MONELL

Partners in Transforming World Health

ANNUAL REPORT 2022 | 2023
The Center’s future is taking shape as new faculty members join and the scientific enterprise continues to expand in exciting new directions. We are translating our discoveries into real advances in global health and well-being through richly productive collaborations with academic and industry partners.

This year brought a deeper understanding of how viral infections can lead to smell and taste loss and how olfactory tissues recover from infection, important guidance toward new treatments for smell loss. New findings about the reliability of SCENToel™ – Monell’s rapid, inexpensive smell test – as a population-wide screening test for smell function put us closer to our goal of making smell and taste testing part of routine medical practice. Identifying smell and taste disorders earlier could allow for better treatment approaches, health outcomes, and quality of life.

New cell-based therapies for neurodegenerative diseases such as Alzheimer’s dementia are the ultimate goal of Monell researchers who have developed a new technology for reprogramming human taste cells into nerve-like cells. And new insights on how neural signaling between the brain and gut affects eating behavior relate to body weight control-related diseases and disorders such as diabetes or anorexia.

This year also marks a transition in leadership as Benjamin P.C. Smith, PhD, an internationally recognized leader in food and fragrance research, joins Monell as its next Executive Director and President. Esteemed for his ability to forge fruitful scientific collaborations across academia, industry, and government, Smith takes the helm at a transformative time for chemosensory research. Acting Director and President Nancy E. Rawson, MSc, PhD, FCPP, is now Executive Vice President and Chief Impact Officer.

Partnership and collaboration define our success in bringing chemosensory research to life. Monell works at the nexus of a global scientific enterprise, connecting and collaborating on research with close to 60 academic partners and 35 corporate partners on five continents. Bridging scientific disciplines to advance its research, Monell connects academics to industry and industry to the science it needs to create solutions for improving health and well-being for us all. Burgeoning relationships with elected officials help advance our mission. Most importantly, partnership with our generous donors enables our success.

Thank you for joining us on our remarkable journey of discovery. Together, we are Partners in Transforming World Health.
In May, the Board of Directors of the Monell Chemical Senses Center announced international leader in food and fragrance research Benjamin P.C. Smith, PhD, as its next Executive Director and President.

Smith joins Monell from the Agency for Science, Technology & Research (A*STAR) in Singapore where he served as Director of the Future Ready Food Safety Hub, the Innovations in Food & Chemical Safety Programme, and the Singapore Institute of Food & Biology Innovations, as well as an Adjunct Associate Professor of Food Toxicology and Risk Assessment at Nanyang Technological University.

For most of his career, Smith has worked at the intersection of taste, smell, and public health, serving in senior positions at Firmenich, one of the world’s largest flavor and fragrance companies and a long-standing corporate partner of Monell. He is highly regarded as an innovator and champion of building science programs and collaborations across academia, industry, and government.

Smith’s appointment is a homecoming of sorts. He had first served as a postdoctoral fellow from 2002 to 2003 studying behavioral genetics in the lab of Monell Director Emeritus Gary Beauchamp, PhD.
Monell has been expanding its faculty and diversifying its expertise, taking Monell science in exciting new directions toward achieving its four strategic research aims. New Associate Member Guillaume de Lartigue, PhD, and Assistant Member Amber Alhadeff, PhD, are investigating the neuroscience of eating, the exquisite coordination between the gut and the brain that governs how, when, and how much we eat. Their field asks such basic and essential questions as: How does neural signaling along the gut-brain axis motivate eating behavior? What are the circuits that control the innate drive to consume fats and sugars? Their work in sensory nutrition could ultimately redefine our understanding of the neural control of food intake and lead to new treatment strategies for such diseases and disorders rooted in body weight control as obesity, diabetes, and eating disorders.

Assistant Member Kevin Bolding, PhD, who joined Monell in 2022, is studying the behavioral neuroscience of olfaction. His growing lab focuses on how neural and biological mechanisms allow memories to be stored and retrieved in the brain. Bolding’s findings have helped describe a mechanism that allows a region of the brain called the piriform cortex to perform the task of perceiving and recognizing odor identity regardless of concentration. Without it, our brains would mistake different concentrations of the same odor as completely different odors. By advancing our understanding of the neural control of olfaction, this work has the potential to inform new strategies for regenerating the sense of smell as well as a better understanding of how the sense of smell relates to memory and emotions.

Rich interdisciplinary collaboration and mentorship have been hallmarks throughout Monell’s history. To grow these academic partnerships and increase the ability to impact public health, the Monell Seed Funding Program launched this year with the intent to establish new internal collaborations among senior investigators and early career scientists who have not previously worked together to bring fresh perspectives to their research. Initial seed funds were awarded to three highly innovative projects:

- Paul Breslin, PhD, and Amber Alhadeff, PhD, will explore the reward mechanisms underlying preference for combinations of sugar and low-calorie sweeteners.
- Hong Wang, PhD, and Michael Napolitano, PhD, will use metabolomic profiling to determine the role of taste receptors in sepsis.
- Joel Mainland, PhD, and Federica Genovese, PhD, will investigate the role of the trigeminal nerve in perceiving odor intensity.

The Monell Center itself is evolving to support 21st century chemosensory science. In December 2022, Monell received $1 million in Redevelopment Assistance Capital Program (RACP) funds from the state for the immediate creation of quality jobs for Pennsylvanians. The grant – a first for Monell – will finance significant phase 1 physical plant improvements that support the Center’s growth strategy in staff and infrastructure.

