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Science Innovations and Discoveries

NO. 1, 2020

 Sustainability Issue

Feeding Our Future:

A New Sustainable Option for Diversifying Our Diets

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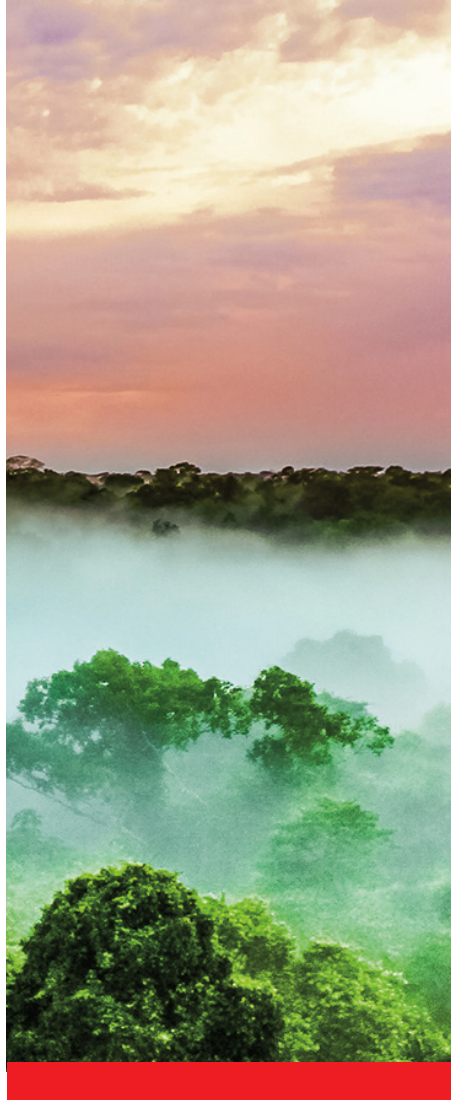
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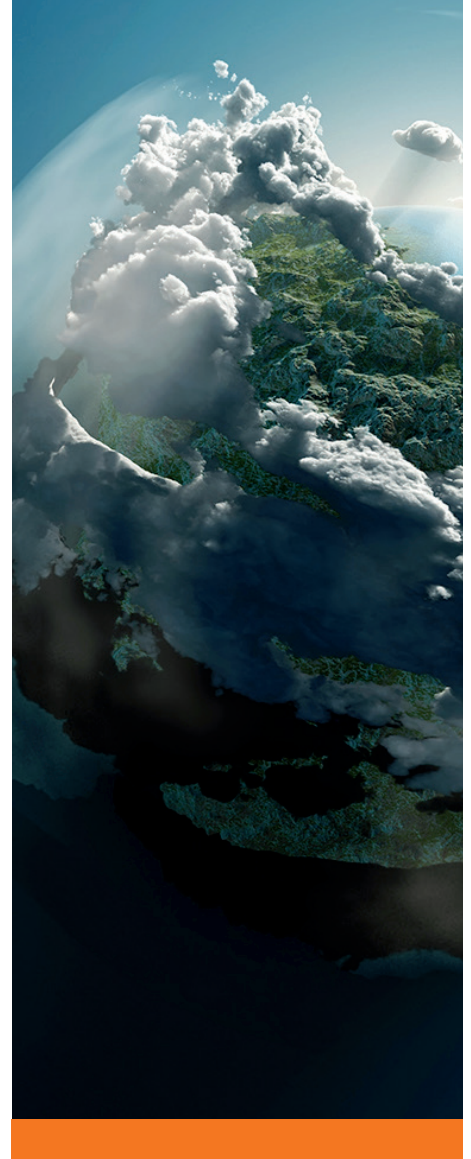
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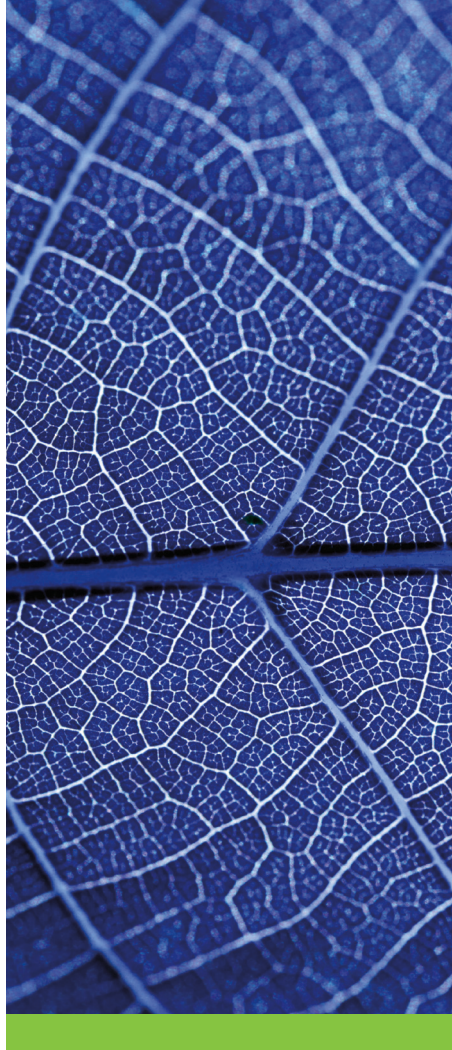
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Drones Perform Amazon Health Check

By Christina Phillis

The Amazon rainforest is a vast and difficult-to-traverse region, so observing its health can be a challenge. It spans eight different countries and accounts for half the planet's remaining tropical forests. That's why a team of scientists at Harvard's John A. Paulson School of Engineering and Applied Sciences (SEAS) turned to high-flying drones to track the well-being of this important resource.

A Planet Under Duress

The health of the planet and the Amazon rainforest is invariably linked. As deforestation continues, more harmful carbon dioxide stays in the atmosphere instead of being converted into oxygen. This only aggravates the effects of climate change, and in turn, causes further harm to the rainforest.

One way to track how these plants are responding to climate change is by monitoring their chemical signals. Each species of plant emits unique volatile organic compounds (VOCs) that help them interact with other organisms. When a plant is responding to stress, these signals can change.

"Plants and insects often communicate via chemical signaling, rather than visual or vocal signaling more common among animals," said Scot Martin, the Gordon McKay Professor of Environmental Science and Engineering at SEAS. "With our chemical sensors, we can better understand the current functioning of the forest and how it is changing with shifting regional climate, including a more frequent occurrence of fires in recent years in the central part of the Amazon."

Even trees from colder regions of the world have been found to emit higher levels of terpenes as temperatures rise. When VOCs from plants enter the atmosphere, they can react with existing chemicals to form aerosols, further contributing to air pollution. Increased air pollution leads to higher-than-average temperatures and plants that are under stress emitting VOCs. It's a vicious cycle.

Up until this point, monitoring the health of the Amazon has been accomplished using large platform towers that rise above the forest.

"The Amazon contains thousands of small ecosystems, each with their own biodiversity and VOC signals," said Jianhuai Ye, a postdoctoral fellow at SEAS. "Yet, there are less than 10 of these towers in the entire forest and they are all built in similar ecosystems where the soil can support large structures. As you can imagine, this leads to a lot of bias in the data."

The team, which included collaborators from Amazonas State University (UEA) and the Amazonas State Research Support Foundation (FAPEAM), believed they could get more accurate data using a drone-based chemical monitoring system. The drone could collect samples of VOCs at various altitudes and specific points. Utilizing lightweight materials, it could withstand the heat and humidity of the jungle.

Taking to the Skies

In the summer of 2018, the team used their specially designed drones to map the chemical fingerprint of two different ecosystems in central Amazonia. Their findings, published in the Proceedings of the National Academy of Sciences, challenged most present-day models, which assumed nearby ecosystems had the same emissions.

"This research highlights how little we understood forest heterogeneity."

Researchers flew drones over plateau forests and slope forests and found a significant difference in the VOCs of these two locations. The plateau forest had 50 percent higher concentrations of isoprene than the slope forest. The model they developed based on this data suggested isoprene emissions doubled to tripled among these forest sub-types. Prior emission models assumed no difference.

"This research highlights how little we understood forest heterogeneity," said Martin. "But drone-assisted technologies can help us understand and quantify VOC emissions in different, nearby ecosystems in order to better represent them in climate and air quality model simulations."

