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Innovative Products and Science News
NO. 4, 2019

# Can I Eat This?

## Cornell Decodes Food Shelf Life

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**Scientists Discover** Olfactory Receptors on the Tongue

**Regulations and PPE** Help Make Farm Work Safer

**Engineered Bacteria** Help Robots Detect Chemicals

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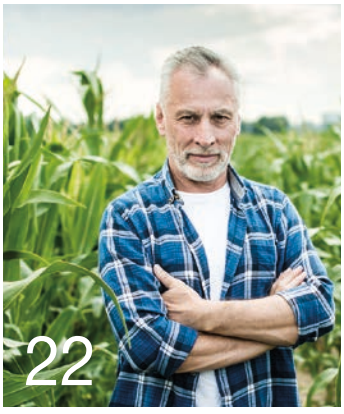



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# Scientists Discover Olfactory Receptors on the Tongue

By Rita Waimer

Scientists from the Monell Chemical Senses Center in Philadelphia, Pennsylvania, have found that our senses of smell and taste may be more closely related than was previously thought. Using genetic and biochemical methods, the team discovered key molecules known to exist in olfactory receptors — the sensors that allow our noses to detect odors — in living cultures of taste cells kept alive with methods developed at Monell. They then used calcium imaging to show that olfactory receptor cells and the cultured taste cells responded similarly to odor molecules. Their work was published in the journal *Chemical Senses*.

The findings suggest that taste and smell begin to combine and inform the flavor of food on the tongue, reinforcing the idea that food tastes like it smells. We've long known that the sense of taste lives in the tongue, where it detects sweet, salty, sour, bitter, and savory molecules and helps gauge the nutritional value and potential danger of food. Similarly, we've known that the sense of smell lives in the nose, where it provides detailed information about flavor and helps differentiate one food from another. But while we previously thought that our senses of smell and taste were completely separate, combining to form the perception of flavor only once their information reached the brain, the scientists now believe that the two senses actually combine in the mouth. Their new study reveals just how closely linked the two senses are.

However, this does not mean that humans can smell with their tongue, and it doesn't undermine the importance of the nose's ability to pick up smells and inform the flavor of the food we eat.

## Modifying Flavor with Smell

The scientists, led by Monell cell biologist Mehmet Hakan Ozdener, MD, PhD, MPH, believe their work can help explain how odor molecules modulate taste perception. It could eventually be helpful in developing odor-based taste modifiers that promote healthier eating and reduce consumption of sugar, salt, fat, and other foods that can lead to diet-related diseases like diabetes and obesity. "The presence of olfactory receptors and taste receptors in the same cell will provide us with exciting opportunities to study interactions between odor and taste stimuli on the tongue," Ozdener said.

The work could also help scientists better understand how the olfactory system detects odors. There are 400 different types of functional olfactory receptors, but we still don't know what molecules activate the vast majority of them. These new cultured taste cells respond to odors, so they could possibly be used as screening assays to help identify which molecules bind to specific human olfactory receptors.

> "The presence of olfactory receptors and taste receptors in the same cell will provide us with exciting opportunities to study interactions between odor and taste stimuli on the tongue."

The work provides the first demonstration of functional olfactory receptors in human taste cells. In the wake of their findings, the Monell scientists performed more experiments and found that a single taste cell can contain both taste and olfactory receptors. Now the scientists want to see if the olfactory receptors tend to be located with certain taste cells, such as those that detect sour or savory tastes, and study the ways in which odor molecules modify taste cell responses and our perception of taste.

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# QueChERS SPE in Food and Beverage Testing

Food testing is essential for identifying potential health risks and ensuring that foods and beverages meet regulatory requirements.

More than 1,000 pesticides and their metabolites, including over 100 chemical classes, may be used during food production or may also be present in the environment and foods we consume. Food testing laboratories routinely analyze large groups of samples to accurately measure a variety of parameters. Simple and robust analytical methods are important to help manufacturers overcome the challenges of compliance to a new and stricter regulatory environment.

Sample collection, transportation, and storage that avoids cross-contamination and the potential degradation of residues is vital. Sample preparation includes removing components that will not be included in the actual analysis, such as soil, stones, and bone fragments.

QuEChERS (Quick, Easy, Cheap, Effective, Rugged and Safe) dispersive solid-phase extraction (SPE) is one of the most common techniques used in modern laboratories. It offers a convenient and effective method for sample extraction and cleanup for the multi-residue analysis of pesticides and herbicides in fruits, vegetables, and other complex products like meat and fish.

The QuEChERS method is a two-step process: extraction followed by clean-up. Three variations of the QuEChERS method are currently used:

1. Original: The original QuEChERS method for non-base-sensitive compounds uses sodium chloride to enhance extraction.

2. Dispersive: The AOAC 2007.01 method, Pesticide Residues in Foods by Acetonitrile Extraction and Partitioning with Magnesium Sulfate, uses sodium acetate instead of sodium chloride as a buffer and is compatible with base-sensitive compounds.

3. European: Method EN15662 is similar to the AOAC method, but the extraction replaces the sodium acetate with sodium chloride, sodium citrate dihydrate, and disodium citrate sesquihydrate.

The salts and organic solvents in the extraction separate the analytes of interest from the food matrix. Thermo Scientific HyperSep Dispersive SPE (solid-phase extraction) products use magnesium sulfate to facilitate extraction, accompanied by either sodium chloride, sodium citrate, or anhydrous sodium acetate. The latter is preferred for folpet, captan, and other base-sensitive compounds. Available in a range of pre-prepared sorbent combinations, each HyperSep kit contains the specific sorbents to optimize the extraction. The organic layer is subjected to a cleanup that removes lipids, organic acids, and other interferences.

HyperSep Dispersive SPE Clean-Up products contain PSA (primary and secondary amine) to remove organic acids and polar pigments, among other compounds. Some products couple the PSA with end-capped C18 for the removal of most lipids and sterols, or GCB (graphitized carbon black) for the removal of sterols and pigments such as chlorophyll. These are also available with a range of pre-prepared sorbent combinations for optimum cleanup of the

## Troubleshooting QuEChERS methods:

| Problem | Causes | Recommended Solutions |
|---|---|---|
| Loss of planar pesticides | Presence of GCB may result in a loss of planar compounds | • Use a product with less GCB<br>• Use the Dual-Phase QuEChERS product |
| Loss of acidic compounds (2,4-D) from starting matrix | Presence of PSA will extract acidic compounds from matrix | Use a product containing magnesium sulfate and C18 |
| Loss of compounds during subsequent analysis | Some compounds are unstable and can break down during analysis | Use an analyte protectant like toluene or sorbitol |
| Addition of sample to QuEChERS extraction tube containing sorbent causes an exothermic reaction | Exothermic reaction between water in sample and magnesium sulfate | Add the sample to the tube first, then the solvents, then the sorbent materials |
| Poor recovery of pesticide compounds | Sample not in appropriate homogenization state | • Wrong products used in method<br>• Ensure sample is hydrated to 80% or higher<br>• Verify nature of pesticides, e.g. are base-sensitive compounds present? |

extracted analytes. When the extracted sample is "clean," it can be analyzed by gas chromatography (GC) or liquid chromatography/mass spectrometry (LC/MS).

LC/MS enables highly selective and sensitive quantification and confirmation of hundreds of target pesticides in a single run. However, the method requires extensive compound-dependent parameter optimization, and therefore cannot be used to screen for untargeted pesticides.

Using high-resolution accurate mass (HRAM) technology in full scan, MS/MS, or both, it is possible to address these and other challenges faced by pesticide residue testing laboratories. A full-scan HRAM approach coupled to ultra-high-pressure liquid chromatography (UHPLC) is ideal for rapid and sensitive screening and detection of targeted and non-targeted chromatography-amenable pesticide residues.

HPLC and UHPLC analytical columns provide solutions for challenging multi-residue pesticide analysis, and the columns of choice are standard C18 reversed-phase columns. When analyzing for polar analytes, as when using LC/MS for pesticide residues, use an aqueous C18 column, like the Thermo Scientific Accucore aQ.