The Monell Center gratefully recognizes our elected officials whose support and advocacy made the RACP grant possible: U.S. Representative Dwight Evans, 3rd Congressional District; U.S. Senator Bob Casey; U.S. Senator John Fetterman; State Senator Vincent J. Hughes, 7th Senatorial District; State Representative Rick Krajewski, 188th Legislative District; and Philadelphia City Councilmember Jamie Gauthier, District 3.
OUR RESEARCH

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Attack the Loss of Smell and Taste

Shedding Light on Smell and Taste Loss at the Molecular Level

Molecular biologist Hong Wang, PhD, is at the center of collaborations that advance our understanding of the genetic underpinnings of how viral and other types of infections can lead to smell and taste loss.

With Monell colleagues Peihua Jiang, PhD, Akihito Kuboki, MD, PhD, and Johannes Reisert, PhD, Wang is investigating how inflammation associated with viral infection changes or damages olfactory tissues. In mice infected with the flu virus, they found that it damaged both the olfactory sensory neurons and their supporting epithelial cells.

Their preliminary data shows that certain genetic mutations in viral defense mechanisms lead to more severe olfactory loss. In addition, the team is studying how olfactory tissue recovers from viral infection, which will inform developing treatments for smell loss. This work is supported by Monell's philanthropic Smell for Life campaign.

Wang also advanced work this year that has substantial implications for human taste perception. In a study published in *Science*, Wang and colleagues shed new light on genetic mechanisms involved in the complex interplay...
between taste perception and immune function. This could explain why a bitter taste in the mouth could be a symptom or side effect of illness.

Bitter receptors are encoded by Tas2r taste-receptor genes, which, in addition to their roles in taste sensing, provide an important defense against bacteria and parasites in the mouth and gut. Wang explored how inducing inflammation would affect Tas2r gene regulation in mice using lipopolysaccharide (LPS), a compound that causes inflammation similar to bacterial infections. The team found that mice showed an elevated aversion to bitter tastes and confirmed, through nerve-recording experiments, that this aversion originates in the taste buds, rather than in their brains.

This shows that genes in taste cells govern bitter taste distortion due to inflammation and gives insight into behavioral aspects of illness, such as loss of appetite, which may help inform nutritional strategies for managing illness.

Investigating how gene expression underpins the bitterness response, they found increased expression across the majority of Tas2r genes with peak expression at three to five days during the LPS-induced inflammation period. They also found that LPS globally affected gene expression in taste cells, suggesting a remodeling of this cell type's genome. The diverse response across taste receptors has potential implications for making more effective bitter blockers for medications and other health and wellness products.

Gary Beauchamp Recognized with John Scott Award

In November, Emeritus Director and President Gary Beauchamp, PhD, was honored with the prestigious John Scott Award in recognition of his achievements in the sciences. Established in 1822 and administered by the board of directors of the City Trusts of Philadelphia, the oldest science award in America is given to "the most deserving" men and women whose inventions have contributed in some outstanding way to the "comfort, welfare, and happiness" of humankind. Beauchamp has made fundamental discoveries about the human senses of taste and smell which have had enduring impact on world health and well-being, including studies of the biology of taste which provided the scientific basis for the U.S. Food and Drug Administration and other policy-making bodies worldwide to recommend reduction of salt in commercially prepared foods. Past recipients of the John Scott Award include Madame Curie, Thomas Edison, and Jonas Salk.
Further Validating SCENTinel for Population-Wide Screening for Smell Function

A Monell study published in Chemical Senses this year shed new light on SCENTinel™, a rapid, inexpensive smell test that measures odor detection, intensity, identification and pleasantness developed by Monell for population-wide screening of smell function.

The study examined whether a version of SCENTinel™ using multiple target odors could discriminate between anosmia (total smell loss), hyposmia (reduced sense of smell), parosmia (distorted odor perception), and phantosmia (odor sensation without a source). Having such information may help clinicians diagnose diseases where smell loss is a symptom, such as seen in head trauma, neurodegenerative diseases like Alzheimer’s, and viral illness. It also would help them evaluate the impact of therapies for those living with olfactory disorders.

The research team led by Monell Assistant Director Valentina Parma, PhD, recruited participants through two private Facebook groups hosted by AbScent – a UK-based charity serving individuals with smell and taste disorders – and mailed them a SCENTinel™ 1.1 test that included one of four odors: flower, bubblegum, coffee, or caramel popcorn. Participants were instructed to take an online survey which asked them to self-report on their issues with their sense of smell, then lift and smell the odor patches on the SCENTinel test card and answer questions about what they were smelling.

They found that SCENTinel™ 1.1 accurately discriminates quantitative (anosmia and hyposmia) and qualitative (parosmia and phantosmia) olfactory disorders versus a normal sense of smell. The test also discriminates between hyposmia, parosmia, and anosmia, and is the only rapid direct test to detect parosmia.
IUBMB Jubilee Award Honors Robert Margolskee

Robert Margolskee, MD, PhD, Monell Emeritus Director and President, was honored with the International Union of Biochemistry and Molecular Biology Jubilee Award, the most prestigious award decreed by the organization in recognition of a senior investigator who has made transformational findings in the fields of biochemistry and molecular biology. Margolskee’s long-standing research focus and expertise is on the molecular mechanisms of signal transduction in mammalian taste cells. His recent research is focused on alternative sweet taste signaling and the functions of taste signaling proteins in cells outside the mouth. Margolskee delivered the Jubilee Award lecture “Multiple Sweet Taste Signaling Pathways” in January.

