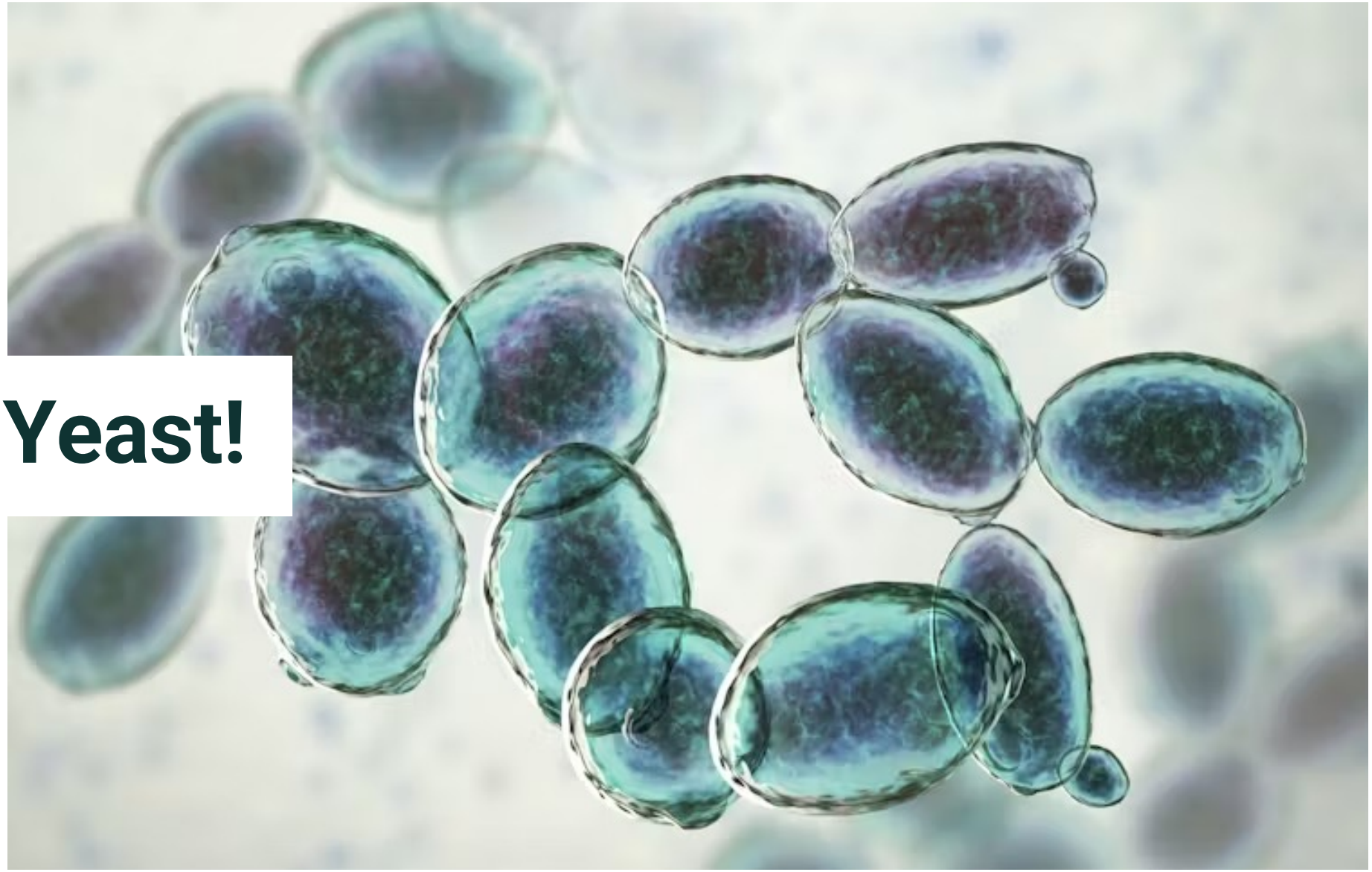
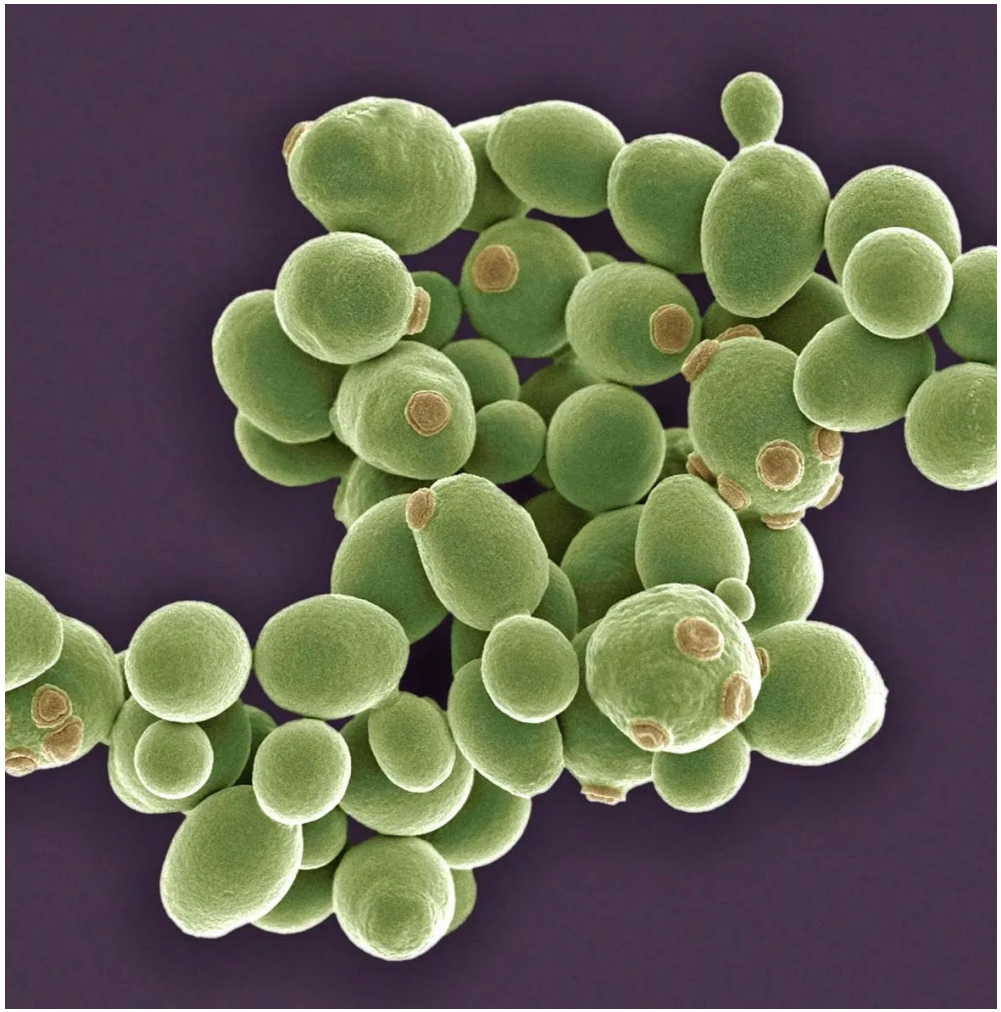
Yeast!



