed us to work with electrical circuits, build and test systems using breadboards and Arduino microcontrollers, and apply hands-on problem-solving in real engineering projects. In the Rover competition, we collaborated to design and build our own rover, integrating mechanical and electrical systems. In the

FSAE competition, we contributed to the process of designing and building a formula-style race car. This demonstration highlights the practical knowledge, teamwork, and engineering experience we gained through these competitions.

Keywords: Engineering, Fabrication, Design, FSAE, NASA

#62. Mars Entry, Descent, and Landing Simulation — A Multiphase MATLAB Analysis

Isaiah Thompson, Joshua Strickland*, Abdoulie Bojang*, Peter Bryant**

Mentor(s): Dr. Pinder

Department of Mechanical & Civil Engineering and Construction Management

This project delivers a high-fidelity computational simulation of a Mars Entry, Descent, and Landing (EDL) sequence, built entirely in MATLAB. With full-scale EDL testing being physically and financially prohibitive, both on Earth and Mars, we aim to verify and validate our simulation to directly addresses that need. The simulation resolves each mission-critical EDL phase from first principles: atmospheric entry dynamics with aerodynamic drag and convective heating, parachute deployment modeled under both discrete-stage and continuous reefing formulations, heat shield jettison sequencing, retropropulsion burn mechanics, and terminal touchdown via a spring-damper landing leg model. Every phase was implemented as a coupled dynamical system, not a lookup table, not a simplified approximation. To quantify system robustness, a Monte Carlo analysis was integrated across thousands of simulated entry scenarios, sweeping parametric uncertainty in atmospheric density, deployment timing, and vehicle state. This statistical sweep revealed the dominant sensitivities driving landing success probability. Insights that no finite set of hardware tests could realistically produce at this scale. Results validate the proposed EDL architecture and pinpoint parachute deployment timing and atmospheric density variation as the highest-leverage design drivers. Developed as a senior design capstone at Alabama AM University, this work applies rigorous aerospace engineering methodology to one of the most dynamically complex and unforgiving mission profiles in planetary exploration.

Keywords: Matlab, modeling, simulation, reentry dynamics, Mars

#63. Autonomous UAV-UGV Rendezvous and Precision Landing via Visual-Inertial Odometry

Miguel Andres Alasia Garcia* Isaiah Thompson* Makarios Etheridge* Jamal Newberry II* Jaushwa Sutton* Vance Price**

Mentor(s): Dr. Pinder

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This project presents a GPS-denied autonomous landing system in which an Unmanned Aerial Vehicle (UAV) must detect, intercept, and land on a moving Unmanned Ground Vehicle (UGV), developed under sponsorship from Raytheon. In environments where GPS is unavailable or unreliable, the system relies on a Visual-Inertial Odometry (VIO) pipeline

built around an OAK-D stereo camera and VINS-Fusion running on a Raspberry Pi 5, providing real-time pose estimation fused directly into the UAVs flight controller via MAVLink. This approach replicates the navigation demands of real-world contested environments where adversaries may deny or spoof GPS signals. The project is structured around three progressive challenges. The first challenge requires the UAV to manually fly and land on a moving UGV. The second challenge introduces full autonomy the UAV must independently navigate to an ArUco marker located in an open field and execute a precision landing on the moving platform without human input. The third and most complex challenge combines all prior elements while adding active obstacle avoidance, requiring the UAV to navigate through a dynamic environment, locate the marker, and land on the UGV simultaneously. To support obstacle detection and avoidance on the UGV, the system integrates a BrainChip neuromorphic processor, enabling low-latency, event-driven perception without the power overhead of traditional vision processing. On the UAV side, ArUco marker detection serves as the terminal guidance mechanism during final approach, while the CubeOrange Plus flight controller running ArduPilot ingests the VIO-derived external navigation solution through EKF3, blending visual and inertial measurements to maintain stable localization throughout the intercept trajectory. This system demonstrates a fully integrated hardware-software autonomous rendezvous architecture with direct applicability to defense logistics, contested battlefield resupply, and GPS-degraded reconnaissance operations core mission areas for Raytheon and its customers.

Keywords: UAV, UGV, autonomous flight, autonomous navigation, GPS denied

#64. Analysis, Importance and Benefits of Green Building

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Mentor(s): Dr. Tamara Chowdhury

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A Green Building or Net-Zero Energy Building (NZEB) can be residential or commercial building with greatly reduced energy needs. In such a building, efficiency gains have been made such that the balance of energy needs can be supplied with renewable energy technologies. The energy used by the building sector continues to increase, primarily because new buildings are constructed faster than old ones are retired. Recent EIA (Energy Information Administration) analysis shows several major factors increasing electricity demand, such as data centers and computing infrastructure; Al and cloud computing workloads and electrification of heating and building systems. Computing already accounted for about 8% of commercial electricity use in 2025, and EIA projects it could reach 20% by 2050. Energy consumption in the commercial building sector will continue to increase until buildings can be designed to use energy efficiently and produce enough energy to offset the growing energy demand of these buildings. There are numerous benefits associated with green building practices, which can have positive impacts on the environment, economy, and the well-being of occupants. Green buildings can reduce energy consumption by 30-40% compared to traditional buildings. Green buildings can reduce water consumption by 20-30%. Green buildings can reduce CO2 emissions by up to 35%. The average operating cost savings in the first year for new green buildings is 10.5%. Over a five-year period, green buildings see an average operating cost reduction of 16.9%. Owners report that green buildings and renovations have an increased asset value of over 9%. Occupants report 36% higher satisfaction in sustainably designed buildings, reflecting improved comfort and workplace experience. This paper analyzes the importance and benefits of Green Building and will provide some case study and statistical analysis of Green Building usage in United States.

Keywords: Green Building, Energy Consumption, Environmental Impact

#65. Drone Integration for Civil Engineering Education and Workforce Preparation

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Drone technology is rapidly transforming engineering practices as its capabilities expand across multiple disciplines. With the ability to integrate specialized gimbals, thermal sensors, and high-resolution imaging systems, drones have become valuable tools for infrastructure inspection, environmental monitoring, surveying, and data collection. As a result, engineering firms are increasingly adopting drone technology to improve efficiency, safety, and quality of technical assessments. Institutions of higher education must adapt to these advancements to ensure students are prepared to meet evolving industry expectations. Alabama AM University has a strong opportunity to equip Civil Engineering students with remote pilot skills and hands-on experience using emerging technologies shaping professional practice. This proposal introduces drone technology into the Civil Engineering Department to enhance technical training, strengthen experiential learning, and improve career readiness. This initiative aims to maximize opportunities for growth at the university while positioning students from an HBCU to remain competitive in a technology-driven workforce. Implementation of this proposal involves acquiring a professional-grade drone and integrating its use into coursework and student projects. This approach expands hands-on learning while aligning the program with current industry practices. Ultimately, incorporating drone technology will better prepare civil engineering graduates with relevant, marketable skills and enable them to support safer, more efficient, and environmentally responsible engineering solutions.

Keywords: Innovative, Applied, Sustainable, Technological, Transformative

#66. Enhancing Civil Engineering Site Evaluations Through Drone Technology

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Drones have become increasingly valuable across many fields, with ongoing discoveries of how drone technology can be applied to real-world situations. The technology has advanced to the

point that drones are now a powerful tool in civil engineering. Civil engineers are responsible for designing safe, sustainable, and economical projects. By integrating drone operations into civil engineering practices, engineers can improve safety through remote inspections, enhance sustainability by assessing environmental conditions, and increase economic efficiency through timely and accurate data collection. Site evaluations in civil engineering are traditionally time-consuming, costly, and in some cases risky. However, drone technology allows engineers to conduct more efficient assessments using high-quality visuals and reliable data. The purpose of this project is to evaluate how drone technology can be used to collect data and enhance site evaluations. Our approach included careful flight planning and adherence to legal operating requirements. Understanding authorization rules at Brookhaven National Laboratory was essential, as conducting this research required special approval from the Department of Energy. Each flight mission was designed to capture infrastructure imagery using both visible and thermal imaging. Once the imagery was collected, it was analyzed and applied to relevant civil engineering applications. This project demonstrates how drone technology can support more efficient and informed engineering decisions. Future work will focus on refining the data analysis process and expanding drone operations to further assist engineers in addressing complex infrastructure and site challenges.

Keywords: Unmanned Aerial Systems (UAS), Site Evaluation, Infrastructure Assessment, Remote Sensing, Sustainability

#67. Collective Impact of Landscape and Climate Change on Regional Water Bodies between 2000 and 2020

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Climate change is increasingly overtaking landscapes and regional water bodies. Factors like an increase in global temperatures and more frequent extreme weather events are causing drastic changes to be made to the Earth. The purpose of this study is to understand the changes in biochemical and hydrodynamic processes and the effects they have on landscapes and aquatic systems. According to the IPCC, global temperatures have increased by 0.74C between 1906 and 2005. The rate of warming has nearly doubled in the last half century. These continuous climate trends contribute to water and air quality, water and land ecosystems, and the availability of water in certain regions observed in the 2000-2020 study period. Extreme climate events such as droughts and floods can increase concentrations of pollutants, causing an influx in nitrogen levels, degradation in water quality, and disruptions to a variety of habitats. To evaluate these collective impacts, nitrate concentration and land-cover data from 2000 to 2020 were accessed, examining how landscape and climate variability influence nutrient movement in regional water bodies. The analysis found that areas with greater human involvement, like agricultural land use and heavily altered landscapes, frequently experienced higher amounts of nitrate in surrounding water systems. This is primarily caused by an excess in fertilizer used by farmers and the erasure of certain

habitats of animals. This study reflects that heavy water movement, like flooding and extreme runoff, increases nutrient movement. This causes biochemical changes in a variety of habitats. This could cause excessive algae growth and reduced oxygen levels, immediately affecting wildlife. Understanding the relationships between land use, climate change, and their impacts on the environment is essential for predicting risks to water systems. In this study, data were collected to develop models that configure nitrate vs land covers. They illustrate the biochemical processes across a variety of landscapes which are used to improve predictions of pollutant trends and to determine long term water quality management.
Keywords: landscapes, water bodies, climate change, nitrate

#68. The Influence of Market Analysis on Buyer Interest in Lakefront Residential Development

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This study analyzes how location-based market analysis influences buyer perceptions and decision-making when purchasing residential real estate. The research uses Rocket City Residential Groups proposal, as presented at the National Association of Home Builders (NAHB), International Builders Show (IBS) student competition. The proposal focuses on the Minors Cove Phase 3 development at Lake Martin in Alexander City and evaluates how regional demographics, housing trends, and comparable waterfront listings influence the attractiveness of a proposed residential property. Findings show that location plays a significant role in shaping buyer interest and perceived property value. Lake Martin is one of the most desirable lakefront housing markets in Alabama, with average waterfront home sales approaching 778000, *andfourlistingsexceeded*1 million. The areas proximity to larger metropolitan areas such as Birmingham, Montgomery, Auburn, Atlanta, and Columbus expands the potential buyer pool and increases the appeal of vacation or secondary homes for higher-income households. Market trends also indicate that although the total number of lake home sales has fluctuated, property values have steadily increased, demonstrating continued demand for waterfront properties. These results highlight the importance of detailed location market analysis in guiding residential development decisions and shaping buyer confidence in long-term property value. Overall, Rocket City Residential Groups proposal represents a strategically positioned development opportunity due to its lakefront location, target demographic reach, and alignment with current housing market conditions.
Keywords: Market Analysis, Location Influence, Waterfront Housing, Buyer Perception, Residential Development

#69. Design of Solar PV System with Dual-Axis Tracker

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Fossil fuels such as petroleum, coal, and natural gas currently serve as the worlds primary energy sources. However, because they form over millions of years from decaying organic matter, their reserves are finite and will eventually be depleted. Moreover, the combustion of fossil fuels releases carbon dioxide, a major greenhouse gas contributing to global warming. Renewable energy sourcessuch as solar and windoffer clean, sustainable alternatives, but must be made economically competitive with conventional fuels. Solar energy, received by the Earth as electromagnetic radiation, can be harnessed through technologies such as solar thermal systems and photovoltaic (PV) cells. PV cells convert solar radiation directly into electrical energy and are assembled into PV panels. This project focuses on the design, construction, and performance analysis of a solar power system incorporating a dual axis tracking mechanism. The system includes a PV panel, charge controller, storage batteries, inverter, and a tracking unit. The dual axis tracker adjusts the panels orientation along both east-west and north-south axes to minimize the angle of incidence of solar radiation, thereby improving energy capture. Key performance parametersincluding PV characteristics, the relationship between solar radiation and power output, panel efficiency, and the comparative benefits of single versus dual axis trackingare evaluated. The systems performance with and without battery storage is also analyzed. The final design delivers approximately 120 watts of clean power suitable for household appliances and battery charging. The entire setup is mounted on a mobile cart for demonstration purposes and to promote awareness of renewable energy technologies among engineering and technology students.
Keywords: Solar Energy, PV Panel, Renewable Energy

#70. Analysis of Hypersonic Thermal Protection System Defects

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Understanding how high-speed airflows interact with surface defects is essential for designing hypersonic vehicles capable of withstanding extreme aerodynamic and thermal loads. At hypersonic speeds (Mach ≥ 5), intense shock waves form ahead of the vehicle, leading to dramatic increases in pressure and temperature that must be managed by an effective Thermal Protection System (TPS). Carbon-carbon composites are often used in these systems for their high temperature tolerance and structural integrity, but their performance in the presence of surface defects is not fully understood. In this work, we examine the effects of a crater-like defect on the nose cones TPS under hypersonic flow conditions. Using Computational Fluid Dynamics (CFD), we compare the airflow behavior, pressure distribution, and thermal loads over both an intact and a defected TPS geometry. Our simulations reveal that even a small defect can significantly disturb the shock structure, causing local shifts in

shock position and creating elevated thermal gradients near the defect region. These flow disturbances result in increased localized heating and pressure that may accelerate material degradation and compromise structural stability. By quantifying how defects alter aerothermodynamic behavior, this study highlights the sensitivity of hypersonic flow to geometric imperfections and underscores the importance of defect evaluation in TPS design. The results provide insight into potential failure mechanisms and inform approaches for improving reliability and survivability in high-speed aerospace systems such as re-entry vehicles and hypersonic cruise vehicles.
Keywords: Hypersonic flow, Computational Fluid Dynamics (CFD) , Computer Aided Design (CAD) , ASTM Standards

Natural Resources & Environmental Sciences

#71. GeoAI-Driven Road Extraction and Urban Growth Time Series: A Multi-Sensor Analysis of NLCD Feature Evolution in Huntsville, AL