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|---|---|---|
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| Trace Elemental Analysis | ICP-MS, ICP-OES, AAS | High-Purity Acids, Bases, Water, and Standards |
| Karl Fisher Titration | Aqualine Volumetry, Aqualine Coulometry | Solvents and Standards |
| Fat Analysis | Certified ACS, Babcock Milk Test, Gerber Method | Solvents and Reagents |
| Nitrogen Content (Protein) Determination | Certified ACS Plus, Certified | Reagents and Stains |
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|---|---|---|---|
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| C18 Bonded Silica | • EPA 506 Phthalate and Adipate Esters<br>• EPA 508.1 Chlorinated Pesticides, Herbicides, and Organohalides<br>• EPA 525.2 Semi-Volatile Organic Compounds<br>• EPA 550.1 Polynuclear Aromatic Hydrocarbons<br>• EPA 608 ATP 3M0222 Organochlorine<br>• Pesticides and PCBs<br>• 1613B Dioxins and Furans<br>• Other EPA Methods | 13-110-018 | 13-110-019 |
| SDB-XC Polystyrenedivinylbenzene | EPA 515.2 Chlorinated Acids | 13-110-020 | 13-110-021 |
| SDB-RPS Polystyrenedivinylbenzene Reverse-Phase Sulfonated | Explosives Residues (HDX, RDX) | 13-110-022 | 13-110-023 |
| Cation Exchange — SR | Metals, Amines | 13-110-026 | N/A |
| Anion Exchange — SR | • EPA 548.1 Rev. 1 Endothall<br>• EPA 552.1 Rev. 1 Haloacetic Acids and Dalapon<br>• Other analytes containing carboxylic acid groups | 13-110-024 | 13-110-025 |
| Oil and Grease | EPA 1664 Rev. A n-Hexane Extractable Materials | 13-110-003 | 13-110-004 |
| Chelating | Divalent metals and other divalent cations | 13-110-029 | N/A |
| Activated Carbon | • N-nitrosodimethylamine (NDMA)<br>• Water-soluble or volatile analytes such as oxamyl and methamidophos | 13-110-027 | 13-110-028 |

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### Popular Products

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|---|---|---|---|---|---|
| Sodium Phosphate, Dibasic, Dihydrate, 98% | FCC | Food pH adjuster | Poly Bottle | 500g | **18-606-736** |
| Potassium Chloride, Granular, 99% | FCC | Flavoring agent, Nutrient supplement, pH control agent, Stabilizer, Thickener | Poly Bottle | 500g* | **18-605-511** |
| Potassium Phosphate Monobasic, 98% | FCC | Stabilizer, Thickener, Food acidity regulator, Food moisture regulator | Poly Bottle | 500g | **18-605-679** |
| Acetic Acid, Glacial, 99.5-100.5% | FCC | Kosher additive, Halal additive, Pickling processes | Amber Glass Bottle | 100mL* | **18-600-207** |
| Acesulfame Potassium, 99-101% | NF | Calorie-free sugar substitute (commercial baking) | Amber Glass Bottle | 25g* | **18-600-182** |

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# Can I Eat This?

## Cornell Decodes Food Shelf Life

By Mike Howie

Ever wonder how accurate the dates on packaged foods are? The myriad ways in which they're phrased don't help: "best by," "enjoy by," "sell by," "use by" — there are almost too many to count. But how are these dates determined? What do they really mean? And what might happen if we eat the food after the printed date?

"The dates you see on packages, the vast majority of them, have nothing to do with safety," said Dr. Martin Wiedmann, the Gellert Family Professor in Food Safety at Cornell University. His research group predominantly works in microbial food safety, studying how the bacteria that can cause food-borne illnesses are introduced into foods at different stages of production — from the farm to the store — and how to reduce the risk of getting sick from the food we eat. Now they're working to make expiration dates clearer and more meaningful to consumers.

## Bringing Data to the Masses

As Dr. Wiedmann explained, most of the dates we see on food only reflect the way the food tastes. After the expiration date, or "best by" date, or however the manufacturer prefers to phrase it, the food simply has a higher chance of not tasting the way it was intended to taste. Some dates reflect food safety — like those on deli meat sliced in the grocery store — but the vast majority of dates on packaged foods are an indicator of quality. If something is past the printed date, it's not necessarily unsafe to eat — though it can be. There's just a better chance that you won't like the way it tastes, or that it's "spoiled."

So how are these dates defined, and how do we know if they're meaningful?

It depends on the food and the manufacturer, but in general, those dates are set conservatively. If a manufacturer thinks a product might last for about 21 days in a refrigerator, they'll test it. Does it taste good on day 21? What about on day 25? If it tastes all right on both of those days, a 21-day shelf life is reasonable. Perhaps the manufacturer will remove a few days just to be safe, but by considering possible storage temperatures, bacteria that could be present, and other factors, they can calculate a date when customers can still open a product, eat it, and have a good experience.

But a lot can happen over 21 days to affect the shelf life of food. Perhaps it was shipped on a hot summer day in a truck that wasn't properly insulated, so the inside temperature was closer to 50 degrees Fahrenheit instead of the ideal 40. Perhaps you accidentally left milk on the counter for a few hours before remembering to put it back in the fridge. These things happen, and you can only know so much about how the food you purchase has been stored. "When you open your refrigerator and take that food out," Dr. Wiedmann said, "you tend to have no idea what happened to it until it got there."

Dr. Wiedmann and his team are trying to change that. They're working to develop the science and data to dynamically predict shelf life and provide better estimates of when people should eat the food they bought. By adding a time temperature indicator to food packaging, they can roughly track the temperatures at which a product has been stored. That information can then be combined with knowledge of the supply chain to produce a more accurate expiration date — one that reflects the conditions a product was subject to from the time it was harvested on a farm to when the consumer removed it from their refrigerator. The consumer can then access the expiration date by scanning a QR code. And so cleaning out the kitchen can become less of a guessing game and more of a process informed by actual, quantifiable data.

Plus, the smarter QR code labels will help retailers just as much as they help consumers. With better data, grocery stores can make better decisions about how to manage inventory. They could even price their products dynamically based on remaining shelf life.

> "The problem with food spoilage is sometimes and in many cases it's in the eye of the beholder."

Most of us will move aside the gallon of milk with an expiration date two days in the future because surely there's one with five or six days of life hiding in the back. But what if that expiring milk were a bit cheaper? It's still safe to drink, and maybe the customer is planning to use it in two days anyway. Now they have an economic incentive to purchase a product at the end of its shelf life. By providing more data, the labels can help customers save money while simultaneously helping reduce food waste.

*continued on page 21*

*continued from page 19*

# **Can I Eat This?** Cornell Decodes Food Shelf Life

## Spoiled, Safe, and the Difference Between the Two

Food can spoil for a variety of reasons. For example, the flavor of food will change as microbes begin to break it down. Perhaps it becomes acidic, fruity, rancid, or rotten. That's natural, and it doesn't mean that the food is unsafe to eat.

Environmental factors can also spoil food. Perhaps you leave a few beers in clear glass bottles in the sunlight for a day. They're still fine to drink, but the flavor might be off. That's why so many people add a lime wedge to their drink — it masks the "skunked" flavor — and why so many beers are bottled in dark glass.

"The problem with food spoilage," Dr. Wiedmann said, "is sometimes and in many cases it's in the eye of the beholder." What tastes great to one person might taste awful to someone else. A delicacy in one country might clear everyone out of a restaurant in another. Food spoilage, as it turns out, is largely subjective, and it's tricky to define. The sniff test can help you decide if something is spoiled, but it won't help you determine if something is unsafe to eat.

Food is unsafe when there's something in it that will make you sick, either mildly with an upset stomach or more seriously, requiring medical attention. This, unfortunately, is where we can become our own worst enemies.

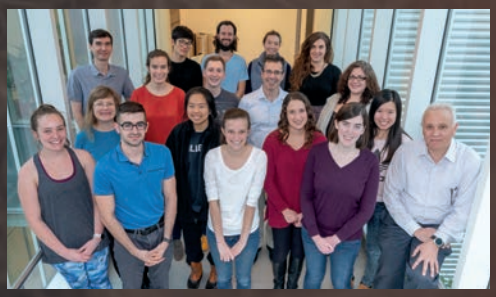
The best way to keep food safe is to do what we've always been told: Follow the storage instructions. Keep cold food cold and hot food hot. Make sure your refrigerator and freezer are running at the right temperatures. Cook your chicken to an internal temperature of 165 degrees Fahrenheit. Don't eat moldy bread. Simple, right?

But we also have to make sure that we're handling our food properly. For example, you shouldn't rinse your Thanksgiving turkey because you'll increase the risk to every other dish while not actually making the turkey any safer: When you move it from the sink to the roasting pan, you're likely to drip bacteria-filled water onto cutting boards and utensils you'll use to prepare ingredients for other dishes — potentially even the veggies you're planning to chop up and serve raw as an appetizer. It's mistakes like this that can make it easier to get food poisoning at home than in a restaurant.

> "The dates you see on packages, the vast majority of them, have nothing to do with safety."

While spoiled food is tricky because it's hard to define, unsafe food is tricky because it's hard to detect. Unsafe food might taste and smell fine — it could even be freshly picked — but it will still make you sick.

Experts like Dr. Wiedmann and his colleagues can already look at the food in their homes and easily make the right decision about what to do with it. But we're not all so well versed in food safety. "Now we're trying to give everyone the same tools and the same knowledge that the experts have," he said. "That's really our big-picture goal, and that's what we're doing one step at a time."



# Regulations and PPE Help Make Farm Work Safer

By Kevin Ritchart

Every day, more than four million U.S. workers are directly involved in tending crops and livestock, picking and packaging produce, and slaughtering and processing meat, poultry, and seafood.

These workers are vital to ensuring that there's an accessible supply of nutritious food for the public. But in many cases, these workers are performing jobs that adversely affect their health.

Most agricultural workers are paid low wages, and there's a high rate of work-related injuries and fatalities associated with their daily tasks.

