

# How to Manage Yeast for the Home Brewery

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# How I started with yeast

- Graduate work: Stony Brook University



- Thesis work in the Konopka Lab
- was on cell signaling in *Saccharomyces cerevisiae*
- Homebrewer since Jan 2002

# Why study yeast?

- Single cell organism
- One of the simplest Eukaryotic organisms
  - Bacteria are prokaryotic
  - Humans and all animals Eukaryotic
- Many cellular processes are conserved in yeast and humans
- About 20% of gene linked diseases in humans have a corresponding gene in yeast
- Many drugs were first tested in yeast.

# Advantages of working in a yeast lab

- Always had a supply of yeast growth media
- Autoclaves for sterility
- “free consumables”
- Ability to isolate and freeze down any yeast strain
- Could have enough yeast to pitch overnight
- Yeast strains were always “Free”

**UCONN/ Plum Island: Use Yeast to Study Viruses**

# Yeast and the Homebrewer

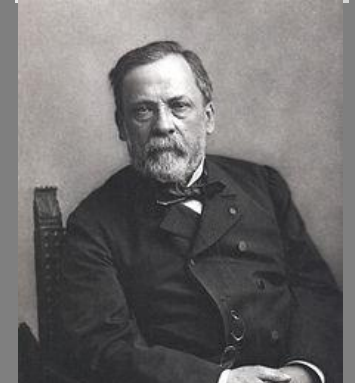
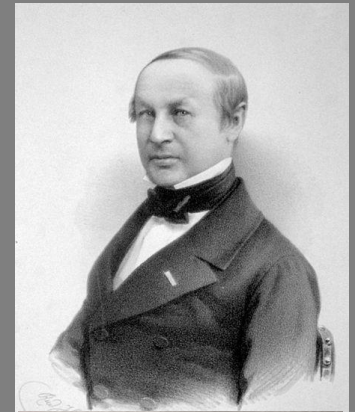
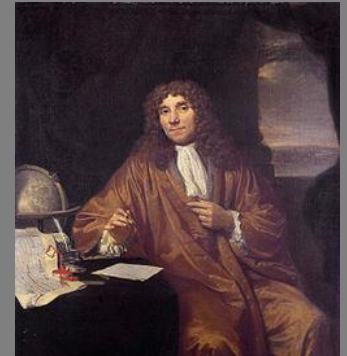
- **Liquid yeasts not always available or fresh**
  - Expensive some times 1/3 of the cost of ingredients
- **Spontaneous brew day**
  - Typically requires dried yeast or homebrew store visit
- **Starters grow more slowly**
  - Lab optimal growth conditions
- **Freezing/ Storing yeasts more difficult**
  - Most homes don't have
    - a -70oC freezer (typical home freezer is -20)
    - Sterile working environments

# Overview

- History of yeast
- How yeast grow/ferment
- Yeast terminology/choosing a yeast strain
- New advances in yeast technology
- Simple ways to harvest yeast
- Maintaining a house yeast/reusing yeast

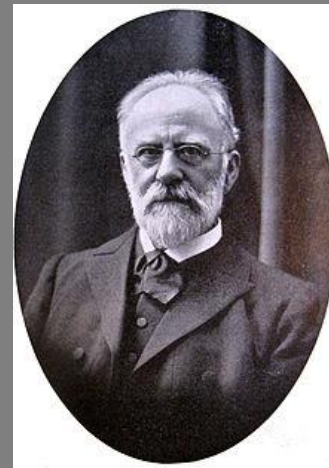
# Discovery of yeast for fermentation

- 7000 years ago: Oldest records of beer
- Inoculation stick (vat to vat)
- Anton van Leeuwenhoek 1680
  - First to observe yeast
- Theodore Schwann 1837
  - Determined yeast was alive (*Zuckerpilz*)
  - Latin translation: *Saccharomyces*
- Louis Pasteur 1866
- fermentation was from living cells



# Yeast and Brewing

- 1876 Carlsberg established first brewing laboratory
- 1883 was the first brewery using pure yeast cultures Emil Christian Hansen.



