We all have been living in transformative times – for world health and for the Monell Chemical Senses Center.

Throughout the COVID-19 pandemic, Monell’s researchers have worked at the forefront of the global effort to understand the link between COVID-19 infection and loss of smell and taste. We are making numerous important and enduring contributions to the field and to public health efforts. Collectively, the world’s research and clinical communities have learned so much. At Monell we are urgently advancing new discoveries and translating them to improve our lives.

This year brought a deeper understanding of taste and smell dysfunction in COVID that will enable practice-changing advances in health care. SCENTinel, Monell’s rapid screening tool for new-onset loss of smell has moved into the field as the centerpiece of a new campaign for universal smell testing. Because this sense is so integral to human health and well-being, our goal is to make smell testing a routine medical practice, available in every doctor’s office, perhaps even as part of your annual physical exam. Identifying smell disorders earlier in their course could allow for new treatment approaches that better support patients.

Other research underway at Monell may bring us new bitter-blocking formulations so children infected with HIV will find it easier to take their life-saving medicines. Our discovery of biomarkers for Parkinson’s disease could lead to developing a simple diagnostic test for earlier detection and treatment before motor impairments begin – a potential game-changer for patients. And new information about how we individually sense “sweet” in our mouths may help us develop healthier beverages and foods. Please read the sections on our four research aims to learn more about these initiatives and many others.

This year also marks a transition in leadership as Robert F. Margolskee, MD, PhD, stepped down as Director and President, a role he has held since 2014. Under his leadership, Monell surpassed its 50th Anniversary Sensing the Future capital campaign goals and embarked on an ambitious strategic plan to ensure the Center’s primacy in chemosensory science for years to come. Monell Vice President Nancy E. Rawson, PhD, who returned to Monell in 2016 to lead the Corporate Partners Program, is now Acting Director and President.

Today at Monell we are Bringing Our Legacy to Life, with new discoveries in taste, smell and related senses that will transform global health and well-being.

Most importantly, our progress toward a healthier future is only possible with the strong support of you - our donors, partners, and collaborators. Thank you for being part of our enterprise.

Nancy E. Rawson, PhD
Acting Director and President

Robert F. Margolskee, MD, PhD
Past Director and President

David Macnair, PhD
Chair of the Board

Richard L. Berkman, Esq
Vice Chair of the Board
Morley Kare founded Monell as a bold experiment in collaborating freely and richly across scientific disciplines and embracing innovative partnerships with academia and industry to advance understanding of taste, smell, and related senses.

In 1967, The Ambrose Monell Foundation made an equally bold founding investment to create the Monell Chemical Senses Center.

The result is a legacy of superlative chemosensory science and innovation that continues to transform world health care practices. Fifty-five years later, through collaboration and philanthropy, Monell’s basic discoveries are enriching health outcomes in ways no one could have imagined at the time.
PROPELLING MONELL INTO ITS NEXT HALF-CENTURY

In January the Monell Foundation awarded the Center a transformative grant of up to $26 million, securing its position as the world’s premier independent basic research institute for taste, smell and related senses. The largest single donation in Monell’s history, the funds would be disbursed in grants of $5.2 million per year over five years, conditioned upon the achievement of certain milestones.

In a very real sense, the Monell Foundation grant is a testament not only to the Center’s achievements, but to the philanthropy that enables and inspires it. Coupled with the generosity of loyal donors and corporate partners, the Foundation’s investment will support Monell’s strategic plan to ensure the Center’s primacy in chemosensory research. This is a visionary roadmap for the future that prioritizes four strategic research aims, enhances its research environment, and expands and diversifies its expertise through recruiting and nurturing its next generation of scientists.

“With this grant we intend to plant the seeds for the Center’s success for the next 55 years and await the Center’s continued contributions to the world of sensory science.”

Ambrose K. Monell
President and Director, The Monell Foundation
NEW OPPORTUNITIES FOR ACADEMIC EXCELLENCE

Part of discovery means training future scientific leaders, immersing them in Monell’s collaborative, interdisciplinary approach to chemosensory science. This has been a core principle since Monell’s founding and is fundamental to its success.

To advance Monell’s strategic research aims by facilitating opportunities for academic excellence, the Center has created a new Office of Academic Affairs under the leadership of Valentina Parma, PhD, Monell Assistant Director and Assistant Member. The new office coordinates the activities of the nationally recognized Monell Science Apprenticeship Program (MSAP), which fosters an interest in careers in biomedical science or medicine among high school students from groups typically underrepresented in science; Monell’s Postdoctoral Advisory Committee; and its science seminar series and journal club. It also advances Monell’s formal academic partnerships and works to expand national and international trainee exchange programs.

The Office of Academic Affairs has set ambitious goals for expanding Monell’s mentorship model, increasing diversity among its trainees, stimulating academic excellence through academic outreach, and growing its academic partnerships, all with the aim of improving health and well-being through the science of the chemical senses.
Monell’s interdisciplinary chemosensory science integrates four research aims: disease prevention; diagnosis and treatment; sensory nutrition; regeneration of the senses; and digitization of taste and smell. Our goal is to accelerate the translation of basic science on taste and smell into real improvements in human health and well-being.
Tackling the loss of smell and taste through COVID-19 and beyond

With sudden loss of smell and taste as hallmark symptoms of COVID-19 infection, Monell has led the global effort to understand the link between COVID-19 infection and sudden sensory loss. Now, as the COVID pandemic is well into its third year, Monell researchers are taking on longer term olfactory and gustatory dysfunction. Other areas with a focus on the future are using taste stem cells to study repairing taste loss.

CONFIRMING TASTE LOSS IN COVID-19

Reports of taste loss have been rising in the past two years of the pandemic, but chemosensory scientists have questioned their authenticity in part because prior to COVID-19 taste loss was rare and often confused with smell loss. To confirm whether taste loss is indeed a symptom of COVID-19 infection, Monell Associate Director Danielle Reed, PhD, postdoctoral fellow Mackenzie Hannum, PhD, and colleagues conducted a systematic review and meta-analysis of 241 studies published in 2020 to 2021.

