YEAR THREE OF THE

Institute of
Cannabis Research
COLORADO STATE UNIVERSITY–PUEBLO

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Institute of Cannabis Research
COLORADO STATE UNIVERSITY–PUEBLO

ICR FROM THE DIRECTOR

July 1, 2018, marked the start of the third year of the **Institute of Cannabis Research (ICR) at Colorado State University-Pueblo.** This year has seen some exciting expansion of the Institute that built upon the successes of the previous years and fomented a number of exciting changes, including the continuation and expansion of cutting-edge research as well as the establishment of partnerships with external industry, scientific, and technical organizations.

The Journal of Cannabis Research (JCannabisResearch.BioMedCentral.com) launched in Fall 2018 in partnership with Springer Nature and under the leadership of Dr. David Gorelick, the journal's first Editor-in-Chief.

For the third annual Institute of Cannabis Research conference (March 23-25, 2019), the conference committee implemented aggressive improvements to the diversity and quality of content of the conference proceedings and created opportunities for sponsorship and exhibition to foster stronger relationships between academia and industry, focusing on research and technology.

Furthermore, the Institute launched a national patient registry in partnership with Colorado-based **ValidCare.** This registry will facilitate the compilation of HIPAA-compliant clinical data from actual medical cannabis patients to allow for comprehensive scientific research into the efficacy of medical cannabis as an alternative to pharmaceutical treatments. In addition, the registry will be one of the first in the nation to provide this service to researchers worldwide.

To better serve the needs and understand the concerns of our local community, the ICR has implemented a Community Liaison Board consisting of Southern Colorado community leaders who represent a cross-section of industries and sectors, including law enforcement, K-12 education, health and wellness, and the business community.

ICR leadership is also developing the ICR **Scientific Research Advisory Board** to enhance the ICR's scientific research effectiveness and timeliness and to help guide the ICR in high-impact research directions.

The following pages detail the breadth and depth of work created by the dedicated educators, students, researchers, and industry partners of the Institute of Cannabis Research. In an environment where communities across the United States seek to legalize hemp and cannabis products, the ICR can serve as an invaluable resource for unbiased data and research to inform the ongoing conversation regarding cannabis.

Chad Kinney, Ph.D.
Director, Institute of Cannabis Research

MEET THE **ICR STAFF**

CHAD KINNEY DIRECTOR

Dr. Kinney received his bachelor's degree in environmental chemistry at the University of California, San Diego, and his Ph.D. in applied chemistry from Colorado School of Mines. Research in the Kinney lab has traditionally focused on the presence, fate, and effects of pharmaceuticals and personal care products (PPCPs) as contaminants in the environment. Many of the same analytical techniques are being employed in the development of novel extraction methods of phytochemicals by his group. In addition to serving as the ICR Director, Dr. Kinney currently serves as the Chair of the Chemistry Department at CSU-Pueblo. As Director of the ICR, Dr. Kinney provides leadership and management of the Institute's activities; liaises with external organizations, regional stakeholders, and government personnel/lawmakers; and facilitates the ICR's research, annual conference, and Journal of Cannabis Research.

NICOLE QUARTIERO ASSISTANT DIRECTOR

Nicole holds an undergraduate degree in biology and a master's degree in clinical research management from Arizona State University (ASU) and has worked as a Research Administrator at ASU, the Mayo Clinic, Denver Health, and most recently the University of Colorado, Denver – Anschutz Medical Campus, and brings a commitment to detail, thought, and analysis to her new role at CSU-Pueblo. As Assistant Director of the ICR, Nicole is a working lead and subject matter expert in research administration charged with executing important operational and fiscal functions in an attempt to help translate research discoveries into innovative applications while ensuring a disciplined, sound, and effective working environment.

SANG-HYUCK PARK SENIOR SCIENTIST/RESEARCH LIAISON

Formerly a research professor at CSU-Pueblo, Dr. Park completed his bachelor's degree in microbiology at Chung-Nam National University in South Korea and earned a master's degree from the Department of Plant Pathology from the University of Arkansas, Fayetteville. In 2011, Dr. Park obtained his Ph.D. from the Department of Plant, Soil, and Microbial Sciences at Michigan State University. Dr. Park's role at the ICR is to provide leadership to the ICR research team and conduct cannabis research in collaboration with other academic institutions and industries. Furthermore, he acts as a liaison to connect with other entities to facilitate expanding existing knowledge on cannabis and translating this knowledge into applications that benefit society.

XIAO CUI DATA ANALYST

Xiao Cui has extensive experience in clinical trials and proficiency in SAS, R, Minitab, SQL, and Tableau, and is the coauthor of several publications. Having earned master's degrees in biotechnology and applied statistics from Pennsylvania State University, Ms. Cui has worked for private companies as well as Johns Hopkins Medical School as a research technologist/ clinical coordinator. In her role as ICR's Data Analyst, Ms. Cui supports ICR researchers with experimental design and statistical analysis, as well as monitoring fiscal data for the ICR.

WENDY FAIRCHILD OFFICE MANAGER

Wendy Fairchild is an alumna of CSU-Pueblo with a bachelor's degree in art and a minor in biology. She has worked 6 years with the University as an administrative assistant in the Department of Art and more recently as the Office Manager for the Institute of Cannabis Research. Previously, Wendy worked for Bechtel, Inc., as part of the Pueblo Chemical Agent Destruction Pilot Plant, and her early career included the conservation of fine art and historical documents for the University of Denver's Conservation Center, which she continues to practice today on a limited basis. Within the ICR, Wendy manages communications, coordinates activities planning/scheduling, and assists with contracts and purchasing.
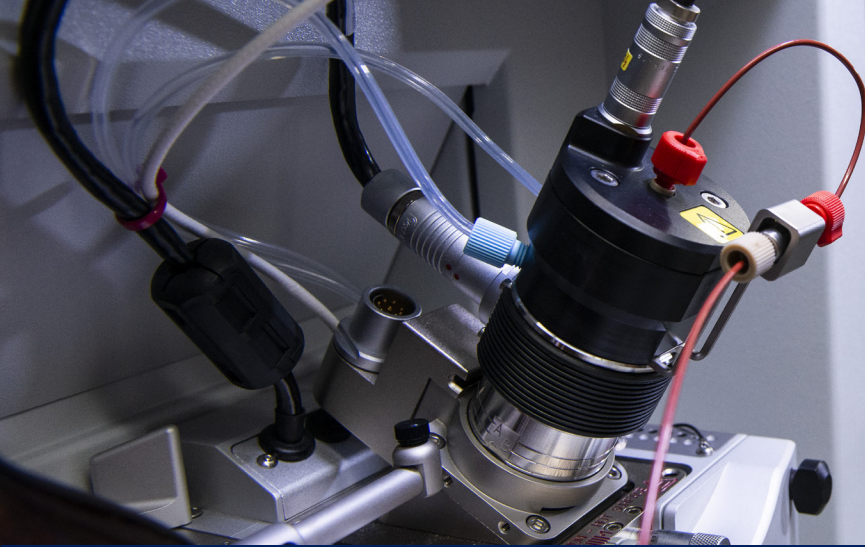
The Mission of the Institute of Cannabis Research is to generate new knowledge and understanding of cannabis and its derivatives through research and education. Ongoing research projects facilitated through the ICR work to meet this mission while routinely engaging student research assistants in the process. This gives the next generation of researchers invaluable, first-hand experience within their discipline.

