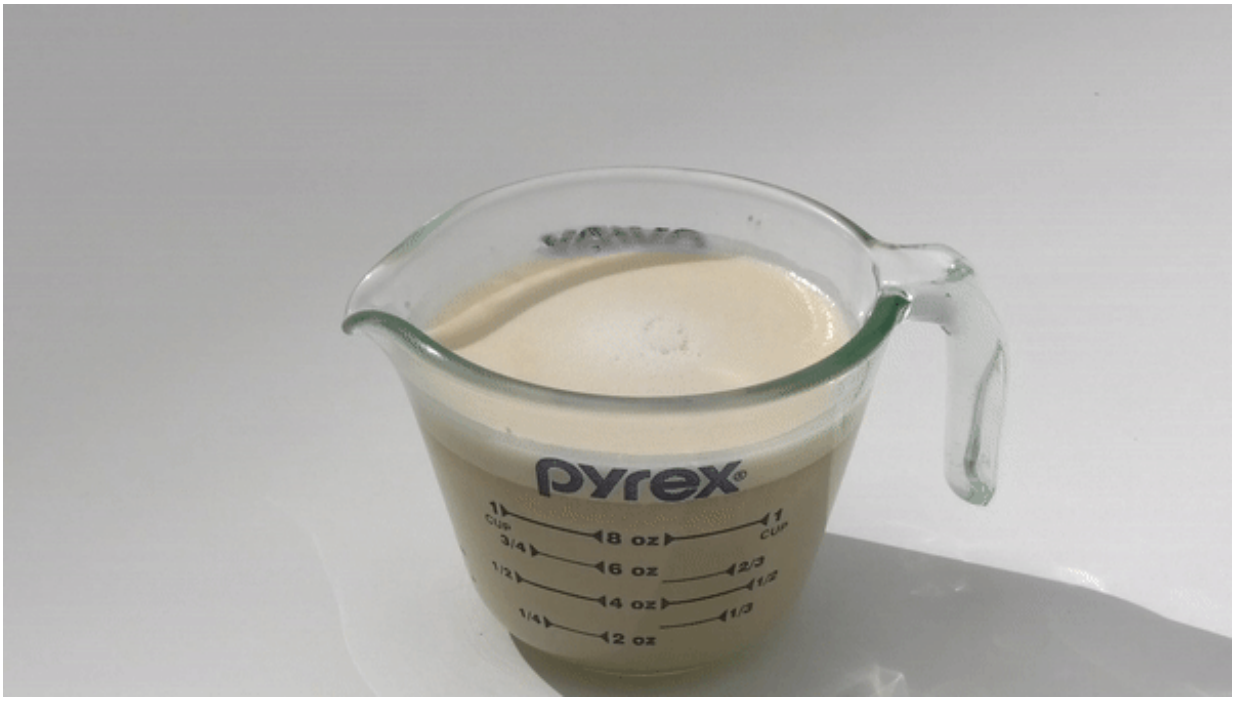
Meet baker's yeast, the budding, single-celled fungus that fluffs your bread

July 10 2020, by Charlotte Hsu



Baker's yeast, Saccharomyces cerevisiae, proofing with sugar and water in a 40-minute time-lapse animation. Credit: Douglas Levere / University at Buffalo

They live in bread dough. They die in your oven.

At the grocery store, where you buy them, they sit in little glass jars, dormant on the shelf, waiting to be rehydrated so they can do their life's work, eating sugar and releasing carbon dioxide to form bubbles in your

bread.

Baker's yeast has become a sought-after pandemic commodity as people bake at home.

But how much do you really know about this organism, a single-celled fungus that scientists call Saccharomyces cerevisiae?

As it turns out, baker's yeast is a common model organism that researchers use to study biological processes, including disease. A number of biologists in the University at Buffalo College of Arts and Sciences regularly grow the species in their labs, and a few took time to discuss the wacky, wonderful science of S. cerevisiae.

