

# Rockhoppers Education Series

- **Structured approach**
- **Light touch on technical aspects**
  - Focus on homebrewing application
    - Overview, Application, Sensory
- **Assume range of knowledge: Beginner to Advanced**
  - Expect beginners to ask questions
  - Expect seasoned brewers to share knowledge and experience
  - I will try to prompt and facilitate discussion
- **Try to mix it up with different members giving presentations as way to bring many perspectives**
- **Hope to be able to augment our discussions with peripheral activities:**
  - Field experiences, Sensory experiences, Guest speakers, Experiments, Demonstrations (video)

## Topics

Primary Ingredients (Yeast, Water, Malt, Hops)

Brewing Process (Planning, Recipes, Brewing, Packaging)

Funky Beers

Sensory/Judging

A grayscale micrograph showing several yeast cells of various sizes and shapes, some appearing as bright, rounded structures against a dark background. The cells are scattered across the frame, with some showing internal details like budding or internal organelles. The lighting creates a halo effect around the cells, making them stand out.

# YEAST

Rockhoppers Brew Club

April, 2017

# Overview

- Discovered by Louis Pasteur (Circa 1860)
  - Although previously observed, thought to be a chemical reaction (like enzymes), rather than a biological process.
  - *“Memoire sur la fermentation alcoolique”*
- Single cell fungi
  - Metabolize sugars into CO<sub>2</sub> and Alcohol
    - As well as: Esters, fusel alcohol, keytones, phenols, fatty acids
  - Reproduce via “budding”
- More selection available to brewers than ever before:
  - Dry Yeast
  - Liquid Yeast



# Overview: Types

Some 1500 Types of Yeast have been identified, but brewers are primarily interested in:

Saccharomyces Cerevisiae	Saccharomyces Pastorianus	Brettanomyces	Bacteria	
<ul style="list-style-type: none"><li>• Top fermenting</li><li>• Warmer temps (&gt;55)</li><li>• Ale Yeast</li><li>• Fruit, Spice and alcohol</li></ul>	<ul style="list-style-type: none"><li>• Bottom fermenting</li><li>• Cooler temps (44-50)</li><li>• Lager Yeast</li><li>• Sulfur</li></ul>	<ul style="list-style-type: none"><li>• B. anomalous;</li><li>• B. bruxellensis,</li><li>• B. lambicus,</li><li>• B. claussenii</li><li>• More Robust</li><li>• Able to metabolize more complex sugars (Dextrines)</li><li>• Super attenuative</li><li>• Funky, Earthy Horseblanket, Barnyard, Fruit, Acidic</li></ul>	<b>Pediococcus</b> <ul style="list-style-type: none"><li>• By product: Lactic Acid (No CO2)</li><li>• Heavy amounts of Diacetyl</li><li>• Ropy: Carbohydrates, acids and proteins</li><li>• Not as tart as Lacto, but more complex</li></ul>	<b>Lactobacillus</b> <ul style="list-style-type: none"><li>• By-products: CO2 and Lactic Acid</li><li>• Tart and Tangy</li><li>• Yogurt</li><li>• Probiotics</li><li>• Not tolerant to hops</li></ul>

Sanitizing Note: While sanitizers rely on acid to kill yeasts, these bacteria create acidic environment, so require heat to sanitize

# Overview: Terminology

**Viability:** Percentage of living yeast within a population

- Chris White says < 90% = noticeable flavor impact on beer

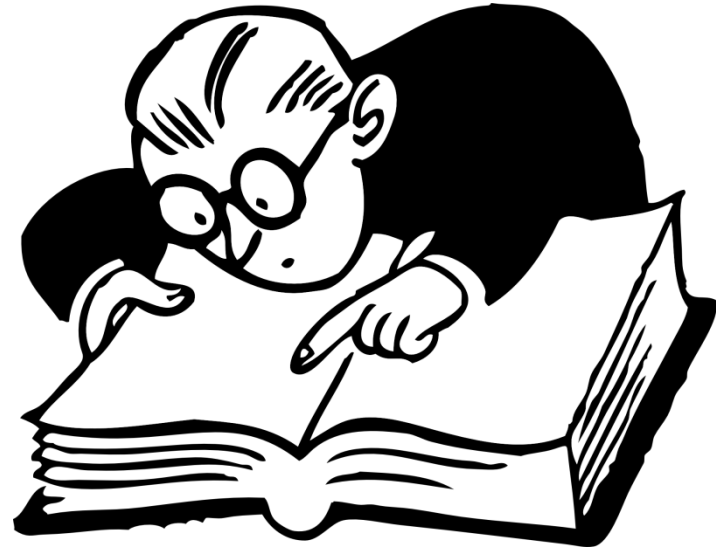
**Vitality:** Condition of living yeast in culture