# ONGOING **RESEARCH STUDIES**

DR. BARBARA BRETT-GREEN PSYCHOLOGY

▶ INVESTIGATION INTO THE EFFECTS OF MEDICINAL CANNABIS ON SEIZURES IN ADULTS WITH MEDICINALLY REFRACTORY EPILEPSY

The primary objective for this project is to continue an ongoing study into the effects of medicinal cannabis on seizures in adults with medically refractory epilepsy. This study leverages partnerships with the local non-profit Realm of Caring to provide support services for patients and enables the collection of bioanalytical data with the assistance of the company iC42 to process participants' biological samples (blood and urine) for antiepileptic medication and cannabinoid levels.

DR. ANNETTE GABALDON BIOLOGY

▶ STUDY OF THE EFFECTS OF DIETARY HEMPSEED (CANNABIS SATIVA L.) ON GROWTH PATTERNS, BODY COMPOSITION, BONE MINERAL DENSITY, AND GUT MICROBIOTA DIVERSITY IN FEMALE C57BL/6J MICE

The objective of this study is to understand the influence of dietary hempseed on growth parameters and intestinal microbiota diversity. Hempseed is a nutrient-dense food that contains high amounts of protein, carbohydrates, fiber, lipids, vitamins, minerals, and phytochemicals, but its use as a dietary aide is controversial in the U.S. due to the presence of some cannabinoids in small amounts. Hempseed oil and seeds are beginning to appear in the U.S. market for human consumption, but its use in agricultural animal feed has not gained approval from the FDA.
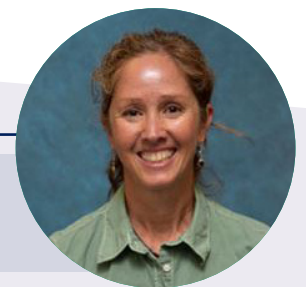
▶ DETECTING CANNABINOID-INDUCED ALTERATIONS TO CELLULAR METABOLISM USING A SEAHORSE XF BIOANALYZER AND MONITORING ITS IMPACT ON VIRAL REPLICATION

Cannabinoid receptors are ubiquitous and are found on cells all throughout the body. The objective of this study is to gain a better understanding of how cannabinoids alter cellular metabolism and will have a significant impact on cannabis research by providing critical data on how medicinal or recreational marijuana use impacts cellular physiology.

DR. YOANNA LONG COMPUTER INFORMATION SYSTEMS

DR. KUANG YUAN HUANG COMPUTER INFORMATION SYSTEMS (CO-PI)

▶ BIG DATA ANALYTICS IN CANNABIS RESEARCH

The project focuses on Data Analytics related to cannabis rehabilitation. By collecting and analyzing data from two online cannabis rehabilitation forums, the PIs investigated the types and the degrees of social support to quitters, specifically, what factors impact the quitters' emotional state and determination to seek rehab. The results of this research can be used in practice by designing a mobile application to facilitate cannabis rehab, which is one of the ongoing goals of this project. This research has also been published as a conference proceeding in HICSS (52nd Hawaii International Conference on System Sciences) and was nominated to the **Best Paper Award.**

DR. NEB JACKSIC ENGINEERING
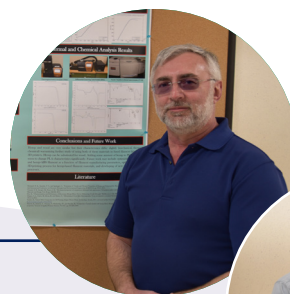
DR. MEL DRUELINGER CHEMISTRY (CO-PI)

▶ RHEOLOGICAL CHARACTERISTICS OF HEMP-BASED FILAMENT COMPOSITES FOR 3D PRINTING

This research investigates flow characteristics of various hemp-based composites used in 3D printing. Hemp is stronger and less expensive than plastic, making it a cost effective and recyclable reinforcement composite agent to expand the use of 3D printing. However, if the hemp particles in the filament are too large, they can clog the 3D printing nozzle and subsequently stop the process, resulting in wasted material and time (time to clear the nozzle and time to re-print the object). If the hemp particles are too small, then the created objects are not as strong as they could be. In addition, the PIs consider the recyclability of 3D-printed objects.

DR. JEFF SMITH BIOLOGY

▶ MODULATION OF NMDA-RECEPTOR DEPENDENT NEUROLOGICAL FUNCTION BY DEXANABINOL

In collaboration with a noted neuroscientist at the University of Montana, the PI of this study seeks to characterize the role of dexanabinol NMDA receptors in mouse brain and to demonstrate its relevance for modulating NMDA receptor-dependent learning and memory in mice at both the electrophysiological and behavioral levels. The project addresses missing knowledge related to the potential use of dexanabinol as a selective therapeutic for brain disorders involving impaired learning and memory such as depression, post-traumatic stress disorder (PTSD), stroke, brain injury, and dementia (for instance , Huntington's and Alzheimer's diseases).

DR. KAREN YESCAVAGE PSYCHOLOGY

MS. XIAO CUI INSTITUTE OF CANNABIS RESEARCH (CO-PI)

