| THE FUTURE OF EVERYTHING

# High-Tech Smell Sensors Aim to Sniff Out Disease, Explosives—and Even Moods

*Advances in artificial intelligence, bioengineering and synthetic biology power a new breed of odor sensors, some using living cells*
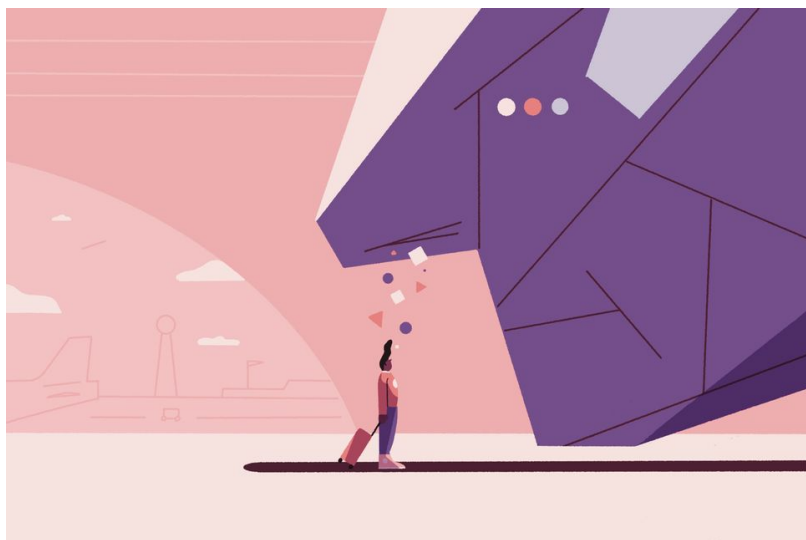


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We live in a world of odors—chemical signals that contain valuable data about our health, the environment and even personal choices like which foods, perfumes and beverages we enjoy. Despite decades of research and development, however, this aromatic information has remained mostly untapped.

But now scientists and entrepreneurs are redoubling their efforts to recreate the sense of smell in compact devices that detect and analyze odors similar to the way cameras now recognize our

faces and microphones our words. In pursuit of these high-tech devices–which could use odors to detect disease like cancer or Covid-19, locate hidden explosives or decipher our moods and behaviors—some companies are leveraging advances in synthetic biology and genetic engineering. Others are harnessing advances in artificial intelligence.

"It's absolutely a growing field," says Andreas Mershin, an odor-sensor researcher at the Massachusetts Institute of Technology. "We're recognizing that there's a whole world of molecules we're blind to." He calls the field an "unexplored goldmine."

The quest to build better olfactory sensors is a challenging one because odors are made up of many different chemicals and because animals' olfactory receptors—specialized cells in the nose that recognize odor molecules—are remarkably diverse. Humans have three types of receptors for color vision, for instance, but hundreds of different olfactory receptors.

Among the most futuristic devices are those that incorporate living cells engineered to react to specific odor components. Koniku Inc., a startup in San Rafael, Calif., is now using bioengineered nerve cells as the basis for sensors capable of recognizing the subtle odors of explosives. The cells contain proteins designed to detect so-called volatile organic compounds, carbon-containing substances that seep into the air from a range of sources, including food, paints, beverages, bodies and unexploded bombs.

Koniku Inc. uses bioengineered nerve cells in sensors that can recognize the subtle odors of explosives.

'We design smell cyborgs,' says Osh Agabi, Koniku's founder and chief executive.

"We design smell cyborgs," says Osh Agabi, founder and chief executive of the firm. He says the firm is working with Airbus Americas to develop sensors for use at airports to detect packages and luggage containing explosives. The goal is not to replace bomb-sniffing dogs and other security measures now in use but to augment them, according to Bruce Coole, head of aviation-security programs at Airbus Americas.

In recent tests at San Francisco International Airport, a prototype of Koniku's bomb-sniffing device identified pieces of planted luggage known to contain explosives with an accuracy of 97%, according to Dr. Agabi. In separate tests, Koniku's sensors matched trained dogs' ability to detect explosives, he says, adding that the company is also developing sensors for use in healthcare and other industries.

"When you look at the scale of how many compounds or how many smells are impacting human life that are yet to be cataloged, we have barely scratched the surface," Dr. Agabi says.