**Attenuation:** Percentage of sugars in wort converted

- $[(OG-FG)/(OG-1)] \times 100 \dots [(1.060-1.010)/.060] \times 100 = 83\%$

**Flocculation:** Tendency for yeast to clump together and drop out of solution

- Low, Medium, High
- Low flocculating yeast can be cloudy and yeasty tasting
- High flocculating yeast can drop too soon and under-attenuate



# Overview: Bi-Products

## Esters (Fruity)

- Banana
- Warmer pitch and ferm temps
- Lower Pitch Rates

## Acetaldehyde (Green Apple)

- By product of ethanol production
- Generally associated with “young” beer as it tends to condition out

## Keytones (Diacetyl: Butter)

- Unstable and leads to oxidation (stale, papery)
- Natural part of the mechanics of fermentation; Will clean up through conditioning

## Phenols (Spice)

- Clove, pepper, smoke ...
- When combined with chlorine = medicinal notes (bandaid)

## Fusel Alcohol (Solvent)

- Heavier weight alcohols
- Warmer pitch and ferm temps
- High gravity beers/refined sugars)
- Over/under aeration
- Some Fusels will “esterify”

## Fatty Acids

- Partners in chemical reactions. Some good, but often oxidizes

## Take-Aways

### Conditions that drive increased cell growth tend to drive increase in bi-products (good and bad)

- Cool wort to primary ferm temp before pitching yeast
- Pitch sufficient quantities of healthy yeast (don't over-pitch)
- Aerate sufficiently, but not excessively
- Condition
- Step up your high gravity beers
- Choose yeast strains to balance effects

# Overview: Phases

## Lag Phase (Adaptation)

- 0-24 hours after pitching
- Yeast takes stock of available resources (Sugars, Oxygen, FAN, nutrients)
  - Glucose – fructose – sucrose – maltose – maltotriose - dextrines
- Begin building up cell membranes and budding
- Aerobic conditions are important for efficiency of this stage

## Exponential Growth Phase (Primary/Attenuative)

- 4-hours to 6-days (up to ten days for lagers)
- Majority of attenuation occurs (Two-thirds to three-fourths)
- Krausen
- Anaerobic

## Stationary/Conditioning Phase

- 3-10 days
- Environment becomes alcoholic, anaerobic and lacking in nutrients
- Much of the yeast goes dormant, or dies
- Remaining yeasts are scavenging for food
  - More complex sugars
  - Many of the bi-products produced during primary (acetaldehyde, diacetyl)



# Application: Levers

## Type/Style

- There are many types of yeast available. Choose one that exhibits the characteristics of your desired beer.
- [WhiteLabs.com](http://WhiteLabs.com)
- [Wyeastlab.com](http://Wyeastlab.com)



## Pitching Rate

- Assuming high viability; generally a function of style (desired character), OG, and fermentation temperatures.
- Typical vial of WL, or Smack Pack, or dry yeast pak contains about 100B cells ... enough for a 5 gallon batch of <1.055 OG Wort. But then there's this:

**1 million cells per milliliter of wort per degree Plato (BYO)**

**Double for Lagers**

Plato is roughly gravity points/4. So 1.040 = 10 degrees Plato

1B/L = 4B/G = 24B/6gallons = **240B Cells WTF!!**



# Application: Standard Pitching Rates

STYLE	GRAVITY	PITCHING TEMPERATURE (°F)	FERMENTATION TEMPERATURE (°F)	PITCH RATE (Million Cells/ml.)
Ale	<1.060 (15P°)	>65	>65	6.00
Ale	1.061-1.076 (15-19P°)	>65	>65	12.00
Ale	>1.076 (19P°)	>65	>65	>18.00
Lager*	<1.060 (15P°)	>65	<60	6.00
Lager*	1.061-1.076 (15-19P°)	>65	<60	12.00
Lager*	>1.076 (19P°)	>65	<60	>18.00
Lager	<1.060 (15P°)	<60	<60	12.00
Lager	1.061-1.076 (15-19P°)	<60	<60	18.00
Lager	>1.076 (19P°)	<60	<60	>24.00

\* Technique of pitching a lager warm, allowing fermentation to begin, and cooling to the desired fermentation temperature.