## A Closer Look at the Dangers

The American Public Health Association (APHA) notes that farm and food production workers may also suffer from poor health based on their working conditions. But through its policies, the APHA is pushing for a sustainable food system that's grounded in safe working conditions, fair wages, and human rights protections.

Food production workers are exposed to a wide range of hazards on a daily basis. For example, dairy and hog farm workers are constantly at risk of being injured by animals and heavy machinery.

Workers who handle livestock and poultry are at a higher risk of contracting zoonotic diseases like rabies, trichinosis, and others that can be transmitted from animals to humans.

Field workers who tend and harvest crops often suffer from heat-related illness, pesticide poisoning, and chronic back and shoulder injuries that result from repeated bending, reaching, and lifting.

Slaughterhouse workers expose themselves to repeated laceration and amputation dangers along with infections and exposure to antibiotic-resistant pathogens. They're also at risk for musculoskeletal disorders that are caused by the intense, repetitive work they perform.

## By the Numbers

The rate of fatal work-related injuries among agricultural workers is seven times higher than that of workers overall and two times higher than the rate for the construction and mining industries.

Additionally, the rate of non-fatal, work-related injuries is higher among workers in food production jobs, particularly relating to incidents requiring days away from work or restricted duty. The meatpacking and poultry industries rank among the highest U.S. industries when it comes to work-related injuries and illnesses.

While they can't eliminate injuries completely, the use of safety goggles and cut-resistant or antimicrobial gloves can help workers limit their exposure to certain hazards.

No matter the industry, workplace injuries, illnesses, and disabilities are costly to the businesses, communities, governments, workers, and families involved. The annual cost of work-related injuries, illnesses, and fatalities in the U.S., including productivity losses, is estimated at $250 billion.

Workers' compensation covers less than 25 percent of these costs. As a result, families and taxpayers subsidize most of the lost income and medical costs from work-related injuries and illnesses.

## Paying by the Piece

Certain agricultural workers are paid according to the amount of product harvested. This system can result in a higher weekly wage, but it encourages an intense pace that involves repetitive tasks, heavier loads, and other risk factors that could cause injuries.

One recent study showed that Latina farmworkers who were employed under piece-rate contracts were five times more likely to report an injury than those who did not work in a piece-rate system.

The piece-rate system encourages discriminatory practices and inequality and can be abused by employers to defraud workers. Farm workers report that the only way to consistently increase and ensure the use of safety equipment is to switch from the piece-rate system to an hourly wage.

## Moving in the Right Direction

Since the Occupational Safety and Health Act (OSHA) went into effect, fatality rates decreased from 18 deaths per 100,000 workers in 1970 to 3.4 deaths per 100,000 workers in 2015.

While some small businesses consider government intervention to be costly and unnecessarily burdensome, enforcement of regulations — along with the proper use of personal protective equipment — is making agricultural work safer.

# 5 Ways Color Labels Can Improve Efficiency in Your Lab

The use of color identification in the laboratory can be a powerful tool in conveying information quickly and helping to reduce errors. Color helps create a visual language that employees are able to process before they are even aware of it. That's because color, when used as part of a repetitive, standardized system, becomes a part of your automatic, intuitive response.

Switching to color printing and labels can even make you more efficient. Effective labeling has been found to reduce sample prep time by as much as 80 percent. Color identification also helps reinforce employee training and guide workers to complete their tasks more quickly.

With 60% of scientists reporting some form of label failure at least once in their career, it's important to have the right tools to prevent costly errors. Here are some additional ways color identification can benefit your organization:

- Differentiate samples — Samples differentiated by color identification can make it easier to find what you're looking for, allowing you to move through your work faster.
- Reduce errors — Color identification provides context that can help reduce errors. It has also been found to play a significant role in enhancing memory performance.
- Emphasize information — Color helps to emphasize or de-emphasize areas or objects within the workplace, which can make it easier for employees to process multiple objects within their view at one time.
- Show associations — Consistent use of color can quickly show the relationship among items.
- Communicate important messages — When a standardized color code is in place, colors can effectively communicate important information quickly.

To make the transition to color identification easy, Brady provides a variety of options designed specifically for the lab, including our B-494 Color Polyester Labels and the BradyPrinter M611 Mobile Label Printer. This combination of lab-specific color materials and smart mobile printing capabilities makes adding color to your identification processes an easy transition.

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# Be Prepared for USP <800> with the Right Respiratory Equipment

By Carly Engels Johnston, Personal Safety Division Senior Journalist, 3M

The U.S. Pharmacopeia (USP) explains updated practice and quality standards for handling hazardous drugs (HDs) in USP Convention General Chapter <800> Hazardous Drugs — Handling in Healthcare Settings. These new guidelines promote not only patient and healthcare worker safety but also environmental protection, and they're expected to go into effect in December of 2019. While there's still time to prepare for the new standard, it's important to understand and begin preparing for it now, especially the requirements for respiratory protection.

## Background on USP Effective Dates

The revised USP <800> standard was originally scheduled for implementation on July 1, 2018. However, the USP delayed the publication and enforcement of USP <800> to coordinate with the December 1, 2019 publication of the General Chapter <797> Pharmaceutical Compounding — Sterile Preparations standard revision. This provides a more unified approach to compounding practices overall.

Although additional time is available for adopting sections of the revised chapter <797>, the USP strongly encourages early adoption and implementation of USP General Chapter <800> to help protect public health and safety in healthcare settings.

## The Respiratory PPE Component

USP <800> includes guidelines for the use of personal protective equipment (PPE) — such as gloves, gowns, and head, hair, and shoe covers — when compounding sterile and nonsterile HDs. Despite what some may think, surgical masks do not provide adequate respiratory protection against the hazards of exposure to certain drugs.

Particulates and aerosols are the primary concerns for airborne exposure, and NIOSH-approved particulate respirators can help limit this exposure when used correctly. Exposure is potentially present during:

- Handling, unpacking, and inspecting supplier HD shipments
- Cutting, crushing, or manipulating HD tablets or capsules
- Compounding HD formulations
- Administering HDs to patients
- Handling patient body fluids that contain HDs or metabolites
- Addressing HD spills or leaks
- Deactivating, decontaminating, and cleaning inside and around engineering control work surfaces, including biosafety cabinets and laboratory ventilated hoods
- Cleaning patient rooms and bathrooms and handling HD-contaminated laundry
- Handling HD-contaminated wastes

Respiratory PPE may also be needed to help protect against unsafe exposure to neutralization chemicals, such as bleach (sodium hypochlorite) and peroxide-based (peracetic acid) cleaners. Particulate respiratory protection alone may not address the unpleasant odor of these chemicals, but a combination particulate cartridge with an acid gas absorbing carbon filter can help.

Choose your respiratory protection based on your hazard and exposure assessments as well as the engineering and

administrative controls you have in place. Compare the capabilities and features of disposable, reusable, and powered air-purifying (PAPR) respirators. And keep in mind, too, the importance and impact of proper fit testing.

The National Center for Biotechnology Information has noted that the use of PAPRs in healthcare settings is increasing. One reason for this increase may be the fit test requirement for tight-fitting disposable or reusable respirators. According to the Occupational Safety and Health Administration (OSHA), employers must perform these tests at least once per year:

> A fit test tests the seal between the respirator's facepiece and the employee's face. It takes about fifteen to twenty minutes to complete and is performed at least annually. After passing a fit test with a respirator, you must use the exact same make, model, style, and size respirator on the job.

PAPRs, on the other hand, use hoods and head tops, offer loose-fitting options that can accommodate many full beards, and do not require a fit test.

Multiple types of respiratory PPE can help you achieve USP <800> compliance, including:

- Surgical N95 respirators worn with safety goggles
- Reusable full-face respirators with particulate (P100) filters, particulate (P100)/organic vapor/acid gas cartridges, or particulate (p100)/multi gas cartridges
- PAPRs with a particulate (HEPA) filter or particulate (HEPA)/organic vapor/acid gas cartridge

For each part of the standard, USP <800> requires someone to be designated to help oversee implementation of USP <800> procedures and compliance. This includes evaluating the processes for selecting and using PPE and determining the protection level needed for compliance. Along with other respirator users, the designee must carefully review and follow all user instructions for respiratory PPE. That person is also responsible for consulting with manufacturers and distributors during the PPE selection process to help ensure compliance and proper PPE use.

Visit **fishersci.com/3MUSP800Compliance** or **fishersci.ca/3MUSP800Compliance** to learn more about specific respiratory PPE options to use with hazardous drugs.

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| Description | Quantity | Mfr. No. | Cat. No. |
|---|---|---|---|
| AquaPur | 1 gal. | 9301 | **04-355-124** |
| | 5 gal. | 9305 | **04-355-125** |
| | 55 gal. | 9355 | **04-355-126** |
| AquaPur ST | 1 gal. | 8904 | **22-281-500** |


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# Engineered Bacteria Help Robots Detect Chemicals

By Iva Fedorka

Soft robotics is expanding our definition of a robot. Engineers at the University of California, Davis, and Carnegie Mellon University recently created a gripping arm that responds to the reaction of transformed bacteria when a specific chemical is detected or "tasted." This work was recently published in the journal *Science Robotics*. The gripper is their proof-of-concept for future biologically-based soft robotics.