Section 1

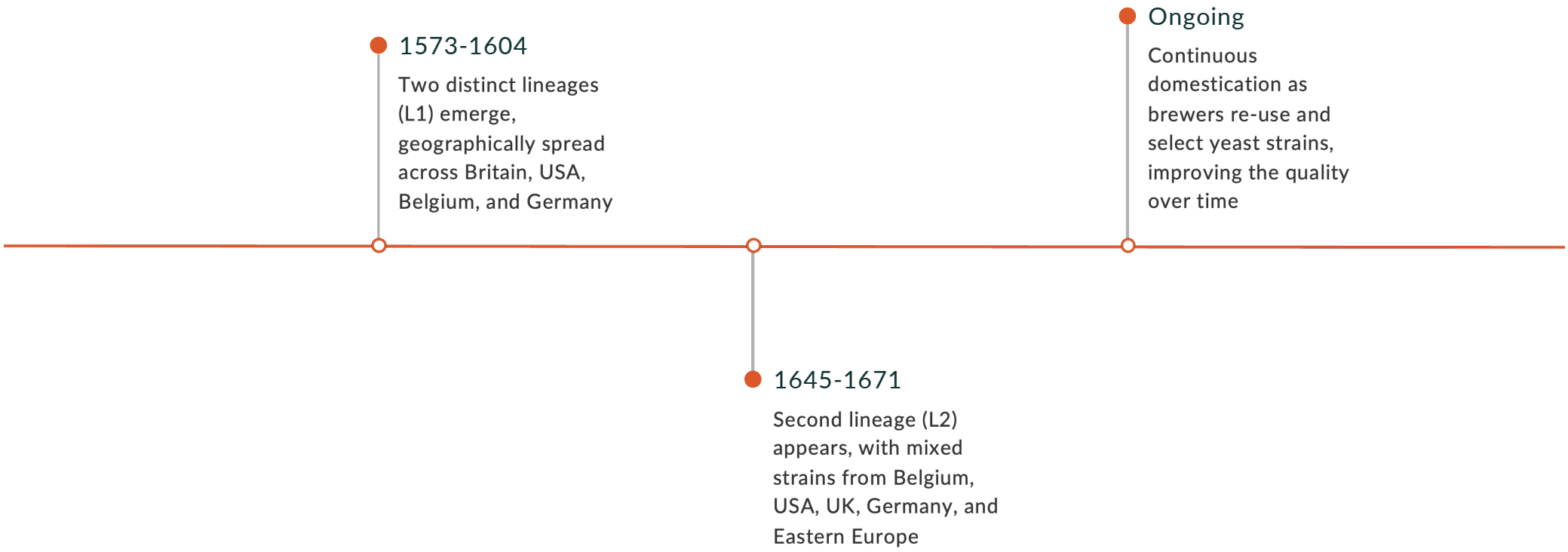
Yeast Basics

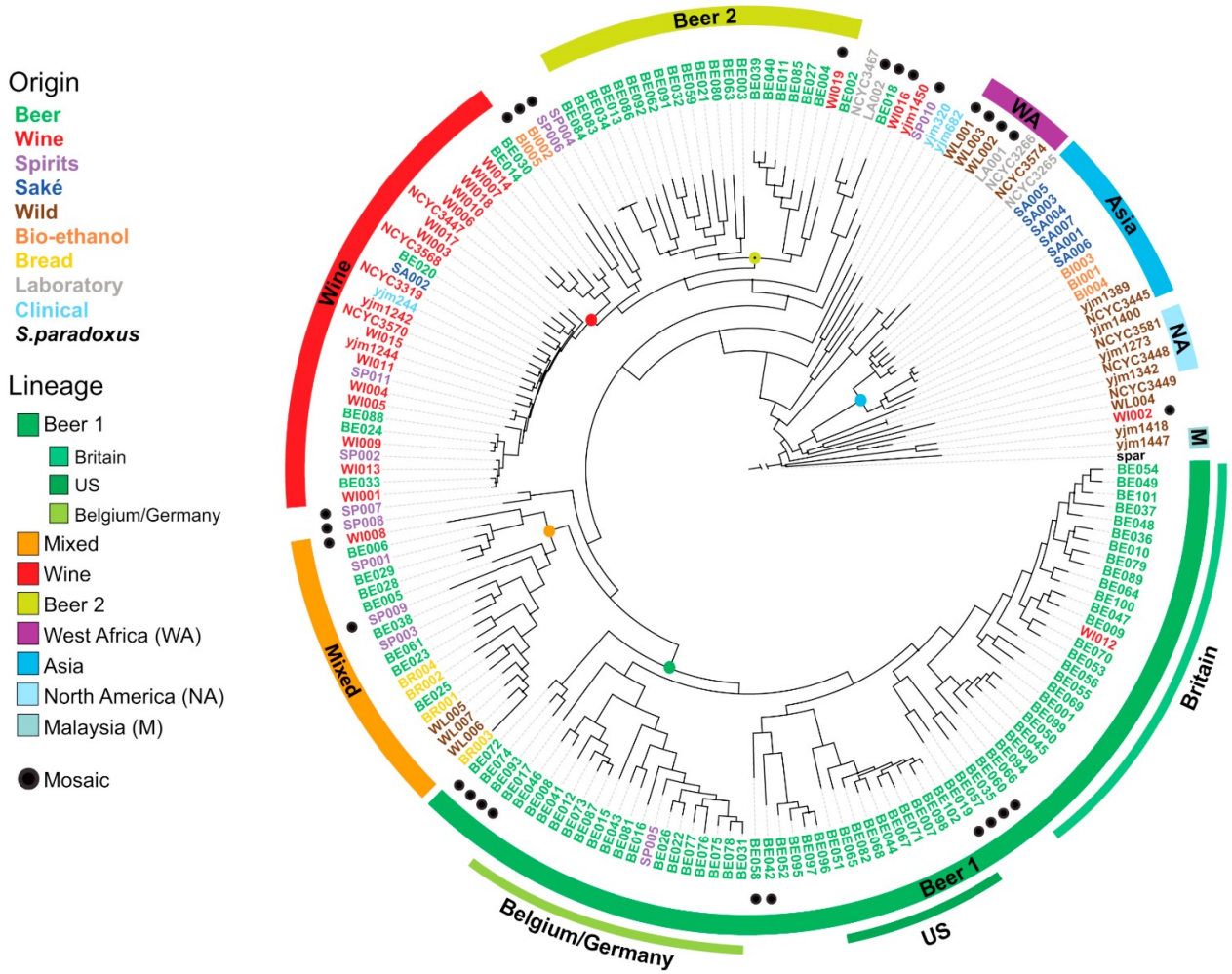


What is Yeast?

Yeast is a microscopic fungus that plays a crucial role in the fermentation process, particularly in the production of beer. It is responsible for converting the sugars present in the wort (the liquid