The team continued their research in Fall 2019, this time observing the valleys and rivers of the Amazon. In the future, they plan on testing a three-drone fleet operated in unison. As climate change remains an issue, this technology will only help us truly understand its far-reaching effects. 🌿

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pH	Color	Cat. No.	Quantity	Cat. No.	Quantity
Traceable CRM					
4.005*	Red	06-664-259	16 oz. (473mL)	15-078-280	16 oz. (473mL)
7.000*	Yellow	06-664-260	16 oz. (473mL)	15-078-281	16 oz. (473mL)
10.012*	Blue	06-664-261	16 oz. (473mL)	15-078-282	16 oz. (473mL)
ISO Guide 34					
One Shot (Single Use)					
4.005*	Red	06-664-262	6 x 100mL	15-078-285	6 x 100mL
7.000*	Yellow	06-664-263	6 x 100mL	15-078-286	6 x 100mL
10.012*	Blue	06-664-264	6 x 100mL	15-078-287	6 x 100mL
Assorted (2 of each)	—	—	—	15-078-288	6 x 100mL

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4.00		Batch Tested		Individually Tested		One Shot (Single Use)
200000μS	06-664-266	16 oz. (473mL)	06-664-274	16 oz. (473mL)	—	—
150000μS	06-664-265	16 oz. (473mL)	06-664-267	16 oz. (473mL)	—	—
100000μS	09-328-5	16 oz. (473mL)	15-077-953	16 oz. (473mL)	09-328-10	6 x 100mL
10000μS	09-328-4	16 oz. (473mL)	15-077-952	16 oz. (473mL)	09-328-9	6 x 100mL
1413μS	09-328-11	16 oz. (473mL)	15-077-951	16 oz. (473mL)	09-328-12	6 x 100mL
1000μS	09-328-3	16 oz. (473mL)	15-077-950	16 oz. (473mL)	09-328-8	6 x 100mL
100μS	09-328-2	16 oz. (473mL)	15-077-949	16 oz. (473mL)	09-328-7	6 x 100mL
10μS	09-328-1	16 oz. (473mL)	15-077-948	16 oz. (473mL)	09-328-6	6 x 100mL
5μS	06-664-24	16 oz. (473mL)	15-077-947	16 oz. (473mL)	06-664-25	6 x 100mL
1μS	15-077-945	16 oz. (473mL)	15-077-946	16 oz. (473mL)	—	—

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Seafood with a Side of Microplastics

By Iva Fedorka

Plastic waste has been found in the Arctic Circle, at the top of Mount Everest, and at the bottom of the oceans. These tiny plastic particles or microplastics are frequently ingested by marine animals in our food chain, and we do not yet fully understand how these microplastics may affect aquatic and human health.

Plastic, Plastic Everywhere

Plastic production has increased annually by 8.7 percent since the 1960s and is now a global industry worth hundreds of billions of dollars. From four to 12 million metric tons of plastics find their way into the oceans every year and the amount of plastic in oceans is expected to outweigh the fish population by 2050. Conservatively, 5.25 trillion plastic particles were circulating in the Earth's surface waters in 2018.

Eighty percent of these plastic waste materials are trash and items discarded from industrial discharge, inland waterways, and wastewater outflows. Approximately three-quarters of this trash is uncollected waste and the waste management system contributes the remaining 25 percent.

What Are Microplastics?

The term microplastics (MP) was introduced in 2004 to describe plastic particles from 0.1µm to 5mm in size. They vary in size, shape, chemical composition, and polymer type. The most common resins are polyethylene and polypropylene. Some MP were manufactured in a small size ("primary" MP), while others ("secondary" MP) are created as larger items degrade.

Sources of Microplastics

Personal care products (like exfoliants) contain microbeads, one type of primary MP. The daily release of microbeads into marine habitats is estimated to be eight billion in the United States alone. Industrial abrasives and pellets used to make larger plastic items are another significant source of primary MP. Secondary MP may include textile microfibers and dust from tires, along with the particles created by the degradation of other plastic items.

Plastic Degradation

Even if plastic manufacturing were stopped completely, secondary MP would continue to be produced from existing plastic waste as that litter degrades. The rate of degradation depends on the resin or polymer, and the type, shape, density, and age of the plastic item. Environmental conditions (weather, temperature, radiation, and pH) also affect the rate of degradation.

Although plastics are durable, they can still be affected by biodegradation (decomposition by microorganisms), photo degradation by sunlight or photons, thermo or thermal oxidation (slow molecular deterioration at moderate or high temperatures), and the hydrolytic effects of water.

Research Issues

Although many reports have been published about MP pollution in seafood and aquatic environments, a lack of standardized sampling, identification, quantitation, and analytical methods has produced inconsistent results.

Sample Collection and Prep

Water, sediment, and the gastrointestinal tracts of aquatic animals are the usual samples of choice. Surface water is collected using nets or trawls. Sediment can be gathered by shovel or core sampling. The livers, gills, guts, and other organs of aquatic organisms are dissected. The MP is then separated from the matrices using density determination, chemical digestion, and other sample preparation methods.

Characterization and Quantification

Once the MP are segregated, they are chemically evaluated to identify the specific types of polymers they contain. Currently, scientists characterize MP using gas chromatography/mass spectrometry (GC/MS), Fourier transform infrared spectroscopy, Raman spectroscopy, pyrolysis, and other imaging techniques.

The MP content of water, sediment, and biota are typically expressed as "particles per m³," "particles per m²," or "particles per individual", respectively. However, many assessments may not include nano-sized plastic particles (with a size range from 0.001 to 0.1µm), for which effective measurement methods are not always available.

In addition to the resins, chemicals are added in the plastic-making process. As much as 4 percent of MP weight may be plasticizers, pigments, antimicrobial agents, stabilizers, and other additives. These chemicals can leach into the surroundings from the plastics. Leaching increases with degradation as the surface-to-volume ratio of MP increases.

MP has also been shown to absorb persistent organic pollutants (POPs), including polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides, flame retardants, and other by-products of consumer goods or municipal waste.

What's Next?

Although we are advised by nutritional authorities to eat more seafood, concerns about MP content may actually lead to reduced consumption. More research about human and animal health risks from MP is critical if we are to protect consumers and the environment.

Although many water creatures that ingest MP have been studied, more research is needed. Since some MP are denser than water, they sink and bottom-feeding organisms are more likely to ingest them. Other MP are less dense and may be eaten by fish and other species that inhabit the water column.

Preventing and removing MP from water is also a major issue. Engineering and biotechnological tools, such as advanced water treatments, could help to control, reduce, or even eliminate MP pollution. Because the elimination of plastic waste is also affected by economic development, local infrastructure, and legislation, making changes to established habits, practices, and employment will be a challenge. 🌱

Sustainability

Sustainability in the Laboratory: Small Changes Can Add Up

The word sustainability is often used in today’s world, and companies are spending significant time and effort to become more sustainable. Laboratories are no exception.

It is well known that laboratories use large quantities of plastic consumables and disposables. In the lab, plastics offer shatter-proof, durable, lightweight, and single-use products that help reduce cross contamination and are easy to use.

Moving toward sustainability in the laboratory can be challenging. Standard operating and experimental procedures are common, and procedures are repeated day in and day out. Scientists may not be open to changing the products they are accustomed to using.

Sustainability as it relates to plastic consumables generally defaults to a discussion about recycling. Can the product be safely recycled? Is the lab structured to make recycling convenient? Although important, recycling is not the only consideration. One question not often raised is, “How can we reduce the amount of plastic we use from the start?”

In its overall waste management strategy, the U.S. Environmental Protection Agency (EPA) has developed a Waste Management Hierarchy that shows source reduction as most preferred, followed by material reuse and, finally, recycling. Simply put: reduce, reuse, recycle. The order is important — the greatest impact is the reduction in overall use.

One example of reducing overall plastic consumption in the lab is the use of flexible sampling containers rather than rigid plastic. Whirl-Pak sterilized sampling bags were developed more than 60 years ago to transport liquid milk samples to the lab. Today, this flexible package is recognized as the “Gold Standard” in a multitude of industries across more than 75 countries. Not all industries have embraced this sampling format because habits can be hard to change.

However, the water industry is ready for a change in sampling procedures. Of the hundreds of millions of water samples collected annually in the U.S., the majority are placed in rigid, single-use plastic containers. On average, production of these rigid containers uses five to 10

times the plastic needed to produce a comparably sized Whirl-Pak bag.

Nasco Sampling embarked on an evaluation of the environmental impact of our Whirl-Pak 120mL and 500mL sterile sampling bags compared to the standard rigid plastic containers used for water sampling. The evaluation was performed using EcoImpact-Compass software, widely used in the packaging industry for lifecycle assessments. A lifecycle assessment characterizes the impact associated with sourcing, manufacturing, distributing, using, and disposing of a given product. The full-cycle evaluation offers data about packages that may have a lower environmental footprint, which allows you to make better sustainability decisions.