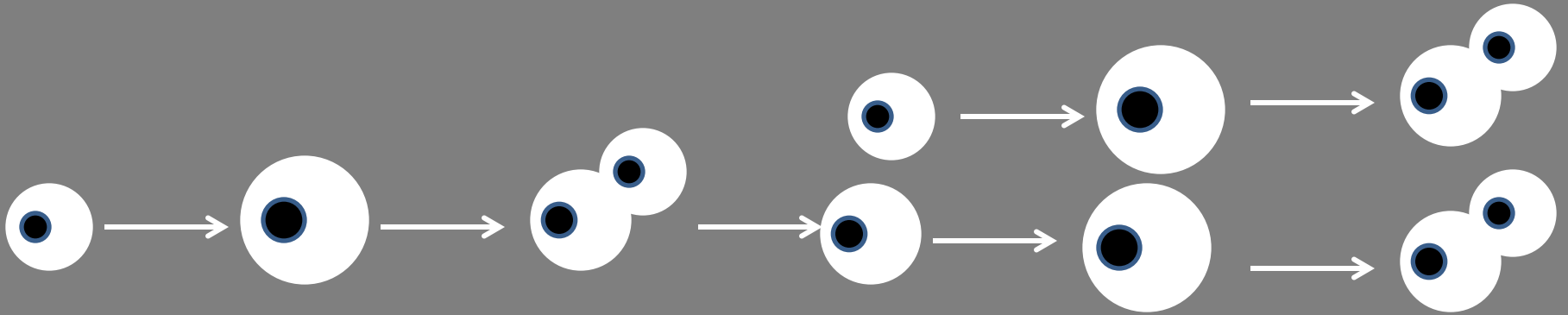


# Overview

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# How do yeast normally replicate?

- Asexual process known as budding



- Electromicrograph
- Bud scars

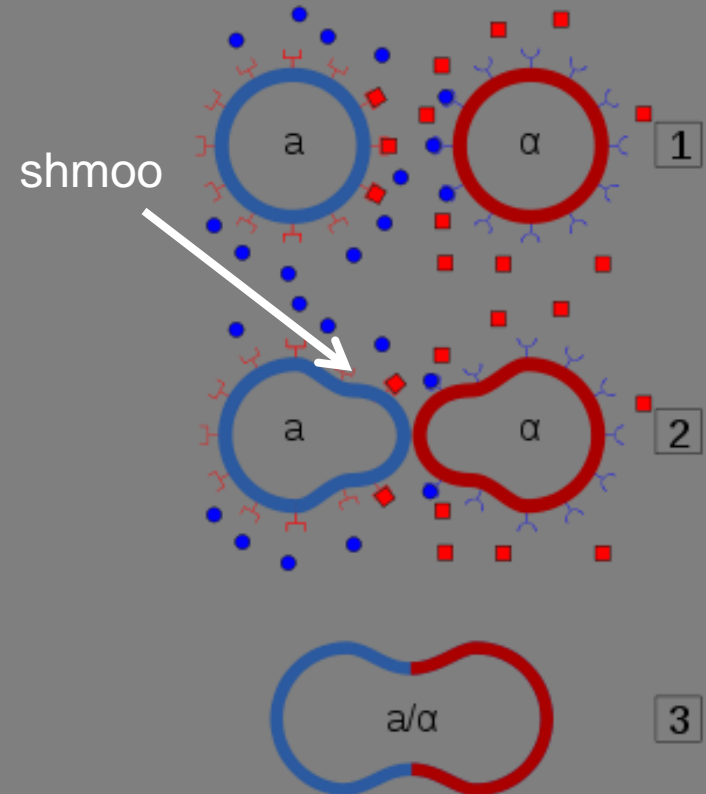


[hxx.ncist.edu.cn](http://hxx.ncist.edu.cn)

# Yeast replication is more complicated

- Asexual and sexual reproduction
- Yeast can be
  - haploid(single set of chromosomes)
  - Diploid( two sets of chromosomes)
  - Polyploid (more than two sets of chromosomes)
  - Most brewing strains are “confused”
    - Some level of polyploid