extracted from the mashing of grains) into alcohol and carbon dioxide, which are essential for the unique flavors and carbonation of beer.

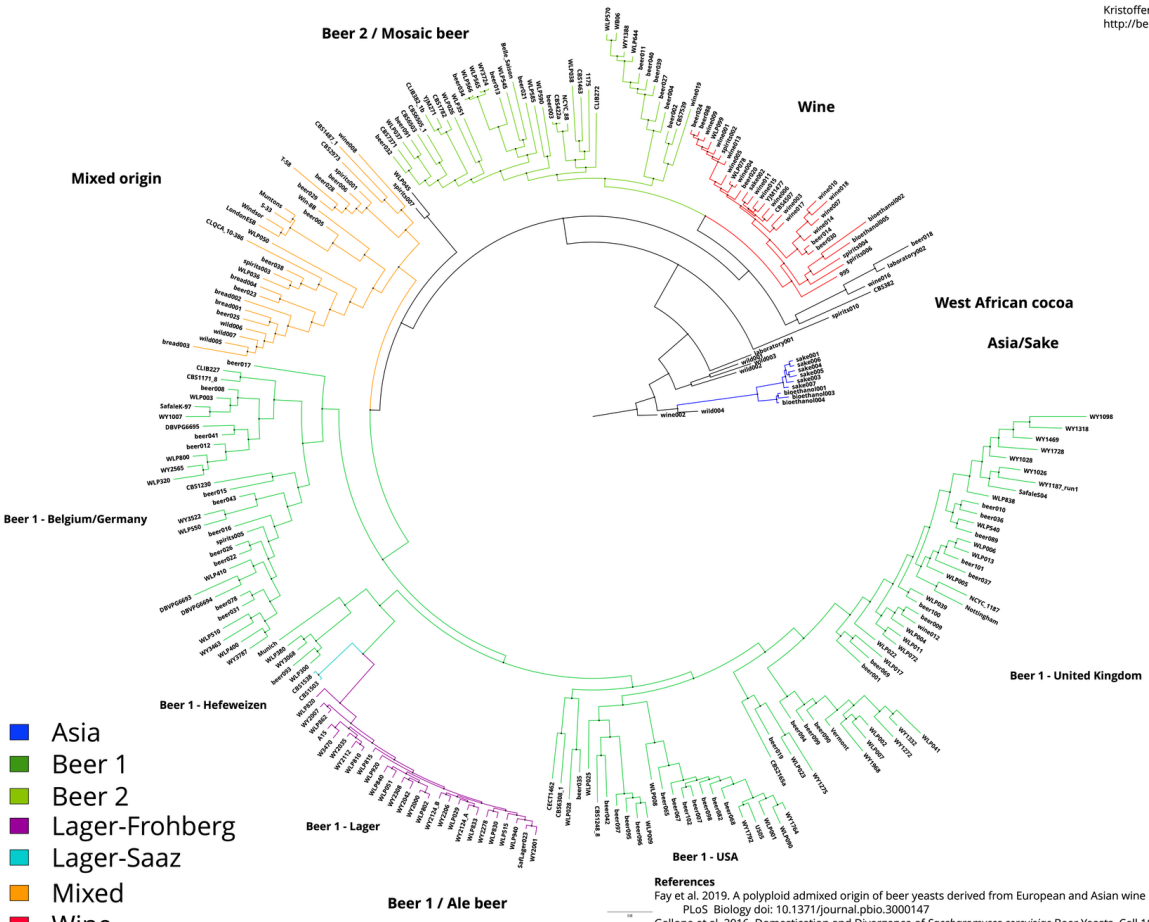
Yeast Genetic History





Domestication and Divergence of Saccharomyces cerevisiae Beer YeastsGallone, Brigida et al.Cell, Volume 166, Issue 6,