▶ **CANNABIS LEGALIZATION AND OPIOD-RELATED DEATHS IN COLORADO, 1999-2018**

The National Institute on Drug Abuse recently funded two studies to examine the relationship between cannabis legalization and adverse outcomes associated with prescription opioids. In both studies, notably, the reduction in deaths was present only in states with dispensaries (not just medical marijuana laws) and was greater in states with active dispensaries. The purpose of this project is to determine if legal access to cannabis impacts mortality rates due to opioid overdose. The PIs assess opioid mortality rates spanning the past 19 years (1999-2018) across Colorado counties with populations of 100,000 or more. The PIs also run interrupted time series analyses to compare opioid-overdose mortality rates among counties with and without recreational cannabis legalization. The change in level and slope of opioid-related deaths are compared.
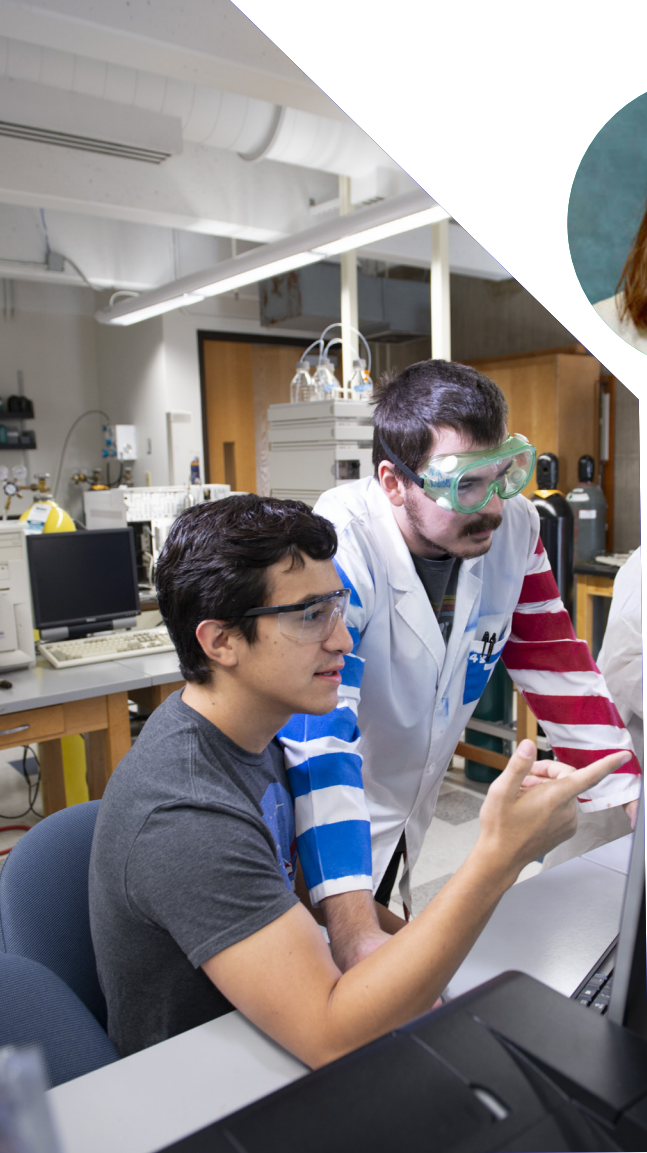
DR. BRIAN VANDEN HEUVEL BIOLOGY

▶ APPLICATIONS OF INDUSTRIAL HEMP

This project studies the use of industrial hemp in a variety of applications, including as a remediation tool for metals and metalloids from soil and municipal sewage sludge, and explores the possibility of scaling cannabinoid extraction methods developed in previous ICR projects to industrial volumes to isolate individual cannabinoids from hemp. This project seeks to determine if waste products from industrial hemp production (stems/leaves) can be a reliable source of important biopolymers and if the recently sequenced genomes for industrial hemp can serve as a framework for continued research into what genes are turned on and off during different growth stages, affecting important traits like disease resistance; drought intolerance; yield; and specific concentrations of CBCs, THC, or other secondary chemicals.

Dr. Brian Vanden Heuvel, Biology (PI)
Dr. Leonardo Bedoya-Valencia, Engineering (Co-PI)
Dr. Yaneth Correa Martinez, Hasan School of Business (Co-PI)
Dr. Richard Farrer, Chemistry (Co-PI)
Dr. Chad Kinney, Chemistry (Co-PI)

DR. CHAD KINNEY CHEMISTRY

▶ PLANT IDENTIFICATION AND TRACKING USING CHEMICAL BARCODING

The purpose of this project is to develop a robust method of identifying the source of plant material and tracking it to the point of sale. As part of the project, the PIs aim to develop and validate a potential tracking technology using a chemical barcode that is versatile enough to be used in a wide range of applications and to encode a range of data. Use of plant/product identification is commonly employed in agriculture and food industries for purposes ranging from public safety to brand protection.

Dr. Chad Kinney, Chemistry (PI)
Dr. Brian Vanden Heuvel, Biology (Co-PI)
Dr. James Carsella, Chemistry (Co-PI)
**Dr. David Boston,** Chemistry (Postdoctoral Researcher)

DR. SANG-HUYCK PARK BIOLOGY

▶ BIOLOGICAL & CHEMICAL PROPERTIES OF CANNABIS

Multi-tiered research projects led by Dr. Sang-Hyuck Park, with the assistance of multiple student researchers, seek insights into fundamental cannabis biology and cannabinoid chemistry to address the intrinsic questions of why cannabis plants produce secondary metabolites such as cannabinoids and terpenoids, how they exploit the chemicals for their survival, and what evolutionary benefits they may have. A variety of research projects explore new agricultural/therapeutic uses of cannabidiol (CBD). One noteworthy research endeavor launched by this ICR research team is the genomic consortium for comparative genomics of hemp varieties to better understand genomic structures and genetic regulations underlying cannabinoid biosynthesis and agronomically important traits. The genomic consortium includes the world-class Arizona Genomics Institute (AGI) at the University of Arizona, led by Dr. Rod Wing, along with renowned cannabis geneticists Dr. John McKay (CSU-Fort Collins) and Dr. Nolan Kane (CU-Boulder). The multidisciplinary research consortium has successfully sequenced two hemp varieties and assembled two draft genomes. All data generated from this project will serve as a valuable genetic resource for investigating the mechanisms of cannabinoid biosynthesis in hemp.
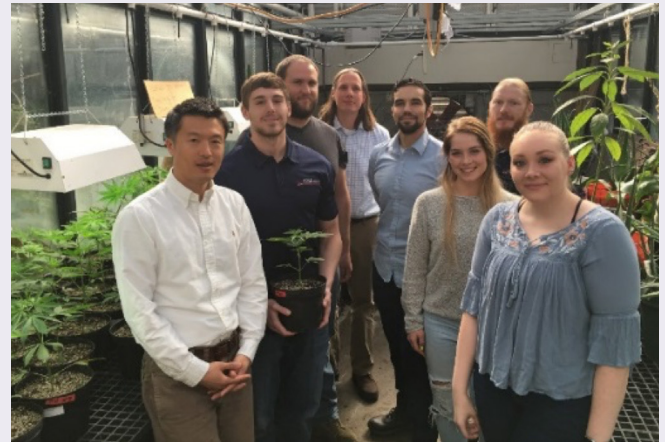
Dr. Sang-Hyuck Park, Senior Scientist/Research Liaison (PI)

HEAR FROM THE STUDENTS

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Following my graduation from South Dakota State University, I made the long trek to the beautiful state of Colorado in order to pursue my master's degree in biology doing work related to cannabis. Personal inquiry along with literature review led to questions pertaining to cannabinoid production: Why does cannabis produce cannabinoids? What factors influence cannabinoid production? Where in the plant and at what stages of its life does cannabis begin to produce cannabinoids? Using visible light as the focus, I aim to determine the effects of different spectra of light found within the visible spectrum, as well as UV radiation, on the production of phytocannabinoids and their precursor throughout different stages of plant growth and development. Identifying the potential impact of various wavelengths of light on cannabinoid synthesis allows researches and horticulturalists to develop highly efficient cultivation methods that can maximize the full potential of cannabis and its cannabinoids, ultimately leading to highly specialized cannabinoid profiles in different cannabis species that have many clinical and medicinal implications.