The study was the largest such effort to date, with data from 138,785 COVID-19 patients. The researchers found that about 4 in 10 COVID-19 patients experience some degree of taste loss. They also found age and gender influence the prevalence of taste loss, with middle-aged (36 to 50 years old) people having the highest prevalence, and female patients more likely to lose their sense of taste than males.

Researchers also examined how the method for measuring the symptom – either through subjective self-reports, such as questionnaires and interviews, or objective direct measures such as taste testing kits – influenced prevalence. They found that when it comes to the loss of taste, both self-reports and direct measures were equally sensitive at detecting taste loss. With smell loss,
CONFIRMING TASTE LOSS

however, the team found in a previous analysis that direct tests are a better measure.

The findings confirm that reports of taste loss in COVID-19 are in fact genuine and distinguishable from smell loss. With that knowledge in hand, Reed and colleagues now turn their work toward finding ways to reverse or repair the loss. The findings also point the way toward developing more sensitive direct taste tests that may someday become part of annual physical exams.

SMELL AND TASTE DYSFUNCTION AND COVID

Two Monell studies this year examined smell and taste dysfunction and its effect on quality of life for those recovering from COVID-19, providing valuable insights into the function of the olfactory system, and helping physicians better treat their patients’ mental as well as physical health.

In the first study, Monell Assistant Director Valentina Parma, PhD, postdoctoral fellows Mackenzie Hannum, PhD, Robert Pellegrino, PhD, and collaborators in the Global Consortium for Chemosensory Research (GCCR) characterized smell function and recovery after smell loss. The international team surveyed 12,300 COVID-19 patients about their respiratory symptoms and chemosensory function, 3,386 of whom completed a follow-up survey several months later. Of the follow-up participants, the team reports that 60 percent of women and 48 percent of men reported they had less than 80 percent of their pre-COVID smell ability. Taste typically came back faster than smell, and taste loss rarely persisted if smell recovered. One key finding: while smell ability eventually improved for many who lost it during the acute stage of their infection, the prevalence of parosmia – a distorted sense of smell – and phantosmia – smelling a scent when no odor source is present – increased substantially over the study period. Armed with this information, healthcare providers can be better prepared to treat post-COVID-19 secondary effects, including patients’ mental health.

In related work, Valentina Parma, PhD, and colleagues looked at the effects of persistent olfactory and gustatory dysfunction on quality of life in long-COVID-19 patients. They surveyed 431 individuals with persisting COVID-19 symptoms at six months post-infection, assessing both physical and mental components of quality of life. The team found olfactory and gustatory dysfunction are frequent symptoms of long-COVID-19, and the presence of at least one persistent symptom led to lower mental quality of life scores, compared to patients whose symptoms resolved. Olfactory and gustatory dysfunction significantly reduce quality of life in long-COVID-19, specifically when it comes to mental health. The researchers emphasize the importance of treating patients early, with healthcare teams that include psychiatrists and nutritionists as well as specialists in smell loss.
**Creating a Research Roadmap on Taste and Smell Disorders**

In December, the Monell Chemical Senses Center was awarded a highly competitive $200,000 Eugene Washington Engagement Award from the Patient-Centered Outcomes Research Institute (PCORI). The funding supports the “Shared Agenda for Clinical Research on Smell and Taste,” a partnership among Monell, the Smell and Taste Association of North America (STANA), and the Otolaryngology Department at Thomas Jefferson University Hospital.

Led by Monell Acting Director and President Nancy Rawson, PhD, and faculty Member Pamela Dalton, PhD, MPH, the program will establish a shared research plan and roadmap for studying smell and taste disorders. It was awarded through PCORI’s special COVID funding cycle in light of high numbers of people experiencing COVID-related sensory loss.

Scientists predict that in the U.S. alone, more than three million people will have long-term smell loss and one million with taste loss as a result of COVID-19 infection.

The Shared Agenda project will define needs and gaps in existing data and embed the full spectrum of patient experiences into a taste and smell prioritized research agenda. It will also produce a stakeholder roadmap to disseminate results and develop a plan to grow and sustain the resources, partnerships, and infrastructure needed for continued patient-centered outcomes research on taste and smell disorders. As a first step, in April the team issued a survey about patient experience that received an astounding response – 6,000 people responded and engaged in the effort, not only confirming for researchers that there are unmet needs in olfactory research and advocacy, but also that there are thousands of individuals eager to engage and move the field forward.

The project builds on Monell’s Chemosensory Clinical Research Center with Jefferson, which operated with funding from the National Institutes of Health from 1986 – 2009 to assess the taste and smell function of patients, and its burgeoning partnership with STANA, North America’s first advocacy group for people with taste and smell disorders.

**EXPLORING TASTE CELL REGENERATION AT THE MOLECULAR LEVEL**

Taste occurs when receptor cells in taste buds on the tongue detect a substance and send signals to the brain, generating the perception of that material. Although taste bud cells have a sensory nature, they are not nerve cells as one might expect. Rather, they are epithelial cells, rapidly turning over throughout life, on average living only about one to two weeks. New taste cells are continuously generated by taste stem cells, and interruption of this process, which is regulated in part by gustatory, or taste-related, neurons, can lead to taste loss.

Understanding taste stem cell renewal has long been a focus of Monell researchers. They have shown, for example, that a protein in the WNT signaling pathway involved in tissue regeneration is a unique biomarker of adult taste stem cells. More recently, this team has shown another compound called R-spondin interacts with the WNT path protein, substituting for the taste-related neurons needed for taste cell regeneration and regulating stem cell activity.

Building on these discoveries, Monell molecular biologists Peihua Jiang, PhD, Ichiro Matsumoto, PhD, and colleagues have uncovered more details about how the R-spondin signaling pathway controls taste stem cell regeneration. In mice, the team found that an enzyme in the pathway acts as either a brake or a promoter for adult taste stem cell development, depending on the type of tissue expressing it. R-spondin releases the brake, allowing stem cells to mature into taste cells.