Aromyx Corp., a startup in Mountain View, Calif., is also using cells to create odor sensors. But rather than selling devices, it offers food and wine producers a lab-based service to help them better understand the specific odor molecules that drive consumer preferences. Company workers pair consumer-survey data on people's likes and dislikes with how Aromyx's bioengineered odor-detecting cells react to certain odor molecules to come up with preference profiles.
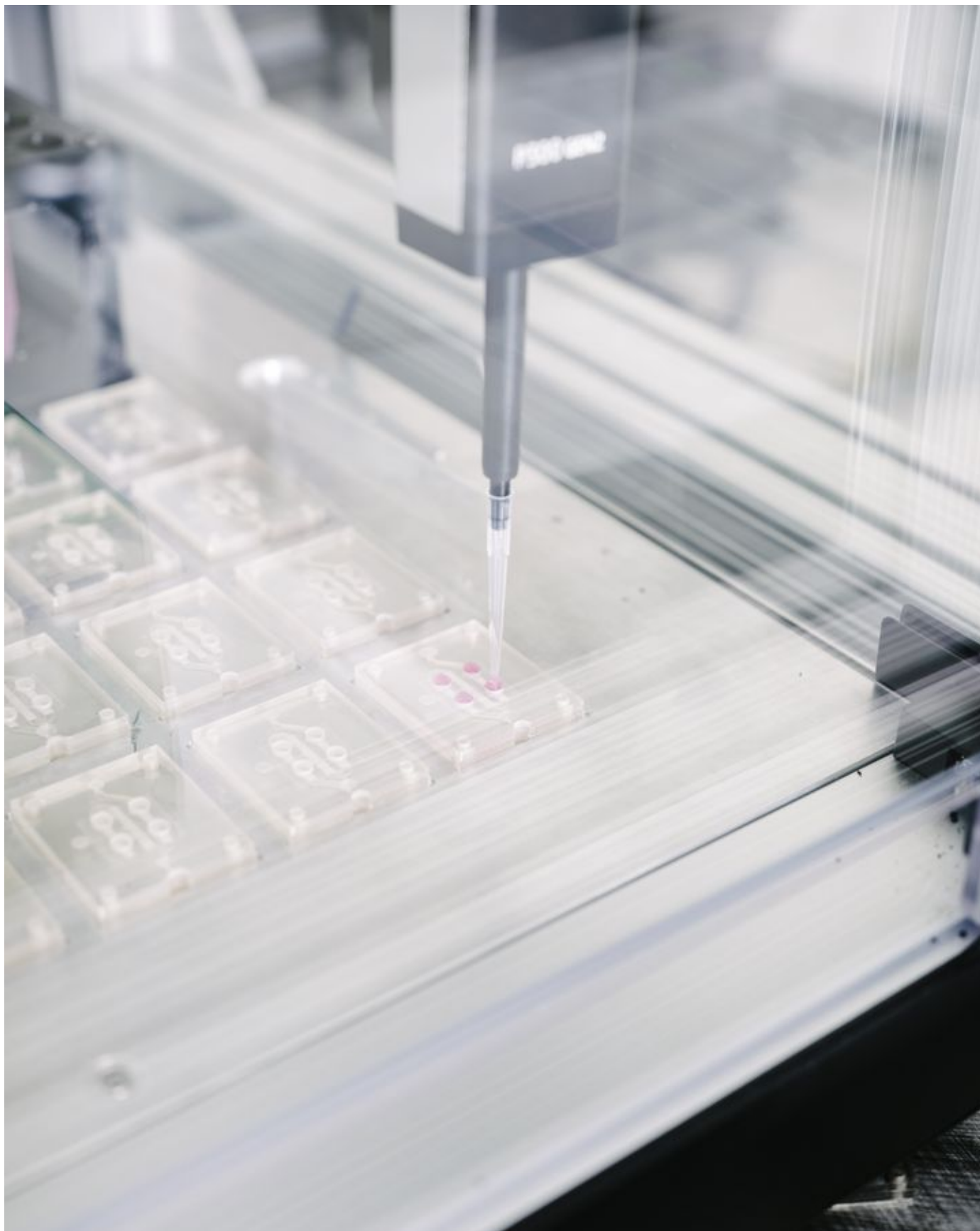
"The value is not in the sensor, but in the data," says Josh Silverman, Aromyx's chief executive.

MIT's Dr. Mershin is focusing on medical applications of olfaction technology. Inspired by dogs that have demonstrated an ability to sniff out malignancies in humans, he's working on an artificial-intelligence odor-detection system to detect prostate cancer.