What is baker's yeast? (Don't worry —it won't grow into a mushroom)

"Yeast is a fungus that grows as a single cell, rather than as a mushroom," says Laura Rusche, Ph.D., UB associate professor of biological sciences.

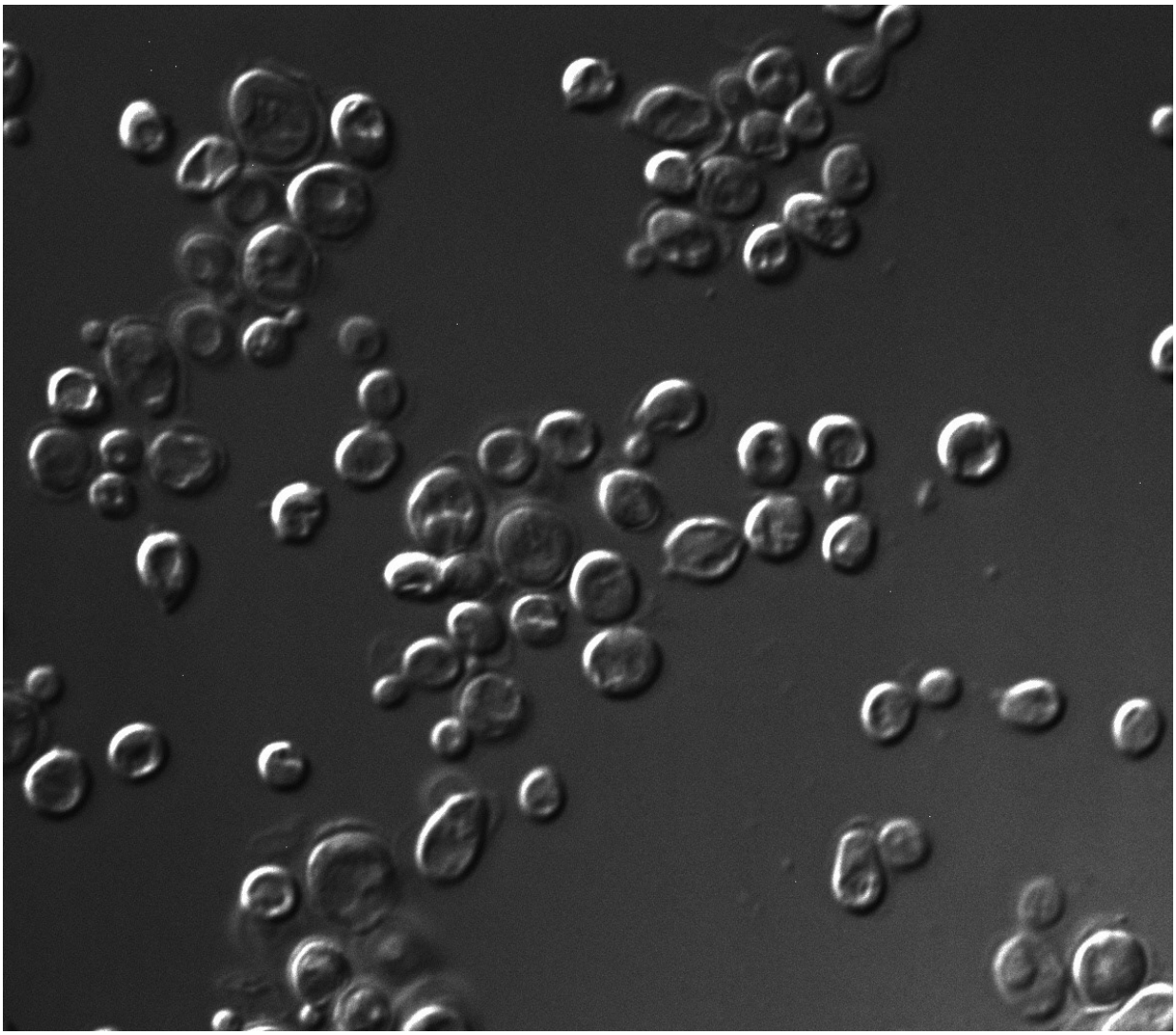
Though each yeast organism is made up of just one cell, yeast cells live together in multicellular colonies. They reproduce through a process called budding, in which a "mother cell" grows a protrusion known as a "bud" that gets bigger and bigger until it's the same size as the mom.