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This research investigates the utility of GeoAI for the automated extraction and temporal analysis of urban infrastructure, specifically targeting road network evolution in Huntsville, Alabama. The project utilizes a sophisticated computational pipeline developed in Jupyter Lab, integrating Python, PyTorch, and ArcPy to bridge the gap between high-performance computing and geospatial engineering. Using Google Earth Engine (GEE), a multi-decadal dataset was synthesized from Landsat 5, Landsat 8, and Sentinel-2 sensors, providing a high-fidelity time series of spectral data across twenty years. The core technical challenge involved training a machine learning model to accurately identify linear infrastructure within the NLCD framework while navigating the resolution disparities between historical 30m and modern 10m imagery. To ensure rigorous validation, the model utilized a rasterized OpenStreetMap (OSM) layer as an ground-truth reference, allowing for an objective assessment of extraction precision through rasterio-managed pixel comparisons. The results demonstrate a quantifiable expansion of 2.82 km in road-specific features, illustrating the acceleration of urban sprawl in a critical aerospace and defense corridor. Beyond the spatial findings, this study establishes a repeatable, open-source framework for utilizing PyTorch and GeoAI to monitor National Land Cover trends, offering a scalable solution for regional planners and civil engineers to automate infrastructure auditing without manual digitization.
Keywords: GIS, GeoAI, Machine Learning, Urban Planning

#72. Investigating PFAS and E. coli in Influent from Alabama A&M University and Effluent from the Huntsville Spring Branch Wastewater Treatment Plant to the Indian Creek Watershed

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Water pollution remains a critical environmental issue with significant implications for biodiversity, human health, and regional economic sustainability. In Alabama, water quality concerns continue to increase as population migration, industrial expansion, and intensified agricultural activities place additional stress on already impaired surface waters. Monitoring these systems using established water quality standards is essential for identifying impaired waterways and protecting ecological and human health. Per- and polyfluoroalkyl substances (PFAS) are persistent environmental contaminants frequently detected in aquatic environments and increasingly recognized for their co-occurrence with microbial indicators such as Escherichia coli. This co-occurrence raises important questions regarding potential interactions that may influence microbial persistence, transport, and environmental risk. This study investigates relationships between PFAS and E. coli in wastewater-influenced surface waters associated with influent contributions from Alabama AM University entering the Huntsville Spring Branch Wastewater Treatment Plant and treated effluent discharged to Indian Creek within the upper Indian Creek watershed of the Tennessee River Basin. This watershed is listed on the EPA 303(d) impaired waters list for pathogens, with documented impairment sources including collection system failures, pasture grazing, and urban runoff/storm sewer inputs. E. coli was enumerated using the IDEXX method to evaluate microbial occurrence across sampling locations representing treatment system inputs and downstream receiving waters. Results demonstrated a measurable association between PFAS occurrence and E. coli concentrations, expanding our understanding of how emerging chemical contaminants interact with microbial indicators in wastewater-influenced surface waters and supporting the development of improved environmental monitoring and protection strategies.
Keywords: Water Quality, PFAS

#73. Investigating PFAS in Influent from Alabama A&M University and Effluent from the Huntsville Spring Branch Wastewater Treatment Plant within the Indian Creek Watershed, Huntsville, Alabama

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Poly- and perfluoroalkyl substances (PFAS) are a class of synthetic chemicals widely used in industrial applications and consumer products. Due to their chemical stability and resistance to degradation, PFAS persist in the environment and have raised concerns regarding potential impacts on human health and aquatic ecosystems. Municipal wastewater treatment plants (WWTPs) are recognized as important pathways for PFAS transport into receiving surface waters, particularly where untreated institutional wastewater contributes to

influent entering treatment systems. This study investigated the occurrence of PFAS in water samples collected from influent associated with Alabama AM University and effluent from the Huntsville Spring Branch Wastewater Treatment Plant within the Indian Creek watershed. Water samples were analyzed to quantify concentrations of perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) using U.S. Environmental Protection Agency (EPA) Method 1633. Results revealed measurable concentrations of PFAS in both influent and effluent samples, suggesting that institutional wastewater sources contribute to PFAS occurrence within treatment-influenced waters of the Indian Creek watershed. Continued monitoring will support local water quality assessment and inform future mitigation strategies.

Keywords: PFAS, E. Coli, Water, Quality

#74. The Long-Term Effects of Biopolymers, Cork and Extracellular Polymeric Substances (EPS) derived from Rhizobium tropici on Soil Microbial Communities

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Organic biopolymer amendments are emerging as sustainable soil management strategies that improve soil health and microbial activity by boosting soil organic carbon. The use of cork powder and Rhizobium tropici-derived extracellular polymeric substances (EPS) represents an environmentally friendly approach that can enhance soil quality and support soil microbial communities. However, the long-term effects of these amendments on soil microbial community structure and stability are not well known. In this study, we evaluated bacterial community composition in Decatur, Alabama, soils following two years of amendment with cork powder and Rhizobium tropici-derived extracellular polymeric substances (EPS). A total of 48 soil samples were amended with four treatment types: unamended soil (soil+control), cork-amended soil (soil+cork), EPS-amended soil (soil+EPS), and combined cork and EPS treatment (soil+cork+EPS), which were maintained under controlled conditions. Four different time-points were used in sample collection, which are (0, 24, 48, and 72 Hrs) after two years of initial treatment, with three biological replicates per treatment. Bacterial communities were characterized using 16S rRNA gene amplicon sequencing, which identified 54,901 amplicon sequence variants (ASVs) across all samples. Among these, 1,097 ASVs were shared between treatments, and 1,621 ASVs were shared between sampling time points, indicating a core soil microbiome. The microbial community was composed of Pseudomonadota (Proteobacteria), Actinomycetota, Acidobacteriota, Chloroflexota, and Bacillota (Firmicutes), which represented the most abundant phyla present. Minor phyla, including Gemmatimonadota, Myxococcota, Planctomycetota, and Verrucomicrobiota occurred at lower but consistent abundances. Thus, our findings suggest that cork and EPS amendments preserve core soil bacterial assemblages, supporting the potential of these organic biopolymers as sustainable soil management strategies.

Keywords: biopolymer; amendments; EPS; Cork; soil; microbial; communities; 16S rRNA; amplicon; sequencing

#75. Somatic embryogenesis and shoot organogenesis in soybeans, along with successful transfer to soil

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Somatic embryogenesis and shoot organogenesis in soybeans are challenging due to genotype-dependent factors, low embryo-to-plantlet conversion rates, and associated tissue culture recalcitrance. This study evaluated the totipotency of four soybean cultivars and one selected line for in vitro plant regeneration through somatic embryogenesis and organogenesis. The cultivars Dare (PI 548987), LEE68 (PI 559369), Young (PI 508266), Houjaku Kuwazu (PI 416937), and S-100 (PI 548488) showed potential for somatic embryo production, with S-100 and Houjaku Kuwazu performing well in organogenesis. Somatic embryogenesis took longer for plant regeneration compared to organogenesis. Key findings included: 1. Higher germination and embryo extraction rates from seeds treated with chlorox and HCl (fumigated 95:5) compared to controls. 2. Over 50% of untreated seeds did not germinate and had no embryos. 3. Early callus induction in darkness and increased somatic embryos were observed under light on Gamborg's B5 media. 4. The highest regeneration rate (90%) was achieved with Gamborg's B5 medium and 4 mg/L BAP. 5. Maximum shoot number was obtained with Gamborg's B5, 0.15 mg/L BAP, and 0.025 mg/L NAA, leading to plantlet growth in four weeks. 6. Regenerated plantlets exhibited normal structural integrity when examined under a stereomicroscope and were successfully transplanted into soil within pots. However, histological analyses are necessary for further validation. A successful regeneration system for soybean cultivars, specifically S-100 and Houjaku Kuwazu, has been developed utilizing mature embryo explants in conjunction with plant growth regulators. This was followed by transplanting the regenerated plants into soil.
Keywords: tissue culture; in vitro; plant regeneration; totipotency; somatic embryogenesis; shoot organogenesis; soybean; genotype-dependent; Gamborg's medium; plant growth regulators

#76. Identification and characterization of aluminum-responsive genes in soybean lines exhibiting differential tolerance and sensitivity

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Soybean (Glycine max) is an important global crop known for its high protein and oil content. It has many uses in food, animal feed, and various industries. However, soybean farming faces problems due to aluminum toxicity, which can harm root growth and nutrient

absorption, especially in the acidic soils found in Northern Alabama. The genetic factors affecting aluminum tolerance make it hard to breed new soybean varieties that can handle this issue. Therefore, understanding the genetics of aluminum tolerance is essential for sustainable farming, as tolerance can vary widely among cultivars. In this study, we analyzed gene expression in two soybean lines: Houjaku Kuwazu (PI 416937), which tolerates aluminum, and Young (PI 508266), which is sensitive to it. We found different patterns of gene expression, highlighting several important genes such as CaM3, DDF1, ERD15, RLK, 14-3-3, ACT14, Actin, CIPK6, CYP1, DREB1, EF1A8, ERF2, GAPDH, GST, His3, MPK2, NHX1, PP2A, TPS1, TUA10, UBI1, UBQ22, and UBQ7. We also identified key transcription factors, including bZIP, WRKY, MYB, ADR6, and NAC. We used PCR and qRT-PCR with 1.2% Agarose Gel Electrophoresis to confirm the presence and activity of these genes. The gene activity results show how soybeans respond to aluminum toxicity and tolerance. Key participants in this response include transcriptional activators like Cys2His2 and ADR6, as well as enzymes that modify cell walls and growth factors. These findings improve our understanding of aluminum tolerance in soybeans and can help us develop resilient soybean varieties.

Keywords: Soybean, aluminum toxicity, gene expression, aluminum tolerance, acidic soils, Northern Alabama, PCR, qRT-PCR

#77. Exploring Gene Expression in Cotton Under Salt Stress: Uncovering Essential Mechanisms for Salt Tolerance

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Salt stress has a significant impact on modern agriculture, especially on Gossypium arboreum, a more tolerant cultivar compared to G. hirsutum, a sensitive cultivar. As soil salinity rises due to climate change and agricultural practices, studying molecular responses to salt stress is vital for breeding resilient cotton cultivars. Identifying key genes for salt tolerance is essential for developing stress-tolerant varieties, which is a priority for food security. This study aims to identify key salt-tolerant and differentially expressed genes (DEGs) using RNA-Seq by analyzing the transcriptomes of salt-tolerant cotton species under stressed and unstressed conditions. This study will examine the responses of salt-tolerant cotton species exposed to NaCl concentrations of 0 mM (control) and 300 mM, with leaf samples collected at 0, 24, 48, 72, 96, and 120 hours after treatment with three replicates (1 species x 2 treatments x 6 collection time points x 3 replicates = 36). DNA/RNA was extracted from the leaves of treated and untreated 30-day-old seedlings. RNA-seq analysis will include quality control, trimming, alignment, counting, normalization, differential gene expression (DGE) analysis, and functional enrichment analyses using GO, COG, and KEGG pathways. This study will identify important genes that regulate osmotic pressure, ion balance, and protection against oxidative damage. It will also identify key gene families linked to plant stress resistance, such as protein kinases, glutathione S-transferases, the CAZy family, and

expansion proteins. Using the polymerase chain reaction (PCR) with 50 primer pairs, we focused on genes that regulate osmotic pressure and ion balance, which are crucial for adapting to increased salinity. The findings from this study on salt-tolerant materials will provide a crucial basis for identifying potential breeding parents for salt tolerance in cotton.
Keywords: Salt, NaCl, salinity, tolerance, stress, Gossypium, RNA-Seq, Transcriptome, DEGs, PCR

Physics, Chemistry, & Mathematics

#78. Synthesis and Characterization of Bis(cyclopentadienyl)vanadium(III) Dithiophosphate Complexes

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A series of bis(cyclopentadienyl)vanadium(III) dithiophosphate complexes, including cyclic Cp2VBr[S2POGO] (where G = -CH2CMe2CH2-, -CH2CEt2CH2-, and -CMe2CMe2-) and acyclic Cp2VBr[S2P(OR)2] derivatives (where R = Et, n-Pr, i-Pr, and i-Bu), were synthesized via the reaction of bis(cyclopentadienyl)vanadium bromide (Cp2VBr) with the sodium salts of the corresponding cyclic or O,O'-dialkyldithiophosphoric acids in a 1:1 molar ratio under refluxing benzene. The resulting complexes were found to be monomeric and highly soluble in common organic solvents. Molecular weight measurements were consistent with monomeric formulations. Structural and compositional characterization was performed using elemental analysis and multinuclear NMR spectroscopy, including 1H, 13C, and 31P NMR. Preliminary studies evaluating the antibacterial activity of these vanadium(III) complexes are currently underway to assess their potential as bioactive agents.
Keywords: Organometallic Chemistry, Vanadium(III) Complexes, Dithiophosphate Ligands

#79. Identifying Metastatic Drivers and Metabolic Targets in Primary Colorectal Cancer and Colorectal Liver Metastasis

Cameron Cummins, Jakeiya Streeter**
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Department of Physics, Chemistry, & Mathematics

Identifying Metastatic Drivers and Metabolic Targets in Primary Colorectal Cancer and Colorectal Liver Metastasis Cameron Cummins Abstract: Colorectal cancer (CRC) remains a major cause of cancer-related death, particularly when it progresses to colorectal liver metastasis (CRLM). Understanding the molecular changes that distinguish primary CRC from CRLM may reveal mechanisms that drive metastasis and uncover new therapeutic opportunities. Among these mechanisms, metabolic reprogramming is increasingly recognized as a key factor in tumor progression, while endoplasmic reticulum (ER)-associated stress

and signaling may further support tumor survival in metastatic environments. This study aims to compare primary CRC and CRLM using public gene expression datasets from GEO, with additional liver cancer reference data from TCGA-COAD where relevant. The project focuses on identifying metastatic drivers, with particular attention to metabolic genes and ER-associated pathways. In addition, the study is exploring the relationship between these molecular signatures and patient survival outcomes. Where clinical annotation is available, cases with metabolic disorders will be compared with those without metabolic disorders to evaluate whether systemic metabolic status may influence tumor biology and metastatic progression. This project is currently centered on discovering candidate biomarkers, potential drug targets, and patterns that may inform model development for metastatic risk and disease behavior. This work demonstrates the value of public databases and undergraduate bioinformatics research in advancing cancer discovery.

Keywords: CRLM Liver Metastasis

#80. An Upper Bound on the Independent Domination Number of k-Trees

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Given a simple, finite, nonempty graph $G = (V(G), E(G))$, a vertex subset $D \subseteq V(G)$ is said to be a dominating set if every vertex $v \in V(G) - D$ is adjacent to a vertex in D. The independent domination number $\gamma_i(G)$ is the minimum cardinality among all independent dominating sets of G. Since determining the domination number for general graphs is NP-complete, we focus on the class of k-trees. Favaron established a tight upper bound for 1-trees, while Campos and Wakabayashi determined a tight upper bound for maximal outerplanar graphs, a subclass of 2-trees. We generalize these results and establish a tight upper bound for the independent domination number of k-trees for all $k \in N$.