Kristoffer Krogerus
http://beer.suregork.com



A black • at a node indicates bootstrap support > 95%

References

Fay et al. 2019. A polyploid admixed origin of beer yeasts derived from European and Asian wine populations. PLoS Biology doi: 10.1371/journal.pbio.3000147

Gallone et al. 2016. Domestication and Divergence of *Saccharomyces cerevisiae* Beer Yeasts. Cell 166:1397 - 1410.e16

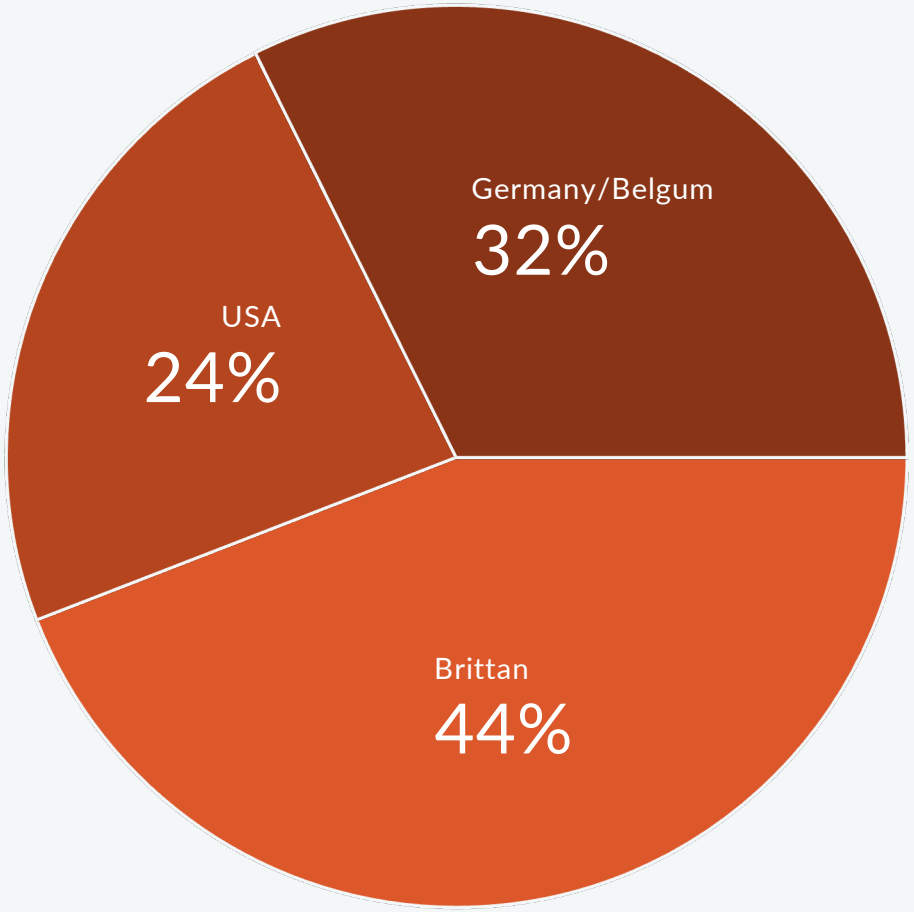
Langdon et al. 2019. Fermentation innovation through complex hybridization of wild and domesticated yeasts. Nature Ecology & Evolution doi: 10.1038/s41559-019-0998-8

Peter et al. 2018. Genome evolution across 1,011 *Saccharomyces cerevisiae* isolates. Nature 556:339–344

Preiss et al. 2018. Traditional Norwegian Kveik are a Genetically Distinct Group of Domesticated *Saccharomyces cerevisiae* Brewing Yeasts. Frontiers in Microbiology doi: 10.3389/fmicb.2018.02137

Beer 1 Strains by Region

The data shows that Brittan has the highest number of strains, followed by the USA and Germany/Belgum.



Domestication and Divergence of Saccharomyces cerevisiae Beer YeastsGallone, Brigida et al.Cell, Volume 166, Issue 6,

Yeast Strains in Beer

- Saccharomyces Cerevisiae
  - American
  - British
  - German
  - Belgian
  - NORWEGIAN KVEIK
- Saccharomyces Pastorianus
  - Lager Yeasts
- Sours, Hybrids, Blends
  - Brettanomyces
  - Lactobacillus
  - Yeast and Bacteria Blend
  - WLP575 - Belgian Style Ale Yeast Blend
  - WLP670 - American Farmhouse Yeast Blend
  - GULO ALE - Hybrid of Grench Saison and Irish Ale
  - **HYDRA - Hybrid of Two IPA Yeasts**
  - Engineered Yeast - GMO

Section 1

Choosing a Yeast for Brewing

Yeast Selection: Considerations

Yeast Characteristic	Consideration
Beery Style	This may be the most important factor to help choose a yeast
Attenuation	The percentage of sugars that the yeast can convert to alcohol. High attenuation yeast will ferment more of the wort's sugars, producing a drier, more alcohol-rich beer.
Flocculation	The yeast's ability to clump together and fall out of suspension. High-flocculating yeast will produce a clearer beer, while low-flocculating yeast will remain suspended longer.
Alcohol Tolerance	The maximum alcohol percentage the yeast can withstand before becoming stressed or dying. This is important for high gravity beers.
Diastatic Power	The yeast's ability to break down complex starches into simple sugars that it can ferment. Important for beers made with adjuncts or unmalted grains.
Biotransformation	The yeast's ability to produce or modify flavor compounds during fermentation, affecting the final beer's aroma and taste profile.
Fermentation Rate	The speed at which the yeast ferments the wort. Faster fermentations may be desired for certain beer styles.
Phenolic Off-Flavors	Some yeast strains can produce undesirable phenolic off-flavors, which should be considered for the target beer style.