# Sexual reproduction of yeast



James Konopka

# In order to make great beer one must make love to the beer



*Shmoo, from  
Al Capp's Li'l Abner*

- Mating occurs only with haploid cells
- Most brewing strains are polyploid and don't mate
- Starvation/Sporulation required for haploid cells

**There is no shmoo-ing or yeast love making in beer**

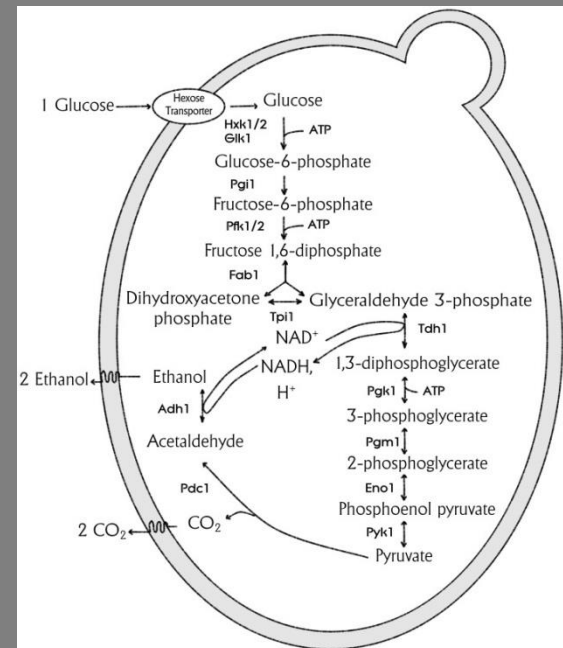
**How does Yeast Make beer?**

# Yeast are anerobic fermentators (no oxygen present)

- Oxygen is depleted 30-60 min after pitching
  - If there is Oxygen no alcohol is made
- Yeast are consuming sugar -> Ethanol and Co2



- Fermentation is complex

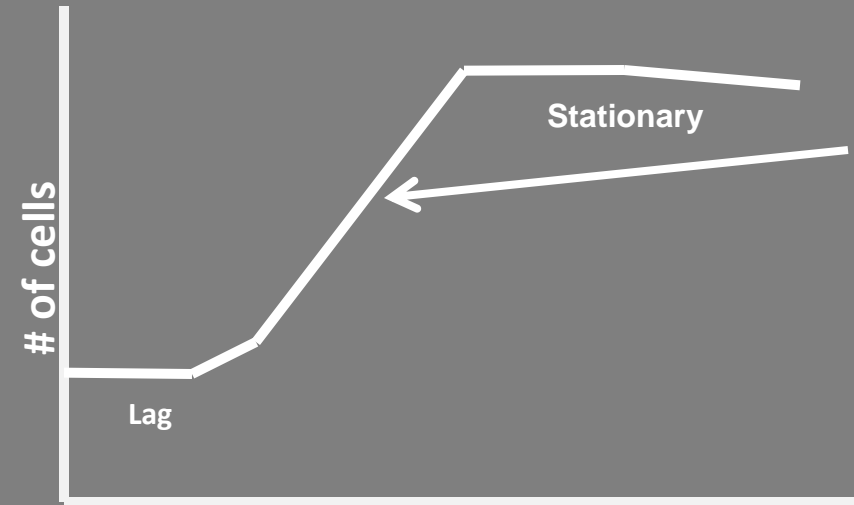


# The lag phase

- When nothing is happening.
- Yeast take up nutrients & Oxygen to prepare for growth
- Yeast start growing/fermenting
- The longer the lag phase=higher chance of contamination.
- How can we shorten the lag time
  - Fresh yeast
  - Increase number of viable yeast cells
  - Proper nutrients (zinc+)
  - Dissolved O<sub>2</sub>



# Growth phase



Exponential growth:

Would you like a \$1 today or a penny today ,  
which doubles every day for 30 days