Keywords: k-trees, graphs, independent domination, colorings

#81. Exploring Metabolic and Endoplasmic Reticulum Pathways in Hepatocellular Carcinoma and Colorectal Liver Metastasis

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Hepatocellular carcinoma (HCC) and colorectal liver metastasis (CRLM) are aggressive liver-associated malignancies with high clinical burden. A major biological question is how tumor cells survive, adapt, and become more aggressive within the liver microenvironment. Because the liver is a central organ for lipid, glucose, and amino acid metabolism, cancer cells that thrive there may depend on distinct metabolic pathways. In addition, the endoplasmic reticulum (ER), which regulates protein folding, stress signaling, and lipid biosynthesis, may play an important role in this adaptation process. This study aims to investigate metabolic genes and ER-associated pathways that may contribute to aggressiveness and

liver adaptation in HCC and CRLM. Publicly available transcriptomic datasets from TCGA-LIHC and GEO are being analyzed using bioinformatics approaches to identify differentially expressed genes, enriched metabolic pathways, and ER-related signatures associated with these cancers. Comparative analyses are being performed to examine shared and distinct molecular features between primary liver cancer and metastatic colorectal tumors in the liver. The long-term goal of this work is to identify candidate drug targets and support development of a predictive model of liver adaptation and tumor aggressiveness. This project highlights how public cancer databases can be used to study disease mechanisms and generate hypotheses for future translational research.

Keywords: Hepatocellular carcinoma (HCC), Colorectal liver metastasis (CRLM), Cancer metabolism, Bioinformatics

#82. Predicting Short-Term Injury Risk in NBA Athletes Using Performance Load Metrics and Machine-Learning Models

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Understanding how performance load contributes to short-term injury risk is essential for optimizing athlete health and availability in the NBA. This study examines how changes in performance load influence short-term injury risk among NBA athletes using a combined statistical and machine-learning approach. Player-game data from multiple NBA seasons were analyzed to capture key workload trends, including total minutes played, game density (the frequency and intensity of games within short intervals), and back-to-back game appearances. These variables were selected to represent both acute and cumulative physical demands placed on athletes throughout the season. Injury outcomes were defined based on next-game availability, allowing predictive models to estimate the probability of injury-related absence under varying load conditions. To assess how workload fluctuations affect injury vulnerability, logistic regression and tree-based models were developed and evaluated. Across both models, workload spikes, congested scheduling, and repeated high-intensity games consistently emerged as strong predictors of elevated injury risk. Analysis revealed that the observed workload-injury relationships held steady across all regular seasons evaluated, supporting the reliability of the conclusions. Overall, the study demonstrates that variations in performance load play a significant role in short-term injury susceptibility among NBA athletes. By quantifying these relationships with statistical and machine-learning methods, this study offers a data-driven basis for enhancing performance analysis and guiding load-management strategies that reduce injury risk and improve player availability.

Keywords: NBA injury risk, workload trends, machine learning, risk prediction, performance analysis

#83. Transient Absorption of PFAS Molecules

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Per- and polyfluoroalkyl substances (PFAS) exhibit exceptional chemical persistence arising from the high bond dissociation energy of the C–F σ bond and the resulting stabilization of the perfluoroalkyl electronic manifold. The σ(C–F) bonding orbitals transform as localized symmetry-adapted combinations along the carbon backbone, while the corresponding σ^*(C–F) antibonding orbitals constitute the lowest accessible dissociative electronic states. Ultrafast interrogation of these excited states provides a direct pathway to understanding the fundamental photophysics governing PFAS stability and degradation. In this study, transient absorption spectroscopy is proposed to resolve the excited-state dynamics of representative PFAS molecules following UV excitation that promotes electrons from σ(C–F) $\rightarrow$ σ^*(C–F) or n(F) $\rightarrow$ σ^*(C–F) orbitals. Population of these antibonding states generates short-lived radical intermediates that initiate C–F bond cleavage and subsequent defluorination pathways. Nanosecond pump-probe measurements will monitor ground-state bleach, excited-state absorption, and stimulated emission signatures associated with these electronic transitions, enabling direct determination of excited-state lifetimes, radical formation kinetics, and solvent-mediated relaxation processes. By correlating transient spectral features with specific electronic configurations and symmetry-allowed transitions, the study will establish mechanistic relationships between PFAS molecular structure and photoinduced bond activation. The resulting kinetic and spectroscopic parameters will provide a quantitative framework for understanding how excited-state population of σ^*(C–F) orbitals drives degradation pathways in perfluorinated compounds. These results will inform the design of photocatalytic and photochemical strategies capable of destabilizing PFAS molecules under environmentally relevant conditions, thereby advancing spectroscopically guided approaches for PFAS remediation.

Keywords: PFAS, Transient Absorption Spectroscopy, Excited-State Dynamics ,C-F Bond Activation, Photochemical Defluorination

#84. Bridging Gaps in Algebra Through Secondary Education: Addressing Misconceptions in Factoring

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Algebra is a foundational subject in secondary education, yet many students struggle with factoring due to persistent misconceptions and an over-reliance on memorized steps. These gaps in understanding often carry over to higher-level mathematics. This study examines common student errors in factoring and explores whether a concept-based teaching approach can improve understanding. A pre-test and post-test will be used to measure changes in student performance, while a student survey will gather information about confidence levels, problem-solving strategies, and conceptual understanding. This research aims to contribute

to improved instructional practices by emphasizing deeper conceptual learning over procedural memorization. Also, help bridge the gaps in algebra learning and support stronger long-term mathematical understanding.
Keywords: Algebra, Survey, Misconceptions, Factoring, Education

#85. Ocean Drifter Trajectory Analysis for Detecting Circulation Patterns in Major Oceanic Gyres

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Department of Physics, Chemistry, & Mathematics

Oceanic gyres are large rotating systems of surface currents that play a major role in the transport and accumulation of floating materials in the worlds oceans. These circulation systems influence the distribution of marine debris, including plastics, which often accumulate in convergence zones within subtropical gyres. Understanding the movement of surface currents is therefore essential for identifying regions where debris is likely to concentrate. This study investigates ocean surface circulation patterns using Lagrangian drifter data to better understand how drifter trajectories reveal the structure and behavior of oceanic gyres. The dataset used in this project contains trajectory records from 1,104 ocean drifters, each with 2,161 time steps representing sequential geographic positions. Latitude and longitude data were extracted and organized into a structured matrix to allow efficient analysis and visualization of drifter movement. By examining the trajectories of individual drifters as well as the combined spatial distribution of all observations, the study explores how drifter paths reflect large-scale circulation patterns in ocean gyres. Visualization techniques were used to plot the trajectories of selected drifters and to examine how groups of drifters move within the ocean over time. These plots reveal looping and converging patterns that are characteristic of gyre circulation. When aggregated, the drifter positions highlight regions where currents tend to converge, providing insight into how floating materials may accumulate in these areas. The results demonstrate that drifter trajectory data can effectively illustrate surface current dynamics and help identify zones of convergence associated with oceanic gyres. Such analyses contribute to a better understanding of ocean circulation and provide a useful framework for studying the transport and accumulation of marine debris. This approach highlights the importance of drifter observations in oceanographic research and supports future efforts aimed at monitoring and mitigating marine pollution in major ocean basins.
Keywords: Ocean drifters, oceanic gyres, surface current circulation, marine debris accumulation, Lagrangian trajectory analysis

#86. Distance k-Bondage Number of Common Graph Classes

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Given a simple finite graph $G = (V(G), E(G))$, a vertex subset D of $V(G)$ is a distance k-dominating set if every vertex $v \in V(G) - D$ lies within distance k of some vertex in D. The distance k-domination number $\gamma_k(G)$ is the cardinality of a minimum distance k-dominating set. The distance k-bondage number $b_k(G)$ is the size of a minimum edge set B such that $\gamma_k(G - B)$ is strictly greater than $\gamma_k(G)$. In this paper, we establish upper bounds on $b_k(G)$ in respect to degree sums and exact values of a k-distance bondage number for any given graph. Our results generalize previous bounds by incorporating distance-based domination constraints. We also introduce a refined bound in respect to the number of internally disjoint paths and find exact values of a k-distance bondage number for common graph classes. These findings contribute to the broader study of domination and bondage parameters in restricted graph classes and provide insights into combinatorial optimization.

Keywords: Bondage, Domination, Graph, Bondage number, Domination number

#87. Ten Fundamental Interactions of Nature Derived from Complex Energy Theory and Neutrino Oscillation

Subham Pokharel, Itiza Subedi, Dr. T. X. Zhang*
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Department of Physics, Chemistry, & Mathematics

This research project was completed under the guidance of Dr. Tianxi Zhang and focuses on two connected theoretical ideas: the unification of natural interactions through Complex Energy Theory and an alternative explanation of neutrino oscillation. In the first part of the project, the four basic elements of naturemass, radiation, electric charge, and color chargeare combined into one complex energy expression. In this framework, mass and radiation are treated as real energy, while electric charge and color charge are treated as imaginary energy. By expanding the interaction between two complex energy expressions, the theory produces ten fundamental interactions. Three are associated with gravitational behavior, three correspond to the familiar electromagnetic, weak, and strong interactions, and four additional mixed interactions arise from combinations of real and imaginary energy. This creates a single mathematical framework for examining how different forces in nature may be related. The second part of the project studies neutrino oscillation using Dr. Zhangs quark-antiquark annihilation model. In this model, neutrinos are formed through Type-II quark-antiquark annihilation rather than being treated as fundamental massive particles. When a neutrino interacts with matter, it may temporarily break into a quark-antiquark pair. That pair can absorb energy, become excited, change flavor, and then re-annihilate into a different neutrino type. This provides a mass-independent explanation for neutrino oscillation based on quark-level processes. Overall, this project explores an alternative theoretical approach to unification and particle behavior in modern physics.

Keywords: Complex Energy Theory, Fundamental Interactions, Neutrino Oscillation, Quark-Antiquark Annihilation, Theoretical Physics

#88. Lagrangian Coherent Structures analysis of time dependent dynamical systems using Finite-time Lyapunov Exponent

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Time-dependent dynamical systems arise in many real-world applications, especially in fluid flows, where the governing behavior changes over time. Traditional dynamical systems methods are often limited to time-independent or time-periodic systems and are not well-suited for analyzing finite-time, non-repeating dynamics. In this work, finite-time Lyapunov exponents (FTLE) are used to study time-dependent systems by examining the separation of nearby particle trajectories over a finite time interval. Ridges in the FTLE field are used to identify Lagrangian Coherent Structures (LCS), which act as boundaries that organize transport and mixing in the system. This approach provides a practical tool for studying transport in time-dependent flows.
Keywords: Finite-Time Lyapunov Exponents (FTLE), Fluid Flow, particle movement

#89. Mathematical Modeling for Financial Risk Management

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Financial risk management focuses on identifying and mitigating uncertainties that affect an organization's financial stability, including risks from market fluctuations, credit defaults, liquidity issues, and operational failures. Machine learning (ML) is revolutionizing risk management by providing data-driven insights and enhancing predictive accuracy. ML techniques such as predictive modeling and anomaly detection help quantify potential exposures and simulate market scenarios, improving decision-making and risk assessment. By applying ML, organizations can optimize risk strategies like diversification and hedging while automating complex assessments of market, credit, liquidity, and operational risks. ML models continuously improve their forecasts, enabling real-time dynamic strategy adjustment. Regulatory frameworks like Basel III increasingly integrate ML to assess systemic risks and ensure financial stability. In an interconnected global financial system, ML is a strategic asset, enabling more accurate risk forecasting, improved financial performance, and enhanced resilience to uncertainty. Organizations leveraging ML for risk management can strengthen their decision-making processes and better navigate financial complexities.
Keywords: Risk Management, Financial Mathematics, Linear Regression

Social Work

#90. Resource Integrity & Follow-through Tracker (RIFT): Improving Benefit Accountability in Child Welfare

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Each year, thousands of children in Alabamaand hundreds of thousands across the United Statesenter the supervision of state child welfare agencies due to abuse, neglect, or unsafe living conditions. These children may be placed under safety plans, in foster care, kinship placements, or temporary shelter care while their cases are reviewed by the court and social service agencies. During these transitions, public benefits intended to support the childsuch as SNAP, WIC, childcare assistance, and Social Securitydo not always follow the child to their new placement. As a result, caregivers may lack necessary resources while benefits remain tied to households from which children have been removed. This gap often occurs because benefit systems are not directly connected to child welfare placement changes, leaving caseworkers and caregivers to manually identify and correct these issues. The Resource Integrity Follow-through Tracker (RIFT) is a technology-supported oversight and coordination system that functions as a mobile and web-based platform designed to ensure that public benefits follow children within the child welfare system. RIFT combines a caregiver-facing interface with a centralized administrative system used by caseworkers within agencies such as the Alabama Department of Human Resources. The system enables receipt tracking, documentation uploads, automated categorization of benefit usage, and real-time dashboards that allow caseworkers to monitor benefit allocation as children move between placements, counties, or states. By improving communication, transparency, and data tracking, RIFT helps ensure that critical resources remain connected to the child rather than the household from which the child was removed. The platform supports caseworkers by reducing administrative burden and helping identify service gaps that may place children at risk. Through a technology-driven approach, RIFT offers a scalable model for improving oversight, strengthening accountability, and supporting policy implementation aimed at protecting vulnerable children.

Keywords: Child Welfare Benefit Misallocation,Oversight Failures in Child Welfare Systems,Foster, Kinship ,Safety plan, Shelter Care Placements, Child Welfare Systems, Alabama Child Protective Services Oversight.

Graduate Abstracts

Biological Sciences

#G501. Assessment of Cold Plasma Effects on Microbial Reduction on goat milk

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Department of Biological Sciences

Cold plasma technology is a new non-thermal food processing technique. It has the potential of enhancing microbial safety in food products without compromising nutritional and sensory characteristics. Microbial contamination leads to early spoilage and reduced shelf-life of goat milk. This research examined the efficiency of cold plasma in reducing microbes in raw goat milk. Fresh goat milk samples were exposed to cold plasma at power level of 6, 7 and 8 kv at exposure time of 1, 3 and 5 minutes with a control sample not exposed to cold plasma. Microbial load and percentage reduction were determined using standard plate count methods. Data were analyzed using mixed model in SAS 9.4 and Tukey posthoc was used to separate significant means. The findings revealed that cold plasma intervention was strongly effective ($P < 0.05$) in eliminating microbial counts in goat milk as compared to the untreated control. Percentage microbial reduction ranged from 15% to 82% depending on treatment conditions. The highest microbial reduction (82%) was observed at 8 kV for 1 min, which also produced the lowest bacterial count (3.15 log CFU/mL) compared to the control sample (3.9 log CFU/mL). Higher plasma voltage also tended to increase the inactivation process of microbes. In conclusion, cold plasma treatment holds significant potential as a non-thermal preservation method for enhancing the microbiological quality and safety of goat milk.

