

the Cannabis Scientist™

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The Power List 2021: 5×5

Celebrating the most influential people in cannabis science with a high five.

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Welcome to our second Power List issue! This year, we're giving you 5x5 – the five most influential people in five different categories: analysis, processing, plant science, biomedical research, and mentors. Nominated by you, our readers, and then selected by our expert judging panel, these leaders in the field share their thoughts on everything from their dream dinner party guests to the future of cannabis science on page 14.

It was particularly enjoyable reading the nominators' comments for the Mentor category, with many touching tributes to those who have inspired and educated you. We were only sorry we could not include more of your choices. Even if your mentor didn't make the list, I encourage you to share your thoughts with them on how they have supported you – I think we could all use a little boost right now.

Though a number of the names featured in 2021 also appeared in last year's inaugural list, there are lots of new faces too – a testament to how quickly the field is developing.

With more and more research being published (over 3,500 new papers on Pubmed in 2020!), and a steady flow of new developments in regulation, business, and policy, there's lots to keep up with.

To help you stay up to date, we're increasing the frequency of The Cannabis Scientist newsletter from monthly to weekly for 2021. If you'd like to get the latest articles from The Cannabis Scientist direct to your inbox, subscribe at tcs.txp.to/tcs-reg/0121.

And don't forget The Cannabis + Cannabinoid Curator, my five-minute roundup of the week's cannabis-related news. I trawl through the week's scientific papers (so you don't have to) and give you just the curated highlights. Sign up at tcs.txp.to/cc-sub/0121.

Now, it's time to grab a coffee, put your feet up, and find out who made it onto this year's Power List. Of course, half of the fun is disagreeing with the judges selections - feel free to get in touch and let me know what you think (and who you'll be nominating next year).

Charlotte Barker

Editor

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Giving You Five!,
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Who are the most influential figures in cannabis science?

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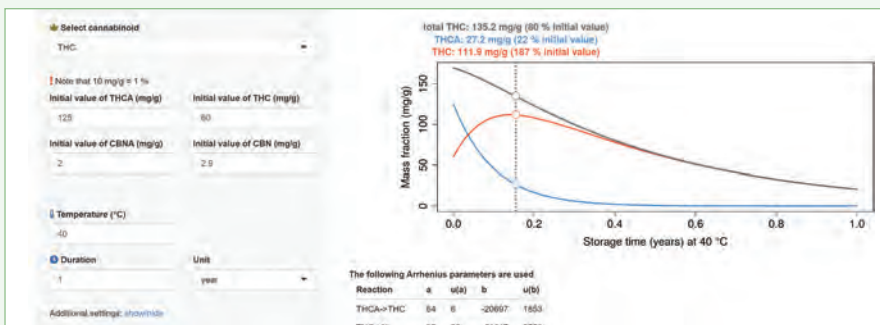
Best Before...?

Study exploring cannabinoid degradation could help set industry standards for stability and shelf life of dried flower

Should cannabis flower be labeled with a “best before” date? Most territories don’t require it (yet), but the topic of stability and shelf-life is under discussion amongst regulators and cannabis companies who want to ensure consumers have a safe and consistent experience.

In a new paper, Juris Meija and colleagues at National Research Council Canada take a detailed look at the impact of temperature on cannabinoid degradation in dried flower (1). We know that temperature affects the rate of decarboxylation (for example, converting THCA into THC). To date, studies have mostly focused on high temperatures (over 100 °C) over a short time – mimicking decarboxylation in an oven or when vaped.

What happens to major and minor cannabinoids when cannabis is stored in warehouses or dispensary shelves for weeks, months, or even years? Previous studies of decarboxylation at room temperature used now-outdated methods or looked at only one cannabinoid. In this study, the team used a homogenous



The Cannabis Stability Calculator developed by Juris Meija and colleagues

cannabis reference standard and a liquid chromatography–tandem mass spectrometry (LC-MS/MS) method to measure (often tiny) changes in samples stored for up to a year, at temperatures from -20 to 40°C.

The results allowed the researchers to develop a cannabis stability calculator (free), where you can input different starting values, temperatures, and durations to see how the concentration of cannabinoids will change over time.

The authors hope that the results will help regulators set degradation thresholds

or shelf-lives, and help the industry lay the framework for standardization of stability testing. There’s still work to be done, though. Speaking to The Cannabis Scientist, Meija said, “There are still many unanswered questions, such as how much the kinetic parameters vary from strain-to-strain, or between hemp and cannabis.”

Reference

1. J Meija et al., *Anal Bioanal Chem*, [Online ahead of print] (2021). DOI: 10.1007/s00216-020-03098-2.

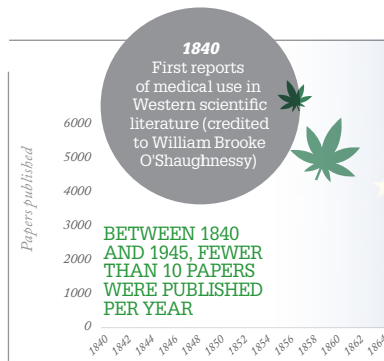
TIMELINE

History of Cannabis Research

2020 saw a record number of scientific papers featuring cannabis and cannabinoids. To celebrate, we decided to take a look at how many cannabis-related articles have been published on PubMed each year, going back to the 1800s.

2000 BC onwards

Written and archaeological evidence for cannabis use as a medicine





**BITESIZE
BREAKTHROUGHS**

The latest biomedical research on cannabis and cannabinoids

Drive safe

Vaping CBD-predominant cannabis did not impair driving ability in a recent study, but vaping THC-predominant or THC/CBD-equivalent cannabis did (1).

Gut feeling

A new study suggested that endocannabinoids could be the missing link between changes in the gut microbiome and symptoms of depression (2).

New (and improved?)

A new phytocannabinoid called cannabidihexol was identified by Italian researchers and shown to have painkilling properties in mice (3).

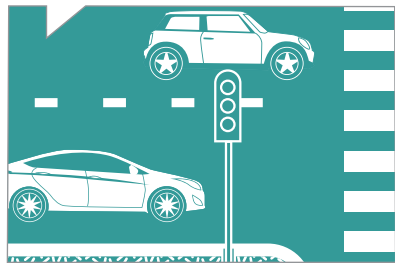
Mixed results

Epidiolex (CBD) improved symptoms associated with Parkinson’s disease but led to side effects (including liver enzyme changes) in a small (13 patients) clinical study (4).

Should cannabis users get liver transplants?

UCLA researchers looked at

outcomes for over 900 transplant patients and found no evidence that patients who used cannabis were more likely to suffer complications or transplant failure (5).



Maybe (not) baby?

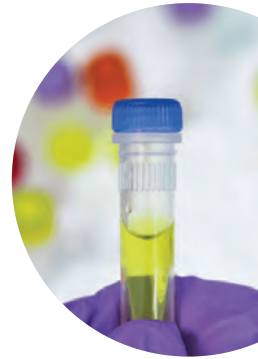
Researchers followed women trying to conceive after a previous miscarriage and found that those using cannabis were less likely to become pregnant (6). However, the study had major limitations – more research is needed.