– Trevor Regas, Biology-MS Student at CSU-Pueblo

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Over the past two and a half years, I have had the pleasure of gaining research experience through the ICR. I began as a research assistant to Dr. Barbara Brett for her observational study on the effects of medicinal cannabis on individuals with medically refractory epilepsy in fall of 2016, which gave me a greater appreciation for the therapeutic potential of cannabis. After about one and a half years of working with Dr. Brett, I found myself working alongside Dr. Sang Park as well, looking at how cannabidiol may affect insects which is surprisingly a topic that has not received much attention due to the lack of an endocannabinoid system within the insect. Since I began working at the ICR, my base knowledge has vastly increased which proved to be quite the boon to me in many of my classes at Colorado State University-Pueblo, as I was able to garner information from the primary literature that was useful in understanding difficult concepts in the classes. I have seen much growth in the ICR over the past few years, and hope to see it grow into a world renowned research facility in the near future to provide valuable insights into the value of cannabis.

– Matthieu Conroy, Senior at CSU-Pueblo

RESEARCH **PROGRESS SUMMARY**

FOR FY19 PROJECTS

PROJECT	LITERATURE REVIEW	EXPERIMENTAL DESIGN/DATA COLLECTION	DATA ANALYSIS	DISSEMINATION/ IMPLEMENTATION	NUMBER OF STUDENT(S)
Medicinal Cannabis on Adult Seizures*	85%	45%	40%	40%	7
Nutritional and Health Effects of Dietary Hempseed*	100%	100%	85%	70%	4
Effects of Cannabinoid on Cellular Metabolism	100%	90%	75%	75%	1
Big Data Analytics in Cannabis Research	100%	100%	75%	50%	2
3D Printing by Hemp-based Filament*	100%	75%	60%	40%	6
Neurological Effects of Cannabinoid Dexabinol	95%	85%	80%	70%	7
Cannabis Legalization and Opiod Related Deaths	100%	100%	90%	80%	2
K12 Cannabis Research Project	100%	80%	80%	75%	1
Applications of Industrial Hemp*	80%	30%	30%	30%	7
Plant Identification and Tracking	100%	95%	75%	60%	1
Cannabis Genomics and Genetics and Cannabinoid Characterization*	100%	70%	70%	40%	5

*Multi-Year Project　　　　　　　　　　　　　　　　**Total Student Research Experiences: 43**

As the ICR enters the final quarter of fiscal year 2019, many projects are nearing completion, with the exception of multi-year projects. The faculty, staff, and student researchers are progressing toward completing experimental work and data analysis in preparation for primary dissemination products. Dissemination of new information will typically include presentations at an appropriate professional conference(s), such as the ICR Conference. In most cases, the final products will include publication of results and analysis in a peer-reviewed research journal. The time period spanning the completion of a project, the preparation and review of a manuscript, and the final print appearance in a journal usually lasts several months.

8 | ICR Annual Report

PROJECT **SPOTLIGHT**

K12 CANNABIS USE AND RESTORATIVE JUSTICE

This project focuses on K-12 student cannabis use in the general population as well as within the LGBTQ student population, programs to prevent cannabis use, and interventions to address student violations of cannabis laws. Restorative Justice programs for students with cannabis-related infractions are being implemented and studied in Pueblo City Schools District 60 and Pueblo County School District 70.

Dr. Tim Peters, Teacher Education (PI)

Dr. Bethany Kies, Exercise Science & Health Promotion (Co-PI)

Dr. Lynn Knight, Teacher Education (Co-PI)

Dr. Margie Massey, Teacher Education (Co-PI)

Dr. Jenny Piazza, Teacher Education (Co-PI)

Dr. Pam Richmond, Social Work (Co-PI)

Dr. Ron Wiley, Resource Exchange International Inc.

"

The current Student Use Study is engaged in collecting data on cannabis infractions committed by middle and high school students from school administrators and law enforcement in Southern Colorado. This builds upon our previous studies of data on student cannabis use collected by the Healthy Kids Colorado Survey, a biennial self-reported survey of middle and high school students across Colorado. Anecdotal evidence from school staff points to higher levels of cannabis use by students since legalization of recreational cannabis in Colorado; the Healthy Kids Colorado Survey data indicates no increase in cannabis use since legalization. Our study aims to provide a broader picture of youth cannabis use in Southern Colorado. We are organizing a panel of experts at the state and local level to share and discuss their findings on student cannabis use in Colorado at the 2019 ICR Conference.

Restorative Justice is the other focus of our research study. Restorative Justice is "a collaborative decision-making process that includes victims, offenders, and others who are seeking to hold offenders accountable" by implementing these five basic principles: "relationship, respect, responsibility, repair, and reintegration". This practice is an alternative to the traditional, punitive approaches towards offenders that became popular under the policy of Zero Tolerance and are still practiced by many schools today. Over the last 6 years, federal and state policies have discouraged the use of purely punitive measures and promoted alternative, restorative practices, such as Restorative Justice.

Our study examines the four stages of Restorative Measures Implementation in the local school systems. Stage one is the commitment to adopt by stakeholders; stage two is the training of a cadre of Restorative Justice practitioners in schools; stage three is initial implementation; and stage four is full implementation. Our study examines the process of institutional change and conducts an ethnographic study of the experiences of youth Cannabis offenders as they navigate a restorative justice process versus a purely punitive process.

Previous research by the K12 Cannabis Research Project includes a study that investigated the possible connection between communities that chose to permit recreational dispensaries and those that did not on student cannabis use and perceptions towards cannabis. As more and more communities wrestle with the choice of whether or not to permit local recreational dispensaries, investigating the influence of local dispensaries on K12 students is timely and relevant. Another study described the cannabis prevention education efforts in regional middle and high schools, and examined the need for additional materials and resources. Other studies have explored education funding from cannabis based tax revenue, and the prevalence of higher cannabis use and other illegal drugs by LGBTQI students.

– Tim Peters, Ph.D.

RESEARCH **PARTNERSHIPS**
CSU-PUEBLO PARTNERING WITH EXTERNAL ORGANIZATIONS TO ADVANCE RESEARCH

MEDICINAL CANNABIS DATA REGISTRY

The goal of this project is to operate the world's preeminent cannabis patient registry that continually engages the medical community; uses technology to collect data from patients, providers, and researchers; and allows data correlation and extraction of insights to answer the most compelling questions associated with the medical use of cannabis. The ICR team worked with the Colorado company ValidCare to develop an online, independent, digital patient communication system intended to facilitate secure, real-time transfer of information between providers and patients. The database platform, which is intended to house patient-reported data and provider reports, is HIPAA compliant, IRB approved, and able to carry out data imports and exports. The platform allows for recording of product-specific data, including cannabis strain, profile, concentration, form, dosage, and concentration/strength. The PIs, partner, and ICR recognized the opportunity to create a trusted source of patient-generated data to understand the impact and effectiveness of cannabis-based products on multiple conditions.