Keywords: Cold plasma, Goat milk, Microbial reduction

#G502. Molecular Pathways of Hyperglycemia-Induced Epithelial Dysfunction: Gene Expression and Network Analyses Relevant to Obesity and Type 2 Diabetes

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Department of Biological Sciences

Type 2 Diabetes (T2D) is primarily a metabolic disorder characterized by chronic hyperglycemia due to inadequate insulin production or tissue resistance, constituting 90% of diabetes cases in the U.S., affecting approximately 38.4 million individuals. Research highlights the significance of glucose in T2D development and obesity, especially within adipose tissue, liver, pancreas, and brain. However, there remains a significant gap in understanding how glucose impacts gene expression and morphology in the small intestines enterocytes, vital for nutrient absorption. EDA of GSE97977 (Caco-2 cells: 5 vs. 25 mM glucose) shows oxidative stress gene upregulated (SOD2, NQO1, GPXI), hub roles in Nrf2/ROS/mitochondrial

networks (WGCNA, centrality plots), and enrichment for hyperglycemia-induced epithelial dysfunction (volcano/heatmap/GO-KEGG plots). Changes in gene expression involve variations in transcript levels that have significant implications for cellular morphology and functions. Therefore, it is critical to understand the molecular mechanisms of intestinal enterocytes as a contributing cause of T2D. This study investigates the gene-level activity within enterocytes under chronic hyperglycemia, utilizing the GSE97977 dataset (47,324 genes). Cells were cultured for 21 days under normal and high glucose conditions, with differential gene analysis conducted via limma in RStudio. We hypothesize that prolonged high glucose exposure alters gene morphology and expression in intestinal enterocytes. Preliminary findings indicate that 93% of genes remain unchanged, nearly 7% demonstrate significant glucose-responsive patterns. Notably, hub genes such as SOD2, NQO1, GPXI, TNF, and OCLN share associated pathways with Nrf2 signaling, (ROS) detoxification, mitochondrial stress response, tight junction integrity, and inflammatory cytokine signaling. Future analyses will involve mapping oxidative stress-related genes from the GSE97977 dataset to KEGG pathways, emphasizing ROS regulation and key gene hubs. Gene set enrichment analysis (GSEA) or gene set variation analysis (GSVA) will be used to pinpoint significantly altered pathways, followed by protein-protein interaction (PPI) network analysis to evaluate network-level disruptions associated with chronic hyperglycemia.

Keywords: Type 2 Diabetes, Enterocytes, Glucose, Gene, Functional Analysis

#G503. Computational Characterization of HIV-1 Envelope Mutations That Enhance Cell to Cell Transmissions

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Department of Biological Sciences

The HIV-1 envelope glycoprotein regulates cell to cell transmission, and this is believed to confer an advantage with replication during the early stages of viral spreading. There are three distinct mechanisms for cell-to-cell transmission, but the underlying mechanism is not very clear. This yields a gap in understanding with regards to how this route of transmission bypasses the physical and innate immune system to establish infection. Studies have identified seven amino acid mutations in the envelope that promote cell to cell transmission; however, the molecular mechanisms that mutations use to enhance CCT is unknown. We computationally characterized the wild type of envelope mutants through energy minimizations, TM-score structural comparison and Poisson-Boltzmann electrostatic calculations to evaluate energetic interactions and predict changes in energy landscapes in efforts to address this knowledge gap. These approaches are meant to show how specific mutations alter the envelopes conformational dynamics to enhance viral synapse formation and CCT transmission efficiency. This work provides vitally important insights into CCT promoting mutations, and it gives potential therapeutic targets for disrupting this transmission route during acute infections.

Keywords: HIV-1 envelope glycoprotein, Cell-to-cell viral transmission

#G504. Investigating the Structural and Biophysical Properties of HIV-1 Envelope Glycoprotein that Enhance Cell-Cell Transmission: Analysis of R298K and V85A Mutations

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Department of Biological Sciences

Early transmission of HIV-1 is influenced by mutations within the envelope glycoprotein (Env) that can alter viral entry dynamics. In this study, we investigated the structural and biophysical effects of two Env mutations, R298K and V85A, using structural bioinformatics approaches. Structural superposition of mutant and wild-type Env proteins demonstrated near-identical global folding, with RMSD values ranging from 0.33-0.37 $\AA$ and TM-scores of˜ 0.99, indicating minimal structural deviation between variants. To further evaluate potential energetic differences, electrostatic calculations were performed using the Adaptive Poisson-Boltzmann Solver (APBS). Total electrostatic energy values were -6.04×10^4 kJ/mol for the wild-type structure, -6.08×10^4 kJ/mol for R298K, and -6.04×10^4 kJ/mol for V85A. These findings indicate that the mutations do not significantly disrupt the global structure of Env but may introduce subtle energetic changes within the proteins electrostatic environment. Such small shifts in electrostatic interactions could influence molecular binding behavior and provide insight into how specific mutations modulate viral protein function.
Keywords: HIV-1, Cell- cell transmission(CCT), Structural bioinformatics, Electrostatic interactions, Glycoprotein

Community & Regional Planning

#G505. Evaluating Green-Space Access Along the Huntsville Bus Rapid Transit (BRT) Corridor

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Department of Community & Regional Planning

This study evaluates the degree to which the Huntsville Bus Rapid Transit (BRT) corridor provides walkable access to parks and active mobility infrastructure. Transit corridors function most effectively when they connect residents to recreational destinations and multimodal transportation networks. Using geographic information systems and spatial analysis tools including ArcGIS Pro and Tableau, this project examines which parks fall within a 0.5-mile walking radius of Bus Rapid Transit stops, identifies which neighborhoods benefit from BRT connected green-space access, and analyzes how greenways, trails, bike lanes, and bike routes align with the BRT corridor both citywide and within its walkable buffer. Results show that only 18 of Huntsvilles 105 parks intersect the 0.5-mile BRT buffer, leaving 87 parks outside walkable reach. Similarly, only 34 neighborhoods have BRT connected park access, whereas 159 do not. Active mobility analysis reveals that although Huntsville has

substantial mileage of bike routes and bike lanes, these facilities are weakly integrated with the BRT corridor, and no trails fall within the walkable buffer. The findings highlight spatial disparities in recreational accessibility and limited integration between transit and mobility infrastructure. Planning recommendations are proposed to improve multimodal connectivity, park accessibility, and equitable transit-oriented development along the Huntsville BRT corridor.
Keywords: Transit accessibility, Green Space Planning, Bus Rapid Transit, GIS Analysis, Active Mobility

#G506. Analyzing Hazard Risk in Rural-Urban Transitioning U.S. Counties

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Department of Community & Regional Planning

Urban transition represents one of the most significant spatial and demographic transformations shaping the United States today. Across the country, counties once characterized as predominantly rural are experiencing rapid population growth, land-use change, and structural reorganization as they evolve into urban and suburban landscapes. While this rural-urban transition can generate economic opportunity and regional growth, it also introduces heightened exposure to natural hazards and uneven patterns of risk and vulnerability. As development increasingly occurs in floodplains, wildfire-prone areas, and other environmentally sensitive landscapes, hazard risk in rural-urban transitioning counties has become an increasingly critical planning and policy concern. This study, titled Analyzing Hazard Risk in Rural-Urban Transitioning U.S. Counties, examines how population growth, land-use change, and social vulnerability interact to shape hazard risk at the county scale. Using a national analytical framework, the research evaluates spatial patterns of hazard exposure and vulnerability across rural-urban transitioning counties in the United States. By integrating demographic data, land-cover change derived from the National Land Cover Database, and social vulnerability indicators, the study identifies counties experiencing compounded risk and assesses how development patterns and governance contexts influence resilience outcomes. The findings aim to inform planners, policymakers, and hazard mitigation professionals by highlighting the spatial and social dimensions of hazard risk in rural-urban transitioning landscapes and by underscoring the importance of integrating land-use planning, equity considerations, and hazard mitigation strategies to support more resilient and sustainable growth.
Keywords: Rural-Urban Transition, Urban Growth, Hazard Risk, Land-Use Change, Social Vulnerability.

#G507. Using Computer Vision Model to Measure Composite Walkability for Social Locations: A Case Study of Huntsville, Alabama

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Department of Community & Regional Planning

Walkability is essential for sustainable, healthy and social urban development yet measuring it remains challenging due to the interplay of infrastructure, environmental conditions, and human activity. This study introduces a Visual Walkability Score (VWS) tailored to geotagged Instagram locations in Huntsville, Alabama an urban area increasingly promoting pedestrian-friendly design. Using a multidimensional urban-analytics approach, the study integrates Google Street View (GSV) imagery, Sentinel-2 NDVI, and parcel-level land-use density. Streetscape features were extracted from GSV using the YOLO object detection model, while vegetation coverage within a 1,000-meter buffer was calculated through Google Earth Engine and ArcGIS. Variables were weighted through Principal Component Analysis (PCA), explaining 83.68% of total variance. Findings show high variation in walkability across Instagram locations, shaped by pedestrian infrastructure, greenery, and land-use intensity. Notably, locations surrounded by a diverse mix of land use categories exhibited higher walkability scores compared to those with a single dominant land use, underscoring the role of functional diversity in fostering pedestrian activity. Locations in Downtown areas such as Chriss Barber Shop and Big Spring Park scored highest due to their high vegetation, infrastructure mix, and land use diversity, while locations like Hampton Cove and Rocket City Fair scored lowest due to limited walkability features. The study confirms that a hybrid methodology combining AI-based streetscape feature extraction, urban analytics, environmental analysis, and land use data provides a more holistic view of urban walkability. It offers actionable insights for urban planners seeking to prioritize infrastructure improvements in socially active but underserved areas.
Keywords: Keywords: Walkability, Urban Analytics, Computer Vision Model, Landuse Diversity, Sustainable Planning

#G508. Examining Industry Clustering and Employment Patterns in Madison County in Alabama: A Comparative County Analysis

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Department of Community & Regional Planning

Mid-sized cities are increasingly central to regional economic growth in the United States, yet their employment structures and spatial equity outcomes remain underexamined relative to large metropolitan regions. This study investigates industry clustering and spatial employment concentration in Huntsville (Madison County), Alabama, using Jefferson, Mobile, and Montgomery counties as comparative cases. A performance-based clustering framework is applied, combining Location Quotient and Shift-Share Analysis to evaluate sectoral specialization and competitiveness between 2012 and 2022. Spatial employment concentration is assessed using the Gini coefficient derived from the Lorenz curve distributions at the census

block group level. The findings reveal variation in both industry performance and spatial employment distribution across counties. Madison County emerges as the most competitive and diversified economy, with strong growth in professional, scientific, manufacturing, and logistics-related sectors. However, this growth is accompanied by a relatively high spatial concentration of employment in key industries, indicating uneven geographic access to job opportunities. In contrast, Jefferson County exhibits a mature but uneven employment structure, while Mobile and Montgomery display more constrained industrial performance and higher dependence on lagging sectors. By integrating industry performance metrics with spatial inequality measures, this study demonstrates that strong economic growth does not necessarily translate into spatially inclusive outcomes in mid-sized cities. The research contributes to the literature by empirically linking performance-based clustering with spatial employment concentration in a county-level comparative framework, offering insights relevant for regional planning and inclusive economic development strategies in growing mid-sized urban regions.

Keywords: Industry clustering, spatial employment concentration; mid-sized cities; Gini coefficient; Huntsville; regional economic development

#G509. Sidewalk-Level Urban Thermal Risk Assessment Using High-Resolution Microclimate Modeling in Huntsville, Alabama

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Mentor(s): Dr. Florina Dutt

Department of Community & Regional Planning

This research aims to investigate how land use, vegetation cover, surface materials, and urban form influence local heat and cold exposure by evaluating spatial and temporal variations in sidewalk-level thermal risk across Huntsville, Alabama, using high-resolution urban microclimate modeling. The SOLWEIG model within the UMEP framework is employed to simulate the Universal Thermal Climate Index (UTCI), integrating air temperature, wind speed, humidity, and mean radiant temperature. The input data includes meteorological variables from the ERA5 (C3S) dataset, LiDAR-derived Digital Surface Models (DSMs), the Tree Canopy Model (TCM), and land-use/land-cover data. Sidewalks serve as the spatial analysis unit, enabling the assessment of micro-scale thermal conditions and identification of extreme exposure zones. Population and age-group data from the U.S. Census are incorporated to evaluate vulnerability among children, adults, the elderly, and individuals with health conditions. Preliminary simulations reveal that commercial corridors and low-canopy residential blocks exhibit elevated UTCI values during summer afternoons, while shaded, tree-lined sidewalks demonstrate substantially improved thermal comfort. These patterns will guide targeted cooling interventions in high-vulnerability areas. GIS-based spatial analysis maps thermal hotspots, informing mitigation strategies such as expanding vegetation cover, applying reflective paving, and enhancing shading. Findings will support cooling strategies along critical pedestrian routes within and around the Alabama AM University campus, particularly in North Huntsvilles neighborhoods, where sparse vegetation and dense built-up surfaces intensify sidewalk-level heat exposure.

Keywords: Urban microclimate; Thermal comfort; SOLWEIG model; Climate resilience; GIS-based planning

#G510. Understanding Single-Family Zoning and Quality of Life Patterns Using Social Vulnerability Indicators

*Kweku Twum Oppong Ampofo**
Mentor(s): Dr. Himanshu Grover
Department of Community & Regional Planning

This study applies spatial and econometric techniques to examine the relationship between land-use regulation and social vulnerability across census tracts in Huntsville, Alabama. Using GIS-based analysis, the share of land zoned for single-family housing was calculated and combined with social vulnerability indicators from the CDC Social Vulnerability Index (SVI), including poverty, unemployment, and housing cost burden. The study integrates both traditional and spatial statistical approaches to better understand urban inequality patterns. Ordinary Least Squares (OLS) regression results show that single-family zoning has a weak and statistically insignificant relationship with social vulnerability indicators, with very low explanatory power ($R^2 < 0.05$). In contrast, spatial analysis reveals strong patterns of clustering. Global Moran's I indicates moderate positive spatial autocorrelation ($I = 0.519$), suggesting that census tracts with similar vulnerability levels are geographically concentrated. Spatial lag models further confirm significant spatial dependence, with high and statistically significant coefficients ($I = 0.811$ for poverty and $I = 0.720$ for housing cost burden, $p < 0.001$), indicating that conditions in one tract are influenced by neighboring areas. The findings suggest that zoning alone does not sufficiently explain patterns of social vulnerability. Instead, broader spatial and socioeconomic processes play a more significant role in shaping urban inequality. This study highlights the importance of incorporating spatial econometric methods into urban planning research to better capture the interconnected nature of communities and inform more effective policy interventions.
Keywords: Spatial Autocorrelation, Land-Use Planning, GIS Analysis, Socioeconomic Inequality

Electrical Engineering & Computer Science

#G511. AI-Driven Autonomous Swarms for Proactive Hydrogen Safety: A New Paradigm in Leak Detection and Response

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This project introduces an innovative paradigm for hydrogen leak detection and response, leveraging an intelligent autonomous drone swarm. By integrating onboard artificial intelligence (AI) for real-time sensor data processing and centralized AI for predictive modeling

and swarm coordination, this system offers proactive monitoring, precise 3D leak localization, severity assessment, autonomous repair path planning, and adaptive swarm/sensors deployment. The collaborative capabilities of the drone swarm, coupled with advanced sensor fusion and anomaly detection, promise significantly enhanced safety, reduced response times, and improved efficiency in managing the risks associated with the expanding hydrogen economy. As a result, we developed a prototype that was invited to be presented at Amazon.
Keywords: Hydrogen Leak Detection, Autonomous Drone Swarm, Artificial Intelligence (AI), Sensor Fusion, Anomaly Detection

Food and Animal Sciences

#G512. The Substitution of Ancient Grain Quinoa (Chenopodium spp.) on Physicochemical and Functional Properties of Muffins.