## Biomechanical Robots

Soft robotics refers to the use of lightweight and flexible or "soft" materials to replicate the activities of living things. In the path toward creating actual biological-mechanical hybrids, adding living cells to soft robots may be the next step.

"By combining our work in flexible electronics and robotic skin with synthetic biology, we are closer to future breakthroughs like soft biohybrid robots that can adapt their abilities to sense, feel, and move in response to changes in their environmental conditions," said Carmel Majidi, a co-author and associate professor of mechanical engineering at CMU.

Integrating synthetic biology and robotics may provide the opportunity to add sensory, diagnostic, and therapeutic functionality to bioinspired machines. To date, adequate soft-matter architecture has been lacking, as are cell-to-electronics interfaces, and actuators for stimulation and response.

## An Innovative Design

The new device uses competent *Escherichia coli* bacteria that have been engineered to produce a fluorescent protein in response to the chemical IPTG. IPTG (isopropyl-β-D-thiogalactoside) is a galactose analog, commonly used in molecular biology procedures. The transformed *E. coli* cells are enclosed in wells with flexible, porous membranes on the bottom. The membranes let chemicals enter the wells while containing the bacteria.

A hydrogel infused with the IPTG is alternately pressed and released by a hybrid bio-LED-actuator incorporated into the surface of a flexible finger-like gripper on a robotic arm. When the IPTG in the gel crosses the membrane into the chamber, the bacteria fluoresce in response.

A flexible LED circuit inside the module detects the light and converts it to an electronic signal. The signal travels to the gripper control unit, which acts to pick up and release an object. The test process used the gripper to check a laboratory water bath for IPTG and then decide whether to use its soft pneumatic actuators to place an object in the bath.

## A New Path

This work opens previously unidentified avenues in soft materials, synthetic biology, and integrated interfacial robotic systems.

"Our long-term vision is about building a synthetic microbiota for soft robots that can help with repair, energy generation, or biosensing of the environment," said Cheemeng Tan, assistant professor of biomedical engineering at UC Davis.

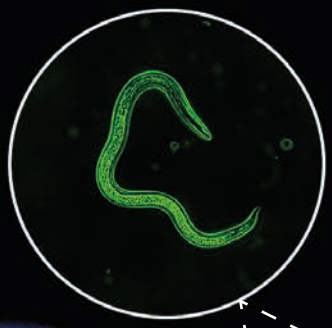
This particular biohybrid robot can only detect one substance, and it may be difficult to build a system that detects changing concentrations, Tan said. It is also a challenge to maintain a stable population of microbes that compares to the human body's microbiome or ecosystem of bacteria and fungi that live in or on our own bodies and carry out many useful functions for us.

However, Tan believes that biohybrid systems potentially offer more flexibility than conventional robotics. Bacteria could be engineered for different robotic functions, like detecting other chemicals, making polymers for repairs, or generating energy.

The work was supported by the National Science Foundation, the Air Force Office of Scientific Research, and the Office of Naval Research.

# Stereo Fluorescence Microscopy

## A new breed of fluorescence



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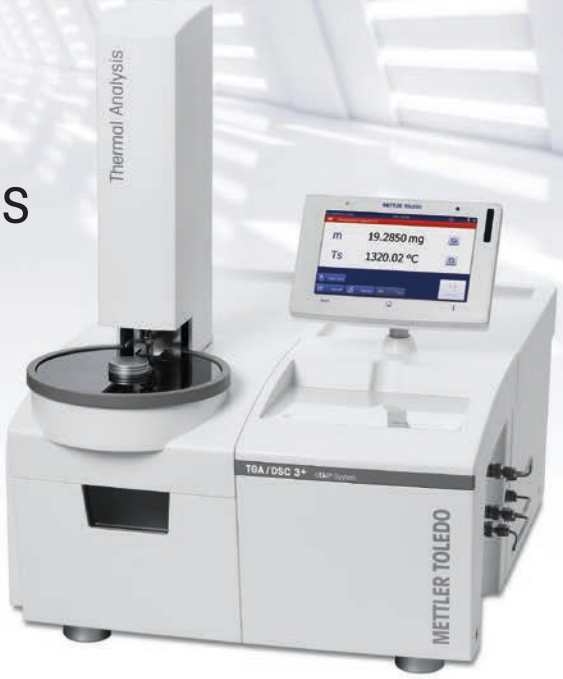


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# Protective Coating, Functional Accessories

## Fisherbrand Maxima Rotary Vane Vacuum Pumps

Fisherbrand Maxima Rotary Vane Vacuum Pumps are durable, have superior vapor handling capability, and include an exhaust filter, funnel, and hose clamp. They can be used for vacuum furnaces, rotary evaporation, freeze drying, vacuum distillations, and other processes.

- Low maintenance requirements
- Corrosion-resistant coatings protect against chemicals
- Large oil reservoir dilutes harsh chemicals
- Built-in cooling system reduces chemical activity and slows oil consumption

| Model | Displacement (Flow Rate) at 60Hz | Ultimate Vacuum | Dimensions (L x W x H) | Shipping Weight | Cat. No. |
|---|---|---|---|---|---|
| M4C | 2.7 CFM (78L/min.) | 5 x $10^{-4}$ torr (4 x $10^{-4}$mbar) | 18.2 x 6.1 x 9.1 in. (46 x 16 x 23cm) | 63 lb. (29kg) | **01-184-202** |
| M6C | 4.2 CFM (118L/min.) | | | 63 lb. (29kg) | **01-184-203** |
| M8C | 5.6 CFM (158L/min.) | | | 65 lb. (30kg) | **01-184-204** |
| M16C | 12.8 CFM (363L/min.) | 3 x $10^{-4}$ torr (2 x $10^{-4}$mbar) | 22.4 x 8.1 x 11.4 in. (57 x 21 x 29cm) | 200 lb. (91kg) | **01-184-205** |
| M24C | 18.3 CFM (519L/min.) | | | 103 lb. (47kg) | **01-184-206** |
| M30C | 22.1 CFM (627L/min.) | | | 106 lb. (48kg) | **01-184-207** |

*All models include an exhaust filter, funnel, and hose clamp.*

# Laboratory Safety Solutions


## AC600 Series Ductless Chemical Workstation

The AC600 Series Ductless Chemical Workstation is an economical solution for protecting operators and the environment from toxic vapors, gases, fumes, and particulates. It ships fully assembled and can be configured for a variety of common applications.

**Standard Features:**

- Microprocessor controller with audible and visible alarms for both airflow velocity and filter change
- 360° visibility
- Ideal for low-volume chemical applications

| Model | Width | Mfr. No. | Cat. No. |
|---|---|---|---|
| Workstation | 32 in. | AC632A | **36-100-4271** |
| Workstation, Tall Version | 32 in. | AC632TA | **36-100-4272** |
| Workstation | 48 in. | AC648A | **36-100-4274** |
| Workstation, Tall Version | 48 in. | AC648TA | **36-100-4275** |

## Endeavour Ductless Fume Hood

The Endeavour Ductless Fume Hood is designed to provide superior operator protection from potential toxic fumes, vapors, and particulates. AirSafe NXT provides simple and effective user interaction within fume hood operational parameters.

**Standard Features:**

- Microprocessor controller has audible and visible alarms for both airflow velocity and filter change
- Bonded carbon filters — no dust
- Polypropylene construction — excellent chemical resistance

| Model | Width | Mfr. No. | Cat. No. |
|---|---|---|---|
| Ductless Fume Hood* | 48 in. | ACPT4000 | **36-100-0063** |
| Ductless Fume Hood* | 60 in. | ACPT5000 | **36-100-0067** |
| Ductless Fume Hood* | 72 in. | ACPT6000 | **36-100-0069** |

*Filters sold separately; application worksheet required



## PowderSafe Type B Enclosure

Seamless polypropylene construction provides vibration resistance crucial for accurate powder weighing, while the AirSafe automatic safety controller monitors airflow and filter condition. HEPASafe technology allows filters to be safely and easily changed under negative pressure.

**Standard Features:**

- Horizontal, HEPA-filtered airflow pattern
- HEPASafe filtration system for simple and easy maintenance
- Thermally fused design for vibration reduction and balance stability

| Model | Width | Mfr. No. | Cat. No. |
|---|---|---|---|
| Type B Enclosure | 32 in. | AC730C | **36-100-4292** |
| Type B Enclosure | 48 in. | AC740C | **36-100-4293** |


## Horizontal Clean Bench

AirClean Systems manufactures a complete range of horizontal and vertical ISO 5/Class 100 laminar flow clean benches. Application-specific plastics allow for easy cleaning and sterilization, which helps prevent cross contamination.