This study compared linear low-density polyethylene (LLDPE) Whirl-Pak bags to rigid containers made from polypropylene (PP), polyethylene terephthalate (PET), and high-density polyethylene (HDPE). Environmental impact variables included fossil fuel use, greenhouse gas emissions, and water use. Similar results



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were observed for both the 120mL and 500mL containers. The results for 120mL containers are detailed here.

The study was based on shipping one million containers 1,000km. The data were segregated by material usage, manufacturing, transport, and end-of-life categories. In all product comparisons, the Whirl-Pak sterilized sampling bag was significantly more sustainable than the three common rigid containers used for water sample collection. Less fossil fuel use, lower greenhouse gas emissions, less water usage, and an overall lower environmental impact were observed throughout the entire lifecycle with the use of Whirl-Pak bags.

Although Whirl-Pak bags offer a sustainable alternative, costs also influence decision making, and budgetary constraints can limit even the most highly motivated lab manager. For flexible sampling solutions like Whirl-Pak bags, the container itself can help reduce overall costs, and additional savings may be realized for shipping, storage, and waste disposal costs. Savings can be further magnified if you are required to ship internationally or over long distances.

When developing a sustainable approach in the laboratory, focus on small yet meaningful changes that can make a measurable impact. Replacing rigid plastic sample collection containers with flexible solutions like Whirl-Pak bags can be the beginning of a journey toward a more sustainable work environment.

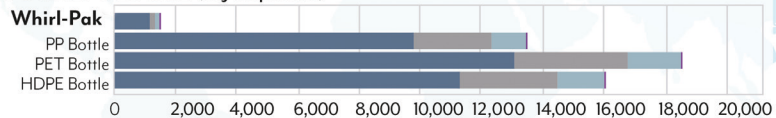


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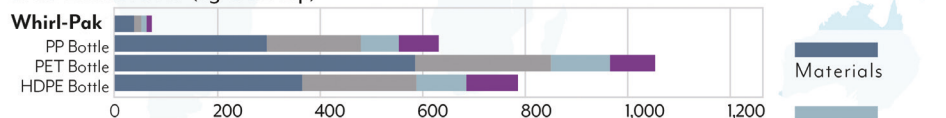
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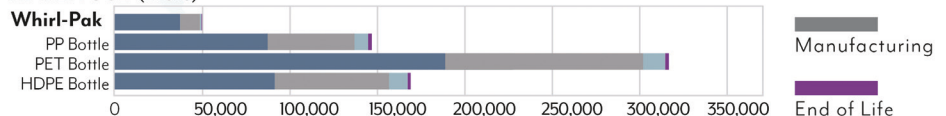
FOSSIL FUEL USE (MJ deprived)



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FEATURED ARTICLE

Feeding Our Future:

A New Sustainable Option for Diversifying Our Diets

By Gina Wynn

With the planet's population at 7.7+ billion and growing, giving everyone access to a nutritious, protein-rich diet will only become more difficult in the years to come. Our current method of growing and distributing food is already taking a tremendous toll on the environment. And beef and other protein sources are often priced out of the reach of lower-income communities.

A team of Tufts University researchers have set out to tackle these problems. They've been working to develop a new alternative meat source with a low environmental impact that can be easily grown and distributed. It's based on cultured caterpillar cells.

Natalie Rubio is leading the study with the help of team members Kyle D. Fish and David Kaplan, PhD, from the Biomedical Engineering Department and Barry A. Trimmer, PhD, from the Biology Department. The team received funding for the project through a New Harvest Cultured Tissue Fellowship.

As a long-time vegetarian, Rubio hopes her work with cultured cells will make an impact on the food system. "We're producing food in a more efficient, more straightforward manner," she said. "Because we don't use animals, it's also a lot better for the environment, it can have great impact on public health and food safety, and it has great benefits for animal welfare."

Improvements to Agriculture

Rubio's team is trying to improve upon both animal-based and plant-based food systems. In addition to compromising animal welfare, livestock farming produces significant global greenhouse gas emissions of methane and nitrous oxide from animal waste. Caring for cattle and providing land for herds to graze on depletes natural land and water resources. And rearing livestock uses valuable cropland to grow animal feed instead of food for humans.

There are more practical considerations as well, according to Rubio. "Conventional animal agriculture is very resource intensive because you are creating entire animals that are really complex ... and then harvesting only specific parts, just their muscle and fat tissue."

Plant-Based Boom

While plant-based alternatives to meat are less harmful to the environment, some argue that they lack the quality, complete proteins that humans need to build muscle and stay satiated. And one of those alternatives, the commonly used high-quality protein soy, has raised concerns about its potential side effects.

Impossible Foods, which uses soy in its Impossible Burger, addresses those concerns directly.

In the article "Soy: facts, myths and why it's in our new recipe" on the company's website, author Sue Klapholz, MD, PhD, vice president of nutrition and health, disputes assertions that "soy causes breast cancer, decreases male fertility, and interferes with thyroid function."

Nevertheless, the market for plant-based food alternatives is certainly a strong one. The Impossible Burger that launched in 2016 already released a 2.0 version in 2019 that is now available in over 15,000 restaurants in the United States, Hong Kong, Macau, and Singapore, and in grocery stores in eight states.

Rubio agrees that plant-based products meet the needs of many people, but she believes in giving people options. "This isn't a problem that needs one solution. I think having many alternatives for people to choose from that have different benefits is really important," she said.

For some die-hard meat lovers, plant-based alternatives just don't cut the mustard. According to Rubio, "Going plant based is a good solution, but most people still eat meat. It doesn't satiate the desire for meat."

A Fatty, Juicy Alternative

Rubio believes that with cultured caterpillar and other insect cells, she and her team have a good chance of being able to reproduce the savory, juicy taste and firm texture of meat that people enjoy. They've already had some success at manipulating the nutrition and texture of insect meat to mimic the muscular consistency of beef.

"What's lacking is the less processed products. A lot of plant-based alternatives are ground meat substitutes, but there aren't really any substitutes for steak or 'natural' whole cuts of meat," said Rubio. "That's something we see as being more achievable with cultured meat. Since it is actual skeletal muscle, it should look, taste, and feel exactly like whole cuts of meat from an animal."

The key, according to Rubio, is fat. So far, her team has focused on cultured muscle cells, but now they are going to incorporate cultured fat cells into the research. The fat should bolster nutrition and add different properties to the products, the most important being juiciness.

continued on page 19



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Feeding Our Future: A New Sustainable Option for Diversifying Our Diets

Caterpillar Versus Cow Cells

Why not manipulate cow cells instead of caterpillar cells to achieve this goal? A team of scientists in the Netherlands led by Professor Mark Post of Maastricht University has already made progress in this area. In 2013, they created the first lab-grown hamburger made from stem cells — at a cost £215,000. But the price would decrease significantly once demand was established, Post told reporter Pallab Ghosh in the BBC News article “Team wants to sell lab grown meat in five years.”

“The number one challenge with cultured meat production right now is it’s difficult to produce large amounts of it and it’s very expensive to produce,” said Rubio. “Mammalian cells like cow, pig, and chicken cells are pretty picky about the environment they grow in. They need a specific temperature, a specific pH, and the right balance of nutrients and oxygen to grow really well.”

Rubio and her team find insect cells more suited to growth in a lab because they have different growth properties than mammalian cells. “They are more tolerant of their environment and can survive in a larger range of temperatures and pHs and with fewer nutrients,” said Rubio. “By using a different cell source, we can make the technology easier and cheaper to do.”

Scaling Up Locally

And scaling up caterpillar meat production would be more affordable as well. You just need a small colony of caterpillars to get started, according to Rubio, whose team harvests their colony’s eggs to isolate the embryonic cells. They then culture the cells to turn them into muscle and fat. They can keep them cultivated in the lab for a long time.

“The focus of scaling is inducing those cells to multiply in the right environment,” said Rubio. “Right now in the lab we do that on a pretty small scale — on the scale of milliliters of growth media, which is what we feed the cells.”

She envisions the process to be similar to the pharmaceutical industry’s use of cell cultures to produce therapeutics or beer breweries’ use of giant fermenters to produce alcohol from yeast. Large bioreactors or fermenters would enable cells to multiply in controlled environments. When the cells reached a sufficient density, they would collect the cells and process them into food products.

“It would be a huge savings of land and water in terms of environmental impact,” said Rubio. And such a process could be easily managed on a local level to provide low-cost meat alternatives to underserved communities.