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1. *TTR Arkell et al., JAMA, 324, 2177–2186 (2020). DOI:10.1001/jama.2020.21218*
2. *G Chevalier et al., Nat Commun, 11, 6363 (2020). DOI: 10.1038/s41467-020-19931-2*
3. *P Linciano et al., Sci Rep, 10, 22019 (2020). DOI: 10.1038/s41598-020-79042-2*
4. *MA Leehey et al., Cannabis Cannabinoid Res, 5, 326 (2020). DOI: 10.1089/can.2019.0068.*
5. *J Guorgui et al., Clin Transplant, e14215 (2021). DOI: 10.1111/ctr.14215*
6. *SL Mumford et al., Hum Reprod, deaa355 (2021). DOI: 10.1093/humrep/deaa355.*

Escaping the Cell

Synthesizing cannabinoids without plants or cells



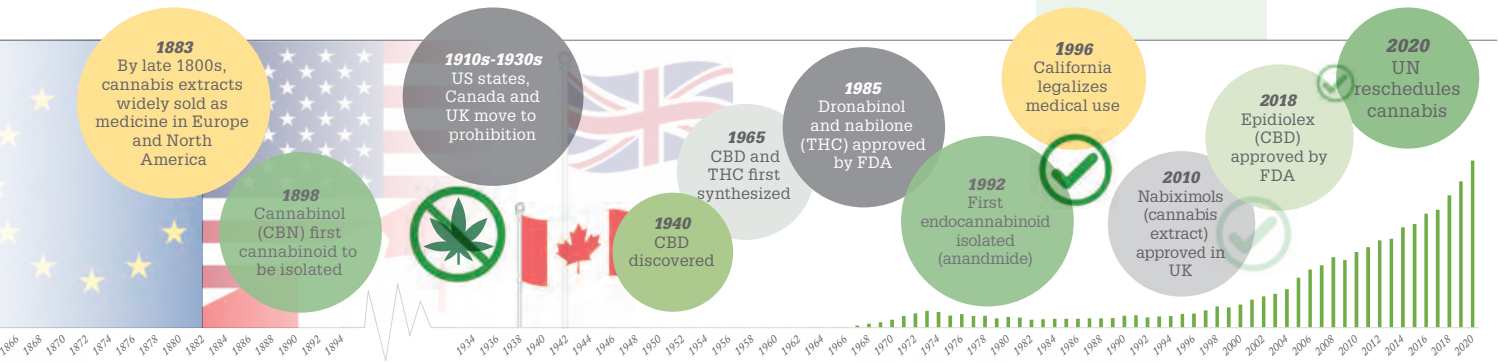
Researchers at UCLA have found a way to produce cannabinoids without “the vagaries of plant extraction” or the use of engineered microbes (1). Their proposed system is based on enzymatic biosynthesis – using 12 different enzymes they were able to produce cannabinoids CBGA and CBGVA from four inexpensive starting chemicals.

This method of production could have major advantages compared with extracting cannabinoids from plants, including speed, consistency, and large quantities of minor cannabinoids.

Previous attempts to make cannabinoids in this way were not commercially viable, requiring up to 25 enzymes and expensive starting materials. Though more fine-tuning is needed, the authors believe that the new process is a significant step towards cell-free cannabinoid production.

Reference

1. *MA Valliere et al., Nat Chem Biol [Online ahead of print] (2020). DOI: 10.1038/s41589-020-0631-9.*



Is Your Elephant Depressed?

Here at The Cannabis Scientist, we take science seriously. But every so often a news item crosses our desks that is a little more... unusual. Here are five stories that raised our spirits (and sometimes our eyebrows) in 2020.

1. Prehistoric pot

Researchers made a fascinating historical discovery this year, when chemical analysis revealed that cannabis was burned alongside frankincense at an Iron Age shrine in Israel (1).

2. Big heart

As animal lovers, we were touched by the story of Fredzia the elephant (2). A resident of Warsaw Zoo, the young African elephant became stressed after the death of herd matriarch Erna, so veterinarians made Fredzia the first patient in a study to assess whether CBD oil can help reduce anxiety and stress in zoo animals. The zoo has yet to report on the success of the experiment, but we wish the poorly pachyderm a happier 2021.



3. Wild West

A less exotic animal, the humble cow, is the subject of a study at Kansas State University. The researchers recently picked up a \$200,000 grant from the US Department of Agriculture to establish concentrations of cannabinoids in cattle fed on industrial hemp byproducts (3). The concern is less that we'll end up with buzzed bovines running amok, and more whether compounds like THC could make it down the food chain into humans.

4. Healing hens

More animal news! CBD could help protect chickens against a nasty bacterial infection, according to a study from researchers at the Department of Poultry Science at the Polish Academy of Sciences (4). CBD increased gut bacterial enzyme activity in response to infection with *Clostridium perfringens*, which can cause intestinal problems in birds and humans alike.

5. Sweet treat

CBD oil may have a surprising alternative use – inhibiting the growth of yeast and mold on strawberries (5). Fruit treated with CBD oil looked better and had a lower microbial load compared with untreated fruit. Whether consumers would see the addition of CBD as appetizing or off-putting remains to be seen!

Read the full article at tcs.txp.to/surprising

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Is Cannabis a Heartbreaker?

Cannabis use may be linked with more complications after heart attack or revascularization procedures

Two presentations at this year's American Heart Association Scientific Sessions report that cannabis may lead to poorer outcomes

for patients with heart conditions (1). One study suggested that cannabis smokers who underwent percutaneous coronary intervention to unblock an artery in the heart were 50 percent more likely to suffer bleeding after the procedure and may be more likely to suffer a stroke.

A second study found that heart attack survivors who used cannabis (consumption method not recorded) were more likely to have a second heart attack than non-users.

Both studies were based on reviews of

medical records, so it's difficult to draw conclusions about cause and effect. But more research on this patient group is definitely needed – one of the studies recorded increasing rates of cannabis use among patients who had survived a heart attack or revascularization treatment.

Reference

1. American Heart Association, "Marijuana use associated with complications after heart attack or procedures" (2020). Available at: <https://bit.ly/38Aqml>





IMAGE OF THE MONTH

*NIST to Be Back*

The US National Institute of Standards and Technology (NIST) are launching the second exercise in their CannaQAP scheme. After weighing this package of marijuana, NIST research chemist Brent Wilson ground up the contents to prepare samples with very precisely measured amounts of THC, CBD, and other compounds. Those samples will be sent to labs as part of a study that will help labs improve their measurement accuracy. Labs that are not licensed to handle controlled substances will receive samples of hemp instead of marijuana.

Credit: R. Press/NIST

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QUOTE of the month

"We see many products in our lab containing cannabinoid isomers or degradation products that do not occur in nature. There is no data on the safety or metabolic fate of these compounds in the human body, and yet these products are being marketed widely to an unsuspecting consumer base, who are essentially being used as guinea pigs."

Chris Hudalla, ProVerde Labs

Read more insights from top cannabis scientists in The Power List (page 14).