**Standard Features:**

- Seamless polypropylene construction
- ISO 5 or better air quality
- Microprocessor controlled
- Available in widths of 4, 5, 6, and 8 feet

| Model | Width | Mfr. No. | Cat. No. |
|---|---|---|---|
| Horizontal Clean Bench | 48 in. | AC4000HLF | **36-100-4381** |
| Horizontal Clean Bench | 60 in. | AC5000HLF | **36-100-4382** |
| Horizontal Clean Bench | 72 in. | AC6000HLF | **36-100-4383** |
| Horizontal Clean Bench | 96 in. | AC8000HLF | **36-100-4384** |

## Combination PCR Workstation

The AirClean Systems Combination PCR Workstation combines anISO 5/Class 100 clean air environment with UV light sterilization for optimal protection from sample contamination. The UVTect microprocessor constantly monitors workstation functions.

**Standard Features:**

- Class 100 clean vertical laminar flow air
- Polycarbonate and polypropylene design to reflect UV energy
- Digital UV light time from 0 to 59 minutes
- UV shelf with integrated pipette holder

| Model | Width | Mfr. No. | Cat. No. |
|---|---|---|---|
| PCR Workstation | 32 in. | AC632LFUVC | **36-101-8894** |
| PCR Workstation | 48 in. | AC648LFUVC | **36-101-8897** |



## PowderSafe Type C Enclosure

The PowderSafe Type C Balance Enclosure incorporates the airflow dynamics and HEPASafe features of the PowderSafe Type B Enclosure with the user-friendly features and chemical fume containment capabilities of the ductless fume hood. Thermally fused polypropylene makes the PowderSafe Type C Enclosure perfect for weighing powders or solvents.

**Standard Features:**

- Horizontal, HEPA-filtered airflow pattern
- HEPASafe filtration system for simple and easy maintenance
- Thermally fused design for vibration reduction and balance stability

| Model | Width | Mfr. No. | Cat. No. |
|---|---|---|---|
| Type C Enclosure | 36 in. | AC760C | **36-101-8906** |
| Type C Enclosure | 48 in. | AC770C | **36-101-8908** |
| Type C Enclosure | 72 in. | AC780C | **36-101-8910** |

# Food and Beverage Quality Control Testing

By Ricki Hartwell, Senior Product Manager, Thermo Scientific Water and Lab Products

In today's food and beverage production, testing of critical quality control parameters is more important than ever before.

Measuring quality throughout the manufacturing process is essential to ensure raw materials arrive as expected before use, intermediate components achieve production requirements, and finished products meet safety and quality specifications for consumer sale and approval. In the pursuit of safer, higher-quality, and longer-lasting foods and beverages, quality control regulations are tightening, all while consumer cost expectations are decreasing. Food and beverage manufacturers are challenged to achieve higher output targets with increased efficiency and reduced testing errors to improve profits.

Leveraging over 50 years of experience with electrochemistry testing, Thermo Fisher Scientific has partnered with food and beverage producers throughout the world to help make their complex quality measurements routine, reliable, and accurate.

The range of Thermo Scientific Orion pH, Ion, Conductivity, and Dissolved Oxygen Meters and Thermo Scientific ROSS Electrodes allows quality control managers to reduce the operational cost of critical measurements, maintain laboratory proficiency, and return significant process efficiency improvements for the business through intuitive instrument operation for fast sample measurement and high-performance electrodes designed to improve accuracy, reproducibility, and stability in food and beverage samples.


Thermo Scientific Orion Star T900 Series Titrators are designed to make performing titrations easier, more reliable, and more reproducible than manual titrations. Our automated titrators significantly reduce the time analysts spend standing in front of the titration equipment, remove the need for color indicators and analyst-interpretation of endpoints, and automatically perform result calculations and data logging. Each titrator stores up to 10 customizable methods so routine procedures can be repeated without additional setup or pre-work, and methods can be shared among titrators using a USB flash drive.

Since most food and beverage samples require testing for acidity, our automated Orion Star T910 pH Titrator is paired with our high-performance ROSS pH Electrode and recommended for a wide variety of food and beverage samples.

Visit **fishersci.com/thermoscientificwateranalysis** or **fishersci.ca/thermoscientificwateranalysis** to learn more about Thermo Scientific water analysis products.


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The new OHAUS Pioneer PX line of balances offers affordability and functionality for everyday applications, from parts counting to essential weighing.

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| Model | Capacity | Readability | Calibration | Mfr. No. | Cat. No. |
|---|---|---|---|---|---|
| **Analytical Balances** | | | | | |
| PX124/E | 120g | 0.0001g | External | 30429846 | **01-922-172** |
| PX124 | | | Internal | 30429838 | **01-922-173** |
| **Precision Balances** | | | | | |
| PX323/E | 320g | 0.001g | External | 30429849 | **01-922-180** |
| PX323 | | | Internal | 30429840 | **01-922-181** |
| PX1602/E | 1600g | 0.01g | External | 30430058 | **01-922-190** |
| PX1602 | | | Internal | 30430055 | **01-922-191** |
| PX4202/E | 4200g | 0.01g | External | 30429852 | **01-922-184** |
| PX4201 | | | Internal | 30429844 | **01-922-189** |
| PX2201/E | 2200g | 0.1g | External | 30430059 | **01-922-186** |
| PX4201/E | 4200g | 0.1g | External | 30429853 | **01-922-188** |

# Process More Samples in Less Time

## Fisherbrand Bead Mill 24 Homogenizer

Grind, lyse, and homogenize biological samples prior to molecular extraction with the Fisherbrand Bead Mill 24 Homogenizer. The convenient, front-loading tube holder can hold up to 24 tubes (2 or 0.5mL) and provides optimal bead/sample interactions. When paired with sample-specific bead beating materials, it produces a thorough homogenate regardless of sample type.

Use with Fisherbrand Bead Mill Tubes, which are available with beads in a variety of sizes and materials.


| Description | Quantity | Cat. No. |
|---|---|---|
| Fisherbrand Bead Mill 24 Homogenizer | Each | **15-340-163** |
| Bead Mill Tubes, Hard Tissue Grinding, 2.4mm Metal Beads | 2mL x 50/Pack | **15-340-151** |
| Bead Mill Tubes, Tough Microorganism Lysing, 0.5mm Glass Beads | 2mL x 50/Pack | **15-340-152** |
| Bead Mill Tubes, Soft Tissue Homogenizing, 1.4mm Ceramic Beads | 2mL x 50/Pack | **15-340-153** |
| Bead Mill Tubes, Hard Tissue Homogenizing, 2.8mm Ceramic Beads | 2mL x 50/Pack | **15-340-154** |

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The SFX Series of cell disruptors provides a new level of ease, precision, and repeatability with advanced energy and temperature control modes, process monitoring capabilities, and programming features.

### Features:

- Precision energy input delivered in continuous or pulse modes
- True temperature control (temperature probe sold separately)
- Control modes for time, temperature, and energy
- In-process feedback for key variables (power level, energy usage, sample temperature)
- Programmable controls with room for 20 stored programs

The SFX150 Sonifier comes with a recessed push button and LED display and either a traditional or handheld converter (designed for ergonomic comfort and easy control). A wide variety of probes/microtips and other Sonifier series accessories are also available to help meet your application needs.

Handheld Converter


Traditional Converter

| Description | Sample Size | Power | Probe | Mfr. No. | Cat. No. |
|---|---|---|---|---|---|
| SFX150 with Handheld Converter | 0.2 to 150mL | 150W | ⅛ in. Microtip | 101-063-1096R | **15-338-528** |
| SFX150 with Traditional Converter | 0.2 to 150mL | 150W | ⅛ in. Microtip | 101-063-962R | **15-345-136** |
| SFX250 | 0.2 to 500mL | 250W | ½ in. Tapped | 101-063-965R | **15-345-138** |
| SFX550 | 0.2 to 1000mL | 550W | ½ in. Tapped | 101-063-969R | **15-345-141** |
| SFX550 | 0.2 to 1000mL | 550W | ¾ in. Solid | 101-063-968R | **15-345-140** |

# Centralized Control

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## Heidolph HEI-VAP Evaporator

Hei-VAP Expert Control and Ultimate Control allow you to centrally control all process parameters: vacuum, cooling temperature, rotation, and heating temperature.

### Customize your solvent library

- Automatically find boiling points with Dynamic AUTOaccurate program (sensor sold separately and required)
- Save processes as favorites
- Easily operate with a pictogram on the 5 or 7 in. touchscreen, which also includes a timer, maximum temperature limit, and multilingual menu
- Control rotation and heating with LED knobs that lock to prevent accidental adjustments

When you purchase an evaporator, vacuum pump, and chiller, you'll get an upgrade kit at no additional cost.*


*Excludes healthcare customers. See page 56 for details.*

| Description | Mfr. No. | Cat. No. |
|---|---|---|
| Hei-VAP Expert, Motor Lift, G3/B Vertical Coated Glassware Set | 036041016 | **03-604-1016** |
| Hei-VAP Ultimate, Motor Lift, G3/B Vertical Coated Glassware Set | 036041058 | **03-604-1058** |
| Rotavac Valve Control Vacuum Pump, 7mbar Ultimate Vac | 036302830 | **13-876-312** |
| Hei-Chill, 350W, -20 to +60°C | 036306517 | **02-321-072** |
| Upgrade Kit: Control Box, RS232 for Chiller Control, Valve for Vacuum Pump Control | 036000017 | **03-600-0017** |
| Tubing for Vacuum and Chiller with Hose Clamps, 12m | 036302180 | **13-878-675** |

# Oil Free, Low Maintenance

## Fisher Scientific MaximaDry Pumps

No more downtime to add or change pump oil. Enjoy quiet, reliable operation without the mess of oil or the operating costs and environmental problems associated with water aspirators.