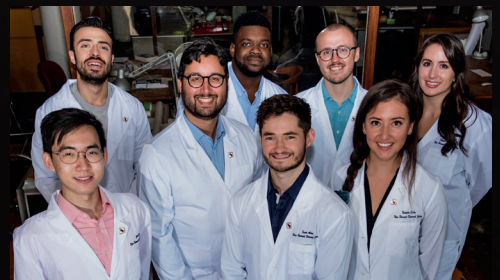
Edible and Nutritious

But the team’s research isn’t quite at the stage where a product has been developed and is ready to go to market. As the only group focusing on culturing insect cells for food applications, they understand there is still much to learn. Rubio doesn’t know what challenges or regulatory hurdles her cultured meat product might face and if consumers would even be on board with it.

She speculates, however, that if people tried it, they would find her meat substitute “nothing too foreign.” When its cells are not manipulated, caterpillar meat is said to have a similar taste and texture to seafood like lobster and crab. But that is not the end goal. Rubio and team are working on the cellular level to influence the flavor and texture, so the finished product will be indistinguishable from meat.

“We’re not trying to introduce a new product [category],” said Rubio. “We’re looking to produce food items that look just like burgers, steaks, bacon, or chicken breasts.”

Essentially, the research team is just using a different cell source to produce the meat that people are already familiar with, just like how people use artificial crab instead of real crab in recipes to cut costs. Rubio explained that the species the meat comes from would be different, but it would still be edible, nutritious food — healthy for us, and vastly better for the health of our planet. 🌱



SAFETY



Green Chemistry: Protecting Our Planet and Ourselves

By Mike Howie

Chemistry has given our world unprecedented scientific advances. From plastics to fuel, fertilizers, medicine, and more, its fruits pervade daily life. But, at the same time, chemistry has taken a toll on our health and our planet: Toxic waste. Polluted air and water. Hazardous working environments. And we don't need to ingest these chemicals to feel their negative effects. Phthalates, which can be found in paper, backpacks, and vinyl tile, have been linked to learning disabilities, loss of IQ, and behavioral issues in children. But our days of worrying over invisible chemical ingredients may be coming to an end thanks to green chemistry.

Green chemistry is promoted in part by the United States Environmental Protection Agency (EPA), which coined the term in 1990 after the Pollution Prevention Act made prevention rather than control the preferred strategy for dealing with environmental pollution. On its website, it explains that green chemistry "is the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances." And this concept applies to the entire life cycle of a product, from design and manufacture to use and disposal.

To that end, green chemistry calls on chemists from every discipline to examine their work and reduce the negative impacts that chemical products and processes can have on human health and the environment, ultimately aiming to prevent pollution at the molecular level. A difficult goal to be sure, so the EPA dissects it into 12 principles:

1. Prevent waste
2. Maximize atom economy
3. Design less hazardous chemical synthesis
4. Design safer chemicals and products
5. Use safer solvents and reaction conditions
6. Increase energy efficiency
7. Use renewable feedstocks
8. Avoid chemical derivatives
9. Use catalysts, not stoichiometric reagents
10. Design chemicals and products to degrade after use
11. Analyze in real time to prevent pollution
12. Minimize the potential for accidents

Green chemistry is good for not only life on Earth but also business, as we've seen in its successful application. Ibuprofen was once produced in a six-step process that wasted 60 percent of the weight of all the atoms in the ingredients. But in the 1990s chemists developed a three-step process to develop ibuprofen with 77 to 99 percent atom economy, making production not only more environmentally friendly, but also easier.

Similarly, science and technology company Amyris engineered a yeast that converts sugars into farnesene, a hydrocarbon that can be turned into a renewable alternative to petroleum diesel that reduces emissions and contains no sulfur or particulates — all while performing better in low temperatures.

The advantages of green chemistry are clear. For chemists and the companies at which they work, it provides safer workflows with less exposure to hazardous chemicals and potential accidents while reducing waste and helping to enhance sales with products labeled as safer for the environment. For consumers, it provides cleaner air, food, and water while reducing exposure to toxic chemicals that work as endocrine disruptors and carcinogens. And for the environment, it lowers the potential for ozone depletion, global warming, and smog formation while reducing the use of landfills. These are just a few of the benefits.

Green chemistry is on the rise, with prominent institutions like Yale University and the American Chemical Society adopting and promoting its philosophy. It is an evolution of chemistry that has and will continue to lead to scientific innovations that make life better for us all. 🌱



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Laying the Groundwork for Soil Moisture Monitoring

By Kevin Ritchart

While meteorological events like hurricanes, tornadoes, and floods can cause a great deal of damage in a short period of time, droughts can be just as devastating.

A spate of recent droughts has had a major impact on farmers and ranchers in Montana, which caused a significant downturn in the state's economy.

Previous drought prediction efforts focused mainly on rainfall, stream flow, and water storage, but they were ineffective because they ignored soil moisture. So researchers and scientists worked together to come up with a better way of predicting drought conditions.

This led to the installation of soil moisture sensors in strategic locations and at varying depths, which allowed experts to make more accurate determinations about drought conditions.

Casting the "Net"

The Montana Climate Office has created a cooperative statewide soil moisture and meteorological information system known as the Montana Mesonet.

The goals of the Montana Mesonet are to combine soil moisture and meteorological information from existing data networks, establish 100 new soil moisture recording sites, and provide a system for accessing historical, real-time, and forecasted data.

The analysis of these environmental factors helps support decision-making in agriculture, range, and forested watershed contexts. The mesonet has already made progress in these areas through the addition of new remote sites and by integrating existing networks to develop the first statewide soil-climate network.

What Is a Mesonet?

A mesonet is a network of automated weather and environmental monitoring stations designed to observe mesoscale meteorological phenomena. The term refers to the collective group of stations that are typically owned and operated by a common entity.

Weather phenomena including dry lines, squall lines, and sea breezes can be observed by mesonets. They typically record surface weather observations, but they also can involve other observation platforms like vertical profiles of the planetary boundary layer.

Working Together

The Montana Climate Office coordinates the state's mesonet and its partnerships with a number of environmental, agricultural, and educational institutions across the state.

The partnerships are aimed at developing an integrated climate-soil water monitoring network throughout Montana to serve the agriculture economy and improve drought resilience.

The groups are expected to work together to support the 56 monitoring stations currently in place and identify locations where additional monitoring could be needed.

A View from Above

While the information collected from the underground soil sensors has been invaluable, the Montana Mesonet could soon be getting data from a more celestial source.

Microwave observations from NASA's Soil Moisture Active Passive Mission satellite can provide statewide remotely sensed soil moisture information. The technology works on the principle that moisture in the soil changes how much incident microwave energy is reflected from Earth's surface.

The satellite's detection of the development of extreme soil moisture deficits and vegetation impacts during Montana's 2017 Flash Drought proved the system's ability to provide early warning of emerging drought conditions. Actual ground data from Montana Mesonet stations helped verify the accuracy of the satellite system measurements.

National Network

While Montana's recent efforts — and subsequent successes — have put the state at the forefront of the mesonet conversation, other states have instituted similar programs.

In fact, there's a National Mesonet Program that has a mission of ensuring a weather-ready nation and delivering critical information that's vital to improving weather prediction and warning systems across the country.

Origin Story


The idea of creating a National Mesonet took root in 2006 when the Congressional UrbanNet Program began leveraging existing local weather tracking stations that report near real-time observations to better assess and respond to potential hazards and incidents in U.S. metropolitan areas.

Since that time, the National Mesonet Program has grown to become a Program of Record within the National Oceanic and Atmospheric Administration's National Weather Service, using surface networks, mobile observations, and remote sensing data to improve forecasts and support critical decisions made daily across the country.

What Happens Next?

In the coming years, the Montana Climate Office will be developing user-guided applications and web-interface tools that use soil moisture and weather information to help farmers, ranchers, and other resource managers make critical decisions.

Knowing that plant-available water is approaching critical minimum values, ranchers will be able to make arrangements to purchase hay or move or sell cattle early, before prices drop.

Additionally, government agencies can obtain a clearer picture of drought effects in the state and target relief efforts accordingly. More accurate weather and soil moisture information can result in statewide savings of several million dollars each year. 

Sustainability

Examining the Costs and Environmental Impact of Water Aspirators

Water Aspirators are a common way to create a low-strength vacuum for many standard laboratory applications. Their simple design employs water running through a narrowing tube to create a reduced pressure via the Venturi effect. The pump's performance is dependent upon the temperature and pressure of the water, two variables that often change based on the number of users and the ambient temperature, resulting in an unreliable vacuum source. In addition, when being used in chemistry and biology labs, aspirators allow potentially hazardous solvents to mix into the water stream and flow down the drain. Because a stream of continuously running water is required to operate the pump, a significant amount of water is wasted. The cost of water coupled with the environmental impact of wasted water and solvent pollution need to be considered.