Nancy Rawson Named to Top 50 Women Leaders

Monell Acting Director and President Nancy E. Rawson, MSc, PhD, FCPP, was named one of the Top 50 Women Leaders of Pennsylvania for 2023 by Women We Admire, a news organization devoted to recognizing the achievements of exceptional women while inspiring others to aim high and continue their journey toward reaching their full potential. Rawson was recognized for making noteworthy strides in her leadership of Monell and the improvements she has driven in diversity, equity, inclusiveness, and belonging, and Monell’s overall success in 2023.

Danielle Reed Explains Taste Mysteries at the American Philosophical Society

Monell Associate Director Danielle Reed, PhD, engaged the audience at the 2023 General Meeting of the American Philosophical Society with an interactive lecture and demonstrations on the science of taste and smell. Watch her presentation here.
New Insights into the Origins of Sweet, Umami, and Salty Taste

Our sense of taste plays an important role in determining what foods we eat by detecting nutritious versus potentially harmful substances. Taste cells are individually specialized to evoke only one of the five taste senses – sweet, sour, salty, bitter, umami – so the diversity of tastes we can perceive depends upon the diversity of our taste cells.

Taste cells rapidly turn over throughout life, on average living only about one or two weeks. New taste cells are continuously generated by taste stem cells, a process that has long been a focus of Monell researchers.

To learn more about how taste cells diversify, molecular biologist Ichiro Matsumoto, PhD, and colleagues examined gene expression in mouse taste cells and neural responses to taste substances. They found that a protein called Etv1 controls the development of sweet, umami, and salty taste cells. The molecule enables taste cells to detect nutritional substances and evoke palatable tastes. Without it, the ability to taste sweet, umami, and salty could be lost or compromised, affecting quality of life. These findings, published in *eNeuro*, provide new directions for further work to discover treatments for taste disorders.

![Triple fluorescence labeling to study Etv1 regulation of taste differentiation.](image)
A New Way to Make Next-generation Therapies for Neurodegenerative Diseases

Monell researchers have demonstrated – for the first time – that human taste cells can be reprogrammed into neuron-like cells. The team led by Hakan Ozdener, MD, PhD, MPH, developed a highly efficient method to induce this transformation. This technology may open new avenues for cell-based therapies to target neurodegenerative diseases.

Having the ability to reprogram certain cell types into others has long been a goal of regenerative medicine, but current technologies are limited and require tedious, multi-step processes.

Ozdener and his team developed a simple method to collect and differentiate human taste cells into neuron-like cells in two to three weeks.

Running several experiments to verify the new neural identity of the transformed cells, they found the reprogrammed cells developed proteins that are specific to neurons, showed axon and dendrite structures.
characteristic of the shape of neurons, and even behaved like neurons in the way they signaled other cells. What’s more, the technology produced stable, neuron-like cells that retained these characteristics following the transformation. Their findings are published in In Vitro Cellular & Developmental Biology – Animal.

Neuron-like cells, developed by reprogramming human taste cells, demonstrated characteristics similar to those of actual neurons.

The Enigma of Lung Tuft Cells

Viral infections like pneumonia, influenza and COVID-19 often cause severe damage to the lungs. Epithelial cells of the alveoli – the tiny air sacs where oxygen and carbon dioxide are exchanged during respiration – can renew themselves following mild injury or infection. In the case of severe injury, however, abnormal epithelial “scar” tissue composed of stem cells forms which is incapable of gas exchange and can lead to chronic lung dysfunction.

Tuft cells, a type of chemosensory cell found in the intestinal and respiratory tracts, are critical for relaying immune signals and are thought to contribute to this epithelial tissue remodeling.

Two Monell studies published in eLife this year looked at the role of tuft cells in the lung in response to viral infection.

In the first study, led by Andrew Vaughan, PhD, of the University of Pennsylvania School of Veterinary Medicine with Monell investigators Robert Margolskee, MD, PhD, Noam Cohen, PhD, and Ichiro Matsumoto, PhD, and colleagues from the University of California, San Diego, and University of California, San Francisco characterized – through RNA sequencing – tuft cells that develop in the lungs of influenza-infected mice to determine if they arise through the same immune signaling pathways as intestinal tuft cells, which help defend against parasites and other infection. They found that, like tuft cells in the intestine, the formation of lung tuft cells depends on the cell type-defining transcription factor gene Pou2f3. However, lung tuft cells arise independently of the signaling pathways which are vital for clearing pathogens in the gut. They also found the post-infection lung tuft cells did not contribute to the formation of epithelial scar tissue, leaving the role of tuft cells in virally damaged lungs open for further study to better understand their functional significance.

For the second study, Monell molecular biologist Ichiro Matsumoto, PhD, and colleagues from Columbia University, Zhejiang University, China, Massachusetts General Hospital, Harvard Medical School and Stanford University also examined how viral infection leads to the appearance of ectopic, or abnormal basal cells (EBCs) and tuft cells in the lung, and whether tuft cells are involved in regeneration of the alveoli following injury. Through lineage tracing studies, a technique used to map out the progeny of a given cell, they showed that basal cells are the cell of origin for tuft cells. These cells did not proliferate or give rise to other types of cells, and the number of tuft cells in the influenza-infected mouse lungs greatly expanded throughout the airways in response to severe injury, suggesting that the developmental signaling pathways were reactivated for injury repair. Analysis of lung tissue samples from COVID-19 patients yielded similar findings. However, the molecular mechanism remains unclear and further studies are needed to understand the role of tuft cells in lung repair following viral infection.
What Happens When a Medicine Can Taste Too Good?