In 2021, Dr. Mershin's team published results showing that their system matched trained dogs' ability to detect prostate cancer in the urine of patients with the disease. Since then the team has increased the software's accuracy to more than 90%, Dr. Mershin says, adding that the system is more reliable than the well-known prostate-specific antigen (PSA) blood test, which can lead to false-positive diagnoses. Only 25% of men who undergo a prostate biopsy following a suspicious PSA finding are later found to have cancer, according to the National Cancer Institute.
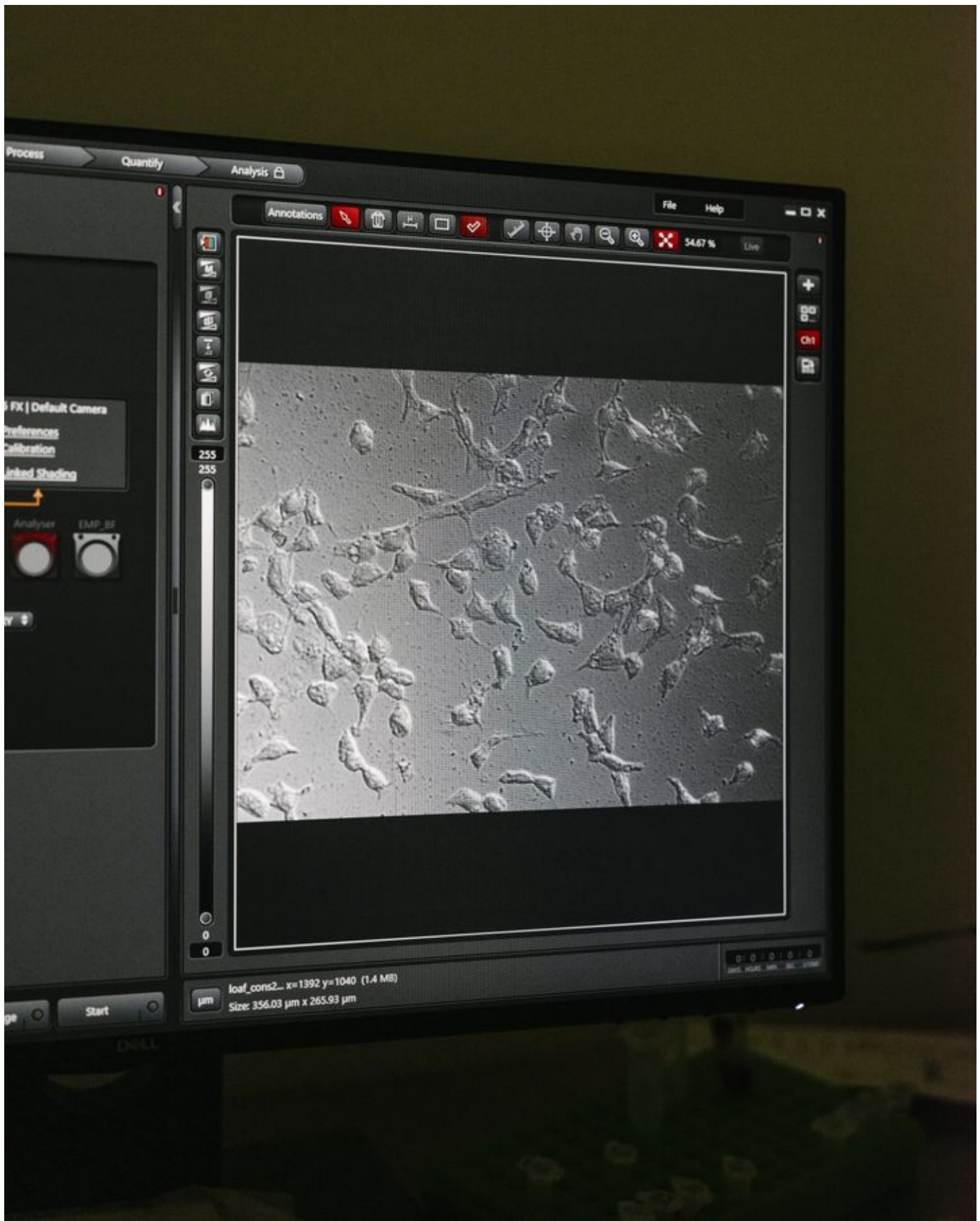
Early-stage neural cells in the production phase at Koniku before they are moved to biochips.

A cell-culture medium of sugars, salts and other minerals is put into biochips to help keep the cells alive and healthy.
IAN BATES FOR THE WALL STREET JOURNAL

Olfaction experts warn that a series of scientific and technical challenges must be overcome before high-tech odor detectors are ready for broad penetration into the marketplace. For systems that use living cells, it will be important to monitor how often devices need to be replaced and how accuracy stacks up over long time frames, they say.

"The idea is great. It's the implementation that's the problem," says Nathan Lewis, a chemist and olfaction-sensor developer at the California Institute of Technology.

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*Do you think the science of smells will grow in importance? What are the benefits and concerns? Join the conversation below.*

Scientists and data rights experts say the emergence of sophisticated molecular surveillance— for example. turning cell phones into what some experts call "smell phones" capable of spotting medical conditions— raises thorny questions of privacy. After all, odors our bodies constantly emit contain clues about our health and personal choices, including the products we use and the foods we eat as well as our drinking and smoking habits and more. The collection and analysis of human olfactory data could affect some insurance coverage, for example, as well as employment, according to legal experts.

"We're not prepared for the implications," says David Carroll, an associate professor of media design at the Parsons School of Design and a data-rights activist. "It's going to bring up deep and profound ethical quandaries."

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