"That's the daughter cell, and it splits off," says Sarah Walker, Ph.D., UB assistant professor of biological sciences. "They're single-celled organisms, so they don't grow to become mushrooms or anything like that."

When food supplies run low or the environment gets harsh, S. cerevisiae

can produce special stress-resistant cells called spores, which can stay dormant for long periods of time, germinating when conditions improve. Regular, non-spore yeast cells can also be preserved through freezing.

"Yeast cells can hunker down and wait—they can go into a sort of suspended animation to survive stress," Walker says. "We can't do it, but they can. In the lab, we put them in a -80 Celsius freezer, so it's a deep freeze, and they are stable for years and years. Later, we take a little bit of the ice out of the frozen culture, and it starts growing again."



Baker's yeast, or Saccharomyces cerevisiae, seen through a microscope in the lab of UB biologist Laura Rusche. Each round object is an individual yeast cell. The cells pictured are a laboratory strain of S. cerevisiae, but wild yeast look essentially the same, Rusche says. Credit: Ashleigh Hanner

What does yeast do in nature?

Out in the world, yeast is all over—on tree sap, on grape skins, on fallen fruits. The organisms drive the process of decay, helping to break down plant material.

"Where is yeast found in nature? It is found everywhere," Rusche says. "It makes little spores, and those spores are kind of just around. Where it proliferates is on rotting vegetative matter, rotting fruit. It likes sugar."

"For a long time, people used to lump plants and fungi together, but they're biologically different," she adds. "Plants do photosynthesis. Fungi don't. Fungi live on decaying material, on things like rotting wood, and they're eating the stuff that other organisms have left behind, whereas plants are making their own food through photosynthesis."

Walker explains that S. cerevisiae and other yeast species eat sugar and produce byproducts including carbon dioxide (responsible for the air pockets in leavened bread), and alcohol (think wine and beer).

"Yeast evolved to take advantage of high-sugar plant material that came about when flowering plants emerged," she says. "The plants make sweet fruits to attract animals to move their seeds around, but the fruits mostly get dropped on the ground, and they rot, and the yeast are taking advantage of all this. They're what's doing the rotting."

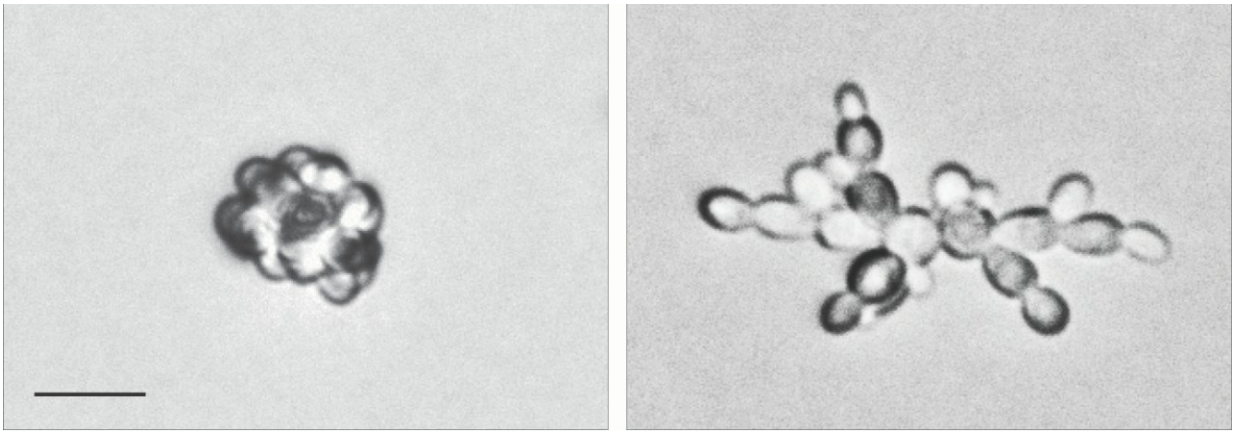
Why do scientists use baker's yeast in the lab?