# Application: Levers

## Nutrients

- Most of the necessary nutrients are inherent in brewing water and mash derived sugars (refined sugars, not so much)
  - Free Amino Nitrogen (FAN)
  - Minerals: Zinc, potassium, calcium, trace metals ...
  - Oxygen (8-10ppm)
- Still, good to add some nutrients
  - Break material and trub, Yeast Hulls, Zinc
  - Servomyces

## And aerate!!

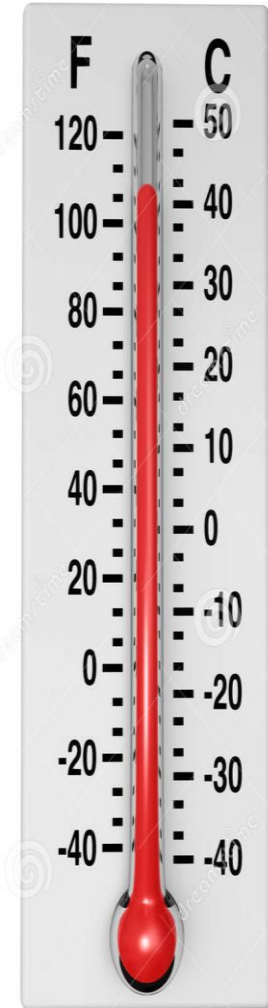
- You boiled the oxygen out of the wort
- Essential during lag phase
- Need about 10ppm O<sub>2</sub>
  - Shaking, stirring, splashing = 4ppm
  - Aquarium pump = 8ppm
  - **Pure O<sub>2</sub>, 60-90 seconds at 1Liter per minute = 10-14ppm**

<b>Nutrition Facts</b>	
Serving Size 1 beer (12 fl oz)	
Servings Per Container 1	
<b>Amount Per Serving</b>	
<b>Calories</b> 150	Calories from Fat 0
<b>% Daily Value*</b>	
<b>Total Fat</b> 0g	0%
Saturated Fat	0%
Trans Fat	0%
<b>Cholesterol</b>	0%
<b>Total Carbohydrate</b> 13g	4.7%
Fiber 8g	40%
<b>Protein</b> 1g	
Contains significant amounts of magnesium, selenium, potassium, phosphorus, biotin, B3 (niacin), B5 (pantothenic acid), B6 (pyridoxin), and B9 (folate), with smaller amounts of B1 (thiamine), B2 (riboflavin), B12 inositol and choline.	
* Percent Daily Values are based on a 2,000 calorie diet.	
<a href="http://www.DrinkingBeer.net">http://www.DrinkingBeer.net</a> - Always a good idea	

# Application: Levers

## Temperature

- **Ale strains grow fastest at 90, Lager strains at 80**
  - However, too much cell growth and off flavors/fusel alcohols
- **Brewers choose 65+/- 3 degree for ales, 50+/-3 for lagers**
  - Adjusting from there to achieve desired characteristics
  - Yeast metabolism generates heat, so 4-6 degrees > ambient
    - But activity slows and temp diff decreases, so factor that in as well
  - Create space that hold steady temp
    - Fridge/freezer and temperature control
- **Recommended Schedule**
  - Pitch 3-5 degrees below target and allow temp to rise over 24 hours
  - Hold temp steady for 2/3 fermentation schedule
  - Final 1/3 of schedule, raise temp 6-8 degrees to foster finishing, conditioning, and attenuation (unless already at high temp: Belgians)
  - Crash: drop temp significantly (< 40) to drop from solution



# Application: Levers

## Time/Conditioning

- **A common error is to take beer off yeast too quickly**
  - Many off flavors (diacetyl, acetaldehyde) are cleaned up
  - Force test
  - Autolysis: When yeast cells die, they may rupture
    - Brothy, meaty, vitamin B, rubber
- **Secondary**
  - Generally done for fear of autolysis (long conditioning/high alcohol beers) or to put on adjunct (fruit)
  - Beware O<sub>2</sub> (careful transfer, minimized headspace, or O<sub>2</sub> purge)
- **Keg**
  - Can serve as conditioning vessel
- **Bottle**
  - Primarily for carbonation, but can also help dry a beer out
- **Cask/Barrel**
  - Generally to impart oak flavor, bugs, or lo carb characteristics



