WORLD BREWING CONGRESS
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#ElevateBeer

Truly local beer and the wild world of wild yeast

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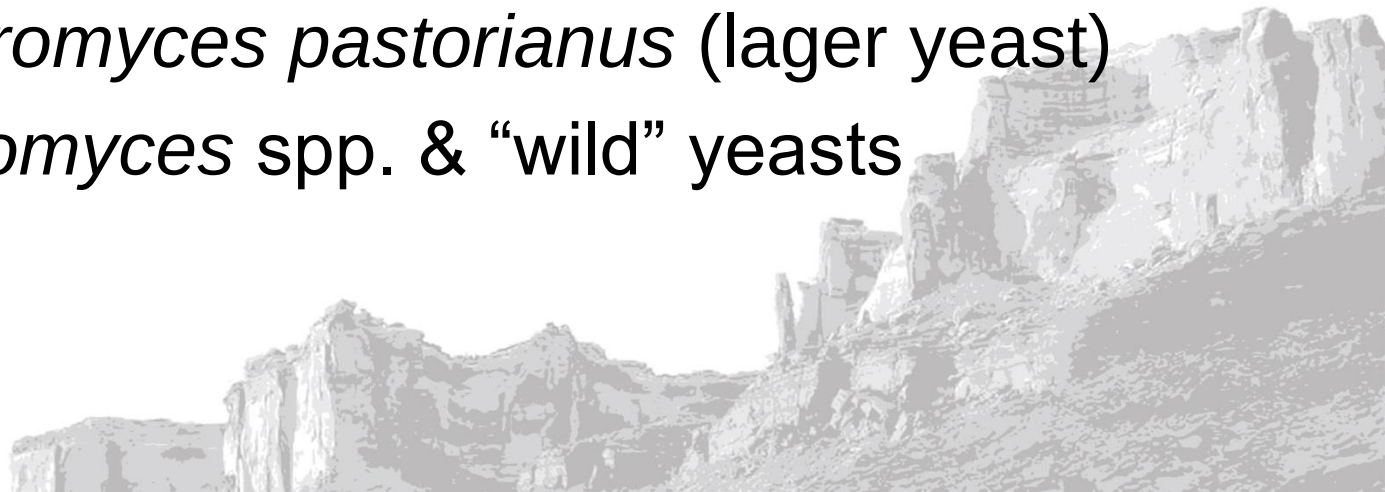
Brewers make wort.

Yeast makes beer.

Yeast: the overlooked ingredient

- Water
- Barley
- Hops
- Yeast
  - *Saccharomyces cerevisiae* (ale yeast)
  - *Saccharomyces pastorianus* (lager yeast)
  - *Brettanomyces* spp. & “wild” yeasts



Outline

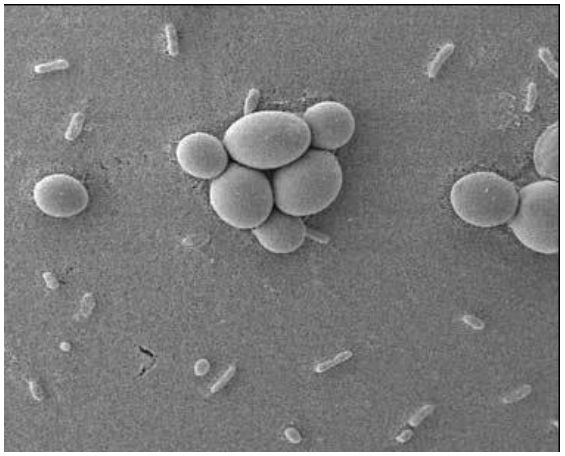
- Yeast basics
- Non-traditional yeasts in brewing
- Genetically modified organisms (GMOs)

Outline

- Yeast basics
  - What are yeasts?
  - Where can they be found?
  - How can they be cultivated?