By shedding new light on taste bud cell turnover, the team’s study could provide new directions for restoring a lost sense of taste. M
Monell is developing new ways to detect changes in body chemicals that signal disease and enlist chemosensory cells to fight pathogens. From training dogs to sniff out the odor signature of bird influenza to discovering biomarkers for early detection of Parkinson’s disease to taking the bitter out of life-saving child medications, Monell researchers are advancing solutions for many of today’s most pressing public health concerns.

**CAN A DOG’S SENSE OF SMELL AVERT A PANDEMIC?**

Recent avian influenza outbreaks across the globe pose significant threats to public health and economies worldwide. Not only damaging to wild birds, highly pathogenic bird flu can disrupt the poultry industry through devastating losses of farmed fowl and potentially become a human pandemic. Wild waterfowl, like mallard ducks, are silent carriers of avian influenza virus, and wildlife biologists must constantly monitor bird populations to prevent potential outbreaks. Typically, they do this by collecting birds from the field.

Monell chemical ecologist Bruce Kimball, PhD, and Glen Golden, PhD, of Colorado State University and a former Monell postdoctoral fellow, are training dogs to sniff out bird flu infections in the field. In previous studies, Kimball and Monell colleagues have shown that certain diseases can alter animal bodily odors, and that mice can be successfully trained to detect bird-flu-induced changes in the continued
TAKING THE BITTER OUT OF LIFE-SAVING MEDICINES

Children with human immunodeficiency virus (HIV) infection must consistently take their medicine or the virus, which is fatal if not successfully treated, may mutate and become even more difficult to manage. But children often reject oral liquid formulations of these medications due to their intense bitterness, resulting in the perfect storm of on-again, off-again medical compliance. Monell scientists and industry partner DiscoveryBioMed, Inc. (DBM, now part of Eurofins Discovery), and academic partner Wuhan University, are learning how to block the bitter taste of these medications so children will take their life-saving treatments.

Earlier Monell-DBM work developed bitter-responsive human taste bud cell assays to screen for bitter blockers. More recent work has leveraged Monell’s expertise in analysis of the “bitterome” – the genome of the 25-plus bitter-taste receptors in human taste buds – to reveal the distinct bitteromes found in different human populations, and create assays with bitterome patterns that reflect these distinct populations. In the latest research using these taste bud assays, the Monell team of Paul Breslin, PhD, Peihua Jiang, PhD, Nancy Rawson, PhD, and Linda Flammer, PhD, working with a DBM team led by Erik Schwiebert, PhD, identified a compound that blocked an intensely bitter-tasting anti-HIV medicine, tenofovir alafenamide (TAF) at both the cellular and bitter-taste receptor level. Human sensory testing confirmed that the compound, 6-methylflavone, reduced perceived bitterness of TAF in half of study participants and completely blocked it in two individuals. This work was supported by the Bill & Melinda Gates Foundation.

CAN A DOG’S SENSE OF SMELL

continued

feces of mallard ducks. In a new publication, the researchers tested whether ferrets could, like mice, discriminate between fecal samples belonging to healthy or infected ducks. Feces of infected ducks have an increased concentration of certain volatile compounds. The team trained ferrets to signal they detected these molecules by scratching boxes that contained the highest concentrations. When presented with fecal samples from both healthy and infected ducks, the ferrets successfully identified which boxes held infected duck feces with 86 percent accuracy.

The team is now training dogs to detect avian influenza in the field, with early encouraging results. In tests with dogs and fecal samples from avian flu-infected and healthy birds, dogs correctly identified the virus in 94.5 percent of the samples and correctly rejected healthy samples 98.3 percent of the time.

feces of mallard ducks.
AN EARLY WARNING SYSTEM FOR PARKINSON’S DISEASE

More than one million Americans and 10 million people worldwide are living with Parkinson’s disease (PD), a progressive neurodegenerative disorder characterized by tremors, limb rigidity, gait and balance difficulties, and other symptoms that range in severity as the disease progresses. Detecting PD early, when it is most treatable, has been a challenge, in part because there are no commercial diagnostic biomarkers currently available.

Monell molecular biologist and immunologist Hong Wang, PhD, is changing that picture. Smell impairment is one of the earliest symptoms of PD, often occurring several years before motor deficits appear. Lewy bodies, the cellular hallmark of PD, accumulate in the olfactory bulb in early-stage disease. Wang’s earlier studies of olfactory mucus identified several PD-associated proteins and inflammatory biomarkers. By examining olfactory mucus at the molecular level in a small cohort of patients, Wang and colleagues found that the ratio of these proteins distinguishes Parkinson’s patients from otherwise healthy participants – tantalizing evidence of a possible PD biomarker. Based on these promising early results, Wang is expanding the study to compare patients with early or advanced disease. The goal: development of a non-invasive diagnostic biomarker test that can detect Parkinson’s disease earlier, which could have a major impact on patient care.

Of Worms, the Sense of Taste, and World Health

Monell cell biologist Peihua Jiang, PhD, has been studying taste-like tuft cells in the gut and their role as immune sentinels against parasitic infection for more than a decade. These infections are a significant health burden that negatively affects the development of infected children in developing countries.

Gut tuft cells detect parasites, protozoans, and other infectious microbes via the cell surface receptor Sucnr1. Its activation triggers a cascade of molecular events, ultimately killing the invading pathogens. Working with Monell visiting graduate student Ranhui Xi and colleagues from West China Hospital of Stomatology, Sichuan University, the U.S. Department of Agriculture, and Tokyo University of Agriculture, Jiang published a study which may advance global efforts against parasitic disease. The team used immune cytokines IL-13 and IL-4 to stimulate epithelial cells in intestinal organoids and noted significant upregulation of the gene gasdermin C. This, in turn, caused pyroptosis, a specific type of inflammation-related cell death. In this study, mice infected with the parasitic worm *Nippostrongylus brasiliensis* showed that turning on pyroptosis and upregulating gasdermin may help clear out the worms. Gasdermin activity may provide a pharmaceutical target for treating parasitic infection, thereby tackling one of the most prevalent threats to health in developing countries.