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Department of Food and Animal Sciences

Quinoa (Chenopodium spp.) is an ancient, gluten-free grain known for its high-quality protein, including all essential amino acids, dietary fiber, and bioactive compounds, making it a potential ingredient for functional bakery products. Incorporating quinoa into muffins could potentially improve their nutritional and functional value while influencing physicochemical characteristics such as pH, color, and water activity. This study investigated muffins formulated with 10%, 20%, and 30% quinoa flour substitution compared to a control made with all-purpose flour. Muffins were prepared under standardized baking conditions, and triplicate samples were analyzed for pH, color (L*, a*, b*), and water activity (aw). Results indicated that pH values ranged from 6.19 to 6.41 and water activity from 0.816 to 0.854, with no significant differences among treatments ($p > 0.05$), although higher quinoa levels resulted in a slight increase in pH. Color parameters were significantly affected ($p < 0.05$), with 10-20% quinoa reducing lightness (L*) and 30% quinoa increasing redness (a*) and yellowness (b*), producing visually darker and more intense colored muffins. Overall, substituting up to 30% quinoa flour modified color properties without negatively affecting pH or water activity, suggesting that moderate quinoa incorporation can improve the visual appeal of muffins while maintaining their physicochemical stability. These findings provide valuable insights into bakery product development using quinoa as a potential functional ingredient with possible implications in the prevention of chronic diseases.
Keywords: Food Safety, Nutrition, and Health

#G513. Effect of Germination Time on Nutritional Composition and Antioxidant Capacity of Dry Bean Seedlings

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Germination is a natural biological process that enhances the nutritional composition and bioactive potential of legumes through the activation of metabolic pathways and enzymatic transformations. This study investigated the effect of germination time on the physico-chemical and antioxidant properties of dry bean seedlings. Dry beans seeds were soaked in water to facilitate hydration and metabolic activation and were subsequently placed in Petri dishes for germination . Seedlings were harvested at the following - T0, T3, T6, T8 and T10 days to evaluate changes in compositional and functional parameters during sprout development. After collection, seedlings were freeze-dried to preserve biochemical constituents and ground into a fine powder for further analyses. Nutrient composition was determined via proximate analysis to evaluate changes in water absorption and mineral content during germination.Bioactive compounds and antioxidant potential were assessed by determining total phenolic content (TPC), total flavonoid content (TFC), and antioxidant activities using DPPH radical scavenging and Trolox Equivalent Antioxidant Capacity (TEAC) assays. The results indicated that germination significantly influenced the nutrient composition and antioxidant profile of the bean seedlings. Germination enhanced several key nutrients, including protein, fat, available carbohydrates, and minerals, as reflected by ash content. An increase in TPC and TFC was observed with increasing germination time, particularly in seedlings harvested at later stages. Seedlings harvested at T6 , T8 and T10 days exhibited higher antioxidant activities.Overall, the findings demonstrate that germination improves the nutritional quality and bioactive composition of dry beans, supporting their potential utilization as nutrient-dense functional sprouts with improved health-promoting benefits. Keywords: Germination, Bean seedlings, Total phenolic content, Total flavonoid content, Antioxidant activity, DPPH, TEAC.

Keywords: Germination, Bean seedlings, Total phenolic content, Total flavonoid content, Antioxidant activity

#G514. Neuroprotective efficacy of Date fruit against Amyloid-β induced toxicity in differentiated SHSY-5Y neurons

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Alzheimers disease (AD) is characterized by amyloid-β (Aβ) induced neuronal degeneration associated with inflammation, antioxidant depletion, and apoptosis. Bioactive rich fruits such as Dates (Phoenix dactylifera L.) offer promising nutritional intervention due to their high content of polyphenols. This study examined neuroprotective effects of Dates on differentiated SHSY-5Y neuronal cells exposed to Aβ toxicity. SHSY-5Y were differentiated using retinoic acid and treated with Dates alone and then treated with Aβ in presence of

Dates (100-800$\mu g/mL$). Cell viability was assessed using MTT assay, Superoxide dismutase (SOD) Catalase (CAT) activity and Glutathione levels (GSH) were assessed to evaluate antioxidant response, while COX-2 and IL-6 expression served as inflammatory biomarkers. Apoptosis was evaluated and Nrf2 activity was quantified to assess redox signaling activation. Amyloid-β (Aβ) toxicity reduced differentiated SH-SY5Y neuronal viability to 55%, confirming cytotoxicity and associated mitochondrial dysfunction. Co-treatment with Dates produced a dose-dependent neuroprotective effect, restoring viability up to 92.3% at 500 g/ml, while Dates alone slightly enhanced basal viability, suggesting intrinsic metabolic support. Aβ induced severe oxidative stress, as evidenced by reduced SOD (7 U/mg) and GSH (2 μM) and compensatory elevation of catalase (145 U/mg). Dates significantly restored redox homeostasis, with 500 $\mu g/mL$ increasing SOD to 14.3 U/mg and GSH to 11 μM, while normalizing catalase, indicative of reduced ROS load and Nrf2 regulated antioxidant activation. Dates reversed Aβ-induced neuroinflammation, lowering IL-6 from 180 to 40 pg/mL and COX-2 expression from 3.5 to 1.3pg/ml at higher concentrations, suggesting suppression of pro-inflammatory signaling. DE reduced Aβ-induced apoptosis from 45% to 8%, supporting mitochondrial stabilization and inhibition of intrinsic apoptotic pathways. Thus, Dates demonstrates robust Nrf2-linked antioxidative, and anti-inflammatory neuroprotection against Aβ toxicity. These results support dates potential role as dietary neuroprotective agent by demonstrating that it modulates antioxidant defenses, regulates inflammatory mediators, increases Nrf2 activity, and protects against Aβ-induced neuronal damage.

Keywords: Neurodegeneration, Oxidative stress, Neuroinflammation, Amyloid beta toxicity, Polyphenols

#G515. Curry Leaf (Murraya koenigii) Extracts Attenuates Oxidative, Inflammatory, and Adhesion Pathways in Endothelial Cells: Implications for Early Atherosclerosis Prevention

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Atherosclerosis arises from endothelial dysfunction driven by oxidative stress, inflammatory cytokines, and monocyte adhesion. Pro-inflammatory mediators (COX-2, IL-6) and adhesion molecules (ICAM-1, VCAM-1) accelerate vascular inflammation and leukocyte recruitment. This study evaluates whether Murraya koenigii (curry leaf) extract can suppress these inflammatory pathways and protect against early atherosclerotic changes. Primary aortic endothelial cells were exposed to H_2O_2-induced oxidative stress and treated with curry leaf extract (10-160 μ g/mL). COX-2, IL-6, ICAM-1, and VCAM-1 were quantified using ELISA, while Giemsa and NucBlue staining assessed cell morphology and nuclear integrity. Curry leaf extract significantly reduced COX-2 levels from 180.14 to 120.24 pg/mL under basal conditions and from 430.56 to 170.12 pg/mL during oxidative stress. IL-6 levels

declined from 94.29 to 32.11 pg/mL and from 120.77 to 28.18 pg/mL in oxidative conditions. ICAM-1 decreased from 85.2 to 57.1 pg/mL and 210.6 to 82.3 pg/mL, while VCAM-1 dropped from 110.4 to 72.4 pg/mL and 265.8 to 118.6 pg/mL. Staining results confirmed preserved endothelial morphology and nuclear structure. This study investigates the protective effects of Murraya koenigii (curry leaf) extract on primary aortic endothelial cells under oxidative inflammation. Results show reduced inflammatory signaling, decreased adhesion molecule expression, and preserved cellular structure, indicating potential protection against early atherosclerosis. These findings demonstrate that curry leaf extract exhibits strong anti-inflammatory and anti-adhesion properties, reduces oxidative damage, and may serve as a promising nutraceutical strategy for preventing endothelial dysfunction and early atherosclerosis.

Keywords: Murraya koenigii, endothelial inflammation, ICAM-1, VCAM-1, COX-2, IL-6, nuclear morphology, oxidative stress, atherosclerosis

#G516. Development of an Adolescent-Friendly Functional Snack Using Spirulina and Bilberry as Natural Colorants

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Spirulina is a protein-rich cyanobacterium. Bilberry is a dark berry known for its medicinal purposes. Overall aim was to use two underutilized ingredients in the food industry to develop an adolescent friendly functional snack food product in the light of food industry trends. Stages of product development, shelf life/physiochemical analysis (texture, pH, color, and water activity) and sensory evaluation were utilized in developing a functional snack cheese cracker. 80% ethanol (ET) extracts of cheese cracker formulations were prepared using standard protocol. Antioxidant potential was determined using 2,2-diphenyl-1 picrylhydrazyl (DPPH) and Ferric Reducing Antioxidant Potential (FRAP) assays. Utilizing a 5-point hedonic scale (1 - Dislike very much, 2 - Dislike a little, 3 - Neither like nor dislike, 4 - Like a little, 5 - Like very much), 3 cheese cracker formulations, were tested among consumer panelists, with majority of the consumers accepting the product based on color, overall appearance, aroma, texture, and taste. Texture (post peak (N) of the cheese crackers did not vary between each formulation. pH, color, and water activity remained constant over the shelf-life period. Spirulina and Bilberry are underexplored and underutilized in the food industry. Therefore, the significance of this research is to further use Spirulina and Bilberry in functional food product development targeted to adolescents due to their health-promoting properties.

Keywords: Functional foods, Spirulina, Bilberry, Product Development, Cheese Cracker

#G517. Development of functional pastry products targeting celiac disease: antioxidative potential of alternative flours and ingredients

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Celiac disease and gluten intolerance have increased demand for safe, nutritious, and appealing gluten-free baked products. This study aimed to develop and evaluate functional gluten-free pastry formulations enriched with nutrient-dense and antioxidant-rich ingredients to enhance product quality and sensory appeal. Five gluten-free cinnamon rolls (blueberry, pecan, sweet potato, coconut carrot, and plain) were produced using optimized blends of rice, sorghum, almond, and tapioca flours. Products were analyzed for proximate composition, pH, water activity (Aw), texture profile analysis (TPA), and antioxidant potential using DPPH, FRAP, Total Phenolic Content (TPC), and Total Flavonoid Content (TFC) assays. Among the cinnamon rolls, the plain exhibited the highest antioxidant activity DPPH inhibition of 75.6% and blueberry had the highest reducing potential power of 5.08, while sweet potato and plain showed superior moisture retention and softness. A focus group evaluated appearance, flavor, texture, and overall acceptability. The sweet potato cinnamon rolls were most preferred. These findings indicate that incorporating functional ingredients into gluten-free pastries enhances nutritional quality, antioxidant potential, and consumer acceptance. As consumer demand for gluten-free products continues to rise, this research will contribute to enhancing their accessibility and market viability.
Keywords: Gluten-free, Celiac disease, Functional pastries, Cinnamon rolls, Alternative flours

#G518. Valorization of Muscadine (Vitis rotundifolia) grape seeds for bioactive oil and functional protein

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Valorization of Muscadine (Vitis rotundifolia) grape seeds for bioactive oil and functional protein M. Busarapu, Al Hazaimeh, M. Yakubu and J. Boateng, Department of Food and Animal Sciences, Alabama AM University, Normal, AL, 35762. Muscadine (Vitis rotundifolia) grape seeds, a major byproduct of muscadine grape processing, constitute an underexploited source of valuable bioactive compounds including oils rich in phenolics and protein with potential functional and bioactive applications. Despite their rich lipid and protein composition, limited research has examined the efficient extraction of bioactive lipid compounds and the recovery and functional characterization of seed-derived protein fractions, particularly in the Noble and Doreen cultivars. Seed oils from both cultivars were obtained by Soxhlet extraction with hexane. Polyphenols from muscadine grape seed oil (MGSO) were extracted with methanol and characterized using spectrophotometric assays for total phenolics (TPC), flavonoids (TFC), anthocyanins, and antioxidant capacity (ORAC, TEAC, and FRAP). The defatted seed meal was used for protein recovery via alkaline extraction

(pH 9-11), producing grape seed protein concentrate (GSPC). Protein yield, purity, and concentration were determined, and the concentrate was subsequently evaluated for techno-functional characterization including solubility, water and oil-holding capacities (WHC and OHC), and bulk density. The results indicated that the MGSO displayed considerable phenolic and flavonoid content, as well as strong antioxidant activity. The Doreen cultivar exhibited higher polyphenols and antioxidant properties compared to Noble cultivar. Elevated extraction pH increased protein recovery yield and enhanced functional properties, including solubility, WHC, and OHC. The findings highlight the potential of muscadine seed pomace as a valuable and a sustainable source of bioactive lipids and functional proteins. Key words: Grape pomace seeds, bioactive lipids, functional proteins
Keywords: Key words: Grape pomace seeds, bioactive lipids, functional proteins

#G519. Exploring the Impact of High-Pressure Processing and Cooking On Phytochemical Composition and Protein Content of Phaseolus Vulgaris L.