Although there are some cultural exceptions to the rule, medicines for children are often given in liquid form that is sweetened to make it taste good. But not every individual experiences the same medicine in the same way.

A multi-disciplinary research team specializing in pediatrics, genetics, and psychophysics, co-led by Monell member Julie A. Mennella, PhD, has identified wide variation in the sensory perception of a pediatric formulation of ibuprofen — some of which were linked to genetic ancestry. These findings indicate that a range of factors come into play in determining how a medicine tastes to an individual. Their work, recently published in the *International Journal of Molecular Sciences*, is the first in a series of studies funded by the National Institutes of Health to look at variation in the taste of medicines.

Taste is personal, and determining how individuals differ, and why, is critical to understanding medication adherence and personal risks. Bitter taste and irritating sensations in the throat are the top reasons for non-compliance, as a child (or adult) is less likely to ingest a medicine that tastes bad. However, a fear of many pediatricians is a medicine may taste too good for children. For example, if a child finds the medicine bottle uncapped and its content tastes sweet like candy, they may ingest too much. Discovering how individuals differ in sensory perception is especially key when it comes to liquid ibuprofen, which accounts for many unintentional poison exposures among children under the age of six in the U.S., according to the U.S. Poison Centers.

Mennella and colleagues at the University of Pennsylvania, Children’s Hospital of Philadelphia, Sidra Medicine and Hamad Bin Khalifa University in Qatar, and the University of Illinois at Urbana-Champaign found genetic markers, both ancestry-related and independent of it, that could predict if someone would find a medication irritating or pleasantly sweet.

The study included 154 adult panelists from Philadelphia, who represented the diversity of their city. According to a genome-wide association study, 63 had African ancestry, 51 European, 13 South Asian, seven East Asian, and seven American. They underwent training in sensory methods and then rated the sweetness, irritation, bitterness, and palatability of a pediatric formulation of a berry-flavored liquid ibuprofen after swallowing, and also after just tasting it without swallowing.

Researchers found that simply tasting the medicine without swallowing predicted what the individual experienced after swallowing. The method developed for this use could be an initial assessment tool to study individual differences in the taste of other medicines, particularly when swallowing is not allowed. The wide variation in how the medicine tasted and whether they liked its taste was associated with whether they experienced these chemesthetic sensations such as the urge to cough or tingling. Overall, panelists of African genetic ancestry had fewer of these chemesthetic sensations such as the urge to cough or tingling. Overall, panelists of African genetic ancestry had fewer of these chemesthetic sensations and rated the medicine as tasting sweeter and more palatable than those of European genetic ancestry. Researchers also found an association between a genetic variation called TRPA1rs1198875 and tingling sensations, independent of ancestry. This is significant as TRPA1 is a family of sensory neuron receptors involved in responding to a variety of chemical irritants found in foods and other medicines. Knowing these associations could help researchers tailor-make medications in the not-so-distant future by designing taste specifically for each individual child.
Artificial Sweeteners May Cancel Out Diabetes Medication

Epidemiologists blame the global rise in obesity and type 2 diabetes on overconsumption of high-fat, high-sugar foods and sweetened beverages, in particular soft drinks containing high fructose corn syrup. Many people turn to artificial sweeteners to reduce their sugar intake, but studies have shown that long-term use can actually lead to diabetes and other health problems, a consequence confirmed by new Monell research and collaborators at the University of Florida.

For decades, metformin has been the standard treatment for type 2 diabetes. It helps control blood glucose levels and weight, and increases levels of the hormone growth differentiation factor 15 (GDF15), which reduces food intake and body weight. However, the impact of sweetened beverages on metformin has remained unclear.

To answer this question, Monell neurobiologist Guillaume de Lartigue and colleagues split diet-induced obese pre-diabetic mice into three groups. The first group was given metformin with high fructose corn syrup, the second was given metformin with saccharin-sweetened water, and the third metformin with plain water. They found after six weeks of treatment metformin improved glucose levels in the obese...
The study, published in *Nutrients*, challenges the current practice of substituting sugary beverages with artificially sweetened ones for patients with diabetes who are taking metformin.

Guillaume de Lartigue Earns Distinguished SSIB Recognition

Neuroscientist Will de Lartigue was awarded the Alan N. Epstein Research Award by the Society for the Study of Ingestive Behavior. The award recognizes an investigator whose research has advanced the understanding of ingestive behavior, the study of all eating and drinking behaviors. Focusing on the vagus nerve, the largest cranial nerve, which communicates to and from all of the body’s major organs, de Lartigue concentrates on how sensing of internal stimuli, such as meal-related cues from the gut, influence the decision of when, where, and how much we eat.

American Society for Nutrition Foundation Honors Arashdeep Singh

The American Society for Nutrition Foundation honored Arashdeep Singh, PhD, with the inaugural National Dairy Council Early Career Investigator Award. The $15,000 grant recognizes early career investigators whose scientific research advances the understanding of dairy’s role in health and wellness. A postdoctoral fellow in the de Lartigue lab, Singh focused on how long-term consumption of palatable high-fat, high-sugar foods can cause changes to the architecture and function of gut-brain circuitry and its relation to metabolic disorders, including obesity.
A Potential New Weapon for Fighting Obesity

Obesity is a chronic disease that can lead to significant health problems including heart disease, diabetes, and stroke. Worldwide, the prevalence of obesity has been rising since 1975; in the U.S. alone, 42 percent of adults are obese. For many people, treating obesity with diet and exercise is not enough, and while bariatric surgery is an effective option for some, it is irreversible and can have serious negative side effects.

