Yeast: A Mighty, Tiny Fungus

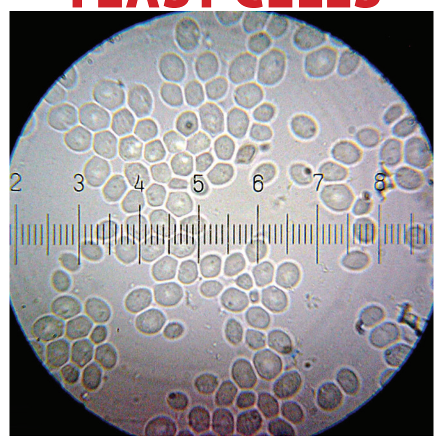
Let's start with fungi...

Yeast are a type of fungus (plural is fungi). Fungi are everywhere. You might have some fungus growing between your toes (Athlete's Foot), you might eat some on your salad (Portabella mushrooms), and you might get a shot of antibiotic that comes from a fungus (Penicillin). But what is a fungus exactly?

Biologists classify Fungi as a kingdom, separate from plants, animals, and bacteria. Like plants and animals, fungi are eukaryotic organisms, meaning that their cells contain a nucleus and membrane-bound organelles such as mitochondria. Fungi have some features similar to plants: They don't move around and their cells have cell walls. Like animals, fungi have no chlorophyl and cannot make their own food. In fact, genetic studies have shown that fungi are more closely related to animals than plants!

Fungi can live as individual cells, such as yeast, or in clumps, such as moulds and mushrooms. The largest living organism ever found—larger than a blue whale—is actually a fungus—a specimen of *Armillaria ostoyae* (the honey mushroom). Long filaments from this fungus cover over 2,000 acres of the Malheur National Forest in eastern Oregon. Most of the fungus exists underground. The only visible parts are the golden mushrooms that pop up in the fall. DNA testing has shown that the huge filaments and the mushrooms that pop up are all one organism.

YEAST CELLS



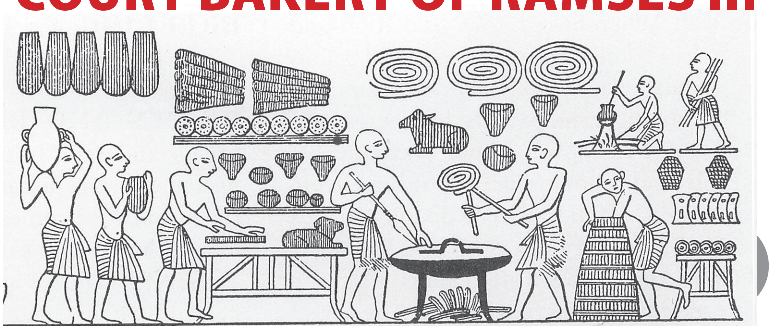
The numbered lines are 11 micrometers (µm) apart. A micrometer equals one-millionth of a meter or about 0.000039 inches.

And now yeast

Yeast is a single-celled fungus. Over 800 species of yeast have been described, but what most people call yeast is common baking or brewing yeast — strains of the species *Saccharomyces cerevisiae*. *S. cerevisiae* has been used since ancient times to make bread, beer, cheese, and wine.

If you have baked with yeast at home, you probably used active dry yeast that comes in packets. This type of yeast has been dehydrated into tiny granules and is dormant (alive but not actively growing). Add warm water and a little flour or sugar and the yeast spring into action—growing, dividing, and producing carbon dioxide. Those bubbles of carbon dioxide are what cause yeast dough to rise up and bake into soft, airy loaves.

COURT BAKERY OF RAMSES III



In ancient times, yeast didn't come from the grocery store in a package! Yeast naturally live on various fruits and grains. By mashing or grinding these foods, adding water, and providing a warm environment, people grew their own yeast cultures for brewing and baking. The best yeast cultures were kept alive and used over and over.

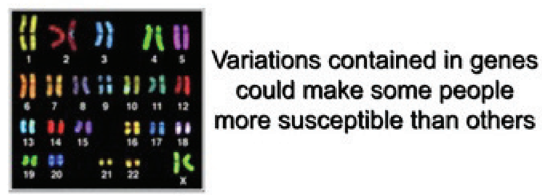
Just a little factory...

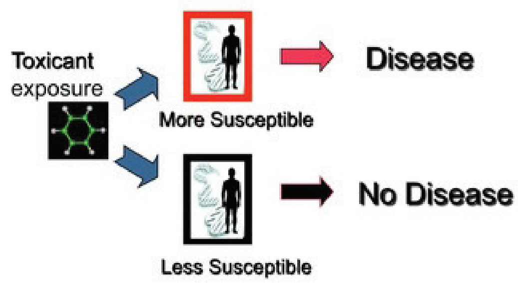
If you think about it, using yeast to make wine, beer, and bread is an early type of biotechnology. The chemical processes that occur in the yeast cell manufacture these food products for us. In a similar way, *S. cerevisiae* and other yeast species are used to produce industrial chemicals and pharmaceuticals. Sometimes the live cells are used and sometimes the enzymes are extracted from the cells and used to catalyze (begin or speed up) chemical reactions.

A model organism for toxicology

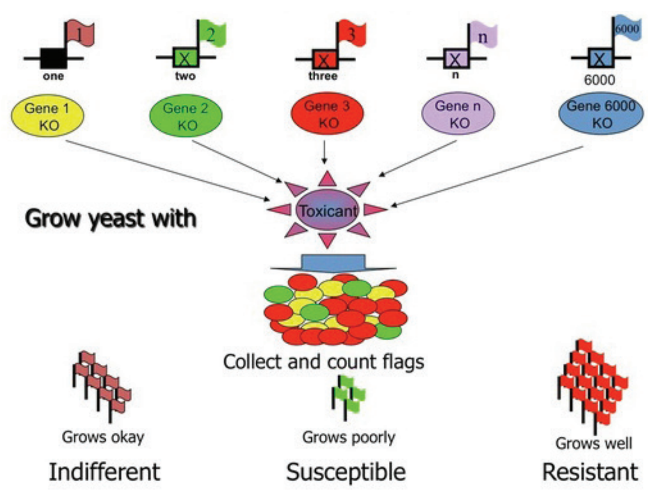
The *S. cerevisiae* genome, representing its complete set of genetic material, became the first eukaryotic genome to be sequenced back in 1996. Based on that work, scientists know that about 1/3 of yeast's 6000 genes are the same as those in human cells. Also, hundreds of human disease genes exist in yeast. Yeast reproduces in a matter of hours and are cheap to work with. Yeast colonies are small and many experiments can easily be conducted on Petri dishes. For these reasons, yeast has become a very powerful and popular model organism for study.

A very important question for toxicologists to answer is why some people get sick when exposed to an environmental toxicant and other exposed people do not get sick. Scientists think that variations in genes can make one person more susceptible than another, but figuring out exactly which genes are involved is extremely difficult. Here's a place where yeast have an amazing role to play in scientific research!





Scientists at Vulpe Lab at the University of California do research using some very special strains of yeast. Each strain of yeast used in the research has a particular gene removed, or knocked out (shown as KO in the figure). A chemical "flag" inserted in each yeast strain identifies which gene has been "KO'd." The yeast strains are mixed together and grown with exposure to a toxicant. Scientists use the chemical flags to find how well each strain grew when exposed.



The figure on the left shows the green flagged yeast strain growing poorly when exposed to a toxicant. Scientists could then investigate what function Gene 2 (the gene "KO'd" from the green strain) has and why missing that gene caused the green strain to be harmed by the toxicant.

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