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This study investigated the synergistic effects of soaking, high-pressure processing (HPP) and cooking on the physicochemical characteristics of dry beans. Pinto and black beans were soaked in 1% NaHCO3 solution for 18hrs and subjected to HPP treatment (400MPa,10min). Samples were subsequently cooked at $98\,^{\circ}C$. Key parameters measured included total polyphenol content-TPC, total flavonoid content-TFC, antioxidant capacity (ferric reducing antioxidant power- FRAP, radical scavenging activity-%RSA), tannins, phytic acid and total proteins. The microstructure of beans was observed using Scanning electron microscope (SEM). The findings revealed that, soaking and HPP reduced TPC and TFC at varying levels, with TFC showing higher susceptibility to the preprocessing technologies utilized. Cooking did not significantly alter TPC, however, TFC remained largely unchanged relative to raw beans. FRAP decreased significantly ($p < 0.05$) prior to cooking, while the radical scavenging ability was not affected in both beans. Pre and post cooking treatments reduced tannin content, while phytic acid was generally stable across treatments. Protein content also remained unchanged. The SEM showed processing effect on cell wall and partial or total destruction of structural matrix integrity. These findings provide evidence of the influence of high-pressure processing on key compounds and serve as baseline information to guide the development of integrated processing strategies that support the adoption of HPP as an alternative technology in the legume processing space.
Keywords: Beans, high pressure processing, antioxidant capacity, protein content, scanning electron microscopy

#G520. Engineering Plasma Activated Water for Non-Thermal Microbial Inactivation in Food Systems

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Plasma-activated water (PAW) has been investigated as a promising non-thermal intervention for microbial control in food systems because of its broad potential across diverse food matrices and processing applications. When water is exposed to cold atmospheric plasma, energetic electrons interact with oxygen and nitrogen in the surrounding gas phase, generating reactive oxygen and nitrogen species (RONS) that dissolve into the liquid. These reactions produce long-lived antimicrobial compounds such as hydrogen peroxide (H_2O_2), nitrite (NO_2^-), and nitrate (NO_3^-), while simultaneously lowering pH and increasing oxidation reduction potential (ORP) and electrical conductivity. These chemical changes have been closely associated with microbial inactivation, as the oxidative environment damages cell membranes, proteins, and nucleic acids. Applications of PAW in food matrices have demonstrated significant microbial reductions without the need for thermal processing. Literature reports showed reductions between 3 and 5 log CFU mL^{-1} for common foodborne pathogens such as Escherichia coli, Listeria monocytogenes, and Salmonella spp. on fresh produce surfaces and in aqueous systems. Importantly, several studies observed minimal changes in quality attributes such as color, firmness, and sensory characteristics of fresh fruits and vegetables, while shelf-life extensions of approximately 2 to 7 days were reported depending on the commodity and storage conditions. Despite these promising results, previous research also revealed substantial variability in antimicrobial performance due to differences in plasma generation systems, treatment parameters, and inconsistent characterization of reactive species in PAW. The absence of standardized methods for quantifying the chemical composition of PAW in situ has limited comparability across studies and slowed industrial adoption. Therefore, the objective of this study is to engineer and characterize PAW for food safety applications by linking plasma operating conditions with measurable physicochemical parameters, including pH, ORP, conductivity, and concentrations of H_2O_2, NO_2^-, and NO_3^-, and by evaluating the resulting antimicrobial efficacy against key foodborne pathogens in representative food systems.
Keywords: non-thermal processing; food safety; cold plasma treatments

#G521. Dubai Chocolate Inspired Functional Chocolate Chip Cookie

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The increasing consumer demand for functional foods has driven innovation in the bakery division, particularly in the development of products that combine indulgent sensory appeal with enhanced nutritional value. The objective of the study was to develop and evaluate a Dubai chocolate-inspired functional chocolate chip cookie formulated with alternative flours,

dietary fibers, and protein sources. The key functional ingredients in the formulation incorporated oat flour, almond flour, green banana flour, inulin, flaxseed powder, and whey protein. These ingredients are known to improve fiber content, protein levels, and overall functional properties while maintaining desirable texture and flavor. A market-driven approach was employed, integrating trend analysis, consumer insights, and competitive benchmarking to identify opportunities within the growing better-for-you snack category. Primary consumer preference data indicated strong interest in functional cookies, with flavor remaining the dominant driver of purchase decisions. The cookie was evaluated for sensory, nutritional, and functional attributes, demonstrating a balance of rich chocolate flavor, nutty notes from the pistachio cream, and improved textural properties through the incorporation of hydrocolloids and protein networks. Cost analysis and pricing strategy positioned the product as a premium functional snack, while formulation optimization and processing conditions supported scalability for pilot plant production. In summary, this research demonstrates the feasibility of transforming a traditional cookie into a nutrient-dense functional food product that aligns with current market trends and consumer expectations for health-oriented indulgence.

Keywords: functional, dietary fiber, baked goods

#G522. Nitrites /Nitrates alternatives in dried cured meat products

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Meat curing is a traditional food preservation technique that is still in use today. At different stages of processing and with varying levels of comminution, it refers to the addition of spices, common salt (NaCl), and nitrite/nitrate salts to fresh meat. The curing chemicals nitrite (NO2-) and nitrate (NO3-) are frequently employed as antimicrobials to prevent the growth of spoilage organisms, inhibit Clostridium botulinum, delay lipid peroxidation, and give cured meats their distinct flavor and color. With the publication of an International Agency for Research on Cancer (IARC) Monograph by the Working Group on the evaluation of carcinogenic hazards to humans, particularly regarding red and processed meat, the debate over nitrites has intensified recently. According to different publications, the synthetic nitrite monograph summarizes toxicological and epidemiological research and proposes a link between dietary nitrite in processed meats and colorectal cancer and health risks. Meat industry operators are interested in finding natural preservatives that can provide meat products with organoleptic, physicochemical, and microbiological stability during their shelf life, and in producing clean-label, hazard-free dried meat. Natural substitutes such as various fruits, vegetables, and herbs, because of their phenolic content, are good substitutes for nitrite and nitrate in meat product technology. The beetroot (Beta vulgaris L.) and cabbage used in this study will be locally purchased. They will be rinsed and cleaned, grated to a thickness of 2 mm. Sample preparation requires that they be weighed, freeze-dried, and quantified by colorimetric or HPLC systems. It is hypothesized that the nitrite content in beetroot and cabbage will be an effective replacement for synthetic nitrate/nitrite in dried

cured meat and will develop cured attributes during processing and storage by positively impacting physico-chemical, microbiological, and sensory properties.

Keywords: Nitrites/nitrate, meat curing, clean-label, health implications

#G523. Optimization of Plant-Based Meat Analog Formulation Using 3D-Printing

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Three-dimensional (3D) food printing has emerged as a promising additive manufacturing technology that enables precise control over food composition, structure, and functional properties. Its increasing application in alternative protein products allows the development of customized foods with tailored textures, structural integrity, visual appeal, and targeted nutritional profiles. This study aimed to optimize the printability of a plant-based meat analog formulation designed for 3D printing. The formulations were prepared using soy protein isolate (SPI) and texturized vegetable protein (TVP) as the primary protein sources, supplemented with functional ingredients such as beetroot powder, mushroom powder, coconut oil, and corn starch to enhance nutritional value and sensory attributes. Three formulations with different SPI:TVP ratios were evaluated: 100:0 (F1), 50:50 (F2), and 0:100 (F3). The formulations were tested under different processing conditions to determine printing performance. Printing parameters included two printing speeds (1500 and 3000 mm/min), temperatures (25C and 75C), and two first ingredient flows (5.1 and 5.5). Printability was evaluated using quantitative indicators, including printing precision, printing speed, and printing error. Statistical analysis was conducted using SAS version 9.4, and treatment effects were analyzed through analysis of variance (ANOVA) at a significance level of p ¡ 0.05. Results showed that formulations containing higher SPI proportions exhibited improved dimensional stability during printing. Formulations F1 and F2 achieved printing accuracy values of 95.65% and 95.16%, respectively, while the TVP-dominant formulation (F3) showed a lower printing precision of 93.67%. These results indicate that SPI plays a critical role in improving structural stability during extrusion and layer deposition. Increasing the printing speed to 3000 mm/min enhanced process efficiency, achieving a maximum printing rate of 4.09 g/min, while printing at 25C produced the lowest printing error (0.59%), whereas printing at 75C increased printing errors to 6.93%, indicating that higher temperatures negatively affect material stability and overall printing performance.

Keywords: 3D food printing, plant-based meat analogs, soy protein isolate, printability optimization, process parameters.

#G524. Developing an Instantized Porridge Baby Formula Fortified with Tree Tomato Extracts

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Vitamin C is an essential micronutrient that plays a pivotal role in supporting immune function, collagen synthesis, and providing antioxidant protection, particularly in infants. Despite its importance, many cereal-based complementary foods are often deficient in vitamin C due to processing losses and limited natural sources. This study aimed to extract and characterize vitamin C from tree tomato (Solanum betaceum) and to develop a vitamin C-enriched instant porridge powder using a blend of selected cereals, including sorghum, millet, wheat, beans, soybeans, carrot, and pumpkin seeds. The growing demand for convenient and nutritious meal options has catalyzed interest in nutrient-enriched instant flours. Our results demonstrate that the incorporation of tree tomato extract significantly boosts the vitamin C content of the cereal-based instant porridge. This formulation not only highlights the potential of utilizing tree tomato extracts to enhance vitamin C levels in baby porridge but also contributes to improving dietary vitamin C intake among infants by leveraging locally sourced and cost-effective ingredients. Keywords. Vitamin C, Instant baby Porridge, Complementary foods, Solanum betaceum

Keywords: Vitamin C, Instant baby Porridge, Complementary foods

#G525. Synergistic effects of Ginger and Turmeric in Functional Muffin Development.

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Spices, Ginger(G) and Turmeric(T) contain phenolic substances with strong anti-inflammatory and antioxidant properties. Studies identified significant antioxidant and carbohydrate and lipid metabolizing enzyme inhibitory effects by ginger and turmeric, spices that are not commonly incorporated into typical Western diets. Combining GT may produce synergistic effects, enhancing functional bioactivity and utilization in the food industry for additional health benefits. The objective was to develop a Functional Food product utilizing Ginger and turmeric in combination. Physiochemical analyses were performed, and total phenolic content (TPC), total flavonoid content (TFC), 1,1-diphenyl-2-picrylhydrazyl radical scavenging activity (DPPH), and Ferric reducing antioxidant power (FRAP) were evaluated. Four muffin formulations were prepared: a control (no spices), 3%Ginger and 1%Turmeric (3G+1T), 6%Ginger and 2%Turmeric (6G+2T), and 9%Ginger and 3%Turmeric (9G+3T). Consumer panelists assessed sensory attributes for four muffin formulations using a 5-point Hedonic scale, ranging from 1 (Dislike very much) to 5 (Like very much). The 2T+6G formulation was the most favored due to its optimal balance of sensory attributes, higher antioxidant activity, and overall acceptability. DPPH % inhibition of the muffin extracts ranged from

15.92% to 51.95%, with the 2T+6G formulation exceeding the 50% threshold for radical-scavenging activity. 2T+6G had high FRAP values (103.12 1.1 mM Fe (II)/100 g DW), indicating remarkable stability compared to other samples. Shelf-life studies have further evaluated the products stability and its potential for commercialization. Results demonstrate that Ginger and Turmeric act synergistically to enhance antioxidant potential and sensory acceptability, highlighting their efficacy in developing health-promoting functional foods.
Keywords: Functional Foods, Ginger, Turmeric, Anti-inflammatory, Antioxidant

#G526. Influence of Selected Processing Methods on the Antioxidant Potential of Black and Red Rice

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Black and red rice, known for its bioactive components, contributes to its potential antioxidant and health benefits. This study examined the effect of selected processing methods, including roasting, boiling, and natural fermentation, on the phytochemical and antioxidant properties of black and red rice. Processed rice samples were extracted with 80% ethanol and aqueous solution following standard procedures. Treatments were carried out in triplicate and examined on a dry matter basis. Ferric Reducing Antioxidant Power (FRAP), Trolox Equivalent Antioxidant Capacity (TEAC), and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assays were used to determine antioxidant capacity. Total phenolic content (TPC) and total flavonoid content were used to determine the chemical profile. The results showed that antioxidant activity and phenolic content varied significantly depending on the extraction solvent and processing method used. Ethanol extracts consistently demonstrated stronger antioxidant activity compared to aqueous extracts. Boiled black rice had the highest FRAP (179.16 $\pm$ 1.34 μmol/g d.w.), while fermented red rice had the highest DPPH radical inhibition (89.31%) in ethanol extracts. Aqueous extracts of boiled black rice (817 $\pm$ 1.34 mg GAE/100 g d.w.) and boiled red rice (607 $\pm$ 2.97 mg GAE/100 g d.w.) showed the highest phenolic content, indicating that heat treatment promotes the release of bound phenolics. In conclusion, processing methods and solvent type have a substantial impact on the antioxidant potential of colored rice. Boiling and fermentation significantly increased phenolic bioavailability, demonstrating the potential of processed black and red rice as a functional food for alleviating oxidative stress-related health problems.
Keywords: Processing methods, black rice, red rice, solvent type extraction, antioxidant potential

Natural Resources & Environmental Sciences

#G527. The impact of low-temperature plasma on gene expression during the germination of legume seeds

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Low-temperature plasma (LTP) consists of reactive oxygen and nitrogen species that induce biochemical changes, breaking seed dormancy and enhancing seed germination and seedling growth. Legumes, rich in nutrients and protein, provide significant health benefits; however, they face challenges, including low germination rates. This study evaluated the potential of LTP to address this challenge and the underlying gene expression changes in two legume species. We investigated the effects of argon (Ar) LTP seed treatments for durations of 0 (control), 30, 60, and 90 seconds on seed germination, seedling growth, biomass, and nutrient composition in a greenhouse setting. To assess seed germination, we placed both treated and untreated seeds in Petri dishes with 25 seeds per dish. We evaluated seedling growth and biomass by planting treated and untreated seeds in potting mix and measuring germination efficiency (GE), mean germination time (MGT), shoot height (SH), root length (RL), and biomass (BM). The 60-second argon (Ar) treatment improved germination efficiency and shoot height by approximately 15% and 50%, respectively, compared to the control. Cold plasma improves plant hormone levels, increases water uptake, and alters seed coats, thereby improving sprout quality. It also boosts key nutrients, such as proteins, carbohydrates, enzymes, polyphenols, and antioxidants, that help seeds grow. Cold plasma is an affordable and environmentally friendly way to enhance sprout quality. It is crucial to use it wisely to maximize benefits while minimizing downsides. Furthermore, comprehensive differential gene expression studies are required to elucidate the key mechanisms underlying seed germination and development. More research is needed to improve these methods for commercial sprout production.
Keywords: Low-temperature plasma, seed germination, legumes, argon, biomass, gene expression

#G528. Comparative Transcriptome Profiling of Soybean Cultivars: Analyzing Salt Sensitivity and Tolerance Using RNA Sequencing

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Soil salinity is a major agricultural stressor, affecting around 20% of irrigated lands worldwide and hindering crop growth and yield. Soybean (Glycine max) is an important food and oil source both in the U.S. and globally, but high soil salinity significantly reduces agricultural productivity. This study included two contrasting soybean genotypes: Lee 68 (salt-tolerant) and Dare (salt-sensitive). Soybean plants were cultivated under controlled conditions and subjected to three NaCl treatments (0 mM, 75 mM, and 150 mM). Leaf/root samples were collected at different time points (0, 1, 2, 3, and 4 days after treatment, DAT), with three

biological replicates assigned to each treatment (R1, R2, R3), resulting in 90 RNA libraries. RNA sequencing was performed using the NovaSeq platform (Illumina), generating high-quality sequencing data comprising 700 million reads. The quality reads were assembled after trimming and filtering, yielding high-quality (Q30) reads $\geq$ 92.35%. The DESeq2 analysis was performed to identify over 1,500 differentially expressed genes (DEGs) associated with salinity tolerance by comparing transcriptomes across the various treatments. Notably, around 300 DEGs were exclusively observed in the salt-tolerant Lee 68 genotype, indicating a genetic basis for enhanced stress resilience. In the Lee 68 genotype, genes associated with ion transport, antioxidant responses, and osmotic balance were significantly upregulated. Conversely, stress-related pathways were markedly disrupted in the Dare genotype, underscoring its vulnerability to salinity stress. These findings provide valuable insights into the genetic mechanisms that confer salt tolerance in soybeans, which may help breeding programs develop soybean genotypes with improved adaptability to saline conditions.

Keywords: Soybean (Glycine max), Salinity, Salt tolerance, differentially expressed genes (DEGs), RNA-Seq.