Yeast are the simplest eukaryotes

- Part of Fungal Kingdom
- 150,000 species
- Single-celled
- ~10x bigger than bacteria
- Biological workhorse organism



Yeast are found everywhere

- Numerous & varied environmental niches
  - Psychrophiles, mesophiles, thermophiles
  - Marine and freshwater
  - Plants, animals, and soil

http://grow.cals.wisc.edu/files/2015/02/galls_beech_tree10_4536.jpg

https://johnsbeard.files.wordpress.com/2013/02/beard-beer-label-web.jpg

Yeast cultivation

- Carbon
- Hydrogen
- Nitrogen
- Phosphorus
- Oxygen

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Historically, all beers used “non-traditional” microbes

https://eurekabrewing.files.wordpress.com/2012/08/dish.jpg

Modern beverages are stuck in a yeast rut

Whole Genome Comparison Reveals High Levels of Inbreeding and Strain Redundancy Across the Spectrum of Commercial Wine Strains of *Saccharomyces cerevisiae*

Anthony R. Borneman,*,†,1 Angus H. Forgan,* Radka Kolouchova,* James A. Fraser,‡ and Simon A. Schmidt*

- 119 commercial wine and beer strains analyzed
- Nearly identical
- Inbreeding
- Small fraction of *Saccharomyces* genetic diversity

How do we get out of that rut?

Let’s find some new yeast…

Are there truly local beers?

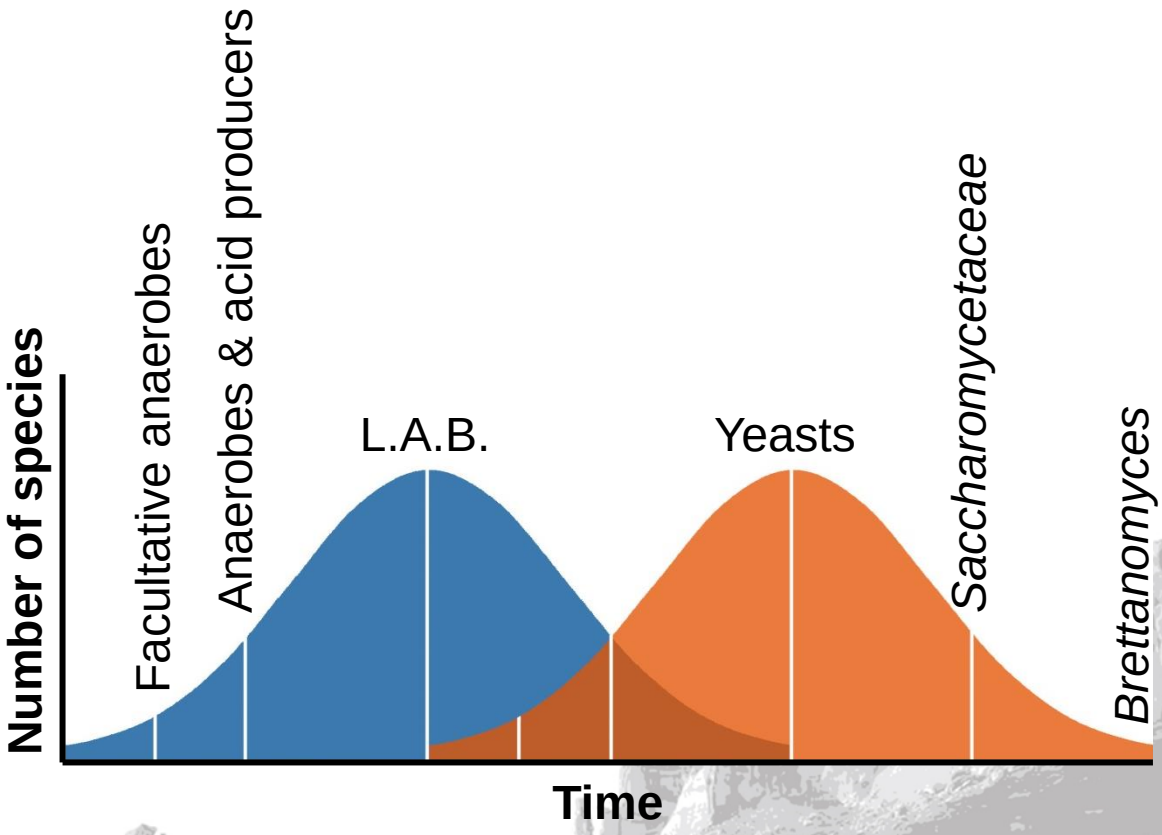
- In most cases no, especially in the U.S.
  - Using European-origin strains

Mystic Brewery, Massachusetts

2013 GABF gold medal

First for an American yeast

Why not just rely on spontaneous fermentation?