PREVALENCE RATE OF PARKINSON’S DISEASE

(Per 10,000 Adults, Ages 30-64)

<table>
<thead>
<tr>
<th>Year</th>
<th>Rate</th>
<th>Increase</th>
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</thead>
<tbody>
<tr>
<td>2013</td>
<td>5.5</td>
<td>107%</td>
</tr>
<tr>
<td>2017</td>
<td>8.4</td>
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EARLY-ONSET (30-50 YEARS OF AGE) FROM 2013 - 2017: 1.2 to 2.5
How does the taste and smell of food and drink affect our dietary choices, and what are the implications for our health? As leaders in the emerging field of sensory nutrition, Monell investigators are making progress in understanding why many of us prefer naturally sweetened food and beverages over artificially sweetened ones, how our sense of sour taste evolved, and how neural circuits in the gut and brain link nutrient sensing and feeding behaviors.

**SUGAR DETECTION SIGNALING**

Can your mouth tell whether calories are in that soft drink? According to a new Monell study, the answer is yes. Experimental psychologist Paul Breslin, PhD, and colleagues report the first-in-human demonstration of an oral signaling pathway that uses glucose, a component of table sugar (sucrose) and high fructose corn syrup, to signal the presence of calories.

Building on recent Monell research that showed taste bud cells in mice could identify when a sweetener has calories to oxidize for energy, the team turned to humans and compared oral glucose sensitivity to the ability to sense the artificial sweetener sucralose, and to a special form of glucose that is sweet tasting but cannot be metabolized. They found there are two glucose-sensing pathways: sweet taste detection and metabolic sensing.

Researchers say the findings help explain why diet sodas have never captured a major share of the beverage market – they’re not as satisfying as sugary drinks – and suggest new avenues for developing healthier, lower-sugar beverages that people enjoy drinking as much as high-sugar ones. Monell is grateful for funding support for this research from corporate partner Suntory Global Innovation Center Limited.
THE EVOLUTION OF SOUR TASTE

Chemosensory scientists agree that our ability to taste sour, or acidity, first evolved as a warning system for acidity in the environment around fish. Paul Breslin, PhD, and colleagues published a study charting the evolution of sour taste among many types of vertebrates. Through an extensive review of the published literature, the team built a database of vertebrate species with the ability to detect acidity in food and whether they liked or disliked sour taste. From there, they mapped the evolution of the like/dislike response to acidity among vertebrates, including humans. Their evolutionary reconstruction of sour taste began with sturgeons, an ancient species of fish. They found that most animals dislike sour taste, but those that do, like humans, have good reason to. For example, humans have lost the ability to make vitamin C, an important nutrient which is high in many fruits. Sour taste, then, may have been a necessary guide to vitamin C-rich fruits for early humans.

Furthermore, in many fermented foods – such as yogurt, pickles, sauerkraut, sourdough bread, and kimchi – the sour taste marks both food safety and the presence of probiotic gut-colonizing microbes that are important for human health and wellness.

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*Only a narrow range of acid concentrations have been tested. Valence at low concentrations is unknown.
1 *Lemur catta* have only been tested at very high acid concentrations.
2 *Sturnus vulgaris* males have a higher threshold of tolerance than females for acidic foods.
3 *Rana catesbeiana* and *Limnodynastes tasmanianus* are seemingly indifferent to high concentrations of citric acid (100 mM, readily accept it, but do not show preference for it). Low concentrations of acid (< 26 mM) have not been tested and valence at these concentrations is unknown.
4 *Acipenser baeri* and *A. stellatus* show attraction to acidic foods but reject these same foods once in their mouth.
MACRONUTRIENT COMPOSITION OF INFANT FORMULA PRODUCES DIFFERENCES IN THE MATURATION OF GUT MICROBIOTA

Early nutrition plays a crucial role in optimizing growth and developing a palate for a healthy diet, but gaining weight too rapidly has long-term consequences, increasing children’s risk for obesity and other diseases.

While infants who are fed formula typically weigh more and are at greater risk for later obesity than those fed human milk, a longitudinal feeding trial of 113 infants conducted at Monell revealed that the macronutrient composition of the formula matters.

Monell member Julie Mennella, PhD, and her long-term collaborators at the University of Delaware and the Children’s Hospital of Philadelphia (CHOP) discovered that infants fed cow milk formula (CMF) for the first year gained weight more rapidly during the first four months compared to infants fed an isocaloric, extensive protein hydrolysate formula (EHF), who had normative weight gain. Unlike CMF, EHF is rich in satiating, free amino acids because its proteins are broken down to lessen the burden of digestion for infants. Greater weight gain velocities during the sensitive period of the first four months predicted greater risks for overweight when toddlers.

To explore whether the macronutrient differences between the formulas shaped the developing gut bacterial environment, the team collaborated with colleagues at the Penn-CHOP Microbiome Center who conducted shotgun metagenomic sequencing on fecal samples collected from 30 of the infants from the larger feeding trial. In this proof-of-principle study, 15 infants were fed CMF and 15 were fed EHF exclusively from the age of two weeks. The team discovered that the microbial composition of the gut microbiota diverged after infants fed their assigned formula for at least three months. The EHF group had faster maturation and greater diversification of the gut microbiota that was driven primarily by bacteria in the Clostridia taxa. Greater relative abundance of Clostridia when infants were three to four months was associated with more normative early weight gain velocities and predicted their body weight status when formula was no longer part of their diet. Toddlers who were at a healthy weight tended to have greater relative abundance of Clostridia at three to four months than those who were overweight.