Dr. Jane Fraser, Engineering (PI)
Dr. Barbara Brett-Green, Psychology (Co-PI)
Dr. Sue Sisley, Scottsdale Research Institute (Co-PI)

Partnership with ValidCare

PROBLEMS EXPERIENCED WITH EDIBLE CANNABIS PRODUCTS

Legalization of cannabis and cannabis products at the state level has been associated with greater overall usage, refined cultivation methods, increased THC potency, and diverse modes of exposure, including edibles. The findings from this research are intended to inform public health education campaigns, product manufacture and labeling, and product information given at the point of sale.

Dr. Jane Fraser, Engineering (PI)

Dr. Sue Sisley, Scottsdale Research Institute (Co-PI)

Partnership with Dr. Joshua Meisel
Department of Sociology at Humboldt State University

STUDY OF HEMP COMPOSITE ELEMENTS AS STRUCTURAL MEMBERS FOR FRAMING HOUSES

This research investigates various hemp composites as a possible replacement for wood products in construction, specifically house-framing elements like trusses, studs, and joists. A number of standard test specimens will be created and tested (compression, tension, flexion, and Poisson's ration) to determine their mechanical characteristics. In this stage, various commercially available hemp textiles will be purchased and used in the creation of composite test specimens.

Dr. Neb Jaksic, Engineering (PI)

Dr. MD R Islam, Civil Engineering Technology (Co-PI)

Kevin Sparks, MS, Civil Engineering Technology (Co-PI)

Partnership with Colorado Hemp Processing Cooperative

SUPPLY CHAIN MANAGEMENT USING BLOCKCHAIN TECHNOLOGY

This project focuses on using blockchain-distributed ledger technology to manage the cannabis supply chain. Collaboration between CSU-Pueblo faculty and students and a Colorado consulting company, BlockFrame, facilitated creation of a demonstration platform called Cannablock to track a supply chain based on the cutting-edge technology from IBM Hyper Ledger. This technology is for tracking the existence of legally supplied instances of this controlled substance as it persists in the user community state wide. Tracking using a blockchain-distributed ledger can securely store and transmit data to provide law enforcement the tools necessary for cannabis regulation. The scope of work for the project was to begin designing and implementing an application using blockchain to provide an immutable solution to track controlled substances using signatures placed within the controlled substance.

Dr. Yoanna Long, Computer Information Systems (PI)

Partnership with BlockFrame

HEAR FROM THE STUDENTS

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The blockchain project was extremely valuable to me as a CIS student. Participating in it helped me master all of the skills that we learned throughout the CIS curriculum—for example, you need to have a good understanding of networking to implement the distributed component of blockchains. All of the other primary concepts that we have learned we applied as well: an understanding of cryptography is required to understand the core mechanisms behind which blockchains work, excellent skills in databases and database management systems allowed us to efficiently plan out the storage model of the blockchain, and of course programming and object oriented analysis and design was necessary for the implementation. Participating in the research project allowed for great synthesis of all of the skills that I have learned that few other projects would have.

– Alex Marck, CSU-Pueblo, CIS Graduate

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Colorado State University-Pueblo has provided an incredible opportunity for students, and others, who are interested in blockchain technology. I was fortunate enough to work with a team of brilliant minds, and cutting edge technology during the Cannablock project. Prior to this project, I had not had much hands-on experience with developing technology, especially as fresh as blockchain. From this experience, I gained multiple skillsets that are of high-value in today's job market. From planning, designing, constructing, implementing, and testing, I was able to improve my skills in all categories. I would never have guessed the value that was going to come from being on this project. Being an active participant in this project has opened up opportunities that would not have been in my realm prior. I landed a job after doing this project, developing and managing blockchain frameworks. I would encourage all students to experience this level of professionalism and self driven work before graduating, because you will be a force to be reckoned with once you have a degree to go with your new skills. I cannot stress enough the knowledge that you will gain from being an active participant in the blockchain project at CSU-Pueblo.

– Jared Horvat, CSU-Pueblo, CIS Graduate

ICR **CONFERENCES**

The ICR 2017 and 2018 conferences combined attracted more than 900 attendees and researchers from every field of cannabis research expertise. The forum included researchers from universities, representatives from government agencies, and a host of industry experts Presentations, panels, and posters covered the scientific, medical, industrial, legal, economic, and social elements of cannabis research. To ensure the relevance and depth of content of the Institute of Cannabis Research Conference 2019, the conference committee solicited session proposals from external researchers to complement those from CSU-Pueblo researchers, thus allowing the cannabis research community to help shape the conference program. In addition, a significant vetting and review process was put in place to ensure high-quality and cutting-edge research studies and efforts. Another first for the ICR Conference is the inclusion of research sponsors and exhibitor opportunities geared toward better serving the research and industry community attendees as well as making the conference a more sustainable event.

In addition to a robust program of panels, research papers, and posters the program included two renowned Keynote Speakers.

Allyn Howlett, Ph.D. delivered the Mechoulam Lecture at the Institute of Cannabis Research Conference 2019. Dr. Howlett's lecture, "Marijuana and Medicine: A Historical Perspective," provided abroad overview of big pharma exploration of cannabinoid treatments in the 1970s and discussed what it will take to make medicine now, 40 years later. Dr. Howlett was personally recommended by Dr. Raphael Mechoulam for this honor, citing her pioneering work on the discovery of the first cannabinoid receptor. Dr. Howlett is a professor in the Department of Physiology and Pharmacology at the Wake Forest School of Medicine in Winston-Salem, North Carolina, and is a member of both the Center for Research on Substance Use and Addiction at Wake Forest and the NIDA-funded P50 Center for the Neurobiology of Addiction Treatment.

Mahmoud A. ElSohly, Ph.D. is a research professor at The National Center for Natural Products Research and a professor of Pharmaceutics and Drug Delivery, School of Pharmacy, at the University of Mississippi (UM). He is also the Director of the National Institute on Drug Abuse (NIDA) Marijuana Project at UM. Dr. ElSohly delivered the Opening Plenary Address, "Cannabis Research Activities at Ole Miss: Analytical and Product Development Activities," at the ICR Conference 2019. He has been with UM since 1975 and has been the Director of the NIDA Marijuana Project since 1981. He has over 40 years' experience working with the isolation of natural products (notably cannabis secondary metabolites) and is an expert in synthetic, analytical and forensic chemistry. He has more than 30 patents and over 300 publications in these areas of science.