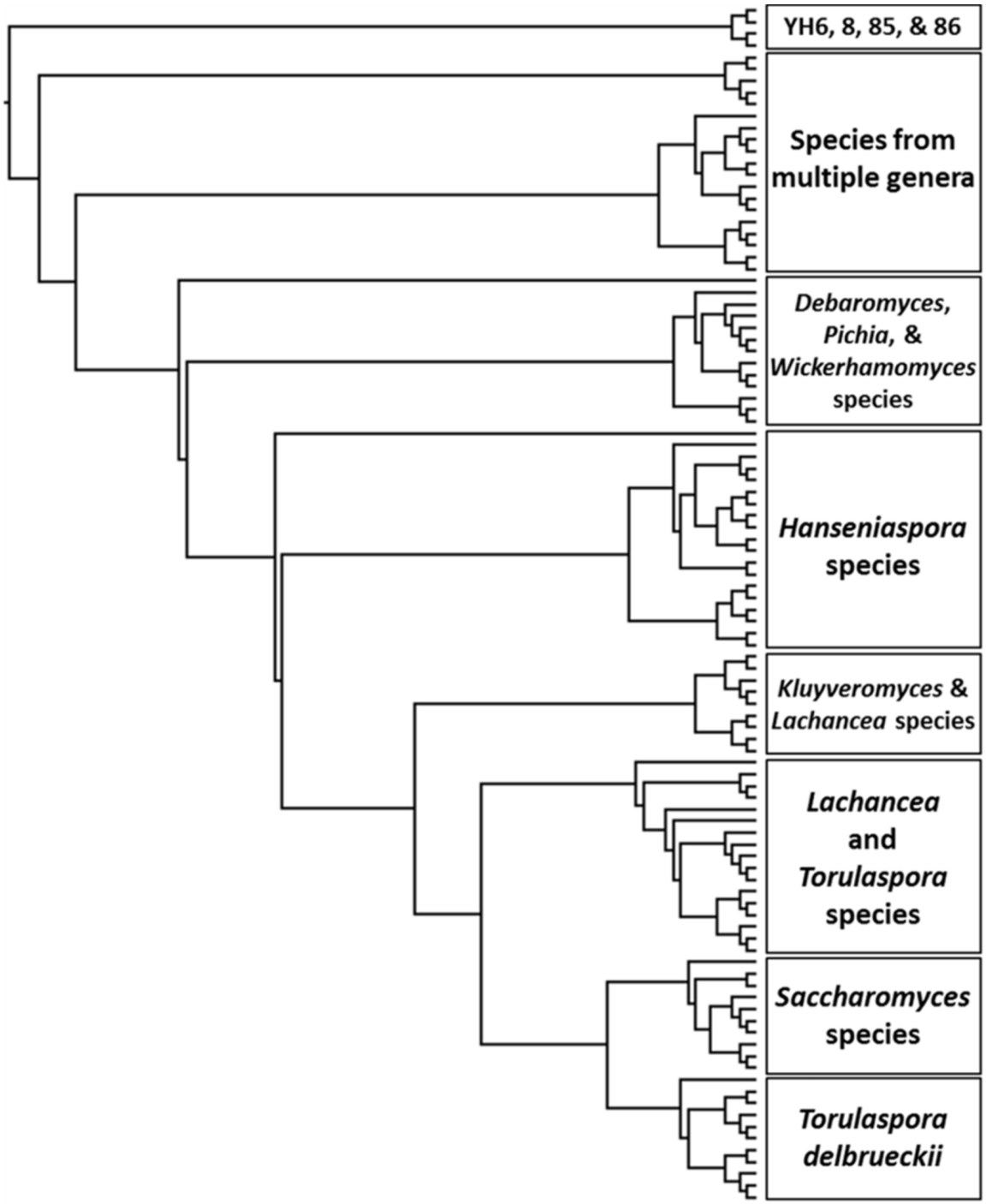


Where can you find brew-worthy yeasts?