- **Corrosion-resistant materials** — The thick, solid PTFE resin heads will not peel or corrode when exposed to most aggressive solvents and the sturdy FFPM valve system handles occasional liquids without degrading performance
- **Quick and easy setup** — Be up and running in minutes; everything connects together without tools or fittings, just add 3/8 in. I.D. tubing
- **Compact, stylish design** — For convenient access, your MaximaDry Oil-Free Pump fits easily where you need it — on your bench or inside your fume hood


*13-880 Series*

| Head Configuration | Capacity | Vacuum | Pressure | Motor | Dimensions (L x W x H) | Cat. No. |
|---|---|---|---|---|---|---|
| Single Stage | 20L/min. | 75 torr | 15psig | ⅙ hp | 13 × 6.5 × 8.5 in. | **13-880-14** |
| Single Stage | 40L/min. | 65 torr | 15psig | ⅙ hp | 13 x 6.5 x 8.5 in. | **13-880-16** |
| Two Stage | 20L/min. | 6 torr | 15psig | ⅙ hp | 15 x 6.5 x 8.5 in. | **13-880-18** |
| Two Stage | 35L/min. | 6 torr | 15psig | ⅓ hp | 16 x 7 x 9 in. | **13-880-20** |
| Two Stage | 35L/min. | 1.5 torr | 15psig | ⅓ hp | 16 × 7 × 9 in. | **13-880-22** |

# Filtered Laboratory Safety Solutions

MYSTAIRE

**Mystaire manufactures fume hoods and laminar flow hoods to provide operator or process protection from toxic fumes, vapors and particulates.**


## MY-PCR Workstations

Mystaire MY-PCR workstations establish an ISO5 clean work area with timed UV light. MY-PCR workstations create a "personal" clean work zone.

**Standard Features:**
- Combines vertical ISO5 air with UV light sterilization
- Safety switch to eliminate UV light exposure
- Polycarbonate construction with polypropylene base

| Model | Width | Mfr. No. | Cat. No. |
|---|---|---|---|
| MY-PCR | 24 in. | MY-PCR24 | **15-338-365** |
| MY-PCR | 32 in. | MY-PCR32 | **15-338-366** |
| MY-PCR | 48 in. | MY-PCR48 | **15-338-367** |

MY-PCR filters included in the purchase price

## Isola Vue Filtered Chemical Workstation

Isola Series Filtered Workstations provide chemical and particulate containment. Advanced monitoring and control are key components of each Isola Filtered Workstation.

**Standard Features:**
- EverSafe III Touch Control with electronic monitoring of face velocity, filter saturation, temperature and humidity with audible and visible alarms
- Polycarbonate construction for 360-degree visibility — excellent for demonstrations
- Solid-state gas detection with three sensitivity set points

| Model | Width | Mfr. No. | Cat. No. |
|---|---|---|---|
| Isola Vue | 36 in. | MY-ISL36 | **15-338-900** |
| Isola Vue | 48 in. | MY-ISL48 | **15-338-901** |
| Isola Vue | 72 in. | MY-ISL72 | **15-338-902** |

Isola filters sold separately; application dependent



## CleanPrep™ Dead Air Box

CleanPrep Dead Air Boxes are circulation-free enclosures that establish an ideal work area to protect against contamination in sensitive PCR amplification reactions.

**Standard Features:**
- Seamless polypropylene design for easy decontamination between amplifications
- Clear polycarbonate access with overlap and safety position switch
- UV shelf with integrated pipette holder — accommodates four pipettes

| Model | Width | Mfr. No. | Cat. No. |
|---|---|---|---|
| CleanPrep | 24 in. | MY-DB24 | **15-338-367** |
| CleanPrep | 36 in. | MY-DB36 | **15-338-368** |
| CleanPrep | 48 in. | MY-DB48 | **15-338-369** |

fisherbrand

# Clean Impossible-to-Reach Areas in Everything from Filling Valves to Vitamin Molds

## Fisherbrand Ultrasonic Cleaners

Fisherbrand 11200 Series Advanced Ultrasonic Cleaners are more powerful than conventional cleaners. They feature a wide range of adjustable parameters for lab applications, including cleaning, mixing, and degassing.

- Safer, faster, and less expensive
- Maximum versatility: choose frequency, power level, time, temperature, and ultrasonic mode
- Modes: normal, pulse, sweep, and de-gas
- 6 tank sizes: 0.7 to 7.4 gallons
- Compatible with multiple cleaning solutions
- Full line of accessories (sold separately)
- Products in stock and ready to ship

| Model | Capacity | Cat. No. |
|---|---|---|
| FB-11201 | 2.75L (0.7 gal.) | **FB11201** |
| FB-11203 | 5.75L (1.5 gal.) | **FB11203** |
| FB-11206 | 6.9L (1.8 gal.) | **FB11205** |
| FB-11207 | 12.75L (3.3 gal.) | **FB11207** |
| FB-11209 | 18L (4.75 gal.) | **FB11209** |
| FB-11211 | 29L (7.3 gal.) | **FB11211** |

Unlike spray washers or immersion cleaners, or using solvents, industrial ultrasonic cleaners decontaminate at a near-microscopic level and can clean threads, drilled blind holes, sharp inside corners, rough surfaces, and inaccessible internal cavities not reachable by other types of industrial washers.

Before Cleaning

After Cleaning

# Ultrasonic Liquid Processors

## Fisherbrand Sonic Dismembrators

Fisherbrand Sonic Dismembrators create energy that is transmitted through a titanium probe into a liquid sample to create cavitation (the implosion of micro-bubbles with high shear forces).

Sonic dismembrators can be used with various accessories to process small (µL) to 1L sample volumes.

- Use any of the four models to process samples smaller than 50mL
- Choose a programmable unit for sample temperature control
- Use a 500 or 700w unit for samples larger than 50mL
- The 700w model is required for high throughput, extended programming times, and sample temperature monitoring

For direct sonication, immerse the probe directly into the sample vessel. Indirect sonication (using the cup horn accessory) can be performed with sealed tubes or vials to eliminate contact between the probe and the sample.

Each Fisherbrand Sonic Dismembrator includes a generator, converter, cables, wrench set, and one probe. Other probes and accessories, including the stand and clamp shown here, are sold separately.

Model 505

| Model | Applications | Capacity | Power | Cat. No. |
|---|---|---|---|---|
| 50 | • Basic Cell Disruption | 0.2 to 50mL | 50w | **FB50110** |
| 120 | • Cell Disruption<br>• Protein Extraction<br>• DNA Shearing/ChIP | 0.2 to 50mL | 120w | **FB120110** |
| 505 | • Cell Disruption<br>• Nanoparticle Dispersion<br>• Homogenization/Mixing | 0.2 to 1000mL | 500w | **FB505110** |
| 705 | • Cell Disruption<br>• Protein Extraction<br>• DNA Shearing/ChIP<br>• Nanoparticle Dispersion<br>• Homogenization/Mixing<br>• Sonochemistry | 0.2 to 1000mL | 700w | **FB705110** |

# Your Balance, Your Way

## Sartorius Cubis II Balances

When Neil Armstrong brought 22.2kg of moon rocks back to Earth from the Apollo 11 mission in 1969, a Sartorius balance — one of the most precise weighing instruments available at the time — weighed them. From its very beginning in 1870, Sartorius was an innovator of new weighing technologies.

Now, the next generation of Sartorius premium balances is here: Cubis II. The state-of-the-art Cubis II sets a new standard in modularity, connectivity, and workflow integration. It's the only laboratory balance on the market that offers fully customizable hardware, software, and connectivity.

Improve your operational efficiency and experimental outcomes with modern user interfaces, pharmaceutical and GxP compliance features, data handling, integrity, connectivity, ergonomic sample handling, easy process integration, and unlimited communication.

- Leading performance: monolithic weighing system, integrated climate sensors, individual sample holders
- Error-free operation: individual QApp workflows; motorized auto-leveling for all models up to a maximum capacity of 8.2kg
- End-to-end data integrity: 21 CFR Part 11 compliance, integrated audit-trail, state-of-the-art user management
- Outstanding service support: integrated status center, service functions, and preventative maintenance based on accredited standard

Combine a display unit, weighing module, draft shield, software packages for various applications and functions, and a comprehensive range of accessories to adapt the Cubis II balance to any weighing task. A weight range from 2.1g to 70kg with readabilities between 0.1µg and 1g offers a solution for any application.