Waste and Cost

With growing pressures due to drought conditions and water shortages throughout the United States, restrictions on water usage are tightening and the cost of water is steadily increasing, with a 33% rise in recent years.¹ An average aspirator pump uses at least 50,000 gallons per year (see "Thirsty Aspirators" section). Besides the sheer waste this represents, in the U.S. this amount of water costs nearly \$200 to \$1,500.² Growing restrictions and increasing water prices ensure that the cost of operating a water aspirator will grow even more expensive and will likely gain greater regulatory scrutiny in the future.

Environment

Handling potentially hazardous solvents is a normal part of common laboratory practices in chemistry and biology labs. Special care must be taken to prevent solvents and solvent vapors from being released into the environment. By design, water aspirators are susceptible to exposing solvents to the water stream and subsequent discharge into the drain. This may cause violations of existing environmental protection laws leading to fines and legal ramifications. While many have turned a blind eye to these types of

can negatively impact the pump's performance and consequently the quality and speed of the work being produced.

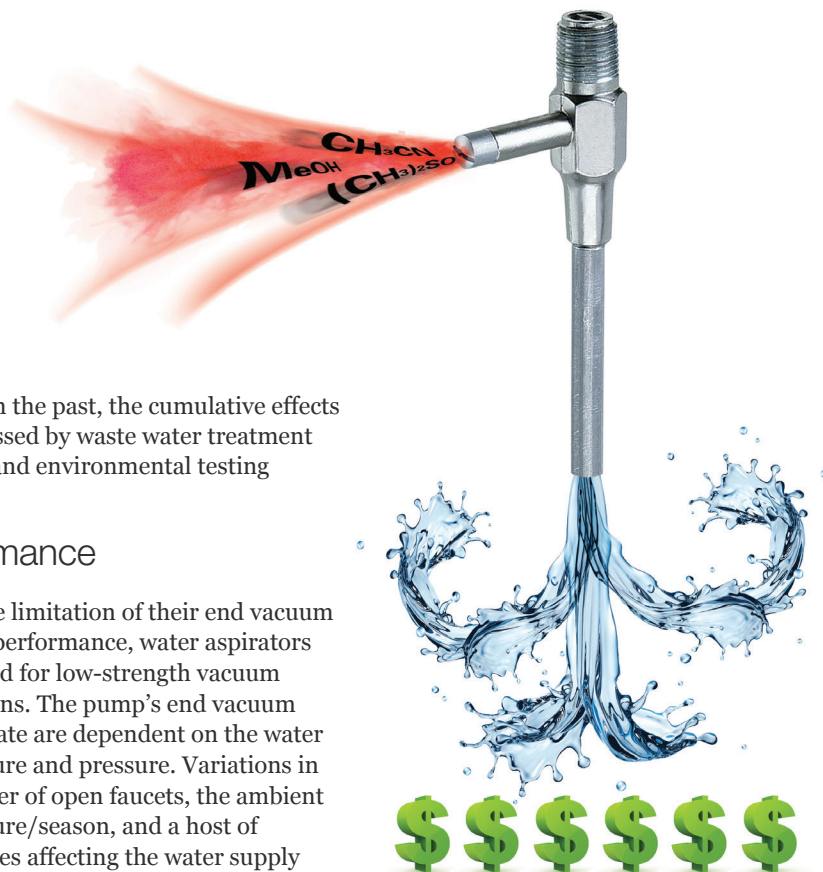
The Solution

While the upfront purchase price and ease of use of water aspirators may make them appear to be an attractive option for low-strength vacuum applications, the hidden costs of ownership are significant and growing. As the price of water increases and

releases in the past, the cumulative effects are witnessed by waste water treatment facilities and environmental testing agencies.

Performance

Due to the limitation of their end vacuum and flow performance, water aspirators are utilized for low-strength vacuum applications. The pump's end vacuum and flowrate are dependent on the water temperature and pressure. Variations in the number of open faucets, the ambient temperature/season, and a host of other issues affecting the water supply



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the restrictions on water usage and environmental protections tighten, water aspirators become more of a liability than an asset. Simple and cheap has become limited and expensive to operate.

Other pump technologies are better suited to provide consistent vacuum performance at an economical price while being in line with growing environmental initiatives. Alternatives like oil-free diaphragm pumps offer deeper end vacuum capabilities and higher flowrates, minimal operating cost, and economical purchase price. In fact, operating cost savings realized by replacing a single water aspirator will quickly offset the up-front and monthly power costs of switching to an oil-free diaphragm filtration pump, leading to a quick payback period — often less than one year.

THIRSTY ASPIRATORS

With concern over water usage on the rise, use of aspirator pumps is understandably under scrutiny due to their excessive water consumption.

A typical aspirator pump requires 1.5 to 2 gallons of water per minute to operate.³ Assuming an average of 1.75 gal/min and an average usage of 3 hours per day, 4 days a week for 10 months a year, one aspirator pump uses more than 50,000 gallons (189,000L) per year. To put this amount of water in perspective, it is equivalent to:

- 39,062 flushes of a low-flow toilet.⁴
- 3,215 eight-minute showers, or a single shower lasting 416 hours.⁴

- Washing 1,852 loads of laundry.⁴
- 1.4 years' worth of water consumed by the average American household for outdoor uses (watering lawns and gardens, etc.).⁵
- 1,250 cars washed at a water-efficient car wash facility.⁶

When one considers the number of facilities with multiple water aspirators in operation, these numbers become staggering!

Note: Although recirculating aspirators consume less water, they still require disposal of contaminated water and suffer from degraded vacuum performance.

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All citations retrieved on 7/22/2015.



 Sustainability

Sustainability Doesn't Mean Sacrifice: Our Cold Storage Solution Is the Best of All Worlds

By Joshua Lewis, Global Product Manager of Ultra-Low-Temperature Freezers

World leaders at the 2019 G7 meeting made climate change a focus and brought renewed attention to one of the modern world's leading contributors: cooling.

Safeguarding our depleting ozone layer continues to be a top priority. Several countries attending the G7 pledged to improve the cooling sector by phasing down refrigerants like hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs), which have been shown to negatively impact the ozone layer.

The Significant New Alternatives Policy (SNAP) is part of the 1990 amendments to the U.S. Clean Air Act. The Act calls for states and the U.S. Environmental Protection Agency (EPA) to solve multiple air pollution problems through programs based on the latest science and technology information.

SNAP requires the identification of known ozone-depleting substances (ODS) and an evaluation of substitutes in applications that have historically used ODS. Evaluation includes overall human health and the environmental impact of both existing and new alternatives. The EPA has approved various natural refrigerants for refrigeration sealed systems and has established phase-out dates for HFC insulating foams.

Thermo Fisher Scientific is leading the cold storage industry with the

transition to cleaner, lower energy SNAP-compliant refrigerants and zero-waste manufacturing.

The Thermo Scientific TSX and STP series ultra-low-temperature (ULT) platforms use SNAP-compliant green hydrocarbon (HC) refrigerants: propane and ethane. Hydrocarbon ULTs reduce CO₂ emissions by over 30%*, and ENERGY STAR models can save you more than 50% in energy usage costs.

In addition to being better for the environment, HC refrigerants promote lower temperatures and pressures within the refrigeration system. This drastically reduces the mechanical stress on refrigeration components and can extend the life of the system. Today's models that have HC refrigerants along with vacuum panel insulation demonstrate less peak variation, lower noise, higher capacity, and improved overall performance.

Thermo Scientific TSX and TSG Series Refrigerators and Freezers are also ENERGY STAR certified and SNAP compliant. These high-performance refrigerators and freezers are available as large-format models and undercounter units, so there's a model for every lab and need.

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also manufactured in a zero waste to landfill facility: more than 90% of the waste generated at the North Carolina manufacturing site is diverted from landfills.

Thermo Scientific cold storage equipment combines the best of sample protection and sustainability, delivering reliable and precise cooling:

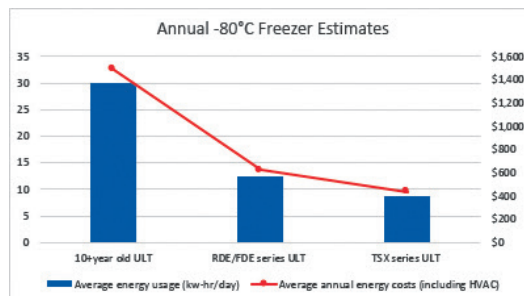
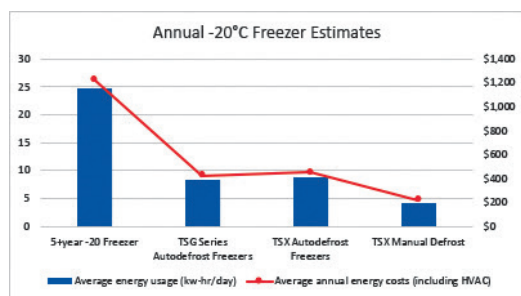
- SNAP compliant with natural refrigerants that protect the ozone layer
- ENERGY STAR certified with significant cost savings over older models
- Manufactured in a zero-waste facility

Let Thermo Fisher Scientific help you bring the green movement to your laboratory.