The long-lasting consequences of the formula-induced changes in early weight gain and the early bacterial environment as children transition to a diet devoid of infant formula is the focal point of current research at in the Mennella lab at Monell.

Monell Leadership of AChemS

AChemS – the Association for Chemoreception Sciences – is the leading scientific research organization dedicated to understanding smell, taste, and related senses and serves as the global forum for bringing together the various scientific disciplines involved in chemosensory research. Monell Associate Director Danielle Reed, PhD, is AChemS 2021-2022 President and Member Paul Breslin, PhD, was named President-Elect for 2022-2023.
Understanding the Underpinnings of Appetite

How do neural circuits in the brain and gut influence hunger and diet-related conditions like obesity and diabetes? This is the research focus of Amber Alhadeff, PhD, who received three prestigious awards this year to support her laboratory’s work on the neurobiology of hunger. The early career scientist was named to the 2022 class of the Pew Scholars in the Biomedical Sciences, earning four years of support from The Pew Charitable Trusts to explore questions of sensory nutrition. Alhadeff is among the 106 grant recipients of the National Institutes of Health High-Risk, High-Reward Research program for 2021, receiving an NIH Director’s New Innovator Award to pursue research that addresses how exposure to smell and taste of highly palatable foods interact with our physiology to promote feeding and weight gain. And in October, Alhadeff was awarded the international Eppendorf & Science Prize for Neurobiology for her research on how gut-brain connections influence eating behavior.

Since joining the faculty at Monell in 2020, Alhadeff has been a dedicated mentor to several trainees, and actively advocates for scientists from underrepresented backgrounds. This year she received a grant from the National Center for Complementary and Integrative Health of the NIH specifically aimed at increasing diversity in science. The grant will support mentoring and training of Alexandra Vargas in neuroscience techniques as she brings her background in behavioral research to Alhadeff’s NIH-funded research on harnessing sensory food circuits to influence feeding behavior.

MOUSE STUDY SUGGESTS BEST DIET BETS FOR KEEPING THE WEIGHT OFF

Researchers have known for years that people who frequently eat in cafeterias and at buffets have higher rates of obesity than those who don’t. They’ve speculated it’s because of the “variety effect” – people will eat more if two or more foods are presented compared to if they were offered a single option. Monell researchers set out to learn more.

In a series of experiments they explored whether providing foods with different nutrient combinations affected weight gain in mice.

Monell Member Michael Tordoff, PhD, and his research team tested variations on two diets – one comprised of 20 percent protein, 75 percent carbohydrate, and 5 percent fat (C75-F5); the other 20 percent protein, 5 percent carbohydrate, and 75 percent fat (C5-F75). They found that mice fed a mixture of the two gained more body weight and fat than did mice fed either diet alone. Peak obesity occurred when mice were fed a 50:50 carbohydrate-to-fat diet (C40-C40). Mice given a choice between C75-F5 and C5-F75 gained almost as much weight as the 50:50 group, and the type of carbohydrate or fat had almost no effect on the incidence of obesity.

What’s the take-away before heading to an all-you-can-eat buffet? The C40-F40 diet – which approximates the Western diet – causes greater obesity than either the C75-F5 diet (roughly akin to the high carb-low fat Pritikin diet) or C5-75 diet (broadly similar to low carb-high fat Atkins diet). Both Pritikin and Atkins would be more beneficial in keeping weight off than the typical Western diet.

Since joining the faculty at Monell in 2020, Alhadeff has been a dedicated mentor to several trainees, and actively advocates for scientists from underrepresented backgrounds. This year she received a grant from the National Center for Complementary and Integrative Health of the NIH specifically aimed at increasing diversity in science. The grant will support mentoring and training of Alexandra Vargas in neuroscience techniques as she brings her background in behavioral research to Alhadeff’s NIH-funded research on harnessing sensory food circuits to influence feeding behavior.
Monell scientists are mining big data to better understand how our genes affect our perception of odors, and why no two people “smell” alike. Engaging commercial partners and patient advocacy groups in this basic olfactory research advances Monell’s vision for delivering odors, tastes, and sensations directly to consumers with new technologies like virtual and augmented reality.

**SMELL DISTORTIONS AND COVID-19**

Suddenly losing the sense of smell and taste is a well-known symptom of COVID-19 infection. New Monell research teases out differences between two other COVID-associated olfactory conditions – parosmia, where a familiar odor suddenly smells like something different, and phantosmia, or smelling a certain odor when no odor source is present.

Monell investigators Joel Mainland, PhD, Robert Pellegrino, PhD, and colleagues from the patient advocacy group AbScent, the University of Reading, and Technische Universitat Dresden, designed a questionnaire to better understand the nuances of these disorders, and the frequency and duration of distortion episodes. They surveyed over 2,100 people with at least one olfactory disorder and found odor distortions were common at 46 percent, with participants reporting parosmia at 19 percent, phantosmia at 11 percent, or both conditions at 16 percent.

Among the findings they report, viral infection (such as COVID-19) led to
DECODING OLFACTION THROUGH GENETIC VARIATION

While the basic biological mechanics of smelling are the same for all of us, no two people perceive odors in precisely the same way. In smell, proteins called olfactory receptors at the ends of olfactory nerves at the back of the nasal cavity lock onto chemicals in the environment and transmit an electrical signal to the olfactory bulb in the brain. But our perception of what we are smelling can vary greatly due to genetic variation. Of humans’ approximately 400 functional types of olfactory receptors, each gene for a receptor can have variations that affect the protein’s shape and function, leading to differences from one person to the next in their experience with the same odor.

Monell neurobiologists Joel Mainland, PhD, and Marissa Kamarck, PhD, and collaborators from the Chinese Academy of Sciences, Tongji University, Rockefeller University, and corporate partner Unilever published a new study that examined 1,000 people from the Chinese Han ethnic group for genetic variation in odor receptor form and function, and how it relates to their perception of 10 different odors. The team also tested six of the odors, some at different concentrations, in an ethnically diverse group of 364 participants in New York City, replicating the findings of the Chinese study. One key finding was the identification of two novel olfactory receptors; OR4D6 for galaxolide, a version of musk used in perfumes, and OR51B2 for trans-3-methyl-2-hexenoic acid, or 3M2H, a prime component of human underarm odor discovered by the late George Preti, PhD, a founding Member of Monell.