Visit **fishersci.com/cubis2** or **fishersci.ca/cubis2** to learn more.

| Type | MCA Models |
|---|---|
| Display | Large high-end 7 in. color touch TFT display in 16:9 format with new user interface |
| Software | Factory installed basic set of essential weighting applications (license free) and packages with special weighing applications and function extensions (license required) |
| Operation | Activated by touch key or touch-free using IR sensor (draft shield M) or gesture sensor (optional), learning capability |

| Type | MCE Models |
|---|---|
| Display | State-of-the-art TFT touchscreen operation with brilliant, readable display, but uncomplex, easy-to-operate user interface |
| Software | Factory-installed basic set of essential weighing applications |
| Operation | Activated by touch key or touch-free using IR sensor (draft shield M) or gesture sensor (optional), learning capability |

# Bring Your Research Into Focus

## Fisherbrand Microscopes

Choose analog or digital compound, inverted, or stereo microscopes with a range of magnifications. Featuring improved optics, a patented illumination system, increased working distances, and lower-profile bases that are more stable, redesigned Fisherbrand microscopes help make lab work easier.


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# 3D Pill May Be Good Gut Check

By Christina Phillis

The gut contains a vast array of microbes and bacteria that can offer a wealth of information about the overall health of a person. That's why a team of engineers at Tufts University developed a new method for exploring the digestive tract. Their small 3D pill samples bacteria as it travels through the gut, giving researchers better information about areas that are difficult to access, like the upper part of the distal colon where a diverse population of microbiomes dwell.

"We are learning quite a lot about the role of the gut microbiome in health and disease. However, we know very little about its biogeography. The pill will improve our understanding of the role of spatial distribution in the microbiome profile to advance novel treatments and therapies for a number of diseases and conditions," said Sameer Sonkusale, study co-author and professor of electrical and computer engineering at Tufts University's School of Engineering.

## A Gut Job

Gut bacteria function to help the body digest food and protect against diseases. But they can also be somewhat disruptive. If the microbiome becomes unbalanced, also known as dysbiosis, constipation, bloating, indigestion, and other unpleasant symptoms can arise. Dysbiosis can also make the body more susceptible to certain infections, or enhance diseases like cancer.

New research is proving that the gut may affect more than just digestion. Recent studies have shown that our genetic makeup determines the mix of bacteria in our gut, and may affect one's weight. Researchers have even found a potential link between autism and gut bacteria. A more detailed view of these organisms is needed to better understand their relationship with these and other conditions.

## Following Your Gut

To create a device for traversing and sampling the digestive tract, researchers used a 3D printer. The resulting pill features a semi-permeable membrane separated into two chambers — one containing multiple helical channels and one filled with calcium. The chamber with helical channels collects bacteria while the calcium chamber helps maintain osmotic flow across the membrane.

A pH-sensitive covering dissolves once the pill reaches the stomach, preventing it from absorbing anything until it enters the small intestine. An internal magnet, which can be guided externally, is used to control the pill for sampling specific areas. Researchers also included fluorescent dye in the salt chamber so they could easily track the pill's path.

> "Compared to other non-invasive diagnostic devices, this is like having an EKG for gut health."

Initial results showed that the bacterial populations collected in the pill closely resembled the populations to which the pill was exposed. Currently, the pill has only been used in pigs and primates. Clinical trials are needed to determine if the pill can be used to diagnose and treat humans.

"The design of this device makes it incredibly easy to use, posing little risk to the subject being measured, yet providing so much information," said Giovanni Widmer, a professor in the department of infectious diseases and global health at Tufts Cummings School of Veterinary Medicine. "Compared to other non-invasive diagnostic devices, this is like having an EKG for gut health."

This is not the first prototype of its kind being developed to make medical diagnosis and treatment less invasive. A remote-control drug delivery system for chemotherapy treatment is being tested. The nanoparticle package delivers chemotherapy only to cancer cells, leaving healthy cells to thrive.

In the future, researchers hope the bacterial populations discovered with the 3D pill can be analyzed using DNA sequencing techniques. One day, this could aid the diagnosis and treatment of a variety of digestive disorders. Although this pill may be small, its potential is mighty.

# Providing Cell Culture Excellence

## A History of Innovation

In 1962, Leonard Hayflick made an important discovery: normal human cells have a finite capacity to replicate in culture. This finding overturned a long-held belief about the mortality of cultured cells and has had far-reaching effects in life sciences research.

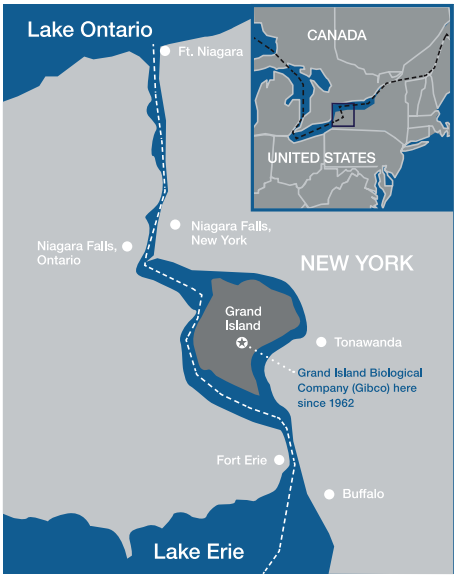
That same year, biologists Bob and Earline Ferguson recognized a business opportunity for supplying animal sera for research use while working from their garage in Grand Island, New York. Gibco sera rose from this humble beginning to the forefront of life sciences research products.

## How Did We Get Here?

Gibco and Thermo Scientific Nunc products are built on more than 100 years of combined experience in designing, manufacturing, and delivering high-quality items to meet your cell culture needs. They create a reliable combination that provides essentials for consistent and reproducible cell growth.

Key to our success is the consistent delivery and quality of Gibco products, which can reduce the number of unknowns that scientists experience. Throughout the global life sciences community, Gibco products have a reputation for reliability, which allows scientists to focus on research rather than troubleshooting any cell culture problems. In addition to supporting innovations in life sciences research, Gibco is a leading supplier for the global biopharmaceutical industry. We have a strong commitment to small and large laboratories alike, from the research bench to production-scale facilities.

The original Gibco manufacturing site in Grand Island is just one of many manufacturing facilities worldwide that produce Gibco cell culture products. We continue to provide scientists with the consistency, reliability, service, value, and innovation that have made Gibco a global market leader for over 50 years.




The original company Nunc A/S was founded in Denmark in 1953 and specialized in laboratory plastic products for cell culture, cell biology assays, sample prep, and sample storage. Thermo Scientific Nunc cell culture products have been used by researchers for more than 60 years in labs around the world.

Today, Nunc offers solutions for biobanking, bioprocessing, and food and beverages, including surfaces and materials (Nunclon Delta, MaxiSorp, and passive adsorption surfaces), flasks, serological pipettes, dishes, multidishes, multiwell plates, cryotubes, cell factory systems, tubes, microplates, cryovials, and many others.

Our products are manufactured to comply with USP Class VI testing. Many Nunc cell culture products are tested with Gibco media to confirm optimal cell growth across multiple cell lines.

Visit **fishersci.com/cell-culture-products** or **fishersci.ca/cell-culture-products** to find the most relevant cell culture surface and format for every step of your workflow — from culture to discovery.

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gibco

# State-of-the-Art PCR Technology

analytikjena
An Endress+Hauser Company

## Analytik Jena Biometra TAdvanced Thermal Cycler

Make your lab workday easier and ensure excellent results with Biometra TAdvanced, the high-performance thermal cycler for DNA amplification by PCR.

Designed for error-free use in varied laboratory environments, it features a universal block design and heating lid with High-Performance Smart Lid (HPSL) technology for unrestricted use of different plastic containers and plates. Easily optimize your PCR protocols using the Linear Gradient Tool (LGT) or the Temperature Optimization Step (TOS) function.

- Flexible Quick-X-Change block system accommodates 12 different block modules for 0.2 and 0.5mL tubes/plates and 384-well plates
- Temperature control and homogeneity offers heating rates up to 6°C/second with aluminum alloy blocks and up to 8°C/second with optional silver blocks
- Extended user management option provides user rights for up to 90 individuals

| Capacity | Includes | Mfr. No. | Cat. No. |
|---|---|---|---|
| 60 x 0.5mL Tubes | 10µL | 8464070200 | **84-640-70200** |
| 96 x 0.2mL Tubes | 10µL | 8464070201 | **84-640-70201** |
| 2 x 48 x 0.2mL Tubes | 200µL | 8464070202 | **84-640-70202** |
| 60 x 0.5mL Tubes | 200µL | 8464070210 | **84-640-70210** |
| 96 x 0.2mL Tubes | 1000µL | 8464070211 | **84-640-70211** |

# FastPrep® Instruments, Lysing Matrix and Kits

## For Preparing Environmental and Agricultural Samples

Grind, lyse and homogenize a variety of plant, animal and environmental samples in 40 seconds or less.

- Leaves, vegetables, seeds, roots
- Bones and animal tissue
- Microbes, soil and other samples

Kits for fast and easy gDNA, RNA or protein extraction from lysates.


High Yields. Consistent Quality. Super-Fast.

MP

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CORNING

# Effortless Pipetting, Reliable Results

## Corning Lambda EliteTouch Pipettors

Corning Lambda EliteTouch Pipettors have been engineered to provide the highest levels of comfort, accuracy, and precision. The lightweight construction, contoured handle, and four-digit counter were designed to ensure comfortable pipetting. All pipettors feature smooth plunger movement and extremely low pipetting forces to reduce wrist strain and fatigue (RSI). The included colored pushbuttons can help identify a user or application for sample safety and lower risk of cross contamination.