<u>Farms/Orchards</u>
Fruits
Berries
Nuts
Honey
Vegetables

<u>Brewery/Industry</u>
Spontaneous fermentations
Spent grain
Pallet wood
Beer spills
Keg collars
Grain mills
Barrels

<u>Nature</u>
Soil
Sand
Tree bark
Leaves
Flowers
Insects



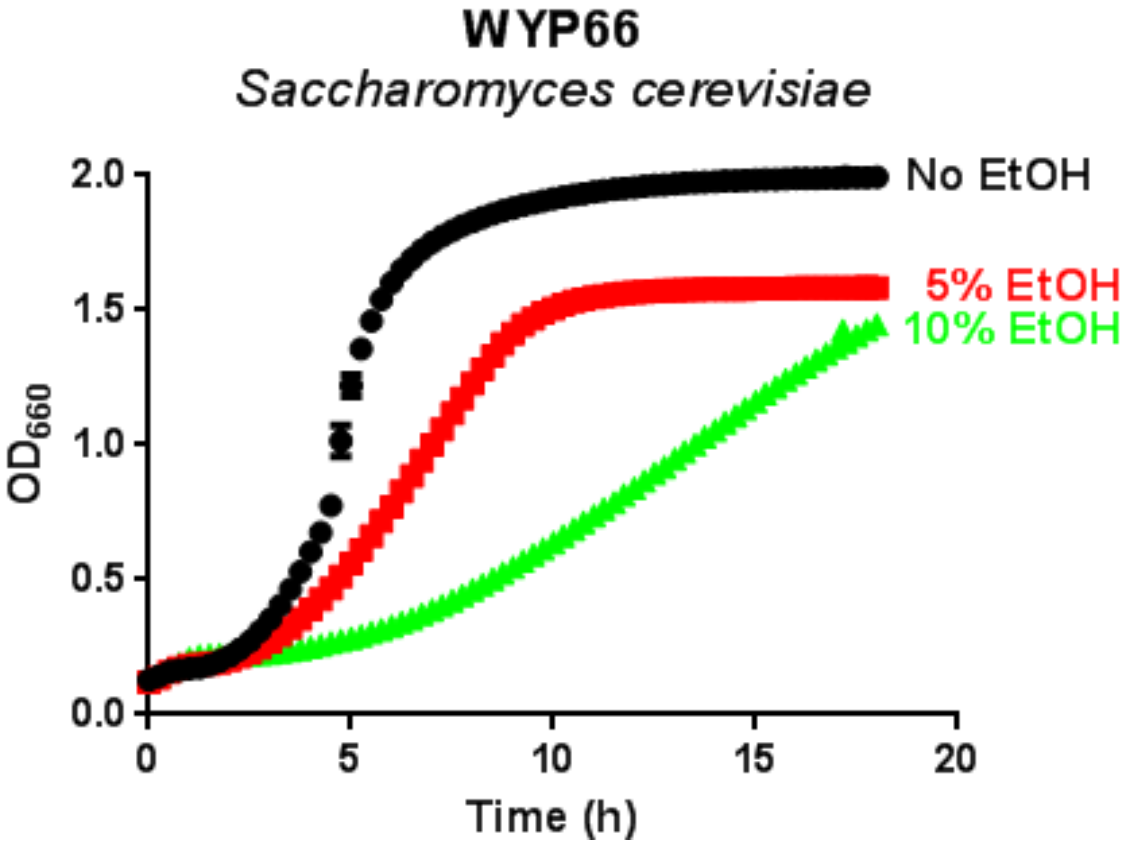
One month of yeast hunting

All wild yeasts

All from Indiana

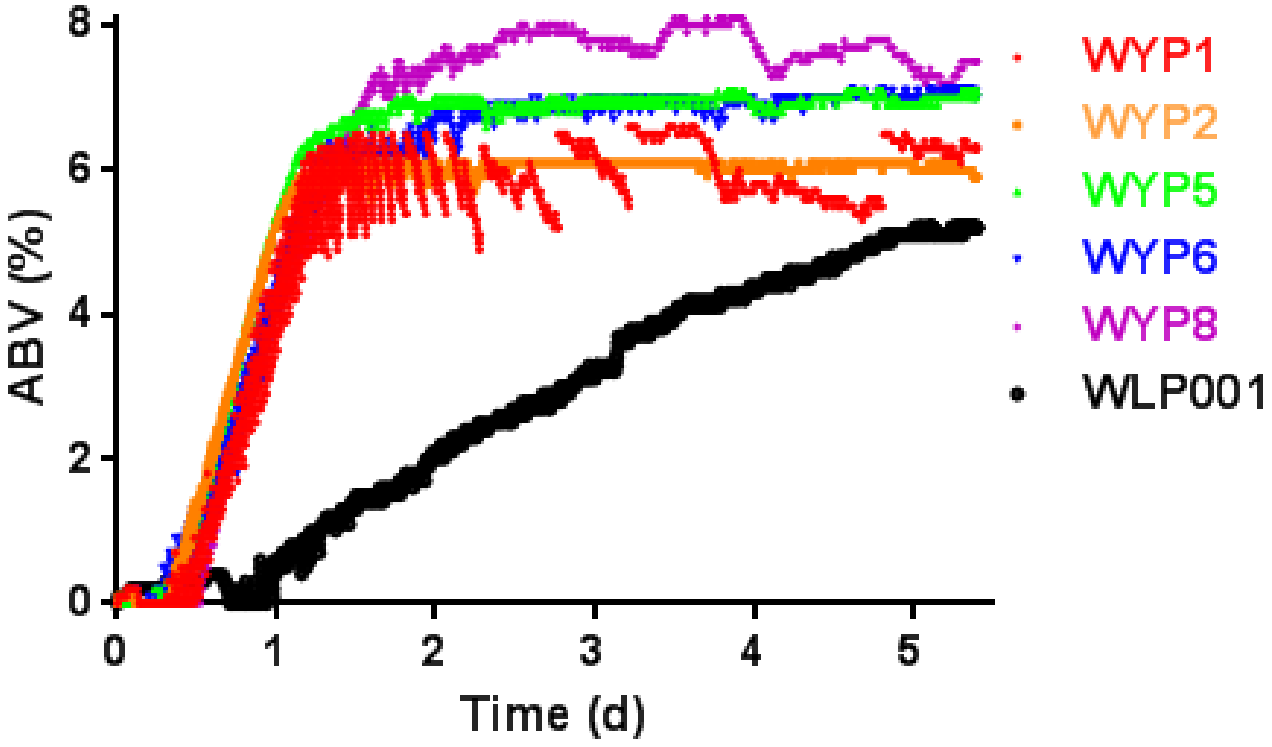
All can make beer

How do the wild strains compare?