#G529. Validating Candidate Genes and Transforming Peanut (Arachis hypogaea L.) for Aflatoxin Resistance

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Peanut, Arachis hypogaea, is an essential crop for food production and economic development in certain parts of the world. In the U.S., the peanut crop is ranked as the seventh most valuable crop and heavily impacts many nations globally, such as China and Sub-Saharan Africa. Aflatoxin contamination, caused by fungi like Aspergillus flavus, is a significant problem for peanut production, processing, and commercialization; exposure to aflatoxin can lead to illnesses in humans and cause stunted growth, liver disease, and poor immune system development. High levels of exposure can even cause cancer or death. Traditional breeding methods have proved challenging as aflatoxin resistance is a multifactorial trait influenced by multiple genetic factors and the environment. Previous studies have identified QTL qPSIIB10 as a locus that confers some resistance to A. flavus contamination. By examining this locus, QTL qPSIIB10, in resistant and susceptible cultivars using comparative genomics tools we expect to uncover resistant genes responsible for aflatoxin resistance. Agrobacterium rhizogenes-mediated transformation allows for the perturbation of gene expression and exploration of gene function. We will transform peanuts with A. rhizogenes to overexpress candidate genes in our locus of interest for conferring aflatoxin resistance. Finding methods to combat aflatoxin contamination is essential for human and animal health, ensuring the safe cultivation and consumption of peanuts, and preventing economic losses.

Keywords: aflatoxin, peanut, Agrobacterium, plant transformation

#G530. Predicting Agricultural Land Conversion in U.S Peri-Urban Areas: Spatial Modeling for Sustainable Land Management and Environmental Stewardship.

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Peri-urban areas, the transitional zones between rural and urban regions, are experiencing rapid and largely uncoordinated development that threatens agricultural land, natural resources, and ecological stability. This study, aligned with USDAs Bioenergy, Natural Resources, and Environment priority area, examines how peri-urban expansion contributes to agricultural land conversion and proposes predictive tools to guide sustainable land management. The research develops a land-use change modelling framework that integrates physical, socioeconomic, and agricultural indicators to forecast development pressures on farmland. Using Cellular Automata and Artificial Neural Networks, the study simulates spatial patterns of land conversion and identifies high-risk agricultural zones. Results are intended to support planners and policymakers in anticipating and mitigating farmland loss before irreversible environmental and economic impacts occur. By linking predictive analytics to sustainable land management, farmland preservation, and food system resilience, this research advances the USDAs mission to balance growth with environmental stewardship. The findings provide a pathway for integrating spatial modelling into regional planning, enabling communities to maintain productive agricultural landscapes while promoting ecological resilience at the rural-urban interface.

Keywords: Peri-Urbanism, Landcover, Agriculture, Transition, Modelling

#G531. Lidar Remote Sensing Data for Mapping Fine-scale Variations of Crop Growth Parameters in Cotton (Gossypium hirsutum L.)

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Mentor(s): Dr. Ranjani W. Kulawardhana
Department of Natural Resources & Environmental Sciences

Lidar remote sensing has been used extensively in agriculture to estimate crop growth parameters. Spatial resolution, temporal resolution and the capability of lidar sensors to penetrate through the vegetation canopy are among the key factors to enhance accuracy in the selected plant growth parameters. Different studies have been conducted on the growth of cotton parameters using multispectral sensors. However, relative accuracies of the lidar-derived variables during different phenological stages have not been extensively evaluated. The purpose of this study is to evaluate relative accuracy of lidar-derived crop growth parameters during different phenological stages of cotton. Specific objectives were to: i) evaluate the applicability of lidar-derived variables to map fine-scale variations in canopy height and cover and ii) evaluate relative accuracies of lidar-derived canopy height and cover variables during different crop phenological stages. Experimental plots were established at the Winfred Thomas Agricultural Research Station (WTARS) of Alabama A M University for cotton

(Gossypium hirsutum L.). UAV-based and terrestrial Lidar data were collected on weekly basis along with field measurements of crop variables (plant height and canopy cover). Findings of this study l revealed the canopy height and canopy cover models relative accuracy to estimate fine-scale variations of cotton growth parameters at different phenological stages.
Keywords: Lidar Remote Sensing Data, Fine-scale Variations, Canopy Height, Canopy Cover, and Relative Accuracy.

#G532. Predicting Agricultural Land Conversion in U.S Peri-Urban Areas: Spatial Modeling for Sustainable Land Management and Environmental Stewardship

Nathaniel Peprah, Himanshu Grover*
Mentor(s): Dr. Himanshu Grover
Department of Natural Resources & Environmental Sciences

Peri-urban areas, the transitional zones between rural and urban regions, are experiencing rapid and largely uncoordinated development that threatens agricultural land, natural resources, and ecological stability. This study, aligned with USDAs Bioenergy, Natural Resources, and Environment priority area, examines how peri-urban expansion contributes to agricultural land conversion and proposes predictive tools to guide sustainable land management. The research develops a land-use change modelling framework that integrates physical, socioeconomic, and agricultural indicators to forecast development pressures on farmland. Using Cellular Automata and Artificial Neural Networks, the study simulates spatial patterns of land conversion and identifies high-risk agricultural zones. Results are intended to support planners and policymakers in anticipating and mitigating farmland loss before irreversible environmental and economic impacts occur. By linking predictive analytics to sustainable land management, farmland preservation, and food system resilience, this research advances the USDAs mission to balance growth with environmental stewardship. The findings provide a pathway for integrating spatial modelling into regional planning, enabling communities to maintain productive agricultural landscapes while promoting ecological resilience at the rural-urban interface.
Keywords: Peri-urbanism, Land Cover, Transitioning, Modelling, Agriculture

#G533. Isolation and Detection of Fungi Associated with Miscanthus Leaf Spot in Northern Alabama

Nikky Sharma, Dr Leopold Nyochembeng*
Mentor(s): Dr. Leopold Nyochembeng
Department of Natural Resources & Environmental Sciences

Miscanthus is popular for biomass and biofuel. Although it shows rapid growth and high carbon content, its productivity is often decreased by fungal leaf spot diseases. For effective management, identifying these pathogens is the primary step. In this study, primary isolation was conducted by sterilizing the infected leaf tissues with distilled water, 70% ethanol for 1 minute, 10% Clorox for 2 minutes, and inoculated onto 2% Water Agar (WA). After 24 hours

of incubation, active tips were sub-cultured onto Potato Dextrose Agar (PDA) for vegetative characterization and V8 Juice Agar to induce reproductive development. Primary results indicate that the leading-edge isolation technique on WA reduced bacterial interference. Cultures transferred to PDA get dense, pigmented mycelial growth within 72 hours. To facilitate identification through a microscope, isolates were kept in both dark and light conditions on V8 media to promote more sporulation. Furthermore, the isolation will also be identified using molecular tools. This series of culturing approaches provides a healthy framework for recovering pure fungal isolations. Through this, we can identify measures to protect Miscanthus from decreasing productivity.

Keywords: Micanthus, Fungi isolation, Pure Culture Technique

#G534. Field Evaluation of a Microbial Biopolymer for Enhancing Soil Aggregate Stability

Owoola Oladukun, Emmanuel Oko, Dedrick Davis*
Mentor(s): Dr. Dedrick Davis
Department of Natural Resources & Environmental Sciences

Soil aggregate stability is a critical indicator of soil health and essential for long-term soil sustainability. It influences infiltration, porosity, root penetration and erosion resistance. Microbial biopolymers, particularly exopolysaccharides (EPS), have emerged as promising natural soil amendments capable of improving soil physical properties. Exopolysaccharides produced by Rhizobium tropici (R. tropici), a symbiotic nitrogen-fixing bacterium associated with leguminous crops, exhibit strong adhesive characteristics that can enhance soil structural integrity. However, the effects of R. tropici derived EPS on soil aggregate stability under field conditions have not been evaluated. This study evaluated the effect of a R. tropici-derived biopolymer on soil aggregate stability using the SLAKES smart-phone application. A plot-scale study was established at the Winfred Thomas Agricultural Research Station. A R. tropici derived biopolymer produced by in an anaerobic bioreactor was applied to six plots, while the remaining six plots received water as the control. At the end of the study, soil samples were collected from the 0 - 5 cm and 5 - 10 cm depths. Soil aggregate stability was quantified using the SLAKES app to assess slaking resistance of amended versus unamended soils. Findings indicated that the R. tropici-derived biopolymer improved aggregate stability across the sampled depths, acting as an organic binding agent that enhanced cohesion among soil particles and supported the formation of more stable aggregates. These results demonstrate the potential of microbial biopolymers to improve soil physical condition, strengthen soil health, and support sustainable soil management practices.

Keywords: Microbial biopolymer, Aggregate stability, Slake App.

#G535. Differential gene expression and functional pathway analysis of cotton in response to reniform nematode infection

Sravan K. Sanathanam, S. Karapareddy, K. Lawrence, L. T. Walker, Venkateswara R. Sripathi*
Mentor(s): Dr. Venkateswara Sripathi
Department of Natural Resources & Environmental Sciences

Cotton (Gossypium spp.) is a leading fiber crop in the southeastern United States; however, the soil-borne reniform nematode (Rotylenchulus reniformis, RN) significantly reduces plant growth and yield. This comparative transcriptomic study evaluated molecular responses of Gossypium arboreum sensitive (SGA) and resistant (RGA) cultivars under control (T0) and reniform-infected (T50) conditions. Plants were inoculated with RN (0K control; 50K treatment). and root samples were collected at 0, 7, 14, and 21 days post-inoculation (DPI). RNA was extracted using the Total RNA Spectrum Kit (Sigma Aldrich, STRN250), and sequencing libraries were generated and sequenced on the Illumina NovaSeq 6000 platform. Differential expression (DE), functional annotation, and KEGG pathway analyses were performed. DE identified 9,475 unique DEGs (Differentially Expressed Genes) in SGA (4996 upregulated and 5412 downregulated) and 9,886 unique DEGs in RGA (5258 upregulated and 5444 downregulated). Overlap analysis revealed 6,495 shared DEGs, while 2,980 genes were unique to SGA and 3,391 to RGA, indicating both common and genotype-specific transcriptional responses. Gene Enrichment analysis identified 706 biological processes, 120 cellular components, and 1,275 molecular functions in RGA, compared with 581 biological processes, 91 cellular components, and 1,023 molecular functions in SGA. In SGA, enrichments were associated with signal transduction, UDP-glycosyltransferase activity, oxidative stress response, and hydrolase activity. At the same time, RGA uniquely showed stronger enrichment in protein serine/threonine kinase activity, apoplast, copper ion binding, and lignin catabolic process. KEGG pathway analysis identified 18 enriched pathways in SGA and 15 in RGA. Plant hormone signal transduction, MAPK signaling, plant pathogen interaction, starch sucrose metabolism, and phenylpropanoid biosynthesis are some of the significant pathways regulated in RGA. This study showed that DEGs in the resistant genotype RGA exhibited higher expression of signaling, defense, and stress-adaptation genes.
Keywords: Cotton, Gossypium, reniform nematode, transcriptomics, DEGs, KEGG, pathway, RNA-seq

Physics, Chemistry, & Mathematics

#G536. Energy-Dispersive X-ray Spectroscopy Studies of CHC

Amari Williams, Jonathan Lassiter, Claudiu Muntele, Stephen Babalola*
Mentor(s): Dr. Jonathan Lassiter, Dr. Claudiu Muntele, Dr. Stephen Babalola
Department of Physics, Chemistry, & Mathematics

This study investigates the surface chemistry, stoichiometry, and electronic energy structure of cesium hafnium chloride (CHC), a novel scintillator. CHC offers a high light yield (54,000 photons/MeV), 3.3% detector resolution at 662 keV, and resistance to moisture due to its non-hygroscopic nature. However, little is known about CHCs elemental and chemical compositions. To address this, we employed JEOL IT810 Ultrahigh Resolution Field Emission SEM setup equipped with performing Energy-Dispersive X-ray Spectroscopy (EDS), a non-destructive analytical technique typically integrated with scanning electron microscopy (SEM) to evaluate elemental composition and stoichiometry. For CHC, this detects stoichiometric deviations, impurities, and degradation, which impact scintillation efficiency, detector resolution, and long-term stability. The EDS spectra displays X-ray intensity (counts) on the y-axis versus photon energy (keV) on the x-axis. Each element produces X-rays at characteristic energies, and the EDS software identifies elements by matching measured peaks to these known energies. The resulting data will inform crystal growth optimization and support the production of high-quality, crack-free CHC crystals for improved radiation detection.
Keywords: Energy-Dispersive X-ray Spectroscopy (EDS), crystal growth , and characterization

#G537. From Alloy Disorder to Light Yield: Understanding Halide Scintillators with First-Principles Modeling

Elijah Adedeji, Jingsong Huang, Eva Zarkadoula, Stephen Babalola*
Mentor(s): Dr. Stephen Babalola
Department of Physics, Chemistry, & Mathematics

Halide scintillators are promising materials for radiation detection because they convert high-energy radiation into visible light with high sensitivity and excellent energy resolution. However, their performance depends strongly on how the crystal lattice responds to excitation, especially in alloyed systems where local atomic disorder can alter structural and electronic behavior. In this work, first-principles modeling was used to investigate how alloy disorder influences the properties of halide scintillator materials, with emphasis on the mixed system $Cs_2Hf_{0.5}Zr_{0.5}Cl_6$ and its parent compounds Cs_2HfCl_6 and Cs_2ZrCl_6. Several alloy-modeling approaches were compared, including the virtual crystal approximation and explicit local-structure models, to determine how well they capture realistic atomic environments. The results indicate that local disorder is not a minor detail but a key factor that affects lattice distortion, dielectric response, and the physical description of excited-state behavior linked to scintillation. Models that explicitly account for local structural variation provide a more realistic representation of alloy behavior than simple averaged approaches. These results demonstrate the importance of atomistic-level modeling for understanding the relationships among composition, structure, and properties in halide scintillators. They also show how to predict and design better materials for detecting radiation at room temperature.