Visit fishersci.com/tsx or fishersci.ca/tsx to learn more about TSX series products, and visit fishersci.com/revcoforma or fishersci.ca/forma to learn more about STP Series products.

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thermo scientific



*Data based on internal testing from 2017 to 2019. Reduction in CO₂ emissions is dependent on freezer size.

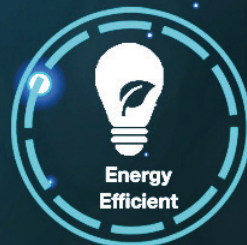
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 Sustainability

Science and Sustainability in the Laboratory — A History of Waste

If current production and waste management trends continue worldwide, researchers in California predict that roughly 12,000 metric tons of plastic waste will end up in landfills or in the environment by 2050. Despite scientists making up only a small fraction of the world's population, they are big contributors to the plastic problem. Many common laboratory items are single-use plastics that are thrown away rather than recycled. Researchers at the University of Exeter estimated that laboratories were

responsible for around 5.5 million metric tons of plastic waste in 2014 — roughly the same as the weight of 67 cruise liners.

Scientists may justify their use of disposables and single-use plastics as a necessary evil that saves their laboratories time and money. But with the plastic-waste problem snowballing, the scientific community can no longer ignore their impact on the environment. Most scientists are well-aware of the amount of plastic waste that their research produces. Worldwide, researchers are beginning to embrace greener laboratory practices by reducing, reusing, and recycling laboratory items that have traditionally been thrown into the trash. And many laboratory supply companies are working to meet the needs of new, greener labs.

Greening Up Research

Laboratory plastic waste comes from a variety of sources, including PCR tubes, tissue culture flasks, pipette tips, and packaging. Most of this waste ends up in the landfill — unless it's particularly hazardous, in which case it ends up in an incinerator. Arta Motadel, Chief Technology Officer of Biotix, recalls being “shocked by the scale of unnecessary waste” when he began his career in bioengineering and biochemistry nearly 30 years ago. With years of hands-on experience as a laboratory engineer and decades working in pipette design, he has been seeing the growth of this dilemma firsthand. He decided that his contribution would be innovating at the manufacturing

level to address this problem and minimize waste at the source.

Many single-use lab plastics can be recycled if they aren't highly contaminated. Several universities and biotech laboratories have introduced recycling programs to reduce plastics entering the waste stream. For example, the Lab Plastics Recycling Program at the University of British Columbia allows all number 1–7 plastics to be recycled, including wrappers from plates and flasks, pipette tip boxes, as well as plastic waste containing Risk Group 1 Agents — deemed low risk for individuals and the community by Health Canada — such as tips used for DNA extraction.

Sustainability Minded

Sustainability-minded companies such as Biotix are embracing comprehensive ways to minimize the amount of plastic entering the waste stream. Biotix is accomplishing this through a well-rounded approach that focuses not only on reusing and recycling plastic items once they have been created, but also addressing the issue at its core by minimizing the amount of plastic used in creating these products.

Biotix pipette tips contain roughly 30% less plastic than competitor tips. This innovative design called FlexFit enables researchers to continue using and disposing of tips at the same rate while still reducing their environmental footprint. As an added benefit, the pipette



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tips' thin-walled design avoids the need for excessive forces during manual or automated processes, reducing energy expenditure. Stackable pipette tips that insert straight into an existing pipette tip rack, such as Biotix CleanPak Reload Tips, reduce environmental impact even further. The company also makes products that offer dual functionality. Biotix pipette tip rack bases are thin walled but strong; they are reusable as automation or manual reagent reservoirs, reducing the need to purchase a second item (and more plastic).

Switching to low-plastic or reusable laboratory items can have a huge impact. Looking at the chart shown here, if a single researcher switched to Biotix racks from competitor E, they would be

reducing their environmental footprint by more than one pound of plastic per pack. Or if a researcher opted to use Biotix CleanPak Reload Tips, inserting them into an existing pipette tip rack, they would prevent another 30% of plastic waste from going to the trash. To combat the plastic problem further, the resealable bags used for the Biotix CleanPak Reload Tips can be reused as storage bags for tubes or other laboratory sundries, eliminating the need for other storage bags.

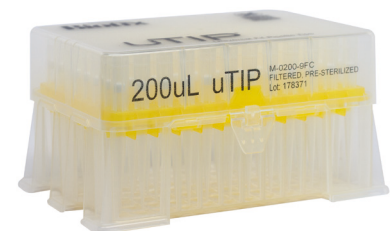
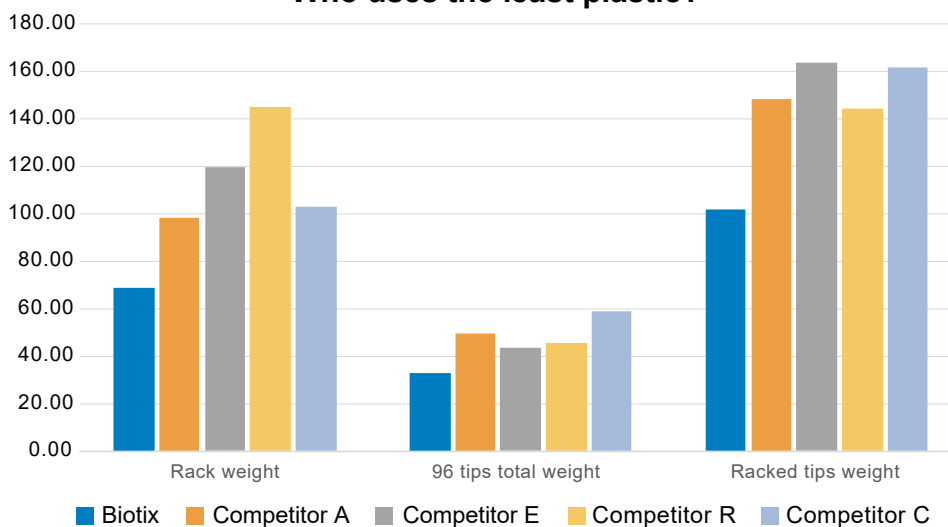
Combined, Biotix's numerous environmentally conscious products and practices are reducing the amount of plastic entering landfills. Their commitment to providing products that offer sustainability alongside exceptional quality is helping

laboratories integrate greener practices into their workflows without sacrificing accuracy or productivity.

With the worldwide scale of research likely to increase in the coming years, finding a comprehensive approach to minimize laboratory product waste is more important than ever. Biotix's innovative product designs minimize the amount of plastic required to produce laboratory plastics, effectively reducing plastic waste at the source. In combination with reuse and recycling, the efficient designs support scientists in doing their part to combat the negative impacts of plastics on the environment. Biotix is committed to making high-quality products with less plastic, providing a hint of what a sustainable laboratory culture will look like in the near future.

Weight (grams)

Who uses the least plastic?



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13-880-90

Specifications	
Flow Rate	20L/min.
Vacuum	1.5 torr (2mbar)
Control	Wireless Remote, Windows Based
Power/Current Consumption	135w/1.7A
Hose Connection, Pneumatic	3/8 in. I.D. (10mm)
Hose Connection, Coolant	5/16 in. I.D. (8mm)
Net Weight	33 lb. (15kg)
Dimensions (L x W x H)	11.6 x 14.4 x 16.7 in. (29.4 x 36.6 x 42.3cm)

Description	Electrical Requirements	Mfr. No.	Cat. No.
Vacuum Pump System	120V 60Hz	SC920	13-880-90
Optional Coolant Valve		117121	13-880-951

Direct and Indirect Sonication

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 500w 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 because there is no 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	<ul style="list-style-type: none"> • Basic Cell Disruption 	0.2 to 50mL	50w	FB50110
120	<ul style="list-style-type: none"> • Cell Disruption • Protein Extraction • DNA Shearing/ChIP 	0.2 to 50mL	120w	FB120110
505	<ul style="list-style-type: none"> • Cell Disruption • Nanoparticle Dispersion • Homogenization/Mixing 	0.2 to 1000mL	500w	FB505110
705	<ul style="list-style-type: none"> • Cell Disruption • Protein Extraction • DNA Shearing/ChIP • Nanoparticle Dispersion • Homogenization/Mixing • Sonochemistry 	0.2 to 1000mL	700w	FB705110



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Fact or Friction

Your Balance Static Questions Answered

Is your balance display slowly drifting while trying to take a weight? Have weighing processes been optimized but the balance reading is still unstable? These issues are often attributed to a well-known culprit: static electricity.