SMELL DISTORTIONS

parosmia more often than other smell disorders, and parosmia patients were more likely to be female and younger than people with phantosmia or smell loss. The people with parosmia were also more likely to say their condition improved over time coinciding with physiological recovery. They found parosmia, which can significantly impact quality of life, tends to occur three to six months after smell loss and typically resolves faster than other smell disorders. This knowledge can be an emotional relief and hope for patients.

Understanding patterns of demographics, medical history, and quality of life issues associated with each condition may provide important insights into the function of the olfactory system and help physicians better treat their patients.
Festschrift, from the German “celebration writing,” is a longstanding academic tradition of honoring a scholar’s special achievements in science and culture by publishing a collection of accolades from colleagues, students, and friends.

In May, Monell held a grand Festschrift celebrating Gary Beauchamp, PhD, his prolific 50-year career at Monell, and his many contributions to chemosensory science and world health.

Hundreds of colleagues, collaborators, and trainees gathered for a two-day celebration in Philadelphia and virtually to laud Beauchamp as one of chemosensory science’s champions. Speakers commended his body of research, mentorship of generations of postdoctoral trainees and early career scientists, fruitful collaborations with academic and commercial institutions around the world, and influence on other scientists and the field itself. 2004 Nobel Laureate in Physiology or Medicine Linda Buck, PhD, delivered the keynote address.

The Festschrift itself, a collection of writings and video messages, is published here on the Monell website.

Among many achievements with enduring impact on world health and well-being, his studies of the biology of taste provided the scientific basis for policy-making bodies worldwide to recommend reduction of salt in commercially prepared foods, benefiting public health. His and colleagues’ research guided the World Health Organization’s Commission on Ending Childhood Obesity and the Food and Drug Administration’s rules for industry reduction of sodium in foods.

In other areas he and his collaborators showed that infants are born with a well-developed perception and liking for sweets and later for salt, informing strategies for guiding children toward healthier dietary habits, a cornerstone of the emerging field of sensory nutrition.

continued
His studies in odor signaling in humans and other animals laid the groundwork for developing novel tools for diagnosing disease.

Beauchamp was one of Monell’s original members, having joined Monell as a postdoctoral fellow in 1971. He quickly rose through the faculty ranks and served as Director and President from 1990 through 2014. Today, as Distinguished Member and Emeritus Director and President, Beauchamp leads an active lab focused primarily on sensory nutrition.

**Gary K. Beauchamp, PhD, Endowed Chair**

In honor of Gary Beauchamp’s 50th anniversary at the Monell Center, several donors came forward with an expressed goal of raising at least $1.5 million to create Monell’s first endowed faculty position. The Gary K. Beauchamp Chair was announced during the May Festschrift.

The honor and keystone support that comes from this named chair will seed a body of research to leverage support from federal and other external funds. The aim is to create a cohort of prestigious faculty whose own contributions will advance Monell’s scientific enterprise well into the future.

*We are pleased to announce that at the end of the academic year, June 30, 2022, we had reached the initial $1.5 million fundraising goal for the endowed faculty position. A full list of generous donors may be found [here](#).*
Rich interdisciplinary collaboration with partners in academia and industry is deeply rooted in Monell's culture and fundamental to its success as the world's leading institution for chemosensory science. These robust relationships enable Monell and its partners to bring discoveries to life, translating knowledge about taste and smell into better clinical practice, consumer products, and public policy that improves global health.

**LAUNCHING WORLD TASTE AND SMELL DAY**

Taste and smell loss was a significant public health problem before the COVID-19 pandemic. However, according to the World Health Organization, with over 500 million cases reported to date and an estimated prevalence of chemosensory loss between 52 to 82 percent, the need to focus attention and resources on this aspect of COVID-19 is profoundly urgent. On September 14, 2021, Monell and partners launched the inaugural World Taste and Smell Day to celebrate and promote a deeper understanding of these essential senses and provide a worldwide resource to support all people experiencing taste and/or smell dysfunction.

World Taste and Smell Day kicked off with a global panel discussion among experts and an online Exploratorium of the Joy and Science of Flavor, a community-fueled online exhibition of writing, visual art, science, and mixed media from around the world.

World Taste and Smell Day was made possible by support from Perfumarie, Inc., Young Living, Takasago, the European Chemoreception Research Organization, HCD Research, the Research Institute for Fragrance Materials, and a worldwide group of scientists, patients, clinicians, and professionals in the fields of flavor and fragrance. Monell Director of Development Jenifer Trachtman chaired the steering committee. Director of Communications Karen Kreeger and Assistant Director Valentina Parma, PhD, are also members of the founding committee.
ARE YOU A SMELL FAN? MONELL AT THE 2022 PHILADELPHIA FLOWER SHOW

Monell and academic affiliate Rowan University partnered at the 2022 Pennsylvania Horticultural Society Philadelphia Flower Show to complete their 2021 sensory exploration and public engagement project to heighten awareness of smell as an integral part of how we engage with the world around us.

The 2021 Flower Show, held outdoors for the first time in its history in Philadelphia's FDR Park, had the theme of "Habitat: Nature's Masterpiece." Monell staff partnered with Jennifer Kitson, PhD, an assistant professor in the departments of Art and Geography, Planning, and Sustainability at Rowan to develop an interactive sensory experience of the Show. Visitors were invited to explore the grounds with their noses and record their journey on a large scent map.

Artist and Rowan jewelry professor Donna Sweigart joined the collaboration for the 2022 Show to visualize the 2021 crowd-sourced smell-map data into a "smell wheel," a graphical convention for identifying and categorizing scent. The wheel was crafted into hand-held Smell Fans, which visitors could use as a botanical fragrance field guide along their journey through the 2022 Flower Show, "In Full Bloom."