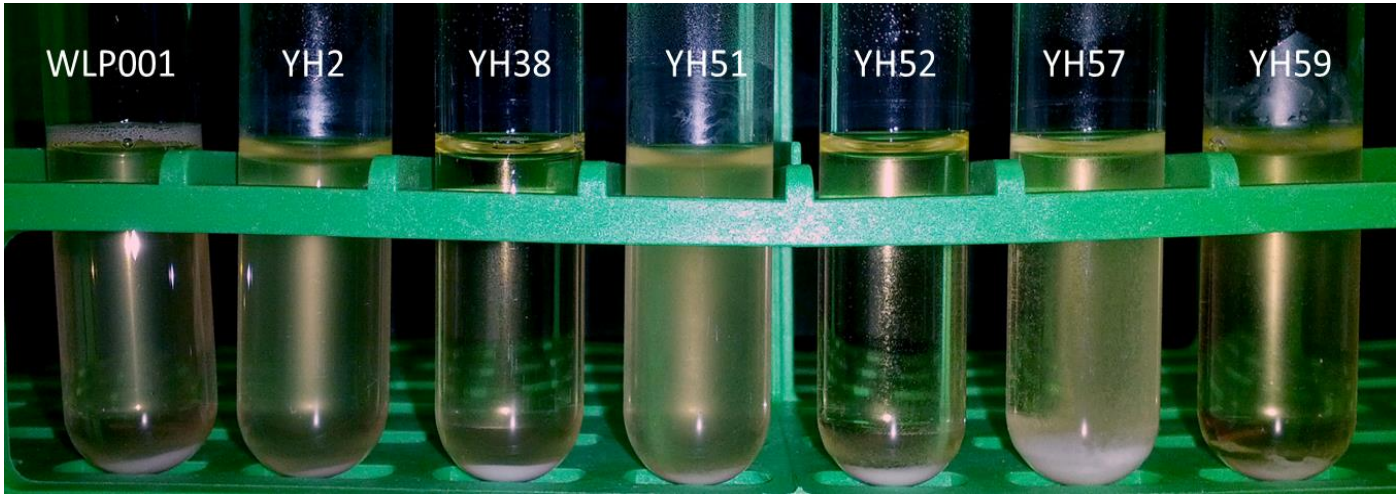
Good ethanol tolerance…

How do the wild strains compare?



Good fermentation kinetics…

How do the wild strains compare?



Good flocculation and aroma…

Does “yeast hunting” actually work in the real world?