FY 2019 BUDGET *($1,800,000)*

RESEARCH PARTNERSHIPS 7%
$124,000

RESEARCH INFRASTRUCTURE 7%
$136,000

FACULTY DIRECTED RESEARCH 54%
$968,000

JOURNAL & CONFERENCE 9%
$163,000

7%

7%

9%

9%

54%

FACILITIES & ADMINISTRATION 9%
$163,000

14%

ICR OPERATION & ADMINISTRATION 14%
$246,000
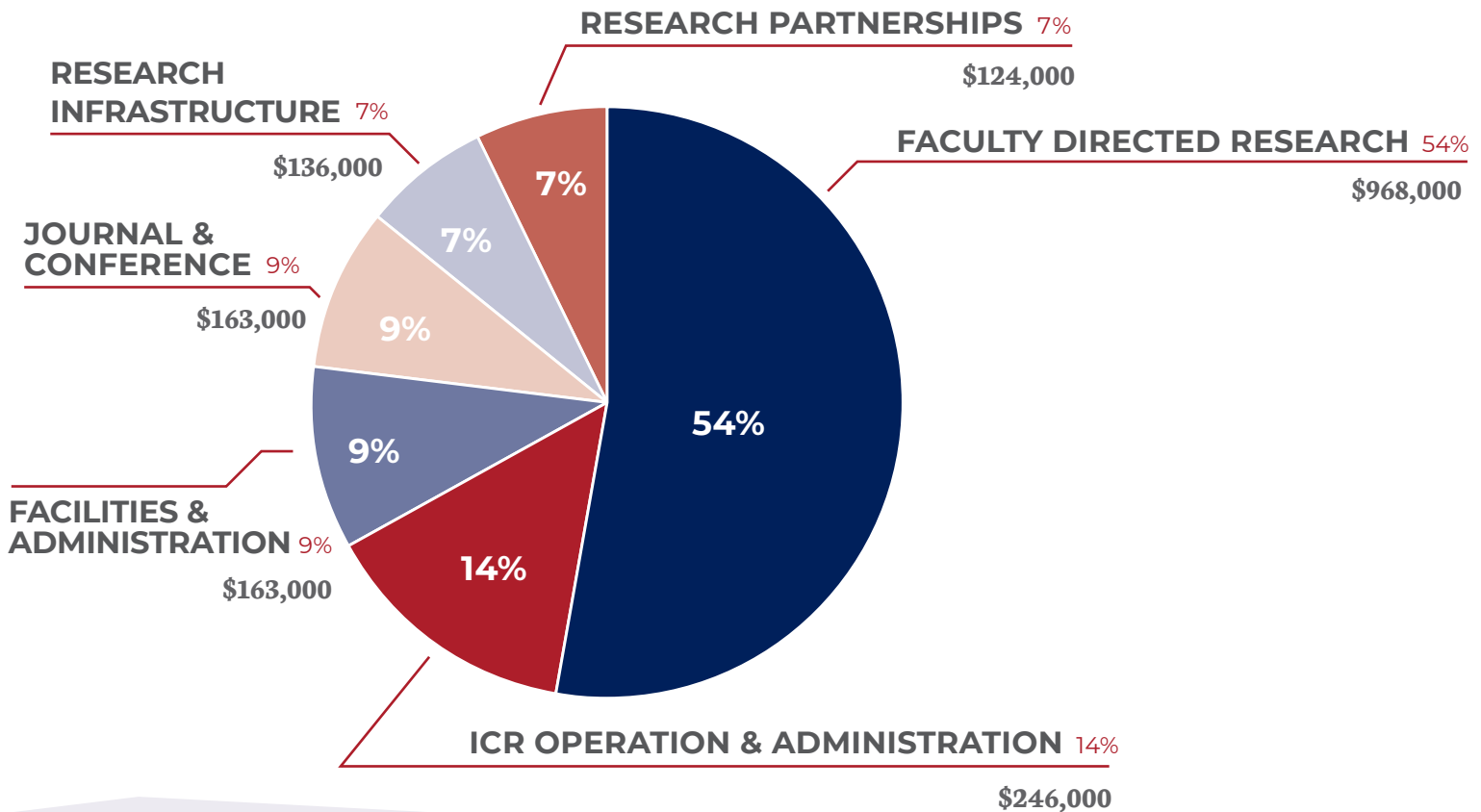
The ICR is staffed by a few dedicated individuals whose responsibility is to facilitate key activities needed to carry out the mission of the ICR. The most visible of these is research. Ongoing research continues to be the largest use of the State appropriation that funds the ICR, making up 67% of the current fiscal year budget, including direct research expenditures for faculty-directed projects, research partnerships, and research infrastructure improvements. The research facilitated through the ICR addresses both current needs and gaps in understanding and maintains a keen eye toward the future. For example, in the current year one team of researchers continues to study the impacts and perceptions of K-12 student cannabis use, programs to prevent cannabis use, and interventions to address student violations of cannabis laws, while other researchers are studying the potential uses of the whole cannabis plant for matters ranging from phytoremediation to building materials. Still other researchers are considering the potential application of cannabinoids as selective therapeutics for brain disorders involving impaired learning and memory, including depression, post-traumatic stress disorder (PTSD), stroke, and dementia-related diseases, while further researchers are studying the potential dietary benefits of nutrient-dense hempseeds. While this research is being led by faculty at CSU-Pueblo to meet the research mission of the ICR, it is done in concert with the educational mission of the University by involving students in the high-impact practice of participating in original research. Beyond research resources granted for the operation of the ICR, funds are allocated toward disseminating the results of research through the annual ICR Conference and the Journal of Cannabis Research.

JOURNAL OF
CANNABIS RESEARCH

Journal of Cannabis Research

The Institute of Cannabis Research has partnered with the well-respected publisher Springer Nature to launch the Journal of Cannabis Research (JCR) this past fall. The Journal will serve as a vetted aggregator of scientific data from researchers across the spectrum of cannabis-related research efforts—around the U.S. and beyond. The JCR will publish papers and studies from acknowledged experts as well as new researchers in the emerging field of cannabis studies. Editor-in-Chief Dr. David Gorelick, a professor of psychiatry at the University of Maryland School of Medicine, has recruited a distinguished group of international experts to serve on the JCR's Editorial Board.

COMMUNITY LIAISON **BOARD**

The Community Liaison Board (CLB) to the Institute of Cannabis Research (ICR) at Colorado State University-Pueblo exists to enhance information sharing between the ICR and regional stakeholders. The CLB was constituted in the late summer of 2018 and meets every other month. The Board members consist of local stakeholders representing the medical and public health communities, education, business, and law enforcement. Board members provide regular input to the ICR Director on issues, concerns, and suggestions regarding the functioning of the ICR and receive information, updates, announcements, press releases, etc., about ICR activities, functions, policies, and events. The Board members are as follows:

Dr. Libby Stuyt, Psychiatrist at Colorado Mental Health Institute

Dr. Brad Roberts, ER Physician, Parkview

Dr. Henry Roman, Retired D60 Superintendent

Matt Centner, Chamber of Commerce Member, Comcast

Lynn Procell, Pueblo County Public Health Interim Director

Jeff Bodmer, Pueblo Police Captain

SCIENTIFIC RESEARCH **ADVISORY BOARD**

The ICR is currently in the process of creating and constituting the Science Research Advisory Board (SRAB), whose purpose is to enhance the ICR's scientific research effectiveness and timeliness as well as to suggest important research directions. Scientific research on cannabis is a dynamic and changing landscape, and the SRAB is intended to assist the ICR in identifying and maintaining activities at the cutting edge of cannabis research. Board members provide regular input to the ICR on the direction of cannabis scientific research and possible research areas warranting attention. The ICR has recruited the inaugural SRAB, which includes the following members:

Dr. Robert Sievers, CU-Boulder Chemistry and Biochemistry and Environmental Studies Program. Research Interests include Pharmaceutical Sciences

Dr. Malik Hasan, Neurologist and NuVue Pharma

Dr. Joseph DiVerdi, CSU-Fort Collins Chemistry Department, Analytical Chemistry. Published cannabis research and operates a private lab/business (XTR Labs) for cannabis analysis.