- Convenient one-handed volume setting with auto-lock prevents accidental changes
- Fully autoclavable and UV-resistant
- Single-channel units are compatible with very narrow tubes
- Multichannel shafts retract individually for better tip loading and ejection
- Easy in-lab calibration procedure
- Individually tested and supplied with certificate of quality



### Single-Channel Pipettors

| Volume Range | Non-Filtered Tip | Mfr. No. | Cat. No. |
|---|---|---|---|
| 0.1 to 2µL | 10µL | 6050 | **07-201-040** |
| 0.5 to 10µL | 10µL | 6051 | **07-201-041** |
| 2 to 20µL | 200µL | 6052 | **07-201-042** |
| 5 to 50µL | 200µL | 6053 | **07-201-043** |
| 10 to 100µL | 200µL | 6054 | **07-201-044** |
| 20 to 200µL | 200µL | 6055 | **07-201-045** |
| 100 to 1000µL | 1000µL | 6056 | **07-201-046** |

### 8-Channel Pipettors

| Volume Range | Non-Filtered Tip | Mfr. No. | Cat. No. |
|---|---|---|---|
| 0.5 to 10µL | 10µL | 6057 | **07-201-047** |
| 5 to 50µL | 200µL | 6058 | **07-201-048** |
| 20 to 200µL | 200µL | 6059 | **07-201-049** |
| 30 to 300µL | 300µL | 6060 | **07-201-050** |

### 12-Channel Pipettors

| Volume Range | Non-Filtered Tip | Mfr. No. | Cat. No. |
|---|---|---|---|
| 0.5 to 10µL | 10µL | 6061 | **07-201-051** |
| 5 to 50µL | 200µL | 6062 | **07-201-052** |
| 20 to 200µL | 200µL | 6063 | **07-201-053** |
| 30 to 300µL | 300µL | 6064 | **07-201-054** |

### Corning Lambda EliteTouch Starter Kit

| Description | Mfr. No. | Cat. No. |
|---|---|---|
| Includes:<br>• Four single-channel pipettors (0.5 to 10µL, 2 to 20µL, 20 to 200µL, 100 to 1000µL)<br>• Universal linear stand for four single-channel pipettors<br>• Corning DeckWorks pipette tips (10µL, 200µL, 1000µL), one pack each<br>• Three colored pushbuttons (four sets) | 6065 | **07-201-055** |

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*Restrictions may apply. See page 56 for full details.*

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# New Sensors Signal When Plants Need Water

By Kylie Wolfe

Plants are more complicated than they seem. Instead of competing for resources, some actually lend a hand, or limb, to help each other succeed. They communicate on the surface and beneath, releasing volatile organic compounds into the air and secreting soluble chemicals into the soil. And they share water and nutrients, sending distress signals when there are signs of drought and disease.

Scientists believe there is a lot to learn from the sophisticated communication strategies of plants. So they decided to eavesdrop on their conversations.

## Nature's Communication Network

Researchers at the Technical University of Crete, led by Aggelos Bletsas, professor of electrical and computer engineering, are testing a new way to tune in to plant communication.

Already, plants are able to relay chemical and physical needs through fungal systems called mycorrhizal networks. But we don't have a way to understand what they're saying. Maybe the plants are lacking an essential resource or facing environmental stress. Perhaps the air quality is poor, or they aren't getting enough sunlight. If we could learn to interpret plant conversations, we could figure out ways to help them thrive.

With the evolution of sensors in size and function, scientists now have an opportunity to learn about factors impacting the productivity, health, and quality of plants.

## When Life Gives You Lemons

Using a variety of basic components, the team created mini plant broadcast centers. They attached an antenna to a lemon growing on a tree, added a humidity sensor, and were able to learn about plant moisture via a transistor and an FM radio station.

When the soil was wet or the atmosphere humid, the transistor turned on and off at a slower rate. When it was dry, the transistor did so at a faster rate. With this setup, they were able to monitor the tree from a smartphone.

"We can literally 'listen' to the moisture of the plant," said Bletsas. The team recently applied for a United States patent for their technology.

"No other team had created a wireless network among plants, transmitting information while consuming only a few microwatts and costing just a few dollars," he added.

Bletsas' technique is less complex and also more cost effective than Bluetooth, for example. A Bluetooth-based sensor costs about $25 and his team's version costs a fraction of that: $3.40.

## Benefits of Botanical Broadcasts

Designing a wireless network for plants is the first step toward a future of tech-savvy farming. New technology like this would provide valuable information about plant needs, giving workers the ability to address them with more accuracy.

> "We can literally 'listen' to the moisture of the plant."

Using these simple sensors to collect real-time data, farmers can learn about the status of their crops in terms of air and soil moisture. More effective monitoring may even reduce pesticide use, maximize fertilizer potential, and help workers manage resources efficiently.

## Helping Plants and Farmers Succeed

By incorporating more sensors, especially on uneven ground, farmers would be able to achieve more optimal results, improving productivity and possibly helping to address global food shortages.

"Two of these sensors for every acre on any given farm might change the way we [conduct] agriculture and 'understand' plants," said Bletsas.

That's why the team has chosen to make them as affordable as possible. The group hopes to launch sensors costing less than $1 a piece, providing an accessible form of agricultural technology and environmental monitoring to the community.

# Designed for Ergonomics

## Biotix xPIPETTE and xTIP4

Biotix manufactures a full line of top-quality LTS compatible tips and pipettes. This pipetting system creates a more ergonomic workflow by minimizing the highest force in the pipetting cycle, ejection force. Available in a wide range of packaging options and two new tip sizes for 300 and 1200µL pipettes.

- FlexFit technology creates a secure seal with less force
- The pipette's symmetrical design, low drag seals, and cushioned ejector make it the best option for a more ergonomic workflow
- Accurate, precise, and manufactured to the highest quality standards

Visit **fishersci.com** to view the full range of Biotix products.

# The Anatomy of Miltex Scissors

The Miltex name is synonymous with premium surgical instrumentation. Skilled craftsmen forge these products to exacting specifications from high-quality stainless steel. The SuperCut and tungsten carbide lines include scissors, needle holders, forceps, rasps, and other specialty patterns. Choose Miltex scissors for general surgery, plastic surgery, dermatology, ophthalmology, dentistry, veterinary, and many other uses.

## Blade Choices

**Carb-N-Sert (Tungsten Carbide)**

Carb-N-Sert Scissors have tungsten carbide inserts bonded seamlessly to the upper and lower blades. These premium-grade scissors offer precision cutting performance and the durability of tungsten carbide cutting edges.

These scissors provide considerable cost savings through their consistently superior performance and extended service life. Carb-N-Sert Scissors are easily identified by their gold ring handles.

**SuperCut**

SuperCut Scissors have a razor-sharp upper blade edge that easily cuts through tissue while the micro-fine serrations on the lower blade hold tissue and prevent slippage. SuperCut Scissors have two black ring handles.

SuperCut Scissors should only be used to cut tissue. Proper handling will ensure a lifetime of service, and regular re-sharpening — a service Miltex provides — is recommended.

**Combination SuperCut/Carb-N-Sert**

Combination scissors offer the durability of tungsten carbide edges with SuperCut performance. SuperCut/Carb-N-Sert Scissors have one short and one long gold-plated ring handle.

## Blade Design

The tungsten carbide inserts are seamlessly bonded to high-quality stainless steel and then precisely ground and honed on diamond wheels. SuperCut Scissors have a finely beveled blade with a razor-sharp edge and an opposing blade with micro-fine serrations to prevent tissue slippage and facilitate effortless cutting. (A)

## Strength and Hardness

Miltex scissors are manufactured for greater Rockwell hardness, instrument durability, and long-lasting sharpness. (B)

## Screw Lock

Fully tempered precision screw locks maintain perfect alignment. (C)

## Laser Etching

The catalog number and company logo are marked on every pair of Miltex scissors using advanced laser techniques that do not damage the instrument. (D)

## Ergonomic Design

Designs combine weight, balance, and feel for optimal comfort and performance. (E)

## Ring Handles

Well-rounded and polished, the handles help prevent hand fatigue. The gold and black finishes also differentiate the blade types. (F)


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# xTIP4

## New LTS Compatible Tips

for 300µL and 1200µL pipettes

- ✓ FlexFit instant seal technology
- ✓ Positive stop for low ejection force
- ✓ Eco-friendly reload options


**Biotix® xTIP4 Pipette Tips, Low Retention**

| Volume | Tips/ Pack | Sterilized | Racked, Filtered | Racked | CleanPak Reload | Tip Eject Reload |
|---|---|---|---|---|---|---|
| 300µL | 960 | Yes | 12111363 | 12111368 | 12111387 | |
| | | No | | 12111373 | 12111383 | |
| 1200µL | 768 | Yes | 12111365 | 12111370 | 12111380 | 12111390 |
| | | No | | 12111375 | 12111385 | |

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