Broad Ripple Brewpub

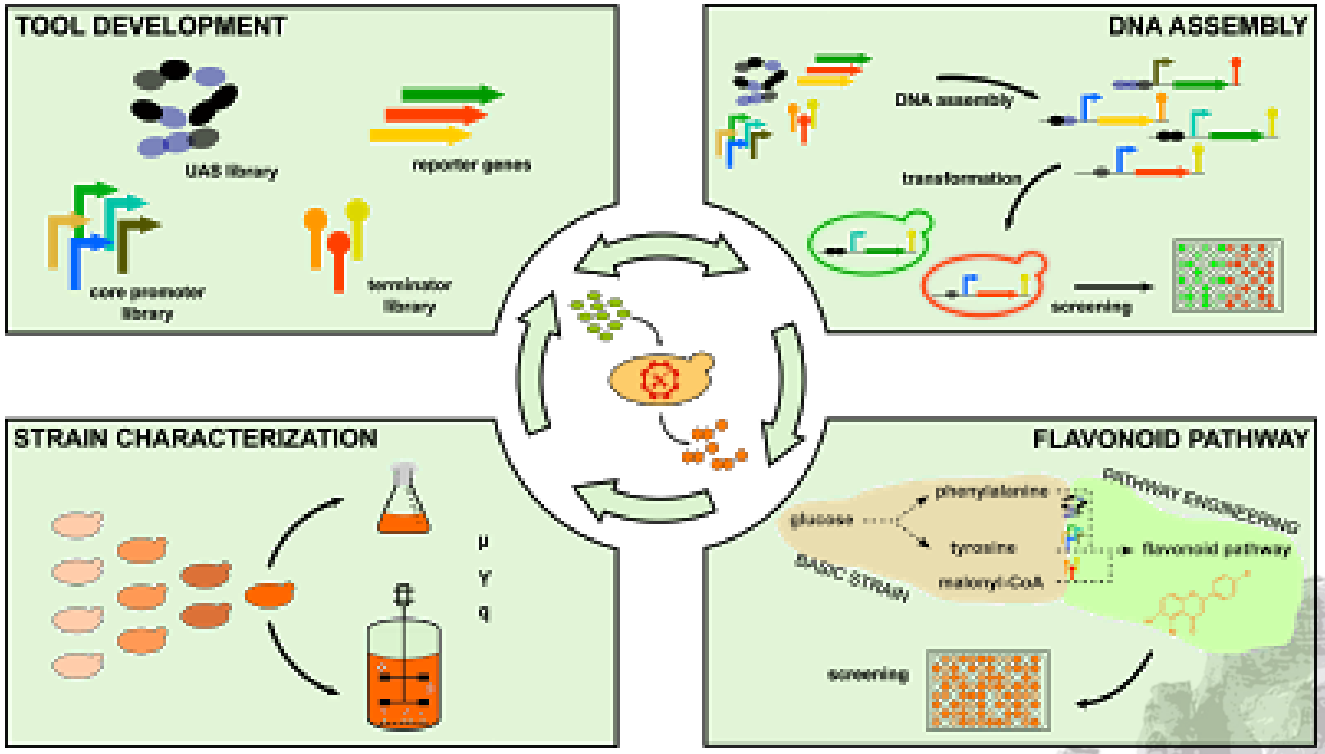
Six weeks & $300

20 samples
- 12 positive for EtOH-tolerant yeast
- 17 strains isolated

17 test fermentations
- 7 strains with good attenuation
- 4 with good flavor/aroma profiles

Mmm…Cobwebs

If you can't find the yeast that you want, why not make it?



https://sites.google.com/site/ugentmemo/_/rsrc/1426100678504/research/yeast-tools/YeastTools_TDC.png?height=226&width=400

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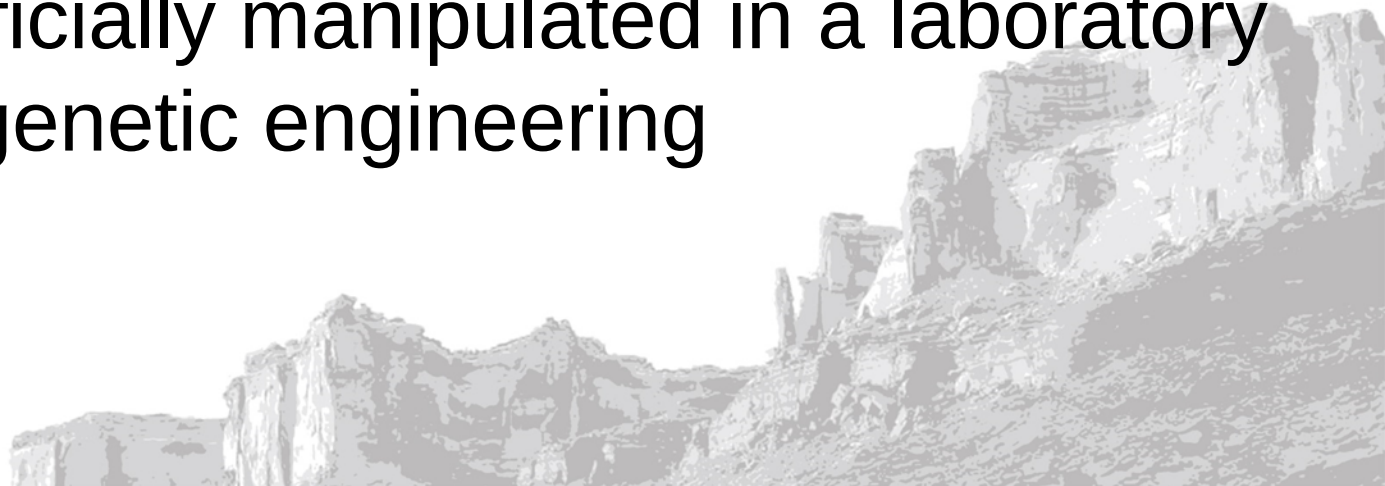
What is a Genetically Modified Organism (GMO)?