Spot the Difference

Genetic test can distinguish cannabis from hemp in minutes

A new PCR test developed by Japanese researchers can quickly and accurately distinguish between drug-type and fiber-type (hemp) cannabis, and hybrids of the two (1).

The test looks for variation in both the THC and CBD synthase precursor genes – allowing more accurate results than testing for differences in either gene alone. And as the approach doesn't rely on directly measuring cannabinoids, it can be used to test seeds and other non-cannabinoid containing parts of the plant.

The authors do add a caveat: genotype does not always perfectly predict phenotype (environmental factors are important too), but they believe the 10-minute test will prove useful for forensic investigators and cultivators alike.

The paper comes hot on the heels of research from the University of Minnesota that also used PCR to predict cannabinoid content of cannabis plants – based on the CBD synthase gene (2).

References

1. TYamamuro et al, "Rapid identification of drug-type and fiber-type cannabis by allele specific duplex PCR," *Forensic Sci Intl*, 318, 110634 (2021). DOI: 10.1016/j.forsciint.2020.110634
2. JP Wenger et al., "Validating a predictive model of cannabinoid inheritance with feral, clinical, and industrial *Cannabis sativa*," *Am J Bot*, 107, 1423 (2020). DOI: 10.1002/ajb2.1550

Diversity and Inclusion = Exploitation and Illusion?

Paying lip service to equality isn't enough. We need to address the systemic racism underpinning the entire cannabis industry

By Christopher Ratliff, President of Victus Capital Ventures, Jacksonville, Florida, USA

Many cannabis companies make great claims about valuing diversity. But discrimination against Black, indigenous or people of color (BIPOC) is rife. Over the past four years, I have watched my wife – an analytical chemist, extraction artist, and cannabis/hemp laboratory build-out specialist – be undermined and gaslighted because she is a female BIPOC.

I've seen her interview for a "director" role, where the CEO of the company was searching for someone to build out, manage, and operate a facility. My wife inquired why – given the level of responsibility involved – she would not be the COO. The CEO's response: "That position would have to be cut from the same cloth, if you will." Translation: "The position is reserved for a white male."

I watched her work hard to build out a facility for some well-funded individuals. After she accomplished for them what they could not do without her, those same executives terminated her employment without warning – her entry card simply stopped working one morning. (The company in question had a predominantly white workforce and was based in a predominantly white town with a history of violent racism.)



In My View

Experts from across the world share a single strongly held opinion or key idea

Diversity and inclusion are hot topics within the cannabis industry, and corporate America in general. But support for BIPOC is all too often fueled by an ulterior motive: to make a profit, to exploit, and ultimately to silence with illusion.

When you saw an article about diversity and inclusion in the industry, did you expect statistics, percentages, or comparisons of women, men, BIPOC and white in the boardrooms and investment groups? While those numbers might convey the idea of diversity and inclusion in cannabis from an affirmative action standpoint, for me, there is a much bigger picture to look at when dealing with diversity and inclusion in cannabis.

The building blocks of exclusion and systemic racism can be traced all the way back to colonialism. These blocks are used to build a wall to protect the privileged (and their money) from seeing the reality of inequality in our society. Even before the so-called "war on drugs," the same disenfranchised groups were unable to collect wealth, land or influence because of slavery or native relocations. Growing up below a certain financial line in the US will quickly teach you about exclusion...

Fast forward to mass incarcerations

"These blocks are used to build a wall to protect the privileged (and their money) from seeing the reality of inequality in our society."

for cannabis possession and supply, and we suddenly have a convenient way to prevent large numbers of Black and Latino individuals from progressing professionally. Expunging non-violent cannabis charges or even legalizing the drug on a federal level isn't enough to address this elephant in the room. We need to take active measures to redress the balance. For instance, social equity programs are designed to award a certain

percentage of licenses to disenfranchised minority groups affected by the “war of drugs” and systemic racism. However, such initiatives have been slow to be adopted. While New Jersey introduced a social equity tax on cannabis, the social equity aspect of Ohio’s medical cannabis law was twice blocked by legislators. It’s difficult to make meaningful progress if politicians, business leaders, and the public don’t understand or acknowledge the underlying systemic prejudice that continues to curate exclusion and illusion.

If you want to understand why a car isn’t working, you must first lift the hood. You might be able to hear or even see the problem while driving – but that is not the same as understanding what you are seeing and hearing from a mechanical or engineering perspective.

In the same way, you might hear about racism, and you might even see some of the more overt examples, but that isn’t the same as understanding the structural barrier to equality. How can you begin to include someone if you do not (or will not) see how they are excluded from the fundamentals of society itself?

We can’t address diversity in the industry without truly understanding the dark history that brought us to this point – where a Black man lies in a jail cell for a minor cannabis possession while mostly white board members are making millions. How many dollars are companies going to commit to helping BIPOC get out of jail for cannabis “offenses?”

The misperception that discrimination in the US consists of a series of isolated incidents, rather than being systemic and

engineered, is depressingly common. And so, genuine diversity and inclusion in our field requires an entire sociopolitical re-education movement about cannabis and engineered discrimination. If your American history education ended in high school, you have a lot to learn (two accessible documentaries to start with are Ken Burns’s “The West” and Ava DuVernay’s “13th”).

Two different educational ideologies battle for the minds of Americans: the 1619 Project (1), which seeks to put the legacy of slavery front and center in our understanding of US history, and the 1776 Commission (2) launched by President Trump to promote “patriotic education.”

For now, I am afraid that “diversity and inclusion” in the cannabis sector is really just exploitation and illusion.

Cannabis on the NHS in 2021?

It’s long past time for the NHS to embrace medical cannabis as a credible treatment

By Umesh Chauhan, Medical Expert at Canmart, consolidated by Halo Labs, New Romney, UK



The news that the NHS is planning a clinical study of cannabis oil in 2021, is long overdue and extremely welcome. The Twenty21 trial aims to enroll 20,000 UK patients for a prospective study to assess the effectiveness of medical cannabis for conditions such as anxiety and multiple sclerosis (1). I firmly believe that research will prove the benefits of cannabis, and we hope the UK will quickly move to a dispensary-style system that allows easy access to medical cannabis for those who need it.

Though the conversation around safety, addictiveness, quality, and access continues, there is no doubt in my mind that non-psychoactive cannabinoids, including CBD and cannabigerol, are effective in treating many physical, emotional, and mental health challenges – without the side effects of traditional pharmaceuticals.

Many patients who have tried the traditional route to treat conditions

“I firmly believe that research will prove the benefits of cannabis, and we hope the UK will quickly move to a dispensary-style system that allows easy access to medical cannabis for those who need it.”

such as chronic pain find that not only is treatment unsuccessful, but they now require even more pharmaceuticals to treat drug side effects. Medical cannabis, in contrast, is extremely safe, working directly with the endocannabinoid system to bring the body back to homeostasis.

Many clinicians argue that the UK is sleepwalking into an opiate crisis similar to the one that has been raging in the USA for over 20 years. Regardless of where you stand on the opiate debate, the fact remains that addiction is a problem for both prescription and over-the-counter opiates – and that the pain-relieving properties of medical cannabis could offer a less harmful solution.