New research from Monell lays a strong foundation for developing a new drug therapy to treat obesity.

Monell neurobiologist Amber Alhadeff, PhD, and collaborators from the University of Pennsylvania sought to determine whether two antiobesity medications in combination would be more effective than either one alone. Semaglutide, a drug used to treat type 2 diabetes, was recently approved by the U.S. Food & Drug Administration for weight management as it reduces appetite. Growth differentiation factor-15 (GDF15) is a hormone which has been shown to reduce food intake and body weight in animal studies.

In a series of experiments the researchers found that semaglutide reduced rodents’ food intake and body weight, and the animals showed signs of reduced appetite. Testing each drug separately, they next showed that semaglutide but not GDF15 reduced the rodents’ appetite for sugar as well as their food intake. Finally, they found that a combination of semaglutide and GDF15 reduced the rodents' food intake and body weight significantly more than did either of the drugs alone.

Given these results, the researchers concluded that semaglutide (commonly known as Ozempic, Rybelsus, and Wegovy) combined with GDF15 may be an effective new treatment approach for obesity worth investigating in clinical trials. Their study was published in *Diabetes, Obesity and Metabolism.*

Amber Alhadeff Named Robertson Stem Cell Investigator

Neuroscientist Amber Alhadeff, PhD, was named to the 2022 class of the New York Stem Cell Foundation (NYSCF) Robertson Investigators. The NYSCF program fosters and supports early career scientists whose research holds the potential to accelerate treatments and cures by providing $1.5 million in critical seed funding. Alhadeff, who is also an adjunct professor in the Department of Neuroscience at the University of Pennsylvania, investigates how the gut and brain communicate to regulate food intake and body weight. Her work on the gut-brain axis could pave the way for effective treatments for diseases rooted in the control of body weight. Since joining Monell in 2020, Alhadeff has been a dedicated mentor to and advocate for trainees and scientists from underrepresented backgrounds. This commitment to fostering diversity, equity, inclusion, and belonging is an important criterion in the NYSCF-Robertson Investigator Award selection process.
The Molecular Basis for Alkaline Taste

The scale of how acidic or basic a substance is, called pH, is essential to life in that many biological processes, such as digestion and enzymatic reactions, require a fine balance of its level.

The ability to detect both acids and bases in food sources is important because they both significantly impact the nutritional properties and safety of what we consume.

Whether and how animals can taste basic or alkaline food remained unclear, until now.

A research group led by neuroscientist and geneticist Yali Zhang, PhD, identified a previously unknown chloride ion channel, which they named alkaliphile (Alka) as a taste receptor for alkaline, or basic, pH. Their research was published in Nature Metabolism and highlighted in Nature.

Working with fruit flies, Zhang’s group found that Alka is expressed in the fly’s gustatory neurons (GRNs), which are analogous to taste receptor cells in mammals. When facing neutral food versus alkaline food, flies normally choose neutral foods to avoid the toxicity of high pH. However, the team found that flies lacking Alka lose the ability to discriminate alkaline from acidic or neutral food.

To understand how Alka senses high pH, the researchers performed electrophysiological analyses and found that Alka forms a chloride ion (Cl-) channel that is directly activated by hydroxide ions (OH-). The concentration of Cl- inside the fly’s GRN is typically higher than outside this nerve cell. According to Zhang, when exposed to high-pH stimuli, the Alka channel opens and the negatively charged Cl- ions flow from inside to outside the fly’s GRN. This activates the GRN and signals the fly brain that the food is alkaline and should be avoided.

In 2021, the team made similar discoveries of a taste receptor for acidic, or sour, taste on the lower end of the pH scale. Knowledge of how animals, including humans, taste pH levels has important implications for understanding dietary habits and developing strategies for improving nutrition.
A fundamental question in neuroscience is understanding how our senses translate light into sight, sound into hearing, food into taste, and texture into touch. While different wavelengths of light translate, or map, to perception of colors in vision, and frequencies map to pitch in hearing, mapping our sense of smell to how the brain interprets it is more complex.

Monell neuroscientist Joel D. Mainland, PhD, is partnering with researchers from Osmo, a Cambridge, Mass.-based company spun out of research done at Google to investigate how airborne chemicals connect to odor perception in the brain. The team developed a machine-learning model which was able to match or exceed human-level performance in describing in words what chemicals smell like based solely on the input of their molecular structure. Their research, published in *Science*, moves closer to digitizing odors to be recorded and reproduced. This endeavor may also identify new odors for the fragrance and flavor industry that could reduce the sourcing of endangered plants and eventually
identify new functional scents for use as a mosquito repellent or to mask malodors.

The Osmo team built an artificial intelligence model that learned how to match the word descriptions of a molecule’s odor with that odor’s molecular structure, creating a data-driven map of human olfaction. The model was trained using an industry dataset that includes the molecular structures and odor qualities of 5,000 known odorants.

To test the model, Mainland and former Monell postdoctoral fellow Emily Mayhew, PhD, now an assistant professor at Michigan State University, convened a panel of research participants, gave them each 400 new odorants to smell and trained them to use a set of 55 words to describe their perception of each. The panelists were asked to choose which of the 55 descriptors best applied and to rate the extent to which the term best applied to the odor for each of the 400 odors.