Keywords: Halide scintillators, alloy disorder, first-principles modeling, radiation detection, density functional theory

#G538. Investigation on the Formation and Decay of Heavy Baryons and Fine Structures of Feynman Diagrams based on New Development of Two-Flavor Multi-Excitation Model of Quarks

Hannah Sukarloo, Tianxi Zhang*
Mentor(s): Dr. Tianxi Zhang
Department of Physics, Chemistry, & Mathematics

Investigation on the Formation and Decay of Heavy Baryons and Fine Structures of Feynman Diagrams based on New Development of Two-Flavor Multi-Excitation Model of Quarks Hannah Sukarloo and Tianxi Zhang Department of Physics, Chemistry, and Mathematics, Alabama AM University, Normal, AL 35762 On the basis of the newly well-developed two-flavor multi-excitation quark model, matter in the universe is made up by only two building blocks or quarks with only two flavors, denoted by up and down as done in the standard model of particle physics. Being composites of three fundamental elements (mass, electric charge, and color charge), a quark excites and decays, which are caused by the quark internal interactions among the three fundamental elements, especially the weak interaction between electric and color charges. Combinations of two quarks, in which one is antiquark, at different states from the ground to excited ones, form various mesons if no quark- antiquark annihilation occurs, and form leptons or bosons if their masses, electric charges, and/or color charges are annihilated. Baryons are formed from combinations of three quarks. Recently, four-quark mesons, called tetraquarks, and five-quark exotic baryons, called pentaquarks, are also observed. Protons are the lightest and most stable baryons and all heavy baryons, once produced, quickly decay into lighter ones towards the most stable one, proton, with emissions of leptons and gamma rays. In this study, we will look at formations and decays of heavy baryons such as Lambdas, Sigmas, Xis, and Omegas and their fine structures of Feynman diagrams based on the two-flavor multi-excitation quark model to reveal how various decay modes of these heavy baryons occur and process through quark-antiquark pair emissions and annihilations. In this poster presentation, we will present new results obtained from our recent studies, supported by NSF HBCU-UP Research Initiation Award (240001).
Keywords: Quark Model, Heavy Baryons, Decay and Formation

#G539. A Geant4-based Model of Cesium Hafnium Chloride-based Scintillator Detectors

Nicholas Glenn, Isaiah Nwokenkwo*, Amari Williams, Dr. Jonathan Williams*
Mentor(s): Dr. Jonathan Lassiter, Dr. Stephen Babalola
Department of Physics, Chemistry, & Mathematics

Cesium Hafnium Chloride (CHC) is a novel scintillator detector material, which demonstrates promising performance at a radiation detector with a demonstrated high light yield, and high detector resolution, comparable to benchmark scintillators, while also having low

moisture sensitivity. In this effort, computational approaches were applied to the development of models of CHC-based scintillator detectors and devices, utilizing Geant4. Through a modeling and simulation approach, time and monetary resources can be defrayed with such systems while simultaneously verifying an experimental gamma response system against this robust Monte Carlo model-based benchmark. Such an approach expedites down-selection of detector configurations and material stoichiometry, while providing more reliable performance metrics, along with an improved iteration and throughput of materials fabrication and device engineering. Through this approach, a proper model to elucidate the performance of detector materials is demonstrated. The first phase of this effort shows 137Cs decay product, a 662 keV photon, interacting with a CHC crystal. The modeled gamma spectrum, along with a photopeak, is generated as the output, against which CHC experiments are to be compared. Future research will include higher granularity models by including electric fields, and photopeak broadening.
Keywords: Simulation, Radiation detector, Scintillator

#G540. Impact of the initial Lorentz factor on Kinetic instability growth and magnetic field evolution in relativistic pair jets

Ram Chandra Pageni, Athina Meli, Ioana Duţan, Jacob Trier Frederiksen, Christoph Kohn, Nicholas R. MacDonald, Yosuke Mizuno*
Mentor(s): Dr. Kenichi Nishikawa
Department of Physics, Chemistry, & Mathematics

We analyze the self-consistent evolution of relativistic electron-positron ($e^{\pm}$) jets and their interaction with the ambient medium through global three-dimensional particle-in-cell (PIC) simulations performed in cylindrical geometry. To simulate AGN jets, we implement a modified injection scheme incorporating space -and time- dependent particle velocities with initial Lorentz factors $\Gamma o = 15$ and 10. Our results show that the jets with a higher initial Lorentz factor ($\Gamma o = 15$) exhibit stronger collimation and slower magnetic field dissipation compared to the jets with $\Gamma o = 10$. In both cases, the kinetic instabilities developed in the linear stage generate a non-oscillatory x-component of the electric field, which is responsible for accelerating and decelerating electrons. Upon entering the nonlinear regime, the initial toroidal magnetic field undergoes significant amplification driven by the kinetic Kelvin-Helmholtz Instability (kKHI) and the Mushroom Instability (MI), subsequently reorganizing into complex topologies. We observed the magnetic island with reversal of polarity of the magnetic field towards the end of non linear stage, which is consistent with reconnection-like processes. These findings demonstrate that global 3D PIC modeling is essential for capturing the interplay between kinetic instabilities, magnetic turbulence, and particle acceleration in relativistic outflows, providing a critical bridge between microscopic plasma physics and macroscopic astrophysical observations of AGN and gamma-ray bursts.
Keywords: Astrophysical plasma, Relativistic jets, Kinetic instabilities, Non-thermal acceleration.

Teacher Education & Leadership

#G541. An Investigation of the Effectiveness of the I-Ready Reading Interventions on Middle School Students in a Central Alabama School District

*Cheray Williams**
Mentor(s): Ronald Grace (ASU), Dr. Mebougna Drabo (AAMU)
Department of Teacher Education & Leadership

This quantitative study examined the effectiveness of the I-Ready reading intervention on the literacy outcomes of middle school students in a central Alabama school district. The purpose of the study was to investigate the relationship between participation in the I-Ready reading intervention and student reading achievement as measured by the Alabama Comprehensive Assessment Program (ACAP) Reading assessment and I-Ready diagnostic scores. The study also explored educator perceptions of the programs usefulness as a literacy intervention tool within public school settings. The sample consisted of 1,082 students enrolled in the two lowest performing middle schools in the district across multiple academic cohorts. Archival student achievement data and survey responses from educators were analyzed to address the research questions.

Keywords: Literacy, Achievement Gap, I-Ready, MTSS, and ESSA

#G542. Navigating the Lab: Black Feminist Analysis of Equitable Participation in Fourth-Grade PBL Science Classrooms in Alabama

*Tiesha Watts**
Mentor(s): Dr. Samantha Strachan, Dr. Lena Walton
Department of Teacher Education & Leadership

Black girls in Alabama's fourth-grade science classrooms navigate the intersecting forces of anti-Black racism and sexism in ways that shape their participation in scientific inquiry, their access to epistemic authority, and their developing identities as scientists. Despite widespread adoption of project-based learning (PBL) as a reform pedagogy promising more equitable, student-centered science instruction, no published research has examined whether PBL's collaborative structures disrupt or reproduce the specific marginalization Black girls experience in elementary science spaces. This qualitative study, grounded in Black feminist methodology and supported by descriptive contextual data from the Alabama Comprehensive Assessment Program (ACAP), examines how PBL shapes equitable participation and science identity development for Black girls in fourth-grade Alabama science classrooms implementing the Accelerate Learning ColSci curriculum. Guided by two research questions examining participation and equity dynamics and the curriculum and facilitation conditions that shape them, the study employs Black feminist theory, specifically Collins's (2000) matrix of domination, Morris's (2016) pushout framework, and Crenshaw's (1989) intersectionality theory as its primary analytical framework. Data will be collected across the 2026-2027 academic year through monthly classroom observations, teacher interviews, student artifact analysis, a Black feminist equity audit of the ColSci curriculum, and age-appropriate member-checking activities with four to six focal Black girl participants across two Alabama fourth-grade

classrooms. Findings are expected to illuminate the specific mechanisms through which PBL implementation promotes or constrains Black girls' epistemic authority and science identity development, provide the first equity analysis of the Accelerate Learning ColSci curriculum, and generate actionable knowledge for teachers, curriculum designers, and policymakers committed to equitable elementary science education. This study extends Black feminist scholarship into the understudied elementary classroom context and centers Black girls not as a demographic subgroup but as the primary subjects of scholarly inquiry their experiences demand.

Keywords: Black feminist theory, project-based learning, science identity, elementary science education, intersectionality

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ACKNOWLEDGMENTS

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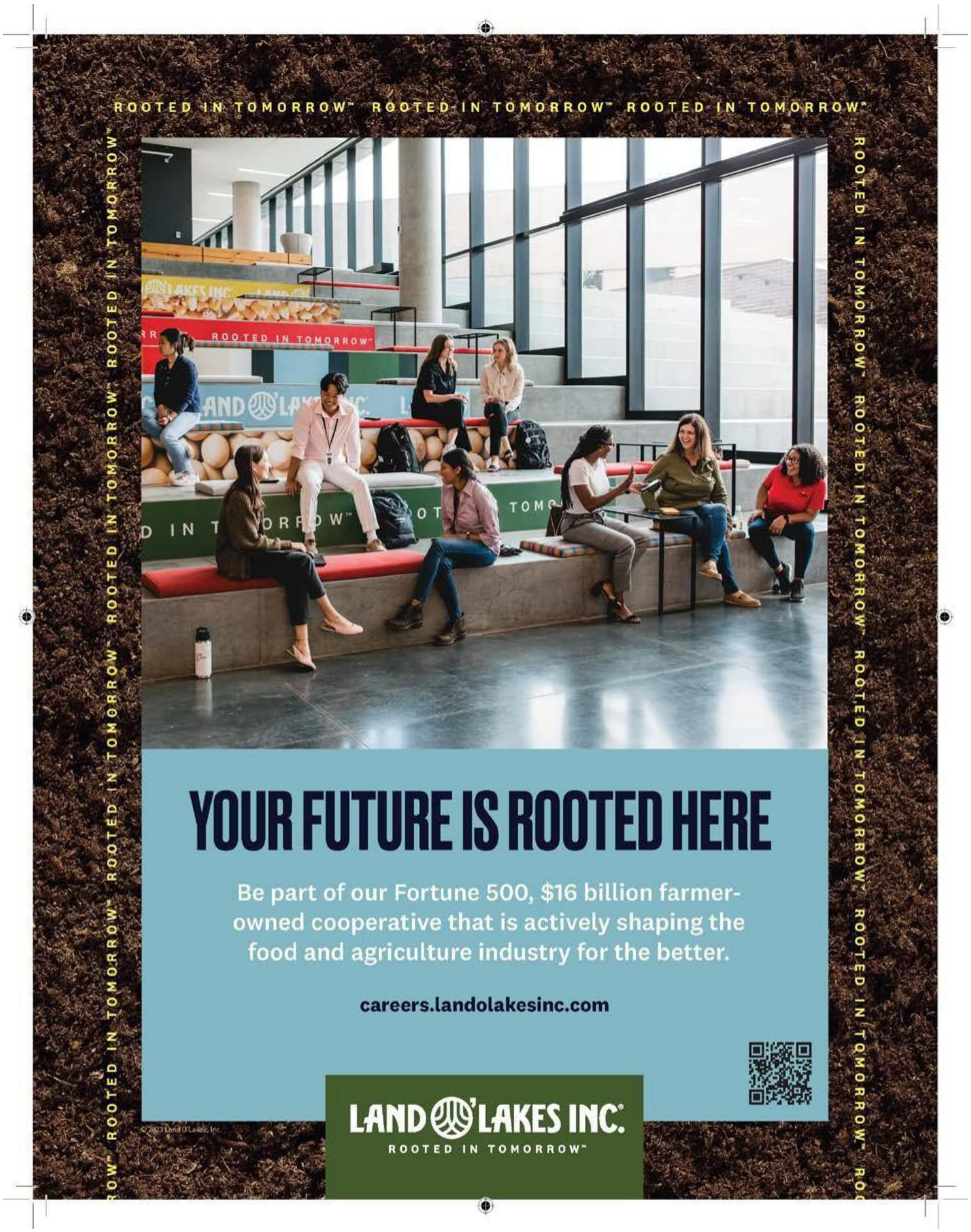
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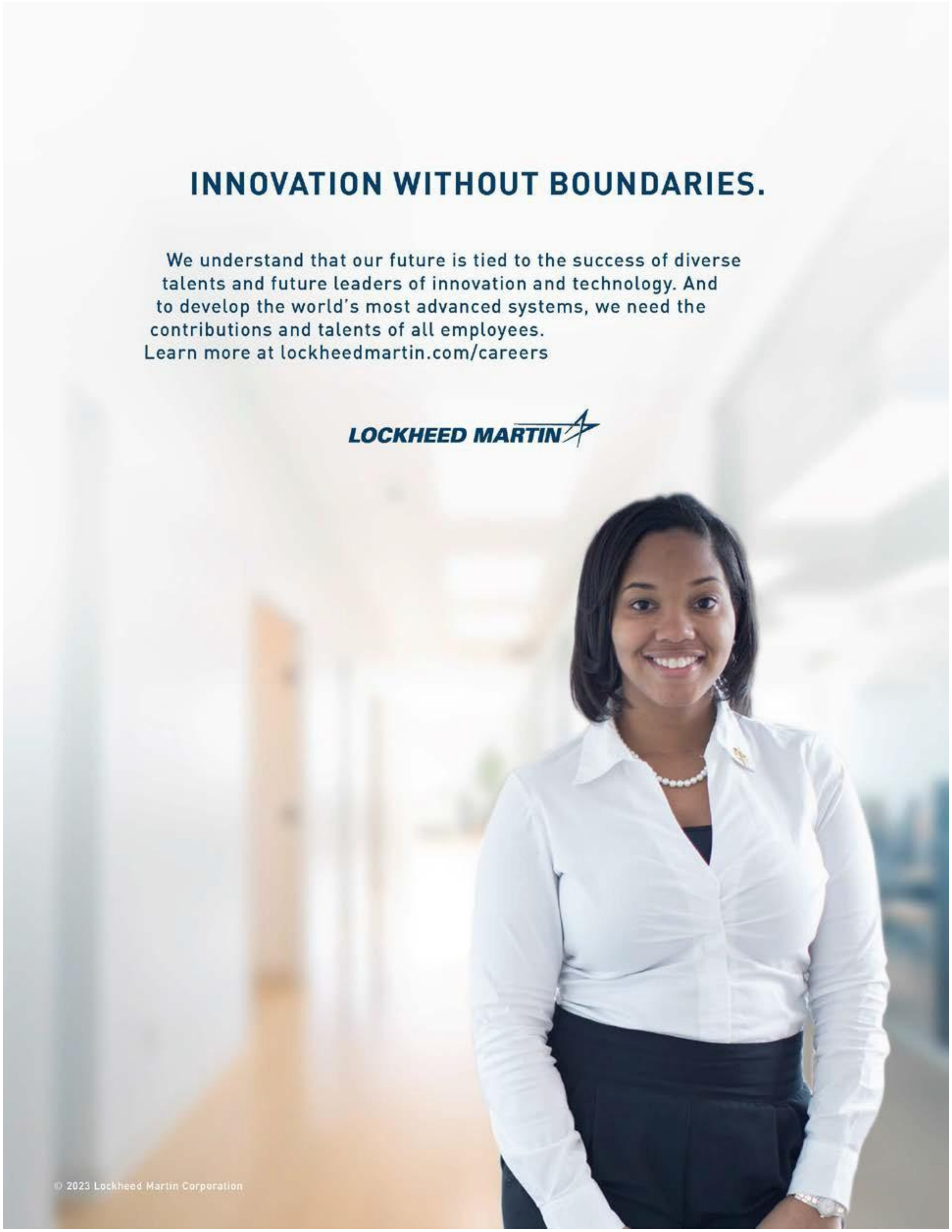
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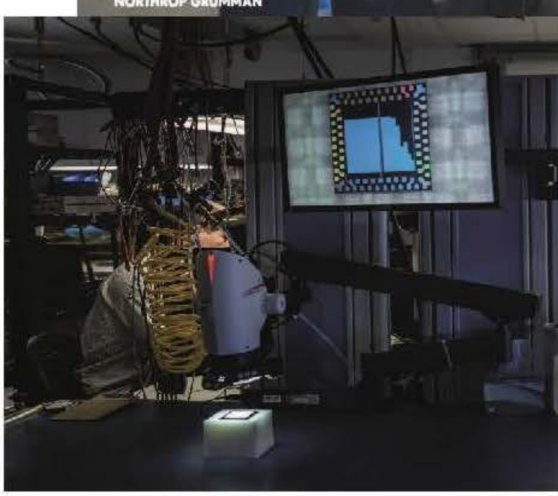


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