Dry Yeast Producers

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Yeast Selection: Liquid Yeast Producers

Yeast Selection: Yeast Strains

ALE

		Attenuation	Alcohol Tolerance	Flocculation	Optimum Fermentation Temp.	Amber Ale	American Pale Ale	American Brown Ale	Barleywine/ Strong Ale	Cream Ale/ Blonde	English Brown Ale	English Pale Beer	Golden Ale	German Kölsch	Hazy IPA	IPA	Imperial Stout	Imperial IPA	Irish Dry Stout	Red Ale	Seltzer
WLP001 California Ale Yeast®	The first yeast strain produced by White Labs in 1995. Versatile and hardy, it accentuates hop flavors and aromas and attenuates well, even for high gravity beers.	73-80%	M	M	64-73°F (18-23°C)	●	●	●	●	●	○	○	●	○	●	●	○	●	○	○	●
WLP002 English Ale Yeast	This is a classic ESB strain from one of England's largest independent breweries. Residual sweetness accentuates malt character and mild fruity esters, adding complexity to the flavor and aroma of finished beers.	63-70%	M	VH	65-68°F (18-20°C)	○	○	○	●	○	●	●	○	○		○	○		○	○	○
WLP004 Irish Ale Yeast	From one of the oldest stout-producing breweries in the world. Moderate ester production and is great for malty British styles such as stouts, porters, and brown ales.	69-74%	M	M-H	65-68°F (18-20°C)	○	○	○	○	○	○	●	○	○		○	○	○	●	●	
WLP005 British Ale Yeast	Known for its use in malty English beers, a great choice for any beers using traditional English malts. Will push bready, grainy malt flavors while being a mild ester producer.	67-74%	M	H	65-70°F (18-21°C)	○	○	○	○	○	●	●	○	○		○	○		●	●	
WLP007 Dry English Ale Yeast	Clean profile with high attenuation, achieving 80% even with 10% ABV beers, making the yeast well-suited for high gravity ales and clean, well-attenuated beer styles.	70-80%	M	M-H	65-70°F (18-21°C)	●	○	●	●	○	●	●	○			○	●	●	○	●	
WLP008 East Coast Ale Yeast	Cleaner and crisper than other haze producing strains, this strain's attenuation leaves some mouthfeel and residual sweetness which balances hop bitterness.	70-75%	M	L-M	68-73°F (20-23°C)	●	●	○	○	○	○	○	●	○		●	○	○	○	○	
WLP013 London Ale Yeast	Oak ester character makes this yeast well-suited for classic British beer styles. Medium flocculation allows attenuation up to 75% leaving beer dry while adding malt complexity and pushing hop bitterness.	67-75%	M-H	M	66-71°F (19-22°C)	○	○	○	○	○	●	●	○		●	○	○	●	○	○	
WLP023 Burton Ale Yeast	This strain is sourced from Burton upon Trent, England which is known for pushing IPAs into the spotlight. It produces a subtle fruity ester profile which can be described as notes of apple, clover honey and pear.	69-75%	M	M	68-73°F (20-23°C)	○	○	○	○	○	●	●			○	○	○	●	○	○	○
WLP028 Edinburgh Scottish Ale Yeast	Produces esters of pear and melon, working well with hop and malt derived notes. Versatile strain that can be neutral at the low end of fermentation temperature range or provide more esters at the higher range.	70-75%	M-H	M	65-70°F (18-21°C)	○	○	●	○	○	○	○	○	○	○	○		○	●		
WLP029 German/Kölsch Ale Yeast	Sourced from a small brewpub in Cologne, Germany, this strain is fitting for German ales. Known for accentuating hop flavor and bitterness while creating crisp, clean lager like characters.	72-78%	M-H	M	65-69°F (18-21°C)	○	●	●	○	●	○	○	○	●		●	○	○	○	○	○
WLP036 Düsseldorf Alt Ale Yeast	A traditional altbier-style yeast from Düsseldorf, Germany, producing clean, malty German brown and amber ales. Keeps hop bitterness in the background while promoting sweet malt notes.	65-72%	M-H	M	65-69°F (18-21°C)	○	●	●	○	●	○	○	○	●		●	○		○	○	○
WLP041 Pacific Ale Yeast	Hailing from the Pacific Northwest, this strain is a mild ester producer while promoting malt character. A great flocculator, it leaves a clear beer, saving conditioning time.	65-70%	M	H	65-68°F (18-20°C)	○	●	●	●	○	●	○				●	○		●	●	
WLP051 California V Ale Yeast	A big ester producer, showcasing notes of cherry and apple which compliment pale ales, blonde and brown ales. Typically leaves some residual, lager-like sulfur compounds in finished beer.	70-75%	M	M-H	66-70°F (19-21°C)	●	●	●	○	○	○	○	●	○		●	○	○	○	○	
WLP060 American Ale Yeast Blend	This blend of three strains creates a clean and neutral fermentation character. It lends complexity to finished beer by exhibiting a crisp, clean lager-like character with accentuated hop flavors and bitterness	72-80%	M-H	M	68-72°F (20-22°C)	●	●	●	○	●	●	○	○	●		●	○	●		○	
WLP066 London Fog Ale Yeast	The go-to strain for New England-style IPAs. Produces a medium ester profile and leaves some residual sweetness, helping accentuate both malt and hop flavors and aromas, while retaining a velvety mouthfeel.	75-82%	M	L-M	64-72°F (17-21°C)		●								●	○		●			
WLP067 Coastal Haze Ale Yeast Blend	A blend of our favorite hazy IPA strains, great for producing beers with a hazy appearance and tropical, fruit-forward esters. Produces dry, yet "juicy" mango and pineapple characteristics lending to drinkability.	70-75%	M-H	L-M	68-72°F (20-22°C)		●								●	○		●			
WLP077 Tropicale Yeast Blend	A carefully selected blend of all-natural yeast strains possessing high B-lyase activity, promoting the release of bound thiol compounds in hops resulting in tropical characteristics of guava, passionfruit, and mango.	75-82%	M-H	L	64-74°F (17-23°C)		●					○			●	●		●			
WLP080 Cream Ale Yeast Blend	A blend of ale and lager yeast, this strain produces a light fruity note, clean pilsner-like flavors and a slightly subdued hop bitterness.	75-80%	M-H	M	65-70°F (18-21°C)	●				●			●	●							
WLP090 San Diego Super Yeast	A low ester producing strain, known for quick fermentations and a neutral flavor and aroma profile. Produces very dry beers with increased perceived bitterness and has a high alcohol tolerance.	76-83%	M	M-H	65-68°F (18-20°C)		●	●	●	●	○	○	●	○	●	●	●	●	○	○	●
WLP095 Burlington Ale Yeast	Signature strain for a well-known brewery in the Northeast United States, contributing esters and body, and blending with hop flavors and aromas while balancing bitterness.	73-78%	M-H	M	66-72°F (19-22°C)	○	●					○			●						
WLP099 Super High Gravity Ale Yeast	From England, this yeast can ferment up to 25% alcohol. Produces dry beer. Ideal for beers aging for extended periods of time. Produces more esters with increasing gravity. Malt dominates at lower gravities.	80-100%	VH	M	65-68°F (18-20°C)			○	●			○				○	○	○			