- Flavor compounds are produced
  - Fusel alcohols
  - Esters ( fruity)
  - Sulfur
  - Phenols (peppery, spicy, clove-like)
- Majority of fermentation occurs
  - Krausen
  - Airlock bubbling



# Stationary phase

- Yeast stop replicating
- Krausen falls
- Yeast settle to the bottom
- Yeast start to reabsorb off compounds
  - Diacetyl
  - Acetaldehyde
  - Hydrogen sulfide (escapes as a gas)

# Signs fermentation went bad

- Contamination (sour, plastic, bandaids)
  - Long Lag time
  - Unhealthy yeast
  - Poor sanitation practices
- Harsh Alcohol taste
  - High temperature (fusel alcohols)
  - Too high a pitch rate
  - Leaving yeast on trub

# Signs fermentation went bad

- Yeast autolysis ( Soapy, high esters, yeasty taste )
  - Old yeast
  - Poor Oxygenation
  - Leaving beer on yeast at high temps or long time
- Diacetyl(buttery)
  - Removing beer from yeast too quick
- Acetaldehyde
  - Removing beer from yeast too quick

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# What kinds of yeast are there?

## Ale vs. Lager

### Ale strains

Top fermenting

Ferment warm “quick”

Clean (American)

Estery/Fruity (English)

Phenolic (Belgian/Weizen)

### Lager strains

Bottom fermenting

Ferment cold “slow”

Dry or Malty

Diacetyl

Sulfur

Exceptions: California Common (lager at ale temp)

# Yeast : Not just Ale vs Lager

- Currently 1500 different types of yeast
  - Not all can ferment sugar
    - only 1% palatable to taste
- Brewer's Yeast : *Saccharomyces cerevisiae*
- *Saccharomyces pastorianus* (lager strain)
- *Saccharomyces uvarum* (lager strain)
  
- *Candida albicans* (infectious yeast)
  - Yeast infections (makes bad tasting beer)
- *Brettanomyces*
  - *bruxellensis*, *anomalous*, *custersianus*, *naardenensis*, *nanus*

# Picking the proper yeast

## #1. What beer is being made

- Flavor profile desired
- Clean
- Fruity
- Esters
- Phenolic
  - Belgian beers
  - German Weisse
- Sour beers



# Picking the proper yeast

## #2: What is available

- Dry yeast
  - Long shelf life
  - High Viability
  - No planning
- Liquid yeast
  - Short shelf life
  - Freshness
  - Planning

# Picking the proper yeast

## #3: What temperature's can I ferment at

- Not as important if you have temperature control
- Fermentation temps in the house
  - Basement
  - Upstairs
  - Near the furnace
  - In a closet
- Important to choose a strain that can ferment at the temperature you have  
(with desired characteristics)

# Different temperatures affect flavor profile



		Belgian Wit	Belgian Wit II Yeast	Trappist Ale Yeast	Belgian Abbey Yeast	Belgian Ale Yeast	Belgian Saison I	Belgian Golden Ale	
Yeast Strain Number		WLP400	WLP410	WLP500	WLP530	WLP550	WLP565	WLP570	
See Notes Below	Flocculation	High/Medium/Low	Low	Low-Medium	Low	Medium-High	Medium	Medium	Low
	Attenuation %	High/Medium/Low	High	High	Medium-High	Medium-High	High	Low-Medium <sup>1</sup>	Medium
	Alcohol Tolerance		Medium	Medium	High	High	High	Medium	High
	Temperature Range and resulting Flavor Profiles	High (75-85°F)	Fruity	Fruity	Fruity	Spicy	Earthy	Earthy	Fruity
			Phenolic	Phenolic	Mod. Phenolic	Phenolic	Phenolic	Peppery	Mod. Phenolic
			Sulfur	Sulfur	Solvent	Solvent	Solvent	Heavy Spice	Sulfur
		Medium (67-75°F)	Tart	Peppery	Spicy	Spicy	Fruity	Slight Earthy	Fruity
			Fruity	Light Phenol	Light Phenol	Light Phenol	Phenolic	Phenolic	Phenolic
			Mod. Phenolic	Fruity	Fruity	Fruity	Sulfur	Spicy	Sulfur
		Low (58-66°F)	Bubble Gum	Tart	Clean	Peppery	Clean	Phenolic	Phenolic
		Clove	Earthy	Balanced	Spicy	Light Phenol	Slight Earthy	Spicy	
	Spicy	Clean & Crisp	Earthy	Light Phenol	Spicy				