Monell staff also shared with visitors the importance of smell by distributing SCENTinel, its proprietary rapid smell test, gathering valuable data for a second year in a public setting to inform its validation research to support its campaign for universal smell testing.

OVR AND MONELL: A PARTNERSHIP IN DIGITIZING SMELL

Our sense of smell is intrinsic to how we interact with our world, through emotions, memories and social bonds, and overall well-being. Monell researchers envision improving human health by digitizing smell and taste: delivering odors, tastes, and sensations instantaneously to people around the world using new technologies and devices. The Center's newest industry partner OVR shares that vision.

OVR is a pioneer in integrating olfactory and virtual reality technologies that address a wide range of health and wellness applications – from sensory VR platforms to help people overcome post-traumatic stress disorder to immersive safety training modules for first responders aiding cleanup of a hazardous chemical spill. The evolving partnership will leverage Monell's expertise in chemosensory science and OVR's state-of-the-art VR delivery technology to advance research in the metaverse of olfaction.
PARTNERS IN UNIVERSAL SMELL TESTING

From birth to death, our sense of smell is a vital component of how we experience the world around us. It impacts our physical, emotional, and mental health and overall quality of life. It is the source of our deepest memories and bonds with others. Smell guides us through life’s pleasurable experiences and helps us avoid disagreeable, and even dangerous situations. What’s more, the loss of smell can serve as an early detection system for such neurological disorders as Parkinson’s disease.

The importance of monitoring our sense of smell over a lifetime cannot be overstated.

But too few of us are keenly aware of the ubiquitous role of olfaction, including some medical professionals who may give it short shrift when assessing the overall picture of a patient’s health. Monell is changing that, driven by a vision for smell testing to become part of routine medical care, that every trip to the doctor involves checking weight, blood pressure and sense of smell.

New partnerships with Ahersla Health, Insurgents, and others are bringing that vision to life.

At the height of the COVID-19 pandemic, Monell scientists and collaborators developed SCENTinel, an inexpensive, 2-minute smell test that can be taken anywhere. Several studies have validated SCENTinel’s accuracy in detecting smell dysfunction and have established its comparability to current clinical smell tests and value as a tool for screening large populations of people to monitor potential viral disease outbreaks.

Ahersla Health, Inc., a company that brings to market olfaction-related medical devices, is building the market for SCENTinel that begins with specific uses, such as COVID-19 or Parkinson’s disease screening, and eventually extends to general wellness checks in primary care offices. Concurrently, Monell faculty and staff continue their ongoing research and development of SCENTinel and public outreach and education efforts.

Branding agency Insurgents will launch a multi-platform marketing communications campaign informed by Monell science to grow awareness of the importance of smell and smell testing with many types of audiences and potential users through their brand Everlusting.

Working together, Ahersla, Insurgents, and Monell are starting to put the idea of universal smell testing on the map to build a healthier future for us all.
Companies from a wide range of industry sectors and trade associations gain broad value from Monell science. For much of our history, our Corporate Partners Program has been dominated by very large, multinational corporations in the food, flavor, and fragrance industries. Over the past few years we have begun engaging with a more diverse set of companies in which basic research is valued (often start-ups and growing companies) and which touch on a wider range of our strategic themes. This is reflected in both the diversity in size and sector of our 36 current partners in 2021 - 2022.

**Monell Partner Industry Sectors**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food and Beverage</td>
<td>28%</td>
</tr>
<tr>
<td>Consumer Product</td>
<td>19%</td>
</tr>
<tr>
<td>Ingredient</td>
<td>17%</td>
</tr>
<tr>
<td>Tech</td>
<td>14%</td>
</tr>
<tr>
<td>Flavor and Fragrance</td>
<td>11%</td>
</tr>
<tr>
<td>Other</td>
<td>6%</td>
</tr>
<tr>
<td>Pharma</td>
<td>3%</td>
</tr>
<tr>
<td>Nonprofit</td>
<td>3%</td>
</tr>
</tbody>
</table>

**Monell Partner Company Size**

<table>
<thead>
<tr>
<th>Size Range</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0 – $2B</td>
<td>33%</td>
</tr>
<tr>
<td>$2B – $10B</td>
<td>39%</td>
</tr>
<tr>
<td>$10B</td>
<td>19%</td>
</tr>
</tbody>
</table>

(Market Capitalization)
Meet our Supporters
The 2021-2022 Honor Roll of Donors

With gratitude we share the list of friends, alumni, employees, foundations, businesses and partnering organizations that chose to give generously to the Monell Center last academic year. Your gifts and grants truly make our research, and our next discovery, possible. Many thanks for your investment.

Monell Circle ($1,000+)

Todd Abraham
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Bill & Melinda Gates Foundation

100% Foundation support more than doubled over the previous year
16% Increase in the number of gifts of $1,000+ over the previous year
28% Increase in philanthropic giving over the previous year
Monell Circle
($1,000+)

Google, LLC  
Barry Green  
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Robert W. Harkins  
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Kunio Torii  
Jenifer Trachtman  
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Alex Woo  
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Young Living Essential Oils  
William N. Zeiger  
Zensho Holdings Co., Ltd.

To discuss a gift to Monell, please contact Jenifer Trachtman, Director of Development, at 267-519-4715 or jtrachtman@monell.org.

Visit monell.org/giving to make a secure online contribution. Every effort has been made to ensure the accuracy of these lists. If we have inadvertently misspelled or omitted your name, please accept our apologies and notify Jenifer Trachtman.