People often think of cannabis as a single drug but, ideally, cannabis treatment should be tailored to the patient, putting it firmly into the realm of 21st century personalized medicine. These days, next-generation vaporizers can tell the patient the amounts of various cannabinoids they have consumed, then gather data on how effective the treatment has been and which mix of compounds works best for that patient. A whole range of innovative delivery systems then becomes available, from app-driven transdermal patches to chewing gum.

There are several projects in development for trialing a range of cannabis-based products for medicinal use in the UK, both inside and outside the NHS. Gathering enough data to convince the medical establishment is especially critical if we hope to solve one of the major sticking points for UK patients – the difficulty of accessing medical cannabis.

The UK has only recently adopted the use of medical cannabis. The current legislative framework is chaotic, with guidelines from different government agencies often at odds. Patients need to have exhausted all pharmaceutical

options before becoming eligible for medical cannabis. Even then, UK doctors resist prescribing it and approving bodies are reluctant to fund it. This means that many people

“People often think of cannabis as a single drug but, ideally, cannabis treatment should be tailored to the patient, putting it firmly into the realm of 21st century personalized medicine.”

who desperately need cannabis-based medicines are forced to raise funds themselves or run the risk of a criminal record by buying it illegally.

In the UK, 40 percent of medical cannabis is currently extracted from the flower; in my view, this should be recognized and regulated as a herbal medicine, which would allow for some variation in active ingredient profiles compared with traditional pharmaceuticals. A full plant extract would level out some inconsistencies, retaining more of the active profile and

preserving the entourage effect, in which the sum of the parts adds up to a more effective medicine than isolated molecules.

That said, being able to isolate and extract the active ingredients is also useful. Currently, only THC and CBD are listed as active ingredients in the UK. Other beneficial compounds are considered contaminants, but I expect this to change as the benefits of minor cannabinoids become more widely researched. For example, cannabitol and cannabigerol show real promise as treatments for conditions like insomnia.

To deal with the complexities of the cannabis industry, we need a central office that regulates quality in the medical market, much like those in Germany and the Netherlands. Now that the UK has left the EU, and especially with the impact of COVID-19, the country will need to move quickly to achieve this. As an added incentive, a full-plant cannabis economy has been demonstrated to provide jobs, opportunities, and much-needed tax revenue.

The UK is a conservative country and it will likely take time to cut red tape and provide a unified regulatory framework. However, as treatments are confirmed through trials and patient numbers increase, the pace of change will accelerate.

Cannabis could be just as big a game-changer as other naturally occurring medicines that we now take for granted, such as aspirin (from willow bark), penicillin (bread mold), and opiates (poppy seeds). We live in a society that requires science to dictate our future. Hopefully, the Twenty21 trial and many others to follow will destigmatize cannabis and provide more information on its medical potential.

Reference

1. Drug Policy Institute, “Project Twenty21” (2020). Available at: <https://bit.ly/3phy5w3>.

Superior Size Separation

KNAUER AZURA GPC/SEC systems are designed to optimize both the user experience – and the end results.

Characterizing polymers and biomolecules is essential to many areas of research – from understanding new materials to fighting pandemics. The separation technique of choice? Depending on your application (or your background), you may call it gel permeation chromatography (GPC), size-exclusion chromatography (SEC) or gel-filtration chromatography (GFC). We spoke to Hanna-Maija Hiltunen to hear how KNAUER's AZURA GPC/SEC systems allow chromatographers to wield size-based separation techniques with the utmost precision.



For the uninitiated, what is SEC and how is it typically applied?

In short, SEC separates analytes by size using special columns with a porous matrix. The basic separation principle relies on the fact that smaller molecules will be more likely to enter those pores, making their travel through the matrix longer than that of larger molecules. Separations (typically of a mixture of polymers, polysaccharides or biomolecules) are facilitated by choosing optimal particle and pore sizes, as well as column length. SEC is often used in quality control and R&D.

What are KNAUER's key GPC/SEC offerings?

Our AZURA GPC/SEC systems are the newest addition to our chromatography portfolio. AZURA GPC/SEC systems

incorporate the well-established KNAUER pump and detector technology from our analytical HPLC systems but optimized and configured to meet the requirements of GPC/SEC applications.

Can you explain your definition of GPC/SEC?

That's a good question! We are trying to be as inclusive as we can within the constraints of confusing terminology. GPC, GFC and SEC all essentially describe the same methodology, but the term GPC tends to be used in polymer chemistry by those working with aggressive, organic

solvents, while SEC and GFC are more commonly used by those separating biomolecules using aqueous solvents (buffers) or to reflect the use of aqueous buffers in polymer separations. Whether working with organic solvent- or aqueous-based systems, there are some inherent system challenges. The solvents used in polymer analysis are chosen for their ability to dissolve polymeric substances – and therefore may damage certain components of a device. And the use of salt buffers in SEC is harmful to metal components of the system. Hence, all liquid-contacting system components, from the valves and seals to tubing, must be carefully considered when developing such systems.

What other challenges does GPC/SEC pose for chromatographic systems – and how does AZURA fit the bill?

In addition to the aforementioned system material requirements, GPC/SEC analyses necessitate lower flow rates and lower pressure

than HPLC. GPC/SEC runs are conducted isocratically, so a good isocratic pump is essential for a steady baseline – and the AZURA's excellent isocratic pump has been specifically optimized to meet the requirements of GPC applications.

We've also put a great deal of thought into optimizing the AZURA RI detector, with a focus on increasing the detector performance using organic solvents. However, our GPC/SEC systems can also be configured to use a UV/Vis detector – there is the choice between variable single wavelength detectors, multi-wavelength detectors and diode array detectors.

AZURA also affords customers the flexibility to extend their GPC/SEC systems with autosamplers, valves, feed pumps, and column thermostats. In fact, many GPC runs are conducted at higher temperatures (~60°C), so the AZURA column thermostat is of great interest.

Can you tell us more about the columns used in GPC/SEC?

The stationary phase in GPC/SEC applications is crucial. GPC/SEC separation efficiency is driven by long columns with large diameters, and the matrix is often based on porous silica or polymer material – the pore size determines the molecular weight range of the separation, and columns with different pore sizes are combined to broaden the separation range and increase resolution.

We've developed a great partnership with a local GPC/SEC column manufacturer called AppliChrom by combining our AZURA GPC/SEC portfolio with AppliChrom columns.

This is a great way to bring our tremendous expertise in these areas together for the ultimate customer experience.





THE
POWER LIST
2021: 5x5

Celebrating the greatest minds in cannabis science with a high five

A year ago, we launched the first Power List with one aim: to celebrate the people who make cannabis science such a varied and exciting field. The response was overwhelmingly positive, so this year we're going bigger and better – adding new categories to cover a wider range of cannabis scientists.

Our “5×5” is made up of the top five influencers across five areas: analysis, processing, plant science, biomedical research, and mentors. Read on to find out who was nominated by their peers and then selected by our expert judging panel as one of the leading lights of the cannabis science sphere.

With only five spots in each category, the judges had tough choices to make, and we ran out of space for some truly great scientists and mentors, both established and up-and-coming. We've included a few of the entries that caught our eye (but didn't quite make it onto the list) at the end of each category.