Comparing the model’s performance to that of the human panelists, the model was better able to predict the odor than the average panelist for 53 percent of the molecules tested.

The model characterized a wide variety of odor properties, such as odor strength, for 500,000 potential scent molecules, creating a digital map that is an effective new tool for investigating the nature of olfactory sensation.
In the 55 years since its founding, Monell’s deeply rooted culture of interdisciplinary collaboration with diverse partners in academia and industry has been fundamental to its success as a global leader in chemosensory science. Poised at the nexus of innovation, Monell connects academics with one another and with industry and joins industry with the science it needs to create solutions for real-world challenges. This is how Monell and its partners translate knowledge about taste and smell into consumer products, clinical practice improvements, and public policy that shapes a healthier future for us all.
Towards Universal Chemosensory Testing – TUCT 2023

Measuring our senses of taste and smell over a lifetime can improve public health and lead to better quality of life. Just one example: smell loss is an early symptom of Parkinson’s disease and many other disorders. Detecting illnesses in their initial stages can mean earlier treatment and perhaps better health outcomes. However, routine evaluation of smell and taste is rare.

Monell is on a mission to change that picture and bring smell and taste testing into routine clinical practice. Partnering with the University of Florida, Ohio State University, Massachusetts General Hospital, the Smell and Taste Association of North America (STANA), and Thomas Jefferson University, Monell is convening a three-day stakeholder conference in November 2023 to create a roadmap for integrating this testing into annual medical check-ups. Towards Universal Chemosensory Testing (TUCT) 2023 will convene people with taste and smell disorders, scientists, clinicians, insurers, public health officials and industry professionals to develop strategies for implementing routine smell and taste testing across a lifespan.

The conveners advocate that advancing universal smell testing will speed the diagnosis of taste and smell disorders and associated health problems, facilitate therapeutic interventions for those affected, and improve human health and quality of life for all. TUCT 2023 is supported by a grant from the National Institutes of Health and generous sponsorship by Berjé, Sensify Inc., and Mary Bertino.

Building Bridges with Local Policy Makers

In April 2023, Monell hosted a legislative open house, welcoming several elected officials, including PA Senator Vincent J. Hughes, PA Representative Rick Krajewski, PA Representative Mary Jo Daley, PA Representative G. Roni Green, PA Representative Tarik Khan, and others. Attendees toured the facility to see how Monell’s Redevelopment Assistance Capital Program funding will create quality jobs for Pennsylvanians and ensure a pipeline of young scientists from underrepresented communities in STEM. They also enjoyed hands-on demonstrations of Monell science and heard about our exciting growth plans. PA Rep. Krajewski lauded Monell’s contributions to the region’s vibrant life sciences ecosystem and its commitment to giving STEM students opportunities to explore careers in science.
Investigating the Sensations of Mouthfeel

Mouthfeel – the physical properties of food and beverages that include crunchiness, astringency, smoothness, stickiness, and creaminess – plays a major role in the eating and drinking experience. It is a key driver in acceptance or rejection of products by consumers.

Monell is partnering with food and beverage firms Danone, Diageo, and Mars in a three-year consortium to study the fundamentals of mouthfeel, which is essential for consumer liking of new healthy and sustainably produced foods, such as the proteins in plant-based foods. Having a better understanding of how mouthfeel works will lead to new solutions for improving human nutrition and food security.

Monell investigators Paul Wise, PhD, Linda J. Flammer, PhD, and Ha Nguyen, PhD, are leading the research program. In the first phase of the study, researchers will explore the scope of mouthfeel perception by having study participants sample simple mixtures of fats and sweeteners. Later, a larger study with more participants will introduce additional ingredients to define the mechanisms of individual differences in the perception of mouthfeel.

Corporate Partner Highlight – FlavorHawk

New collaborations with FlavorHawk aim to help people with conservative tastes try new foods with confidence, and perhaps even choose which restaurants to dine in.

People are born with different abilities to perceive flavors, and vary in their food preferences and aversions. Using advanced computational methods, FlavorHawk processes vast amounts of information about people's unique sensory likes and dislikes and predicts new flavors and foods the person might most enjoy. Monell Associate Director Danielle Reed, PhD, has done similar pooling and analysis of text with an approach called Natural Language Processing. She applied this approach to 400,000 food reviews posted by customers on Amazon, learning that many people find foods in today's marketplace to be too sweet. The study was published in *Physiology and Behavior*. Together, the partners will explore applications that make personalized food recommendations based on data. The goal is to help people who are generally conservative with their food choices to try new foods.
Fragrance Foundation
Fragrance Day

On March 21, Fragrance Day 2023, Monell faculty member Pamela Dalton, PhD, MPH, shared the latest advances in smell research with Linda G. Levy of the Fragrance Foundation.

Academic and Outreach Partnership with Rowan University

For the third year, Monell and academic affiliate Rowan University partnered at the 2023 Pennsylvania Horticultural Society Philadelphia Flower Show to raise awareness about the importance of smell. The theme of the 2023 show was “The Garden Electric.” 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 using the native woodland wildflower trillium to explore the different categories of scents. Monell staff also distributed SCENTinel™ tests to gather data to inform ongoing validation research of the rapid smell test and support its campaign for universal smell and taste testing.