White Labs Yeast Strain Matrix

Yeast Health: Nutrients

Importance of Nutrients: Zinc and Yeast Nutrients during the Boil

Yeast requires a balanced diet of essential nutrients, including zinc, oxygen, nitrogen, and nutrients added during the boil, to ensure optimal health and performance during fermentation. Healthy, well-nourished yeast is able to ferment all available sugars, producing a clean, balanced flavor profile and avoiding unwanted off-flavors.

By ensuring the proper nutrient balance, oxygenation, and yeast health, brewers can optimize fermentation and produce high-quality, flavorful beers.

Yeast Health: Nutrients

Healthy Yeast Ferments Completely and Avoids Off-Flavors

Healthy, well-nourished yeast is able to ferment all available sugars, producing a clean, balanced flavor profile and avoiding unwanted off-flavors.

By ensuring the proper nutrient balance, oxygenation, and yeast health, brewers can optimize fermentation and produce high-quality, flavorful beers.

Yeast Health: Oxygenation Requirements

Category	Optimal Dissolved Oxygen	Notes
Lager	10-12 ppm	
British, NEIPA/hazy yeast	>10 ppm, sometimes up to 20 ppm	Strain dependent
Kveik, Wit, Weizens	8-10 ppm	
Cali, clean American Ales	6-10 ppm	Can tolerate low oxygenation
Saisons, Wild Yeasts, Belgians	5-15 ppm	Highly variable, 10ppm is a good target

https://knowledge.escarpmentlabs.com/article/216-oxygen-requirements-ppm

Yeast Health: Options for Oxygenating Wort

> Shaking Method 1-3 PPM

> Air Pump for 1 Hour 8PPM

> Pure Oxygen 0.5Micron Stone1L/min 10PPM in 2 minutes

https://www.morebeer.com/articles/wort_oxygenation_flavor_impact

Yeast Health: Sanitation and Contamination Prevention

Importance of Cleanliness

Proper sterilization of equipment, yeast containers, and wort is crucial to prevent contamination and ensure the quality of your brew.

Personal Protective Equipment (PPE)

Use a mask and gloves to minimize the risk of introducing contaminants during the brewing process.