Analytical HEROES

Keeping consumers safe and satisfied with better cannabis testing and analysis



SUSAN AUDINO

ISO ASSESSOR AND INSTRUCTOR,
SCIENTIFIC ADVISOR AT AOAC
INTERNATIONAL CASP, AND
CHEMISTRY LABORATORY
CONSULTANT AT S.A. AUDINO &
ASSOCIATES, LLC, WILMINGTON,
DELAWARE, USA

Current focus: I continue to be energized by my consulting business and I'm co-authoring a textbook on measurement uncertainty, regulatory specifications, and decision rules for the cannabis industry. Plus, I'm thrilled to be launching a new business that has been evolving over the past three years and involves multiple pending patents.

Outside interests: I co-own an alpaca farm, which has meant learning a lot about operating farm equipment, camelid genetics, and the textile industry.

CHRISTOPHER HUDALLA

FOUNDER AND CSO,
PROVERDE LABS, MILFORD,
MASSACHUSETTS, USA

Current focus: With little regulation in place, sometimes product development occurs faster than efficacy or safety can be assessed. As a result, we see many products in our lab containing cannabinoid isomers or degradation products that do not occur in nature. There is no data on the safety or metabolic fate of these compounds in the human body, and yet these products are being marketed widely to an unsuspecting consumer base, who are essentially being used as guinea pigs. We have been working to identify and characterize these non-natural components, including the chiral separation of enantiomeric compounds.

Nominator comment: "A well known and highly educated scientist, who is advancing the science of cannabis."



REGINALD GAUDINO

VP R&D, FRONT RANGE
BIOSCIENCES, LAFAYETTE,
COLORADO, USA

Inspiring people: My father. I'm motivated to unlock all the medical capabilities of cannabis so that people like him can have a fuller recovery after a major stroke. When I was a teenager I told my dad – a retired cancer surgeon – that I was going to become a scientist and put him out of work one day. I'm still working on that last part.

Personal mission: Learn everything about this plant, contribute to changing the narrative, and share that information so that everyone can develop their own relationship with cannabis.



DONALD LAND

PROFESSOR OF CHEMISTRY, FORENSIC SCIENCE, AND BIOTECHNOLOGY, UNIVERSITY OF CALIFORNIA, DAVIS; CHIEF SCIENTIFIC CONSULTANT, STEEP HILL; CONSULTANT, FRONT RANGE BIOSCIENCES; EXPERT WITNESS IN CONTROLLED SUBSTANCES, CALIFORNIA, USA; CHIEF SCIENTIFIC CONSULTANT, PURE JAMAICAN

Unexpected career turn: Shortly after we opened Halent Labs, a parent of a young child with Dravet’s syndrome taught me that cannabis could be life-saving – and told me how charlatans would deceive desperate parents (for example, substituting high-THC for high-CBD cannabis oil). I understood then how important it is to have access to reliable test results. It transformed me from an anonymous scientist into a very public advocate and activist for legal access to safe cannabis.

Dream dinner party guests: Louis Pasteur, Jonas Salk, and Anthony Fauci.

JEFFREY RABER

CO-FOUNDER AND CEO, THE WERC SHOP, LOS ANGELES, CALIFORNIA, USA

Inspiring people: My children. They drive me to continue to want to make the world a better place, as the work we put in today will directly shape their world of tomorrow.

Personal mission: Further the standardization of cannabis compositions to allow a better match with each individual’s needs.



Ones to WATCH

JULIA BRAMANTE: As well as her day job as Lead Scientist at Colorado’s Marijuana Reference Laboratory, Julia is also Chair of the Cannabis Chemistry Subdivision of the American Chemical Society (cann-acs.org), which runs a range of educational initiatives for cannabis scientists.

ERIC WALLIS: As CSO of Demeter Laboratory in Oklahoma, he is leading the first US public-private partnership between a regulatory authority and a testing lab, whereby Demeter will provide oversight of licensed labs in the state on behalf of regulators.

SWETHA KAUL: One of the pioneers of the California cannabis testing space, she is passionate about rigorous lab testing standards and advocating for sensible regulations.

Processing PROS

Helping the industry evolve through improved processing, extraction, and formulation

JERRY W. KING

R & D CONSULTANT, CRITICAL FLUID SYMPOSIA (CFS), USA

Cannabis industry origin story: Around 2013, I began getting contacted by people in the cannabis industry wanting advice on CO₂-based extraction, a technique I have over 50 years of experience in. I realized this was an

exciting new application and began to immerse myself in cannabis science and technology.

Proudest career moment: Being recognized by the American Chemical Society with the Kenneth A Spencer Award for Outstanding Achievement in Agricultural and Food Chemistry for my work in extraction technology.





JOHN MACKAY

FOUNDER AND CEO, SYNERGISTIC TECHNOLOGIES ASSOCIATES, BOSTON, MASSACHUSETTS, USA

Current focus: Scientifically, I'm developing a single process stream for cannabis (including hemp) on the "formulation-centric" principle, developing a hybrid of technologies and automation to provide a consistent product formulation. But my most exciting project is expanding my training efforts – from seminars to videos to hands-on training in "centers of

excellence" across the USA. These classes motivate the next generation – I hope to give them the basics and watch their imaginations change the world.

Future of the cannabis industry: Professional scientists from all facets of the process will join with traditional practitioners to advance personalized medicine. Prescription and over-the-counter products will be appropriately regulated for efficacy and safety, and the active isomers and other synergistic compounds will be identified for each application.

MARKUS ROGGEN

FOUNDER AND CEO, COMPLEX BIOTECH DISCOVERY VENTURES (CBDV), VANCOUVER, CANADA

Career highlight: CBDV surviving 2020! In 2018, I made the leap from bench chemist to company founder, moved to a new country, and set about building a new kind of cannabis company. All this was tough enough, but when 2020 cut us off from meeting new clients at conferences, stopped us doing on-site research, and caused many existing clients to cut their research budget, things looked dire for us. We accelerated our plans to be a remote research laboratory, launched web-based products like our compound database, and pushed forward with our extraction AI research. Now, in 2021, we have a solid client base and even more remote solutions in the works.

Nominator comment: "Fantastic pedigree in chemistry, excellent attitude, and the ability to dissect difficult problems into solvable bits."



ANDREW SAMANN

CEO AND PRINCIPAL CONSULTANT, ORION GMP SOLUTIONS, ROCHESTER, MICHIGAN, USA

Cannabis industry origin story: After leaving the US Marines as a Sergeant, I cultivated medical cannabis in California. Through experience with the plant and its benefits, I became enthralled with its potential to help other veterans suffering from war-related disease states and trauma. This led to me study plant biology, human physiology, and biochemistry at the

University of Michigan. After years of bench research – working in pharma as a GMP QC chemist and moonlighting in the budding cannabis industry – it was time to take a risk and start my consulting firm, focusing on cannabis product quality improvement through the application of pharmaceutical good manufacturing practices.

Nominator comment: "By combining knowledge of cGMP, cutting-edge research, and QC management, he is defining the framework for the safe, efficacious, and equitable applications of cannabis."