Electrostatically charged samples can not only be a frustration in the lab, but they can adversely affect weighing accuracy, waste product, and lead to significant errors. Learn more by reviewing common questions and answers about static.



Fact

Friction, while not the only cause of electrostatic discharges, is the most common by far.

Laboratory tasks such as using a cloth to dry a glass beaker, picking up a measuring flask with disposable gloves, or filling a weigh pan with powder can generate measurable electrostatic charges that interfere with weighing results.



Fact

The climate conditions of your lab affect your weighing results. Relative humidity less than 40-50% increases issues with electrostatic charge.

This is because the lower the humidity, the less chance of charged particles finding water molecules to “surf” across and get to a convenient ground.

Depending on the relative humidity, a charge may take from a few seconds to several minutes to dissipate. In a controlled, dry atmosphere (less than 20% relative humidity), charges on material may cause weights to drift several hundred milligrams and persist over many hours.



Fiction

There is no way to dissipate electrostatic charges.

METTLER TOLEDO anti-static kits use alternating current (AC) to generate ions that neutralize the electrostatic charge of a sample or container immediately. This method is effective, completely safe, and does not disturb air currents or increase stabilization time. The time-savings, efficiency gains and safety improvements make it a sound investment that lab specialists often wish they had made earlier.





The XPR Solution

Advances in METTLER TOLEDO analytical weighing technology enable the latest generation of analytical balances to automatically detect the presence of electrostatic charges during a weighing operation. The magnitude of this force can be measured and recorded. Using an integrated ionizer module, these electrostatic charges can be eliminated to avoid any influence on the weighing result. As the static detection cycle is performed while the balance settles, taking only a few seconds, it causes no delay in obtaining the weighing result.

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Don't let drifting and unstable reading come between you and accurate results this winter, or anytime throughout the year!

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XPR Analytical Balances

- XPR205 (01-919-124)
- XPR205DR (01-919-125)
- XPR105 (01-919-121)

Anti-Static Kit with Large U-Electrode (01-910-021)

Don't Have an XPR Balance?

No problem – universal kits can be used with all balances and weighing substances. Kits include an electrode and universal power supply.

MAXIMUM PERFORMANCE AUTOCLAVE



TYPE	Volume (Liters)	Chamber Dimension (WxD) mm	External Dimensions (WxHxD) mm	Heating Capacity kW	Electrical Supply
Labstar 200	200	Ø 500 x 1000	750 x 900 x 1250	9,0	460V 50/60Hz, 20A

FEATURES

- Easy-to-use touchscreen
- 10 variable program channels for maximum flexibility
- Password-protected parameters
- Round chamber
- Maximum allowable operating temperature up to 135°C
- Equipped with electronic pressure sensor and PT100 temp sensor
- Fully-made from stainless steel

DESCRIPTION OF THE INDIVIDUAL COMPONENTS

- **Steam generator** – integrated in the housing of the autoclave. Ensures rapid heating and cooling compared to conventional heating systems.
- **Vacuum pump set** – for mechanical removal of air and drying in vacuum. Possible methods include single-stage vacuum, fractionated vacuum, constant or pulsating drying under a vacuum.
- **Exhaust air filtration** – is stipulated for the sterilization of pathogenic substances in S2/S3 laboratories, with inline condensate sterilization.
- **Touch display (SteriTouch control)** – enables simple and intuitive operation at the autoclave. In combination with user-friendly software, the autoclave can be operated quickly, but it is also highly variable and simple.
- **Steam-air mixture method** – for the sterilization of tightly closed bottles and pressure-sensitive materials. An additional temperature sensor, air deflectors and a circulating air fan ensure precise temperature control and distribution.
- **Rapid water recooling system with air-circulating fan** – allows a shortening of the recooling time by more than 80% compared to the self cooling during sterilization of liquids. This is due to an internal heat exchanger, also known as a “fast cooler,” through which water flows.

NEED MORE INFORMATION?



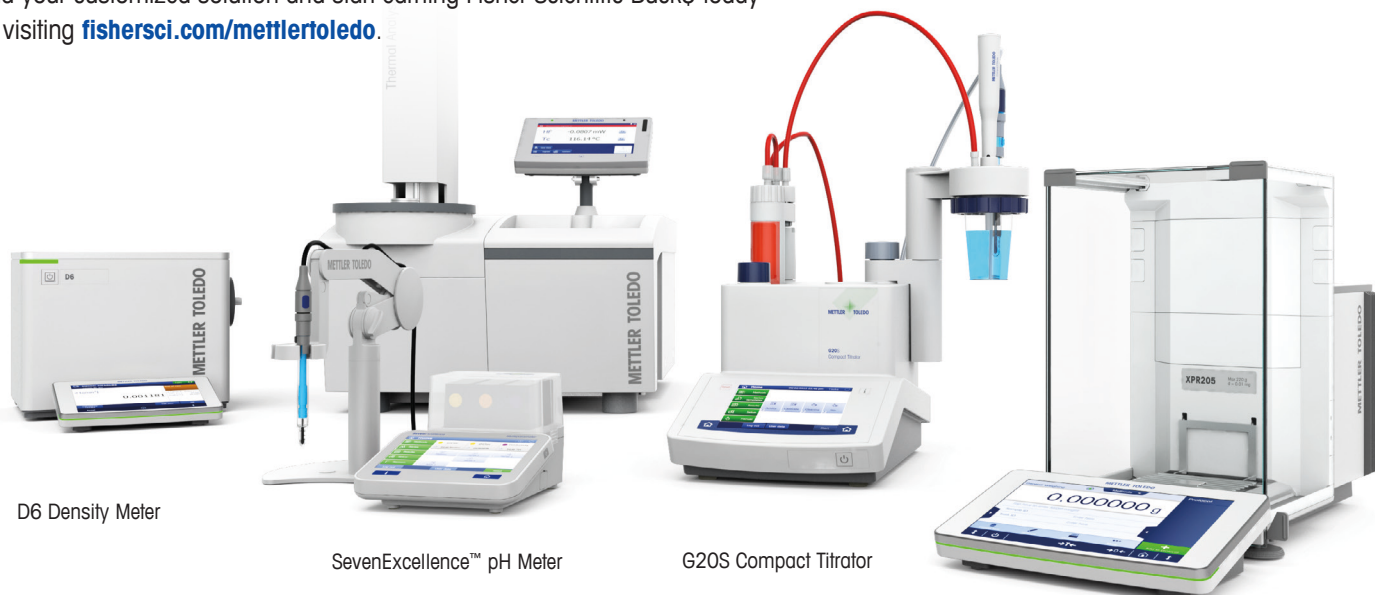
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Sartorius Entris II Balances

Whatever you're weighing, the new Sartorius Entris II is the right choice. Offering value at an affordable price, it's the only balance in its class that features isoCAL, LED touch technology, and 12 built-in applications.

Backed by almost 150 years of German engineering expertise and with 40 different models, the Entris II line of balances surely has a model that meets your specific weighing needs.