Sanitizers and Disinfectants

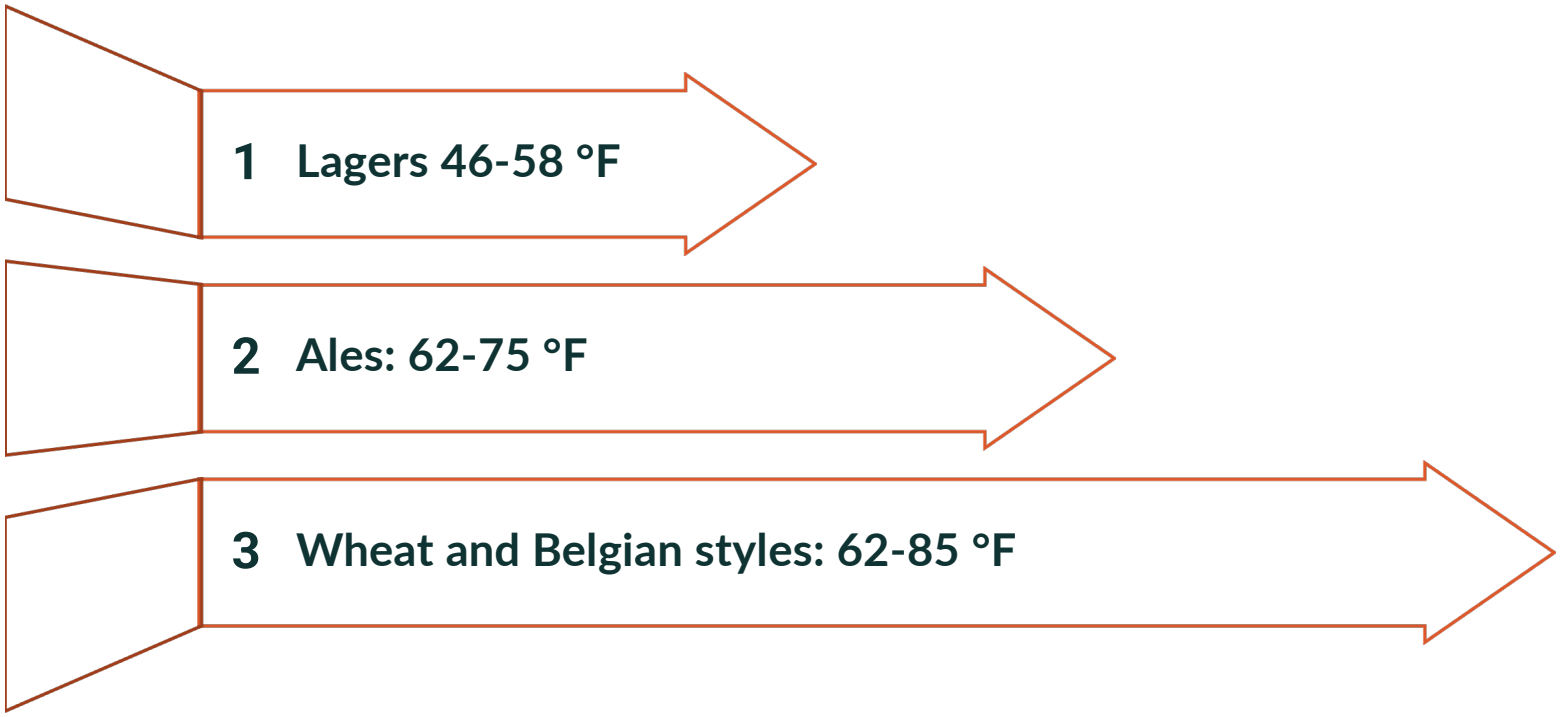
Utilize effective sanitizers like Star San to thoroughly clean and disinfect all surfaces and equipment.

Sterilize

You can sterilize clean glassware and metal parts in the oven. Cover openings with foil and bake the parts @ 350F for 1 hour.

Implementing a robust sanitation and contamination prevention protocol is essential for producing high-quality, consistent, and safe homebrew.

Yeast Health: Fermentation Temperature



Brewing: How much yeast do you need?

Yeast Pitch Rate Defined

Yeast pitch rate refers to the amount of yeast cells pitched (added) per volume of wort at the start of fermentation. It's a crucial factor in ensuring consistent and complete fermentation.

Importance of Proper Pitch Rate

Underpitching can lead to slow, incomplete fermentation, off-flavors, and stalled fermentation. Overpitching can result in excessive yeast autolysis, leading to yeasty flavors and poor mouthfeel.

Pitch Rate vs gravity

- million cells / ml / degree Plato
- New smack pack, MFG guideline: 0.35 (ale only)
- Middle of the road Pro Brewer 0.75 (ales below 1.060)
- Pro Brewer 1.00 (gravity above 1.060)
- Pro Brewer 1.50 (minimum for lager)
- Pro Brewer 2.0 (maximum, lager above 1.060)

Proper yeast pitch rate is essential for brewing consistent, high-quality beer. Using a reliable calculator like the one from Brewer's Friend can help ensure you pitch the right amount of yeast for your specific brewing conditions.

I use a pitch rate of 1 million cells/ml/plato for ales and 2 million cells/ml/plato for lagers

Brewing: Yeast Density Measurements

Somewhere around 150 billion

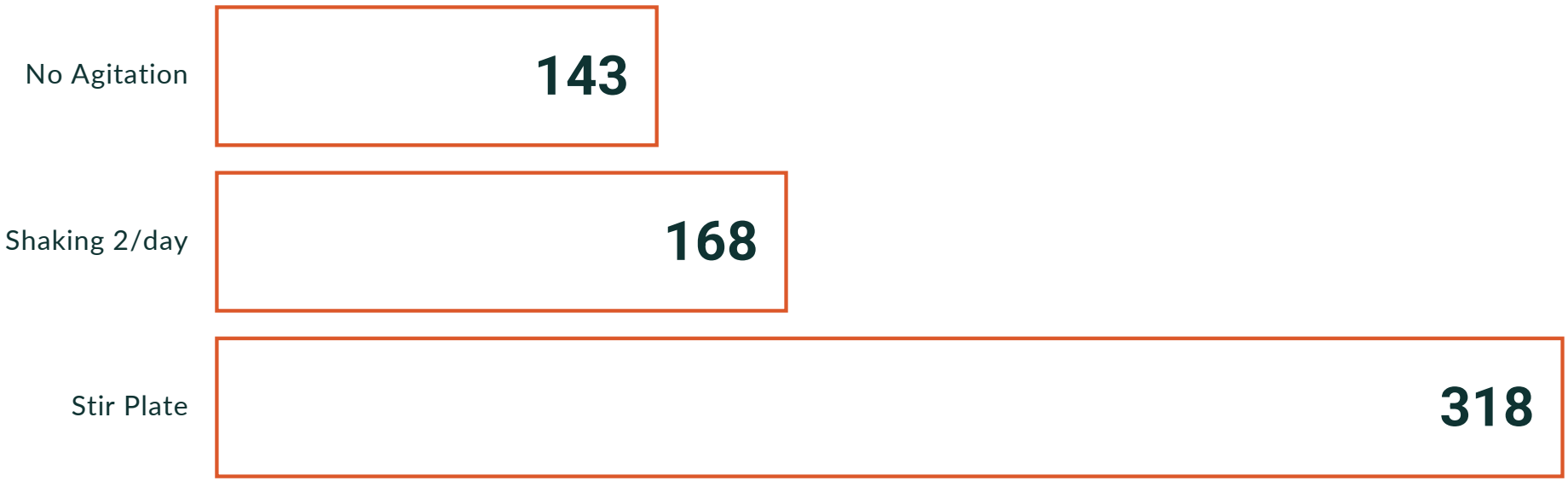
100 billion cells

we measured 250 billion live in our sample

Liquid yeast viability drops 21% each month, or 0.7% each day, from the date of manufacture.