Dr. Justin Boge, Pain and Anesthesia Physician. Interested in cannabis research related topics.

Dr. Joanna Zeiger, Director of Train Away Chronic Pain. Background in Public Health and Epidemiology; Pain Management.

Justin Henderson, CEO, Peak Holdings Group LLC

Dr. Sang-Hyuck Park, CSU-Pueblo ICR Senior Scientist

Dr. Jeff Smith, CSU-Pueblo Biology Department; ICR Supported Researcher

Cannabis research is a dynamic and varied area of scholarly activity, and the ICR represents one key component of Colorado's remaining at the forefront of cannabis knowledge in the U.S. Faculty, staff, and students are excited to play a significant role in advancing science and understanding in this field. At the time of preparing this report, research proposals for next fiscal year are being reviewed and considered as the ICR looks to move into year 4 and build upon the momentum created in the first three years of this exciting endeavor.

Boston, D. J., Carsella, J., Vanden Heuvel, B. D., & Kinney, C. A. (2019). *Chemical barcoding for cannabis source identification.* Paper presented at the 257th American Chemical Society National Meeting Orlando, FL.

Boyd, K., Blanton, C., & Gabaldón, A. M. (2018). *Effects of a symbiotic diet on bone mineral density in mice as measured by DEXA scan.* Paper presented at the 14th Annual CSM Student Research Symposium, Pueblo, CO.

Brett, B., Luckini, T., Conroy, M., Ramirez, Y., & Freeman, K. (2018). *An Observational Study of Medicinal Cannabis Effects in Adults with Medically Refractory Epilepsy.* Paper presented at the International Cannabinoid Research Society Meeting, Leiden, Netherlands.

Conroy, M., Luckini, T., Ramirez, Y., Freeman, K., & Brett, B. (2018). *Effects of Medicinal Cannabis Use on Seizures in Adults with Medically Refractory Epilepsy: A Progress Report.* Paper presented at the 87th Annual Rocky Mountain Psychological Association Conference, Denver, CO.

Conroy, M., Vanden Heuvel, B. D., Gostin, E. L., Staples, S. K., & Park, S.-H.). *Chronic exposure to cannabidiol causes metabolic changes within Manduca sexta.* **Scientific Reports - Nature.** Manuscript in preparation.

Huang, K. Y., & Long, Y. (2019). *Fighting Together: Discovering the Antecedents of Social Support and Helpful Discussion Threads in Online Support Forums for Cannabis Quitters.* Paper presented at the 52nd Hawaii International Conference on System Sciences (HICSS-52), Maui, HI.

Kinney, C. A., Seifried, D. G., Arellano, C. J., Gurau, A. T., Vanden Heuvel, B. D., Cranswick, M. A., & Boston, D. J. (2019). *Development of an efficient method for the extraction and isolation of cannabidiol (CBD) from bulk industrial hemp using pressurized liquid extraction (PLE) and flash chromatography.* Paper presented at the 257th American Chemical Society National Meeting Orlando, FL.

Long, Y. (2019). *Fighting Together: Discovering the Antecedents of Social Support and Helpful Discussion Threads in Online Support Forums for Cannabis Quitters.* Paper presented at the HICSS.

Lujan, W. P., Linkowski, A., & Gabaldón, A. M. (2018). *The potential of whole hempseed as a prebiotic to support growth and metabolism of anticarcinogenic probiotic bacteria.* Paper presented at the 14th Annual CSM Student Research Symposium, Pueblo, CO.

Montoya, Z., Uhernik, A., Smith, JP (2018). *Cannabidiol during Acquisition affects Learning and Memory in Female Mice.* College of Science and Mathematics Student Research Symposium, CSU-Pueblo.

Montoya, Z., Uhernik, AL, Smith, JP (2018). *Fear Memory Extinction is enhanced by Cannabidiol When Given during Acquisition in Female Mice.* Sixteenth Annual Front Range Neuroscience, CSU. Poster session #11.

Park, S.-H. (2017). *Genomics and Genetics of Cannabis & Molecular Marker-Assisted Cannabis Breeding.* Paper presented at the Industrial Hemp Research Foundation, Denver, CO.

Park, S.-H. (2018a). *Contrasting Roles of Cannabidiol as an Insecticide and Rescuing Agent for Ethanol–induced Death in the Tobacco Hornworm Manduca sexta.* Paper presented at the United Natural Products Alliance, Lafayette, CO.

Park, S.-H. (2018b). *Contrasting Roles of Cannabidiol as an Insecticide and Rescuing Agent for Ethanol–induced Death in the Tobacco Hornworm Manduca sexta.* Paper presented at the Medical Cannabis Technology Forum, Denver, CO.

Park, S.-H., Staples, S. K., Gostin, E. L., Smith, J. P., Vigil, J. J., Seifried , D., Vanden Heuvel, B. D. *Cannabinoid Responses of Cannabis sativa to Stresses.* **Journal of Cannabis Research.** Manuscript in preparation.

Park, S.-H., Staples, S. K., Gostin, E. L., Smith, J. P., Vigil, J. J., Seifried , D., Vanden Heuvel, B. D. *Contrasting Roles of Cannabidiol as an Insecticide and Rescuing Agent for Ethanol–induced Death in the Tobacco Hornworm Manduca sexta.* **Scientific Reports.** Manuscript submitted for publication.

Pauli, C. S., Mohalla, M., Conroy, M., Gostin, E. L., Jones, D., & Vanden Heuvel, B. D. *Current medical applications of cannabidiol (CBD)-based medicines.* **Frontiers in Pharmacology.** Manuscript in preparation.

Peters, T. W., & Foust, C. (2019). *High School Student Cannabis Use and Perceptions towards Cannabis in Southcentral Colorado – Comparing Communities that Permit Recreational Dispensaries and Communities that Do Not.* Journal of Cannabis Research.

Rodriguez, J., Lopez, J., & Steel, J. (2018). *The impact of cannabinoid receptor (CB1) antagonism/agonism on alphavirus replication.* Paper presented at the 14th Annual CSM Student Research Symposium, Pueblo, CO.