- An organism whose genetic material has been altered by humans

- An organism whose genetic material has been artificially manipulated in a laboratory through genetic engineering



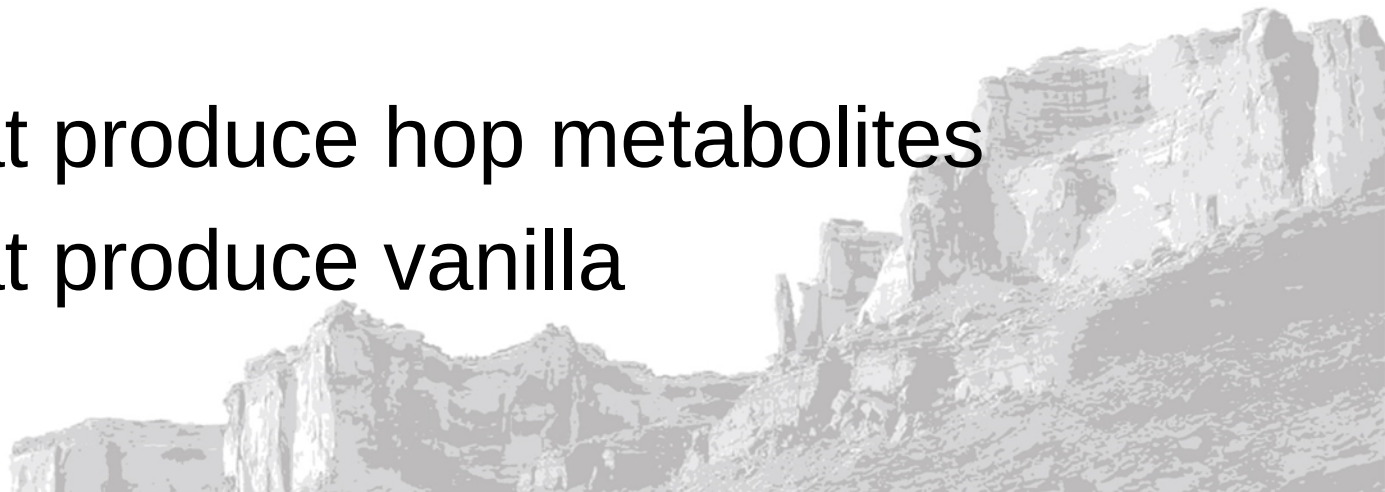
Would you eat/drink a GMO product?

http://www.foodsafetynews.com/files/2016/02/frankenfood-banana-GMO.jpg

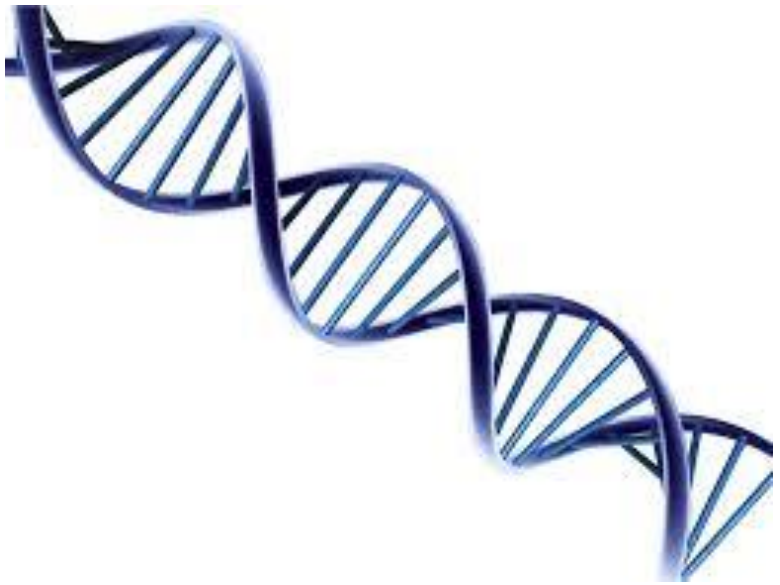
http://joshfecteau.com/wp-content/uploads/2012/11/wildcarrotroots.jpg

What can we do with GMOs?

- “Tolerant” strains
  - Alcohol, pH, temperature, *etc.*
- Fast fermentation, high attenuation, flavor profile
- Yeast that produce hop metabolites
- Yeast that produce vanilla



Molecular techniques for genome manipulations



- CRISPR-Cas
- Genetic transformation
- *De novo* DNA/genome synthesis

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