# Picking the proper yeast

## #4: How much attenuation?

- Attenuation : Amount of sugar that is converted into Ethanol + CO<sub>2</sub>
- Apparent Attenuation  $(OG-FG)/OG$
- Higher final gravity, yeast with lower attenuation
- Lower final gravity, yeast with higher attenuation
- Attenuation is also dependent on mash temps

# Picking the proper yeast

## #5:Focculation (how quick will my beer clear)

- Flocculation: How well a yeast clumps and falls to the bottom.
  - High Focculation falls quick (3-5 days)
    - May need rousing to fully attenuate
  - Medium Focculation falls (6-15 days)
  - Low Focculating yeast may stay in suspension
  - Lowering the temperature can speed focculation

# Picking yeast an example

#1: I'm going to make an IPA

– Esters ok, ale yeast

#2 : I am going to brew right now

– Dry yeast

<u>Name</u>	<u>Focclulation</u>	<u>attenuation</u>	<u>temperature</u>
Fermentis Safale US-05	Medium	High	59-72°
Coopers Brewers' Yeast	High	High	68-80°
Fermentis Safale S04	High	High	59-75°

#3: my basement is at 70°

#4: I want a Dry IPA, high attenuation

#5: Flocculation, medium

<http://byo.com/resources/yeast>

# Picking yeast an example

#1: I'm going to make an IPA

– Esters ok, ale yeast

#2 : I am going to brew right now

– Dry yeast

<u>Name</u>	<u>Focclulation</u>	<u>attenuation</u>	<u>temperature</u>
Fermentis Safale US-05	Medium	High	59-72°
Coopers Brewers' Yeast	High	High	68-80°
Fermentis Safale S04	High	High	59-75°

#3: my basement is at 60

#4: I want a Dry IPA, high attenuation

#5: Quick Focclulation

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# Reusing yeast easy to more complex

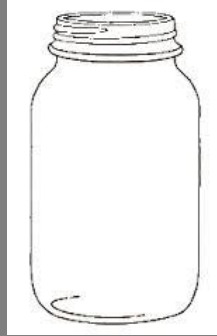
## #1 Easiest

- Dump onto another yeast cake
  - Especially good for a low gravity to high gravity beer
  - Example bock-> doppelbock
- Transfer beer off of yeast, add new beer
- **If batch one tastes bad DON'T reuse the yeast**
- Drawbacks:
  - Need to plan two batches of beer
  - Trub/pellet hops are present from batch one

# Short Term Storage of yeast

- #2 Easy

- Scoop some yeast into a container (sterilize)



- Scoop after primary
- Store Container in the fridge
- **Before use, look, smell, taste.**
- Dump everything into your next batch
- Longer the storage, viability can decrease
- Trub is present , starter may be required



# Short Term Storage of yeast

- #2 Some work involved
- Washing yeast
  - not acid wash but removal of trub
  - Use sterile water (Boiling)



Decant Yeast leaving trub behind.

# Reusing yeast from the source



- Aliquot the original yeast
- Pre-sterilized falcon tubes 15ml/50ml
  - <.50 on ebay
  - Smaller tubes 1-2ml cheaper
- Sterile pipets <.20 on ebay
- Any small vial that you can sterilize
- Use one vial to start a starter
- Store in fridge

**Disadvantages: Must make a starter**

**Viability depends on strain (most strains 1yr+)**

# Long term storage: freezing yeast

- 30% glycerol solution (dilute with sterile water)
- Mix equal volumes of yeast and glycerol solution
- Can do this directly from source yeast
- Freezer
  - Ideally not a frost free freezer
  - If you must put the vials in a small cooler with ice packs, to prevent vials from freezing.
  - Yeast are good for several years in a home freezer
  - (home freezer  $-20^{\circ}\text{C}$ , lab freezers  $-70^{\circ}\text{C}$ )



# Long term storage



Viability of yeast strains vary

Reports of yeast strains in Glycerol stored at RT for 30+ years

Viability will decrease with each freeze-thaw cycle

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# How do I get yeast strains?