Berjé has existed as a family-owned supplier of raw materials within the flavor and fragrance industry for over 70 years, making us keenly aware of the importance of taste and smell. We are immensely passionate about the artistry of perfume, the emotions it can evoke, and the scientific value of its chemistry. We support the Monell Center because they are doing something truly special: restoring that joy and enrichment of the senses to others.”
BRINGING LEGACY TO LIFE  

Supporters

GIFTS TO ENDOWMENT IN 2021-2022

GARY K. BEAUCHAMP CHAIR FUND

The Gary K. Beauchamp Chair is a key element of Monell’s strategic plan, which calls for developing outstanding faculty to advance the Center’s four research aims. The Chair was made possible through nearly 100 contributions, with leadership gifts from:

The Estate of Louise Slade
Richard L. Berkman
Robert F. Margolskee
Stephen R. Manheimer
Dwight R. Riskey
Beauchamp Family
Zensho Holdings

Please [click here](#) for a full list of donors to the Beauchamp Chair.

CAROL M. CHRISTENSEN POSTDOCTORAL FELLOWSHIP IN HUMAN CHEMOSENSORY SCIENCE

The Monell Center is pleased to announce the establishment of a new endowed fund by long-time Monellian Carol M. Christensen. Carol began her career at Monell as a postdoctoral fellow and later as a faculty member. She left Monell to lead R&D consumer research organizations in industry and returned some years later to run the corporate partners program and oversee institutional advancement. She continues as a special advisor to the Director. The impetus for her gift in Carol’s own words: “When I was a faculty member at Monell in the 70s and 80s, I developed a deep respect for my colleagues trained in the behavioral sciences and using humans as a research tool for making fundamental discoveries in the chemical senses. I had the privilege of working alongside Gary Beauchamp, Julie Mennella, Barry Green, Dwight Riskey, Harry Lawless and Chuck Wysocki. When allergies forced me to abandon my own training and passion for mammalian behavioral neuroscience, I moved to human research. It was then that I could especially appreciate the brilliance of my colleagues and the unique contributions that “top-down” research made to the chemical senses. I believe the fellowship is a win-win for Monell and the chemical senses field. Postdocs bring new ideas and new approaches to Monell and their training at Monell creates a new cadre of human chemosensory scientists.”
GIFTS TO ENDOWMENT IN 2021-2022

THE ESTATE OF LOUISE SLADE

We are humbled to announce that in 2021-2022 the Monell Center was the recipient of an estate gift from long-time board member, friend and advisor Louise Slade which is adding considerably to Monell’s endowment. This act of generosity from Louise Slade has helped to ensure the Monell Center’s primacy in taste and smell research. This planned gift will impact our scientific output for many years to come by supporting many facets of the Center’s strategic aims.

RICHARD L. BERKMAN AND TONI SEIDL FAMILY FUND

The Monell Center extends its thanks to Richard L. Berkman and Toni Seidl for establishing a family fund to support students in the Monell Science Apprenticeship Program. Rick Berkman, Of Counsel at Dechert LLP, is a long-time Board Member at the Monell Center and currently serves as Vice Chair. In making this gift, Rick and his wife Toni are demonstrating their commitment to the careers of individuals traditionally underrepresented in the sciences. Through the Monell Science Apprenticeship Program, the Monell Center invests in the next rising generation of scientists, advancing the legacy of leadership to the future.

To view a full list of donors and matching gift companies, and to see consistent, long-term support of the Monell Center, consecutive year donors, and donors by affinity group, please visit monell.org/thankyou.

“I joined the Monell Center board in 2021 in the midst of a pandemic that causes taste and smell loss. I have been pleased to support Monell’s important mission because of my newfound understanding of the role that taste and smell play in our health and because Monell’s research directly translates to my work as chief operating officer at a multi-specialist hospital that was in the frontlines of the COVID pandemic in Nigeria.”
Our People

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Alan I. Leshner, PhD
Chief Executive Officer Emeritus, American Association for the Advancement of Science

Dwight R. Riskey, PhD
Principal, Riskey Business Solutions, LLC
Monell welcomes new leadership perspectives among our Board of Directors and International Advisory Council (IAC). Susan de Mars brings diverse expertise to the Board. Frank A. Franklin II, PhD, JD, MPH; Josh Ghaim; Sheetal Ghelani; Christiani Jeyakumar Henry; Harry Levine, PhD; and Maia Monell, MS, lend fresh perspectives from industry and academia to the IAC.
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Guillaume de Lartigue, PhD
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Amos B. Smith, III, PhD
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Hong Wang, PhD
Paul Wise, PhD
Yali Zhang, PhD

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Yuzo Ninomiya, PhD, MDSci
Luis Saraiva, PhD

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Beverly Cowart, PhD
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Accounting & Payroll Manager
Nathan Walters
Research Grants & Contracts Specialist – Pre-Award
Alyssa Wofford
Development and Corporate Relations Specialist
The Monell Chemical Senses Center relies on three major streams of funding. Government funding consisting chiefly of competitive grants from the National Institutes of Health and this source grew by six percent over last year. The other principal sources of support — philanthropy (charitable foundations and gifts) and industry (partnership fees and sponsored research) — both grew by more than 20 percent. Altogether, the Center’s operating income exceeded last year by 14 percent, enabling an increase of 17 percent in research spending.

While enjoying a strong operating year, Monell was fortunate to receive significant special funding. Long-time Board member, benefactor, partner, and friend, Dr. Louise Slade, left the Center a $14 million bequest to establish an endowment. In addition, The Ambrose Monell Foundation, a source of support since the Center’s founding, announced a $26 million grant over five years, beginning in 2022, to help secure Monell’s primacy in chemosensory research. The Center is deeply grateful for these and all gifts that enable it to improve health and well-being through research in the chemistry of taste and smell.
OUR MISSION
Monell’s mission is to improve health and well-being by advancing the scientific understanding of taste, smell and related senses.

OUR VALUES

COMMITEMNT
We view basic science as the foundation of discovery.

MENTORSHIP
We train the next generation of chemosensory scientists to assure a bright future.

OPEN COMMUNICATION
We share our knowledge widely to impact global health and well-being.

BROAD IMPACT
We work across sectors to advance science that solves problems.