MONICA VIALPANDO

FOUNDER AND CEO,
VIA INNOVATIONS, SAN
FRANCISCO, USA

Cannabis industry origin story: The merging of three very different yet complementary career trajectories brought me into this space. First, I am a pharmaceutically trained product development scientist with expertise in the formulation of poorly water-soluble compounds. Second, I had extensive inhalation development experience in pharmaceuticals and nicotine, where I was involved in testing, safety review, and harm reduction education for the implementation of the Tobacco Products Directive in the UK. Finally, I had exposure to plant-based medicines through Ayurveda during my yoga teacher training.

The cannabis industry presented a perfect opportunity to merge these three streams and unlock my true scientific passion. Prior to that, I felt that my lifestyle and career were in constant conflict with each other.

Ones to WATCH

SHAWN HELMUELLER

previously developed cannabis applications for Waters and Deutsche Process. Now, he's CSO of Ionization Labs, which offers a platform for cannabis companies to bring potency testing in-house.

MELISSA FAUTH

has been a driving force behind laboratory instruments manufacturer Fritch moving into the cannabis space – creating dedicated equipment for cannabis products and funding research to help optimize processes.

KELLAN FINNEY

is a consultant in the science and business of cannabinoid manufacturing. As word nerds, we're big fans of his initiative to create a standard nomenclature for the industry.

Plant Science PIONEERS

Deepening our understanding of the cannabis plant and developing better cultivation methods

KEITH ALLEN

DIRECTOR OF BIOINFORMATICS,
FRONT RANGE BIOSCIENCES,
LAFAYETTE, COLORADO, USA

Inspiring people: Anthony Fauci, who has always acted with absolute integrity and an unshakeable dedication to the science.

Best part of my job: Discovering things about cannabis that nobody knows yet. Every time I turn around, this plant surprises me again.





ALISHA HOLLOWAY

VP RESEARCH & DATA SCIENCE,
PHYLOS BIOSCIENCE, PORTLAND,
OREGON, USA

Motivation: From the time my mom grew a pot plant on our back patio in the 70s, I couldn't figure out why cannabis was illegal. For recreational use, it didn't make sense to prohibit, and medically, cannabis has so much potential. That potential inspired me to join Phylos and

put my training in population genetics and genomics to work. The thought that we can put that information into our breeding program and develop improved varieties for medical, recreational, and other uses inspires me now to keep pushing forward.

Personal mission: We need more diversity in the cannabis industry. I'll be working to make sure BIPOC and women have opportunities to join the industry.

HOPE JONES

CO-FOUNDER AND CEO,
EMERGENT CANNABIS SCIENCES
(ECS), PHOENIX, ARIZONA, USA

Current focus: I am launching a new cannabis biotech and young hemp plant production company here in Arizona. The market is ripe but sourcing good cultivars has been challenging. We are working hard to be the company people can trust to meet that demand.

Proudest career moment: Working with former State Director of Arizona NORML, Mikel Weisser, was an invaluable experience. I served as an expert witness for two key state cases that kept one patient from going to jail and resulted in the overturning of a court ruling that deemed possession of cannabis concentrates a class four felony. Those cases could have ended very differently without Mikel's guidance and mentorship. We sadly lost Mikel last year and the Arizona cannabis industry will never be the same.



LAWRENCE SMART

PROFESSOR OF PLANT BREEDING
AND GENETICS, SCHOOL OF
INTEGRATIVE PLANT SCIENCE,
CORNELL UNIVERSITY;
ASSOCIATE DIRECTOR OF
CORNELL AGRITECH, GENEVA,
NEW YORK, USA

Hemp industry origin story: Cornell College of Agriculture and Life Sciences was asked by the New York State Department of Agriculture and Markets to help support the emerging hemp pilot program with research and extension. I proposed a long-term

hemp breeding program, and we were generously funded with a \$2 million grant from the state. It is an exciting crop to study – because there is so little published research it seems like every little discovery is a Eureka moment. And with multiple potential market opportunities, we get to breed for many different traits and cultivar types.

Current focus: We are trying to understand the functional and evolutionary relationships between the different cannabinoid synthases using directed evolution approaches and in vitro expression of mutants.

**DANIELA VERGARA**

DIRECTOR AND FOUNDER, AGRICULTURAL GENOMICS FOUNDATION AND RESEARCH ASSOCIATE, UNIVERSITY OF COLORADO, BOULDER, USA

Inspirational people: The Sunrise Movement, Justice Democrats, and my fellow coworkers at United Campus Workers Colorado.

Advice to my younger self: Try to slow down and be patient – life is not a straight, clear path but full of twists and turns.

Ones to WATCH

JORDAN ZAGER co-founded Dewey Scientific, a company that provides growers with information on the genotype and chemotype of their crops, to guide future breeding efforts.

ADAM GUILBEAULT, Lab Manager at Medmen, has made a name for himself in cannabis tissue

culture. A nominator praised his efforts in “developing methods to clean and multiply cannabis plant stocks at a rate that far exceeds conventional methods.”

BRYANT JONES, VP of Cultivation Operations at Evokanna and a student at the University of Minnesota, received an ElSohly Award in 2020 for his work on cannabis breeding.

R & D TRAILBLAZERS

Exploring the medical potential of cannabis and cannabinoids

GEOFFREY GUY

CHAIRMAN AND FOUNDER, GW PHARMACEUTICALS, CAMBRIDGE, UK

Motivation: As a physician, I have listened carefully to patient reports, observed clinical phenomena, generated hypotheses, and then found rational explanations in science to validate those observations and drive medicine development.

Career highlight: There have been many highlights over the past 40 years but, without doubt, the rapid and successful development of Epidiolex is the most important.

**MELANIE KELLY**

PROFESSOR OF PHARMACOLOGY, OPHTHALMOLOGY & VISUAL SCIENCES, ANESTHESIA, PERIOPERATIVE MEDICINE AND PAIN MANAGEMENT, DALHOUSIE UNIVERSITY, NOVA SCOTIA; CHIEF SCIENTIFIC OFFICER FOR PANAG PHARMA INC. HALIFAX, NOVA SCOTIA; CHIEF SCIENTIFIC OFFICER FOR TETRA BIOPHARMA INC., ONTARIO, CANADA



Current focus: I have been working at the interface of academic science and biotech these last few years since the company I founded in Halifax, Canada, was acquired by a larger clinical-stage biotech company. My immediate goal is to see some of the

novel lead compounds that I have been involved with reach the clinic.

Advice to my younger self: Don't dwell on the barriers – focus on what you want to do. Be curious and engaged, and above all remember there are no substitutes for hard work and tenacity in getting the job done.

GEORGE KUNOS

SCIENTIFIC DIRECTOR, NATIONAL INSTITUTE ON ALCOHOL ABUSE AND ALCOHOLISM, NATIONAL INSTITUTES OF HEALTH, BETHESDA, MARYLAND, USA



Career highlight: The discovery that peripherally restricted CB1 receptor antagonists are effective in improving visceral obesity and its metabolic complications, including fatty liver disease, diabetes, and diabetic nephropathy. Without the neuropsychiatric liability that led to rimonabant being withdrawn, these compounds are resurrecting the therapeutic promise of CB1 blockade.