In addition, strengthening the academic affiliation with Rowan, Monell neuroscientist Yali Zhang, PhD, now serves as an Advisory Board member to the university’s newly formed Neuroscience Bachelor of Science program. Through the partnership, Rowan graduates may pursue opportunities as research associates and technicians in Monell’s laboratories.
New Patient-Centered Data Points on the Research Roadmap of Taste and Smell Disorders

In 2021, 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 supported the development of a partnership among Monell, the Smell and Taste Association of North America (STANA), and the Otolaryngology Department at Thomas Jefferson University Hospital, to map out the “Shared Agenda for Clinical Research on Smell and Taste.”

In April 2022, the team issued a survey about patient experience with smell and taste to which 6,000 people responded, confirming that there are unmet needs in chemosensory research and advocacy. Led by Monell faculty members Nancy Rawson, MSc, PhD, FCPP, and Pamela Dalton, PhD, MPH, the Shared Agenda collaborators synthesized the survey data into five abstracts which they presented at AChemS 2023, the annual scientific meeting of the Association for Chemoreception Sciences. Among their key findings: older patients reported less success with treatment; eating, nutrition and food-related issues were the most common concerns affecting quality of life; and patients had difficulty obtaining a formal diagnosis, with only a small percentage receiving any type of quantitative smell function test.

In late summer, the partners signed a formal agreement to continue this important collaboration on patient-centered outcomes research on smell and taste.

MSAP – Helping to Build a Diverse Life Sciences Workforce

The nationally recognized Monell Science Apprenticeship Program (MSAP) fosters an interest in careers in biomedical science among high school and college students from groups typically underrepresented in science, such as women, racial and ethnic minorities, and the economically disadvantaged. It helps prepare the next generation to enter the life sciences workforce.

The seven-week summer Program pairs students from across the Greater Philadelphia region with Monell researchers for an opportunity to take part in hands-on chemosensory research and scientific mentoring. The Program culminates with a Capstone Symposium where apprentices formally present their research. The 2022 summer cohort of apprentices is pictured here, joined by PA Representative Rick Krajewski, who delivered the keynote address during the 2022 Capstone Symposium.
Our Corporate Partners

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 33 current partners in 2022 – 2023.
MEET OUR SUPPORTERS

The 2022-2023 Honor Roll of Donors

With gratitude we recognize the friends, alumni, employees, foundations, businesses, and partnering organizations that chose to give generously as part of the Monell Circle last academic year. Your gifts and grants truly make our research, and our next discovery, possible. Many thanks for your investment.
To discuss a gift to Monell, please contact Jenifer Trachtman, Director of Development, at 267-519-4715 or jtrachtman@monell.org. 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.

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: monell.org/thankyou.

For Secure Online Giving: monell.org/support
Evergreen Gifts

How Your Philanthropy Makes an Impact on Taste and Smell Science Now and Into the Future

When Dirk Trauner presented the Meyerson Lecture last October, he joined a growing cohort of scientists who have enriched the Monell community by connecting taste and smell research to broader cutting-edge scientific findings and insights. The Meyerson Lectureship was established in 2009 through a leadership gift from Margy Ellin Meyerson in honor of her late husband and long-time Monell Board Member, Martin Meyerson. Over the years, the Meyersons’ investment has supported eight lectures on a diverse range of topics relevant to taste and smell research.

Congratulations to Ha Nguyen, Monell’s inaugural Carol M. Christensen Fellow. Ha’s interest in the human psychophysics aspect of taste and smell secured her candidacy for the first of what we expect to be a long line of Fellows supported by Carol M. Christensen, Alumnus Member of the Center, who began her own career at Monell as a postdoctoral fellow. Ha is grateful for the support of the Christensen Endowed Fund, which has the dual purpose of bringing new ideas and approaches to Monell and launching her independent career in the chemosensory sciences.

Last summer Reel became the third student to be supported through the Joseph Brand Memorial Fund at the Monell Center. This fund was established in 2021 through contributions made in memory of long-time Monell Member Joe Brand and has been sustained by generous contributions from the Brand Family. It supports an apprentice as part of Monell’s summer program for high school and college students. Patricia and Amari are previous Brand Apprentices.
Evergreen Gifts

Nobel Prize Winner Linda Buck gave the 2021 Kunio Yamazaki Distinguished Lectureship at Monell, becoming the fourth speaker as part of a lectureship established in 2014 honoring the memory and professional legacy of Kunio Yamazaki, Monell Member. Supported by numerous memorial contributions and sustained by the Yamazaki Family, this lectureship brings eminent speakers such as Buck to Monell to speak on topics related to Dr. Yamazaki’s seminal work on odor and communication. The 2023 Yamazaki Lecturer is Dr. Lisa Stowers, an expert in how olfaction drives social behavior.

Congratulations to Nuhamine and Jah’Seek’l, the first two Monell Science Apprentices supported through the Richard Berkman and Toni Seidl Family Fund. Many thanks to Board Member Rick Berkman for establishing a fund which, over the years, will support many more students such as Nuhamine and Jah’Seek’l.

Meet Federica Genovese, Monell’s most recent Kare Fellow. The Kare Fellowship was established in 1990 to honor the vision of Monell’s founding Director Morley Kare, who recognized the importance of nurturing early-career scientists. Support for the Fellowship is provided by donations from Dr. Kare’s family and friends, other individual donors, and the Monell Foundation. These ongoing donations have to date developed the careers of 18 scientists.

On October 25th, when the Monell Center hosts a memorial service for Louise Slade, long-time board member, friend, and advisor who passed away in October 2021, she will be remembered for her desire to do and support good, honest, and practical science to benefit human health. Louise’s role as a benefactor will long be evidenced through her estate gift to Monell which is being put to use each and every day to ensure the Center’s primacy in taste and smell research.