Functionality

- Fast stabilization time
- Overload protection
- Quick connection to printers, a second display, or a PC

Technology

- Reliable monolithic weigh cell technology (invented by Sartorius)
- isoCAL internal calibration and adjustment with notifications
- LED and touch technology hybrid screen

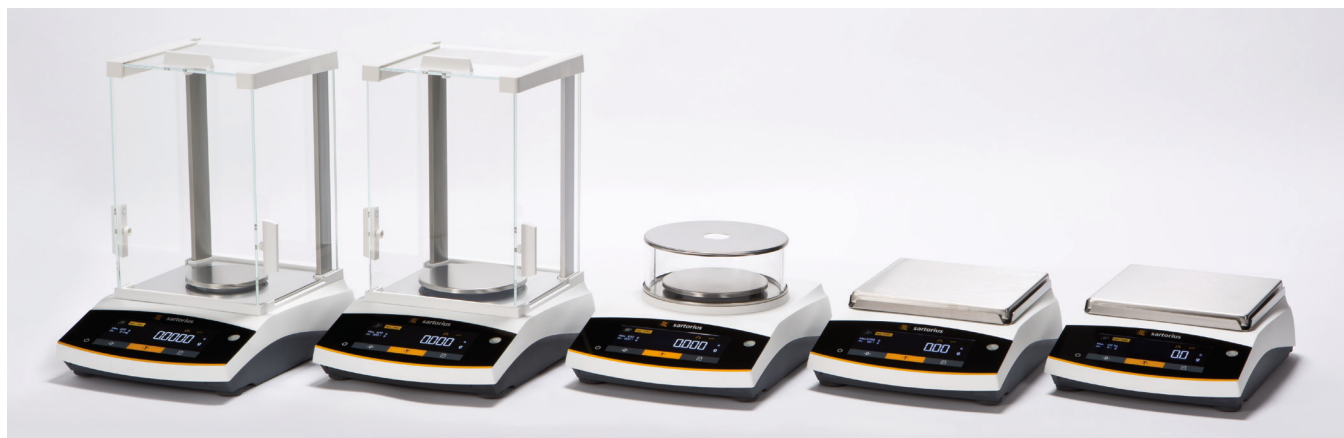
Maintenance

- Made from stainless steel, glass, and polybutylene terephthalate (PBT)
- Wipe clean design with chemical-resistant surfaces
- Easy-to-remove parts

Product Selection

- 40 models: Capacities from 60g to 8,200g with readability from 0.1mg to 1g
- 12 built-in applications (GLP/GMP compliant)
 - Weighing and dosing
 - Counting
 - Percentage weighing

- Mixing and net total
- Components and totalizing
- Animal weighing
- Calculation and free factor
- Density determination
- Statistics
- Peakhold
- Check weighing
- Mass unit conversion
- Underfloor weighing options (for larger samples)
- Weighing chamber (certain models only)
 - Height accommodates larger containers
 - Convenient access to weighing pan
 - Easy-to-adjust top and side sliding doors
 - Removable draft shield
- Choose from eight languages: English, German, French, Italian, Spanish, Portuguese, Russian, Polish
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 - RS232 9-pin interface
 - Backwards compatibility
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- 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.)			63 lb. (29kg)	01-184-202
M6C	4.2 CFM (118L/min.)	5 x 10 ⁻⁴ torr (4 x 10 ⁻⁴ mbar)	18.2x6.1x9.1 in. (46 x 16 x 23cm)	63 lb. (29kg)	01-184-203
M8C	5.6 CFM (158L/min.)			65 lb. (30kg)	01-184-204
M16C	12.8 CFM (363L/min.)			200 lb. (91kg)	01-184-205
M24C	18.3 CFM (519L/min.)	3 x 10 ⁻⁴ torr (2 x 10 ⁻⁴ mbar)	22.4x8.1x11.4 in. (57 x 21 x 29cm)	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.



Understanding the Way Plants Breathe

By Kylie Wolfe

For farmers, a successful crop yield requires the right combination of sunlight and rainfall. Many have drainage and irrigation systems to help manage floods and droughts, but sometimes it's challenging to maintain the right balance for a thriving and healthy harvest.

Scientists at the Institute for Sustainable Food at the University of Sheffield may have found a new way to manage this. Just as oxygen gives us life, carbon dioxide fills the "lungs" of plants, and scientists now understand how. Their results were published in *Nature Communications* in June.

The presence of stomata, or pores, on a plant's surface isn't news to botanists. These tiny openings in the epidermis are the entry and exit point for gases traveling to and from plants' intracellular spaces. They let carbon dioxide in and oxygen out during photosynthesis, but what happens beneath the surface?

Stomatal pores are connected to a complex network of air channels. The channels are like bronchioles, providing a way for carbon dioxide to travel from the atmosphere, through the pores on a plant's surface, and to the mesophyll cells within. The stomata ultimately determine the airflow through these channels, ensuring that every cell is supplied with enough for proper function.

"Until now, the way plants form their intricate patterns of air channels has remained surprisingly mysterious to plant scientists," said Andrew Fleming, professor at the University of Sheffield and a member of the research team.

But in collaboration with the University of Nottingham and Lancaster University, they were able to shed light on the development of these pathways.

Using X-ray CT image analyses, they examined species with different leaf structures and found that stomatal development determines the shape and scale of a plant's air channels. But the stomata must be exchanging gases in order to expand the network.

That said, the more stomata found in a plant's epidermis, the more airspace it will form underneath.

"This major discovery shows that the movement of air through leaves shapes their internal workings — which has implications for the way we think about evolution in plants," said Fleming.

While scientists have known about the existence of stomata and the

intricate network of air channels, they weren't sure how the network managed to provide carbon dioxide to every cell. They created a 3D model of a plant's cellular structure to visualize its inner networks and better understand how they develop.

Researchers also determined that by altering the internal structure of plant leaves, they can control how much water it needs. Other scientists have already bred wheat plants with this in mind, creating new versions with fewer stomatal pores. The result is a plant with decreased stomatal density, requiring less water to survive.

Stomata not only play an important role in gas exchange, they're also the site of transpiration. The more stomata present, the greater the loss of water content to the atmosphere. Therefore, altering stomatal pores not only optimizes carbon dioxide intake, it also minimizes water loss.

Through studies like this one, researchers are hoping to find new ways to respond to the challenges of sustainable agriculture.

As scientists learn more about the relationship between stomata, air channels, and water use, they'll have the tools to design more controlled crops that are more efficient and can survive changes in climate.

The Institute's goal is to address the future of food security as it relates to current environmental concerns. Through studies like this one, researchers are hoping to find new ways to respond to the challenges of sustainable agriculture. Their work could help create more water-efficient and drought-resistant crops, including staple items like rice and wheat.

"The fact that humans have already inadvertently influenced the way plants breathe by breeding wheat that uses less water suggests we could target these air channel networks to develop crops that can survive the more extreme droughts we expect to see with climate breakdown," said Fleming. 🌱

Sustainability

BenchStable Cell Culture Media

Content provided by:
thermo scientific



Green benefits

- **Energy efficient:**
ambient-temperature storage
- **Sustainable packaging:**
increased recyclability

The BenchStable media line of products is the first to market basal media engineered for flexibility and convenience, enabling storage at room temperature. This product line is available in the most commonly used basal media formulations: Gibco DMEM, DMEM/F-12, MEM, and RPMI 1640—all of which include Gibco GlutaMAX supplement. BenchStable media products have been optimized for routine cell culture, maintaining expected cellular proliferation, morphology, and functions of many common cell lines, and maximizing cell densities comparable to conventional basal media formulations when supplemented with 10% fetal bovine serum (FBS).

Green features Energy efficient

Cold storage is one of the primary sources of energy consumption in a lab. A 2015 study on laboratory energy consumption by the Center for Energy Efficient Laboratories (CEEL)¹ determined that California laboratories alone use at least 800 GWh of energy each year — equivalent to the yearly greenhouse gas emissions from 127,489 passenger cars². According to the CEEL study, approximately 25% of the energy consumption in a typical lab is from cold storage. One major benefit of BenchStable media is the ability to store the media bottles at room temperature, freeing up valuable refrigerator space and enabling a substantial decrease in energy usage.

Sustainable packaging

Many cell culture reagents are light sensitive and must be protected from light. When designing BenchStable media for ambient-temperature storage, we realized that there would be a greater risk of light exposure when the product was stored out in the open in the lab. We therefore chose a readily recyclable paperboard box with a dark interior to protect BenchStable media from light. Each bottle is still the same Gibco medium bottle made from polyethylene terephthalate (PET) with a high-density polyethylene (HDPE) lid³—two of the most highly recycled plastics⁴. When ready for disposal, the paperboard

cover can easily be removed, if required, and all the materials recycled.

BenchStable media products will continue to be shipped at ambient temperature in a fully recyclable cardboard box. As with this product and for many years, we have shipped our media products under ambient-temperature conditions without the need for expanded polystyrene (EPS) coolers and refrigerants⁵. From reducing packaging during shipping to eliminating the need for cold storage in the lab, our new line of BenchStable media products is one more way we are enabling our customers to make the world healthier, cleaner and safer.

References

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Mini-UniPrep Filters with 0.45µm PTFE Membrane	1000/Pack	09-923-35
Mini-UniPrep Filters with 0.2µm Nylon Membrane	1000/Pack	09-923-106
Mini-UniPrep Filters with 0.45µm Nylon Membrane	1000/Pack	09-923-36
Mini-UniPrep Filters with 0.2µm PVDF Membrane	1000/Pack	09-923-105
Mini-UniPrep Filters with 0.45µm PVDF Membrane	1000/Pack	09-923-32

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