Advice to my younger self: Be willing to take more risks in exploring new research areas and methodologies.

ALEXANDROS MAKRIYANNIS

GEORGE BEHRAKIS CHAIR OF PHARMACEUTICAL BIOTECHNOLOGY, NORTHEASTERN UNIVERSITY; FOUNDER AND DIRECTOR OF THE CENTER FOR DRUG DISCOVERY, BOSTON, MASSACHUSETTS, USA

Research: Uncovering the biochemical basis of the endocannabinoid system and developing new cannabinoid drugs.

Nominator comment: "His work on cannabinoids has significantly contributed to our understanding of the endocannabinoid system and developed tools to enable receptor identification and crystallization of cannabinoid receptors."

Recognizing Research GIANTS

RAPHAEL MECHOULAM

needs no introduction. The "father of cannabis research", his work paved the way for all of the scientists working with cannabinoids today. Recently, he was awarded the Harvey Prize in Chemical Engineering and Medical Sciences.

ROGER PERTWEE

is another hero of cannabinoid pharmacology, who worked with Mechoulam to identify the first endocannabinoid, anandamide, and is now exploring the possibilities of allosteric modulation of CB1 receptors.

CECILIA HILLARD

a professor at the Medical College of Wisconsin, is carrying out groundbreaking work on the biochemistry of cannabinoids.



DANIELE PIOMELLI

DISTINGUISHED PROFESSOR OF ANATOMY AND NEUROBIOLOGY, PHARMACOLOGY AND BIOLOGICAL CHEMISTRY, UNIVERSITY OF CALIFORNIA IRVINE SCHOOL OF MEDICINE, USA

Career highlight: Seeing so many of my former students and postdocs becoming accomplished and successful scientists.

Motivation: A sense of wonder for the beauty and immensity of the natural world.

Advice to my younger self: Time is precious man, don't waste it on useless BS.

Inspirational MENTORS

Supporting cannabis scientists at all levels to reach their potential through coaching, education, or advocacy

SUSAN AUDINO

ISO ASSESSOR AND INSTRUCTOR, SCIENTIFIC ADVISOR AT AOAC INTERNATIONAL CASP, AND CHEMISTRY LABORATORY CONSULTANT AT S.A. AUDINO & ASSOCIATES, LLC, WILMINGTON, DELAWARE, USA

Best part of my job: The diversity of the role and the opportunity to exert a positive influence. I take great pleasure in working in a collaborative environment where each participant is both student and teacher. The opportunity to interact with aspiring scientists gives me great hope for the future!

Nominator comment: "An incredible mentor and resource to all facets of the cannabis scientific community. It is a sincere honor to have her guidance, as she consistently makes a concerted effort to provide support (despite her extremely busy schedule)!"





JOSHUA CROSSNEY

PRESIDENT AND FOUNDER, JCANNA AND CANNABIS SCIENCE CONFERENCE, USA

Motivation: In 2012, I was shocked to learn that there were more testing standards for wastewater than there were for cannabis. My goal was to bring together many diverse, unconnected groups to share information and advance cannabis science.

Proudest career moment: When we hosted our very first Cannabis Science Conference in October 2016. Leading up to that first show, we outgrew our event space two times and had to find larger venues. From the moment we kicked off our first session, I knew we had created something special.

CHRISTINE SMART

PROFESSOR, SCHOOL OF INTEGRATIVE PLANT SCIENCE, CORNELL UNIVERSITY, GENEVA, NEW YORK, USA

Lessons learned: I always learn as much (sometimes more) from projects that fail as I do from the ones that succeed. Just be sure to take the time to think about why it did not work – this increases your chance of success moving forward.

Nominator comment: “Chris’s lab is working on powdery mildew, Botrytis, and other fungal pathogens that can be devastating to hemp crops. She’s training the next generation of scientists, who will work with farmers and growers to combat these threats.”



ALISIA RATLIFF

CEO, VICTUS CAPITAL VENTURES, JACKSONVILLE, FLORIDA, USA

Cannabis industry origin story: I was in search of a career that allowed me to make a meaningful impact in people’s lives. One of the first medical cannabis start-ups in Florida were looking for experienced chemists, and I found myself in the right place at the right time!

Proudest career moment: Successfully building out a cannabis manufacturing facility in 45 days.

Nominator comment: “A strong, leading voice in the role of women – particularly women of color – in the cannabis industry. She is an extremely approachable mentor who truly cares and follows up with the people she oversees. She has brought professionalism into an industry that so desperately needs it.”



MONICA VIALPANDO

FOUNDER AND CEO, VIA INNOVATIONS, SAN FRANCISCO, USA

Lessons learned: Work-life balance is critical to enduring the entrepreneurial marathon. Once I began to dedicate significant time for myself (and honor it), I immediately noticed an increase in productivity and mood.

Nominator comment: “Monica has been a huge mentor for me in the past 2–3 years. She continues to teach me lessons about product formulations and how to create new and inspiring cannabis products for safety, efficacy, and unique routes of administration.”

Acknowledging
AMBASSADORS of
Cannabis Science

SCOTT KUZDZAL (Shimadzu Scientific Instruments) has been at the forefront of cannabis analysis since its inception and is a tireless advocate for good science in the field, offering support and advice to scientists and entrepreneurs in the space. A nominator said, “He has an amazing knowledge of chromatography and mass spectrometry, but he also really understands toxicity and clinical testing. Without his guidance, our startup would be very far behind.”

JOHN ABRAMS, Chairman and CSO of The Clinical Endocannabinoid System Consortium, is also Scientific Director of the Emerald Conference, responsible for the strong scientific and networking program at one of our favorite cannabis science events. Sadly, this year’s event is postponed due to the pandemic, but we look forward to heading to sunny San Diego again soon.

Rugged Isocratic LC-UV Method for the Analysis of 16 Cannabinoids in Hemp and Cannabis Samples

With the mounting interest in hemp and cannabis products for medicinal and recreational use around the world, suitable analytical methods to identify and determine the concentration of cannabinoids are essential for ensuring consumer safety. Traditional analyses for measuring the potency of cannabinoids in cannabis and hemp samples have focused mainly on five primary analytes: THC, THC-A, CBD, CBD-A, and CBN. As the industry continues to expand and evolve, more attention is being directed toward additional, although less prevalent, cannabinoids that have been shown to exhibit physiological effects. This application note outlines a simple and robust method for the detection and quantitation of 16 cannabinoids in hemp and cannabis samples using an isocratic HPLC method coupled with UV detection. Baseline

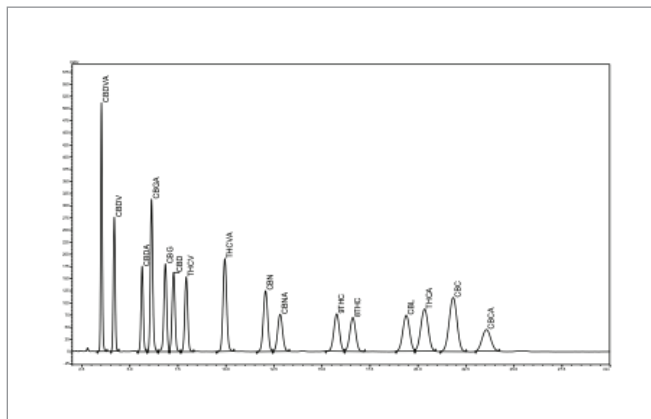


Figure 1. Chromatogram of the highest calibration standard (62.5 µg/mL).

separation of all 16 cannabinoids, including the critical pair Δ^9 -THC and Δ^8 -THC, was successfully achieved using a Selectra® C18 column. Examples of hemp flower and oil samples analyzed using the analytical method are also presented.