- From bottle conditioned beer
  - E-mail the brewery
    - Ask if the yeast in the bottle was the fermenting strain
    - Sometimes another strain/champagne yeast is used
- Carefully decant the beer, leaving the yeast behind.
- Add some wort to this bottle of beer.
  - add airlock to the bottle or transfer to flask
  - step up yeast to larger volume before using



# Other sources for house strains

- Brewery Visit
  - Often they will give you a growler of yeast
- From the wild
  - Rotten fruit
  - Uncovered wort outside
- From your body
  - Beard

# Plates and slants

- Require more startup materials
  - Minimum:
    - Inoculation loop
    - Propane torch
    - Pre-cast plates YPD plates (\$1-\$2 each)
- Ensures purity
- Keep plates sealed in fridge
- Restreak monthly



**Good**



**BAD!!!**

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- **New advances in yeast technology**

# New advances in Yeast

- Wider selection
  - Both Dry and Liquid yeasts
- More yeast suppliers
  - Eventually could bring prices down
- Yeast blends (multiple strains)
  - Different strains grow differently
  - Reusing the blend: Results could vary

# New exciting advances in Yeast

- Genome Sequencing/ Expression profiling
- Production of strains with desired phenotypes
  - Mating yeast

# Genome Sequencing

- Dr. Verstrepen lab & white labs
  - Sequencing 100's of strains
  - Looking for genetic mapping to develop new strains
- First done by Miller-Coors ~15 years ago
  - Sequenced Weihenstephan Weizen
  - To their surprise they found two genes that had multiple copies
    - Isoamyl acetate (banana)
    - 4-vinyl guaiacol (clove)

# Production of hybrid strains

- Omegayeast
- Not the mixing of two strains
- Proprietary mating system
- Making new hybrid strains



**Saisonstein's Monster**  
Cross between  
French and Belgian saison strains

# How much yeast do I need?

- Professional brewery literature:
  - 1 million cells/ml/degree Plato
- Wyeast : 100 billion cells
- White Labs: 70 to 140 billion yeast cells
- Fermentis: 115-150 billion cells enclosed

Pitch rate varies by yeast strain and what you expect

- Esters/compounds made only during yeast growth
- Too high of a pitch cleaner beers, low yeast growth
- Too low of a pitch, long lag times, sanitation more important



# Professional brewery vs Homebrewery



VS



## Differences

1. Weight of the liquid (pressure on yeast)

2. Backpressure of CO<sub>2</sub>

- During primary I don't use an airlock
- Loosen lid/ aluminum foil
- Airlock when primary slow

3. Yeast act differently in different vessels

Photo taken from Short's Brewery 7bbls

# True Starter yeast counts

- Kai Troester NHC 2013 “Step Up Your Starters Insights Into Yeast Propagation for Homebrewers”
- Observations:
  - Different final growth rates depending on how you grow the starter
    - Sit, Shaken, Stirs (Stir/shake speed matters)
    - Gravity of Wort
    - Availability of O<sub>2</sub>

# Why do professional brewerys pitch so much yeast?

- Reusing of yeast
  - low level contamination
  - petite formation
    - Yeast spill its guts (smaller)
    - diacetyl
- Cost and profits
  - Professional starters 100's dollars, typically for a small batch 1bbl.
  - Yeast has to be stepped up for a full batch
  - Waiting for yeast=loss of profits
    - Acid washing yeast (bad idea for homebrewers)

# So how much yeast should I use?

- What works for you
- Lower # healthy is better than high # sick
- Trust the manufactures, they have done at least some testing
- Read hydration instructions
  - Not all dried yeast has to be hydrated
- Read manufactures recommended use by date
- Try pitching less if not getting full flavor profile

Questions?