Researchers harness baker's yeast to study a variety of biological processes.

Rusche's lab uses S. cerevisiae to learn more about how certain genes get switched on or off in response to stress. Walker's team uses the organism to probe the intricacies of mRNA translation, which causes cells to produce proteins.

This research sheds light on the basic biology of S. cerevisiae. But the work could also improve understanding of cellular processes in other species, ranging from disease-causing yeasts to humans.

Scientists like to work with baker's yeast because it's cheap, its genetic material is easy to manipulate, and researchers already know a lot about it. Yeast also grows quickly.



Colonies of baker’s yeast, or Saccharomyces cerevisiae, pictured under a microscope. Yeast don’t grow this way in bread dough: The images are from a 2016 study in the lab of UB biologist Paul Cullen that explored cellular mechanisms that cause certain changes in yeast growth patterns. In glucose-rich

conditions on a flat laboratory plate (left), the yeast cells grow in a tight cluster. But when glucose is limited (right), new cells grow outward, forming a filament-like configuration that may aid in the search for food. Bar, 10 microns. Credit: Paul J. Cullen

"Yeast cells are a good model organism because you can grow a culture overnight. Doubling time is only an hour-and-a-half, whereas if you're growing a mammalian cell culture, it can take a few weeks," Walker says. "A lot of the time, yeast has a pared down version of the genetic machinery that's required for similar processes in higher organisms. So sometimes we do our initial work in yeast, and then we try to follow up on promising results in mammalian cells."

"It's a really well-established lab organism, so if you learn something new about Saccharomyces, you can put it in the context of everything else that the whole community has already learned about that organism. You can relate the data to what you already know," Rusche says. "If you go to a species that hasn't really been studied, and you make a discovery, you have a piece of information in isolation."

Any tips for bakers and brewers?