Brewing: Comparison of Yeast Starter Methods

Assuming you start with a yeast pack with 50 billion cells (~2 months old) and assuming a 2L starter



Brewing: How big should your starter be?

- ## Calculate Required Yeast Cells

  Multiply your wort volume, in gallons or liters, by your target pitch rate to get the total number of yeast cells needed.

- ## Evaluate Yeast Available

  Check if you have enough viable yeast cells from your dry or liquid yeast package. If not, you'll need to make a starter. Remember that Liquid yeast viability drops 21% each month, or 0.7% each day.

- ## Determine the Agitation Method

  The method of agitation will make a huge difference in the quantity of yeast grown. For example using a stir plate produces more than twice a much yeast as no agitation at all.

- ## Determine Starter Size

  Use the yeast calculator to determine the ideal starter size to reach your target pitch rate. It can handle multi-step starters as well.

Using a yeast starter calculator like the one from Brewer's friend makes figuring out how big your starter needs to be very easy.

Brewing: Growing yeast

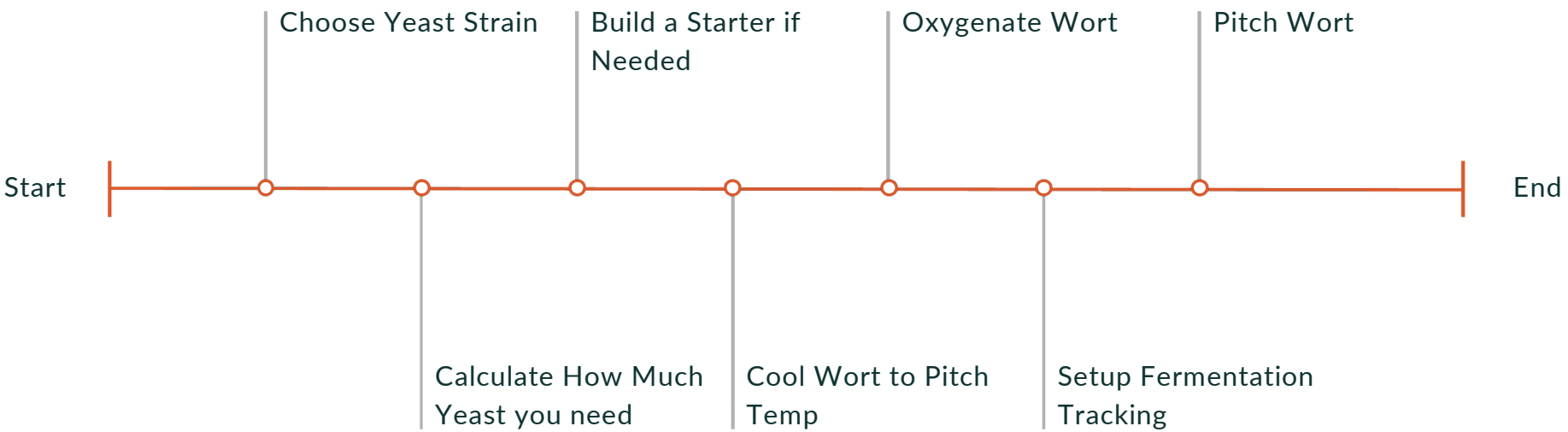
Guidelines

- you want to pitch yeast into ~10-20 times volume
- if you have 100mL of yeast pitch that into 1-2L of starter

Yeast Starter

- Add DME @ 10:1 - 0.1g/ml
- Add Yeast Nutrient @ 5 g/L
  I like Fermaid-O
- Add one drop of FirmCap-s
- Rolling Boil for 10 Minutes

Brewing: Yeast Process



Brewing: Fixing Stuck Fermentations

Make sure you measure your OG and your current gravity. If you are only a couple of points off (1.012 instead of 1.010) its probably done and not stuck.

Examine the temperature and pH to ensure they are within the optimal range for the yeast strain being used.

Introduce oxygen into the wort by agitating or aerating it, which can help revive the yeast and restart the fermentation.

Add a fresh, healthy yeast starter to the fermentation vessel to reinvigorate the yeast and restart the fermentation process.

Closely monitor the fermentation progress and make any necessary adjustments to temperature, pH, or oxygen content to ensure the fermentation is progressing as desired.

Workshops and Field Trip Ideas

- Making yeast starters and concentrates
- Yeast cell counting and viability staining
- Harvesting wild yeast
- Freezing yeast and Yeast Banking
- Field trip to Propagate Labs.

Resources

- Beermaverick yeast comparison tool
- Wort Oxygenation Flavor Impact
- Brewers Friend Yeast Pitch Rate and Starter Calculator
- Yeast Pitch Rates Explained
- Yeast Book
- Optimizing Yeast Starters and Large-Scale Yeast Production
- Stepping up to pitchable amounts/
- Domestication and Divergence of *Saccharomyces cerevisiae* Beer Yeasts