Seifried, D. G., Arellano, C. J., Gurau, A. T., Vanden Heuvel, B. D., Cranswick, M. A., Boston, D. J., & Kinney, C. A. *Development of an efficient method for the extraction and isolation of cannabidiol (CBD) from bulk industrial hemp using pressurized liquid extraction (PLE) and flash chromatography*. **Industrial Crops and Products.** Manuscript under review.

Seifried, D. G., Fernandes Ramos, M., & Kinney, C. A. (2019). *Pressurized Liquid Extraction: A robust extraction method for cannabinoid analysis and in-extraction chemical modification of acidic cannabinoids.* Paper presented at the 257th American Chemical Society Orlando National Meeting Orlando, FL.

Smith, JP (2017). *Cannabidiol-Dependent Modulation of Cognitive Learning.* Industrial Hemp Research Foundation, Denver CO.

Smith, JP (2017). *Cannabidiol-Dependent Modulation of Cognitive Learning.* University of Colorado Boulder, Chemistry Department Seminar Series, Boulder CO.

Smith, JP (2018). *Cannabidiol as a Helpful Adjunct to Exposure Therapy for PTSD Patients?* National Alliance on Mental Illness (NAMI), Pueblo, CO.

Smith, JP (2018). Roundtable Discussion about the use of cannabis for treating mental illness. The forum included about 30 community members from the mental health profession and consumers. National Alliance on Mental Illness (NAMI), Pueblo, CO.

Uhernik, A. L., Montoya, Z. T., Balkissoon, C. D., & Smith, J. P. *Learning and memory is modulated by cannabidiol when administered during trace fear-conditioning.* Neurobiology of Learning and Memory. 149:68-76. doi: 10.1016/j.nlm.2018.02.009.

Uhernik, AL, Balkissoon, C., Vigil, J., Montoya, Z., Smith, JP, (2017). *Differential Effects on Cognitive versus Reflexive Memory Recall after Cannabidiol Treatment.* College of Science and Mathematics Student Research Symposium, CSU-Pueblo.

Uhernik, AL, Balkissoon, C., Vigil, J., Montoya, Z., Smith, JP, (2017). *Potential Modulation of GABAA Cl- Current in CA1 Pyramidal Cells by Cannabidiol in Mouse Hippocampal Slices.* College of Science and Mathematics Student Research Symposium, CSU-Pueblo.
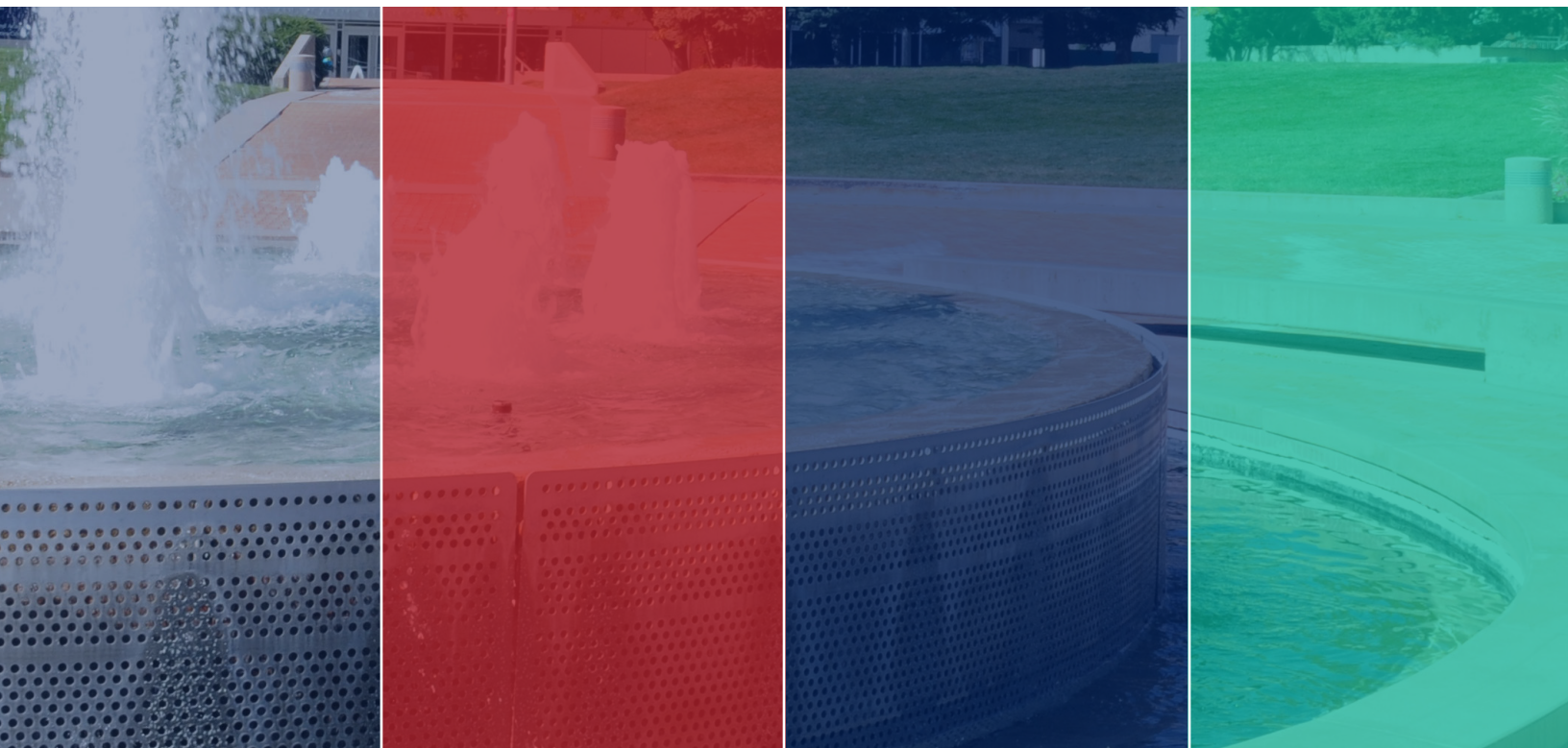
Vigil, J., Uhernik, AL, Smith, JP, (2018). *HU-211-sensitive Cognitive Learning and Memory Processes GluN2B Surface Expression in the Mouse Brain.* College of Science and Mathematics Student Research Symposium, CSU-Pueblo.

Vigil, J., Uhernik, AL, Smith, JP. (2018). *HU-211-Sensitive, Cognitive Learning and Memory Processes Modulate GluN2B Surface Expression in the Mouse Brain.* Rocky Mountain Neuroscience Annual Conference, CSU Fort Collins.

Williams, D. W., & Gabaldón, A. M. (2018). *The effects of 2-arachidonoylglycerol, anandamide, and 17-estradiol on osteogenesis in cultured primary human osteoblasts.* Paper presented at the 14th Annual CSM Student Research Symposium, Pueblo, CO.

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