View the full application note here: <https://bit.ly/2trFS2w>



Selectra® C18 U/HPLC Columns

Providing Simple and Robust Detection
and Quantitation of Cannabinoids in
Hemp and Cannabis Samples.



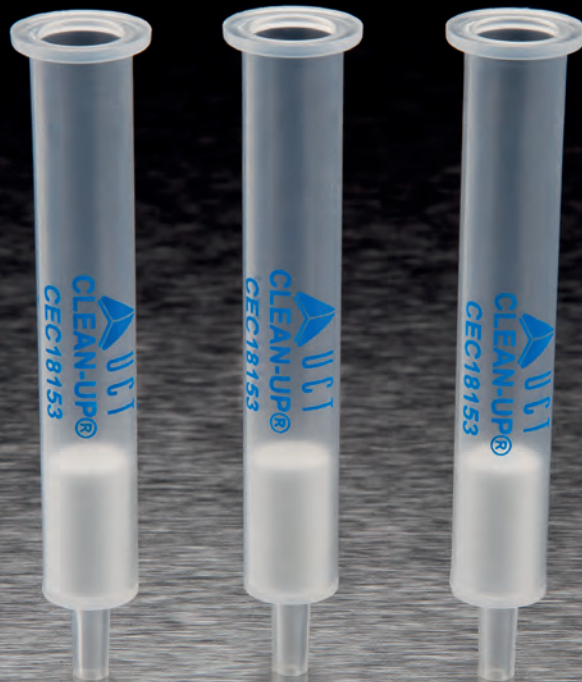
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Spotlight on...
Technology

UCT's 30+ Years in the Making, Gold-Standard C18 SPE Column

UCT's rugged Clean-Up® C18 SPE Column has quickly become a go-to cannabis filtration approach to isolate your cannabinoids from your pesticides - available in both SPE and push-thru column formats.

Learn more at <https://www.unitedchem.com/product/clean-up-c18/>



A black and white portrait of Mary Abood, a woman with dark, wavy hair, smiling warmly. She is wearing a dark top and a thin necklace with a small pendant. The background is a dark wood-grain wall, overlaid with a geometric pattern of overlapping triangles in shades of purple and blue.

A Born Scientist

Sitting Down With... Mary Abood, Professor,
Temple University, Philadelphia, Pennsylvania, USA

How did you get involved in cannabinoid science?

I've been exposed to science my entire life. My father was a scientist – a university professor – and I would visit him at work as a child.

I studied Chemistry at college and then did my PhD in pharmacology, looking at the endogenous opioid system, and continued my work with opiate receptors as a postdoctoral fellow at Stanford University and an Assistant Professor at Virginia Commonwealth University. When I learned about the newly identified cannabinoid receptors (structurally similar to receptors for opiates) I was intrigued – I immediately wanted to understand this new system better.

Is that what's kept you working with cannabinoids – the novelty?

In part, yes. It's exciting learning about a brand-new system; every discovery is important. But what's also kept me in the endocannabinoid field is the excellent, supportive community of researchers. I started attending the International Cannabinoid Research Society meetings soon after their inception in 1990, and was impressed by the collaborative spirit and good science I found there. It's a very special community.

What has been your proudest scientific achievement?

I'm very proud of the work that I did looking at the endocannabinoid system in amyotrophic lateral sclerosis (ALS). We found that THC was able to – at least temporarily – slow disease progression in animal models. Those studies helped inspire others to start clinical trials (still ongoing) of cannabinoids to treat the symptoms of ALS. I know a neurologist who is using medical cannabis for her ALS patients – when I hear that it helps them, that's a big motivator to continue to learn more about cannabinoids and their medical potential.

What are you focusing on right now?

For the past few years, I've mostly been looking at novel cannabinoid receptor subtypes, beyond the more familiar CB1 and CB2 receptors. In particular, we're exploring the pharmacology of two G protein-coupled receptors, GPR55 and GPR18. These receptors could have great clinical significance, and we are working to determine their precise molecular structure and function in the body.

The other main area my group is working on is allosteric modulators of the CB1 receptors (the main receptor for THC). The usefulness of drugs targeting CB1 receptors has always been limited by side effects. Allosteric modulators, which change the shape of the receptor, have the potential to upgrade or downgrade the action of the body's own endocannabinoids, which we hope will come with fewer side effects than taking plant or synthetic cannabinoids.

As a scientist, how do you feel about increasing access to legal cannabis?

As far as medical cannabis is concerned, I am broadly supportive and think that there are several indications where it can be helpful, such as neurological disease and pain. Recreational use is more of a political issue. Clearly, the war on drugs has not been successful, so perhaps a new approach is warranted. But as a drug abuse researcher, it's also clear that people can become dependent on cannabis and suffer harm as a result. It's important that we don't treat it as panacea.

One thing everyone agrees on is that we need more research on cannabis. What changes would make that easier?

As a researcher in the US, the obvious answer is to make it federally legal! Failing that, we need changes in legislation to make it easier for scientists to get access to cannabis and the money to study it. Everyone (including NIDA) agrees that we need to have more research on different strains, but

“It's exciting learning about a brand-new system; every discovery is important.”

for federally funded researchers, there is just one (low THC) strain available.

More funding is now coming from state governments, especially those who are dedicating a portion of tax revenues from legal sales to fund cannabis research. Public-private partnerships are also on the rise. I haven't been directly involved, but the state of Pennsylvania has established relationships with growers and pharmacies to support research here at Temple University.

How has COVID-19 affected your work?

I'm mainly working from home. The folks in my lab are able to continue their experiments, but they're encouraged to just do what they need to do and then leave. I think the biggest impact has been the ability to interact with colleagues. We still talk regularly on Zoom, but it's not quite the same. So many great ideas stem from a coffee break chat!

What are you excited about for 2021?

We just got a new piece of equipment (a specialized plate reader) that will allow us to screen compounds more rapidly and I'm excited to be able to accelerate the pace of our studies of signaling by cannabinoid receptors. We're a small lab so anything that lets us get results faster is exciting!

More generally, I still get really excited about generating new data in the lab. And I've been blessed to work with great mentors, postdocs, and students. Now more than ever, that is what keeps me going.

ACCELERATE YOUR CANNABIS SAMPLE PREPARATION

Dedicated Sample Preparation Station
for Dry Homogenizing, Dry Grinding
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and other Plant Material



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