As the Monell Center embarks on a search for new faculty, one of the positions we will seek to fill is the Beauchamp Chair. This newly named faculty position is made possible through over 85 contributions from devoted individuals and businesses in 2022 as part of a Festschrift marking Gary Beauchamp’s 50 years at Monell.
Donors, in their own words...

“Our support is both professional and personal. After representing several partnering companies, we understand the unique contribution that an independent research center can offer. We have also grown to appreciate the partnership that Monell has with physicians, especially otolaryngologists, to support patients with taste and smell disorders and improve health outcomes.”

RAY AND BARBARA BENDURE

“This year I decided to support Monell’s Summer Apprenticeship Program because mentoring young people and nurturing careers in the sciences has become more important to me over the years.”

JIM ALBRECHT

“I made my first-ever contribution through our Family Fund because I was grateful to Monell’s scientists for providing information on taste and smell loss. I found your Center when I most needed it and you connected me to important science.”

DIANE HEETER
Donors, in their own words...

“

This year I celebrated 25 years of supporting Monell’s Employee Service Awards. I could not be more proud of the partnership that I’ve built with the Center to create an environment where all Monellians feel appreciated and included.”

BILL AND GAIL LUDLUM

“

I became a donor to Monell because I work in a related industry and appreciate Monell’s multidisciplinary approach to taste and smell research. This year I chose to give through a donation of securities which helped me increase my investment significantly.”

ALEX WOO

“

When I learned about Monell’s work towards routine smell and taste testing, I signed up to help right away.”

MARY BERTINO

“

As a new Board Member, I have enthusiastically embraced my role as an advisor to the Center and have gladly made Monell one of my philanthropic priorities.”

SUSAN DE MARS

“

As a former executive in the food and flavor industry, I have always admired Monell from afar. Today I am a proud board member, donor, and increasingly an ambassador of taste and smell research.”

PAUL HERZAN
Smell for Life Campaign

Smell for Life is Monell’s strategic aim to find causes and treatments for smell and taste disorders. It is by design crowd-sourced, supported by contributions from those most impacted by taste and smell disorders.

Contributions to Smell for Life are pooled together with those from many others and awarded competitively to investigators at Monell with the most compelling solutions to the problem of smell dysfunction.

There is wonderful diversity in our growing community of donors. While donors may be geographically dispersed and make gifts of different sizes, they all share a belief that more research will lead to future treatment options for taste and smell dysfunction, an inspiring message for all Monell scientists!

Monell Smell for Life Initiative Since 2014.

- 433 Total Number of Donors
- $100 Most Common Gift Amount
- $2 – $100K Gift Size Range
- 35 US States
- 14 Countries
- $1.2M Private Philanthropic Donations
- $1.7+M Federal Grant Dollars Leveraged from Private Philanthropic Giving
MEET OUR PEOPLE

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Gary Beauchamp, PhD
Kevin Bolding, PhD
Paul Breslin, PhD
Pamela Dalton, PhD, MPH
Guillaume de Lartigue, PhD
Peihua Jiang, PhD
Bruce Kimball, PhD
Joel Mainland, PhD
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Ichiro Matsumoto, PhD
Julie Mennella, PhD
Valentina Parma, PhD
Nancy E. Rawson, MSc, PhD, FCPP
Danielle Reed, PhD
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Amos B. Smith, III, PhD
Hong Wang, PhD
Paul Wise, PhD
Yali Zhang, PhD

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Monell's International Advisory Council is a panel of respected advisors drawn from the worlds of academia, government, business, and philanthropy. Established in 1968, the IAC provides valued guidance to the Center's leadership, helping to prioritize goals, identify resources, and define new directions for Monell's research programs.

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* IN MEMORIAM  
ARTHUR K. ASBURY, MD, FRCP  
1928 – 2022

Arthur K. Asbury, MD, FRCP, Emeritus Board Member of the Monell Chemical Senses Center and Van Meter Professor of Neurology Emeritus at the Perelman School of Medicine of the University of Pennsylvania, died in November at the age of 93.

As we mourn the passing of our colleague, fellow trustee, and friend, we celebrate his remarkable life, distinguished career, and numerous contributions to academic medicine, the governance of Monell, and world health overall.
The Monell Chemical Senses Center continues to grow with spending increasing by $1.8 million over last year with 60 percent of that increase coming from research. A large part of the growth is represented by the contributions of several of our newest scientists – an indication of where the Center is headed in the next few years. The Center continues to rely on a highly diverse stream of income that includes government research grants, industry partnerships, and philanthropic support from foundations and individuals. This mixture of revenue not only fuels Monell’s growth but also helps stabilize the Center’s finances.

Monell wants to make special mention of two long-time benefactors. First, Dr. Louise Slade was a friend and Board member for many years and when she passed in the fall of 2021, she left a very generous endowment to the Center. That endowment is just beginning to have an effect in helping to guarantee Monell’s sustainability into the future.

Finally, in 2022, the Ambrose Monell Foundation provided the Center with a five-year $26 million grant to assist in recruiting new scientists, improving Monell’s laboratories and facilities, and opening up new avenues of business development. New faculty supported by the grant have already started making their mark and the groundwork is being laid for an exciting transformation of the physical space.

The Center is deeply grateful for these and all gifts provided to enable it to improve health 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

COMMITTMENT
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.