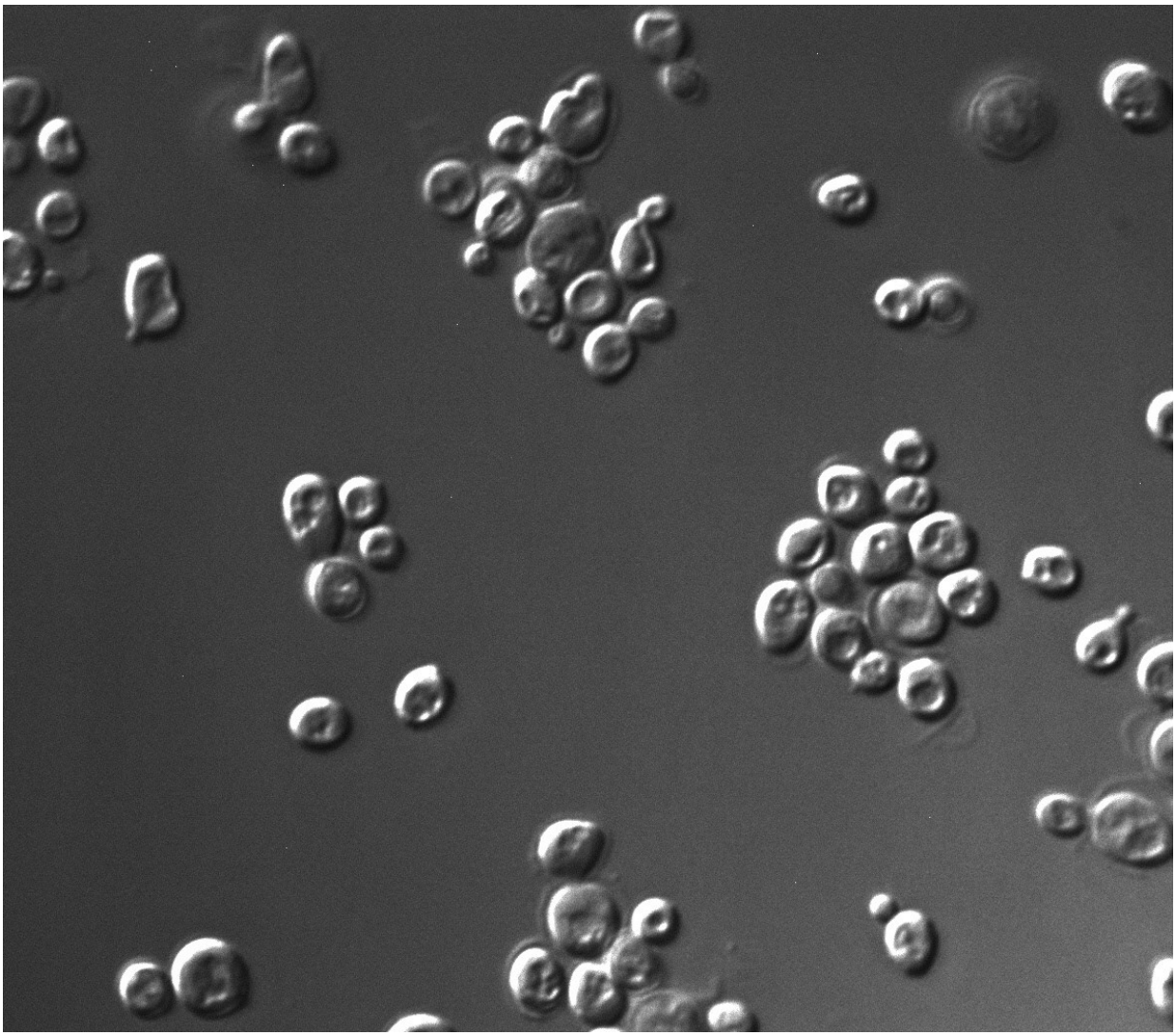
Christopher Rupert, a Ph.D. candidate in Rusche's lab, says one of the neat things about yeast is that these organisms evolved not to help humans make bread and beer, but to survive in their ecological niches.

"A lot of people associate yeast with beer and bread. Yeast ferments—it takes in sugar and spits out alcohol and CO_2—and that's why we love it so much," he says. "But what's interesting is that it is hypothesized that this evolved as a way for yeast to fight other micro-organisms. Yeast has a higher alcohol tolerance, so when it is secreting alcohol, it is killing

bacteria around it, so it's the only one that's left."

Rupert's dissertation deals with the yeast species Candida parapsilosis, which can cause human infections. But he did undergraduate research on S. cerevisiae, and also uses it at home; he's an avid baker, making dinner rolls, burger buns, buttermilk biscuits and sourdough bread (he seeded his with some baker's yeast, but it also contains wild yeasts of different species).

"When we used to go into the lab, he would bring stuff in for us to sample," Rusche says, recalling the days before social distancing. "We would always get all his treats."



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Because yeasts did not evolve specifically to help humans, humans must cater to the needs of yeasts.

For example, S. cerevisiae thrives at temperatures of about 85 degrees

Fahrenheit, which is why seasoned bakers often keep their rising dough somewhere warm. Too cold, and the yeast will be slow to grow. Too hot, and it will die.

When it comes to making wine, choosing the right species of yeast can be important, as some can tolerate higher levels of alcohol than others. If your yeast dies before it's able to consume all of the sugar, your beverage might turn out too sweet, says Walker, who has a peach tree in her yard and makes peach wine.

"If you bake or brew with yeast, you have a living organism. You have to give it time and a nice warm environment," Rusche says. "Humans domesticated Saccharomyces cerevisiae, but there are so many different species of yeast in the world. Sourdoughs contain a lot of wild yeast, and many of those are not Saccharomyces. They're such interesting organisms."

Provided by University at Buffalo

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