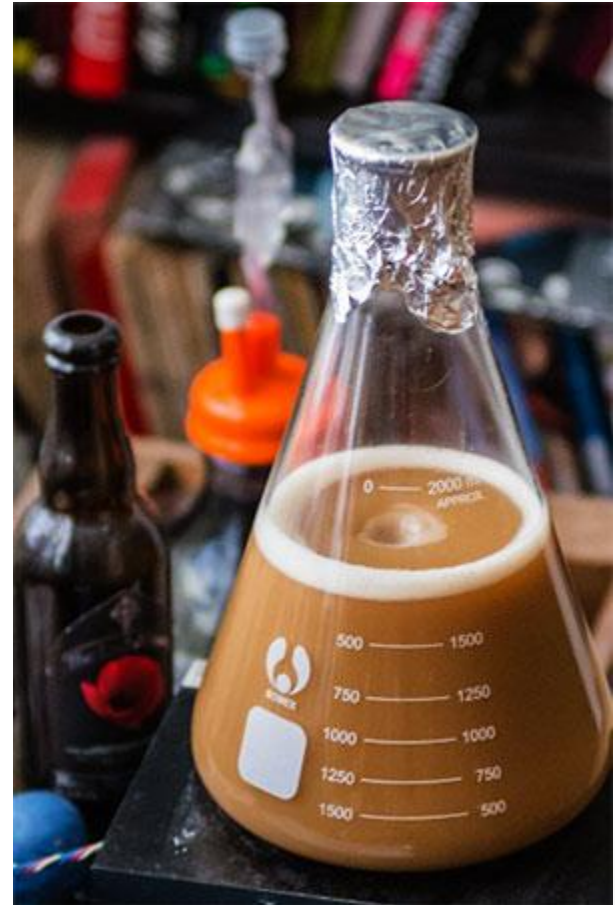
# Application: Tweaks, Techniques & Best Practices

## Yeast Starters

- Increase cell count, cell membrane health, and get them warmed up
  - Glycogen, trehalose (reserves for lag phase)
- Pitch yeast in approx 2L of sterile 1.040 wort
  - 4L for lagers (step up)
  - Add nutrient, aerate (place on stir plate)
  - 18-24 hours after krausen settles (out of sunlight), decant, pitch
  - Canning wort
- Good practice is to pull off pint of fresh starter to store for another batch

## Hydrating dried yeast

- Boil a pint of water to sterilize
- Let cool to 95 degrees
- Add dry yeast and shake
- Let cool to pitching temp



# Application: Tweaks, Techniques & Best Practices

## Yeast Harvesting/washing

- **Great technique for economy**
  1. Boil water and jars to sanitize
  2. Let cool to room temp
  3. Rack beer off yeast
  4. Add sanitized water
  5. Let sit for 20 minutes
  6. Decant to large jar
  7. Let sit for 20 minutes
  8. Decant to pint jars
- **Can refrigerate for 2-3 months (use starter)**
- **Be mindful:**
  - Blended cultures will have different balance than original blend
  - Multiple generations start to mutate and take on new character
  - You are tending to select for less flocculent yeast (that which doesn't fall out of solution)



# Application: Tweaks, Techniques & Best Practices

## Headspace/Blow off Tubes

- Should have 3-5 inches of headspace in fermentation vessel
- Add blow off tube otherwise

## Blending Yeasts Cultures

- Nice way to get character of multiple yeast
- Be thoughtful of how they compete with each other
- If adding later in fermentation, good to have starter, as you are adding to a hostile environment

## Adding sugar in fermentation

- Beware sanitation and oxygenation
- A technique for high gravity beers or for juicing stuck ferms



# Application: Tweaks, Techniques & Best Practices

## **Krausening**

- A carbonation technique in which fresh krausen is added to fermented beer (and perhaps priming sugar)
- California Commons

## **Filtering**

- Clear beer, stop any residual fermentation, keep proprietary yeast
- Of marginal benefit to homebrewers

## **Pilfering Commercial Yeast**

- Bottle Dregs (use lower gravity wort to initially build up)
- Visit your brewer





# Application: Troubleshooting

## **No/Slow start (>18hrs for Ale, >36hrs for Lager)**

- Yeast are old or dead (old yeast, too high temp)
  - Re-pitch new yeast
- Temp too cold (<55 for ales)
  - Raise temp
- Give it an O2 boost

## **Blow your top**

- Clean up mess and replace lid
- Add blow off tube
- Increase head space next time

## **Stuck fermentation**

- Rouse the yeast by swirling carboy (careful of oxygenating)
- Increase temp a few degrees
- Add fresh yeast from starter

## **Isn't Finishing**

- Consult brew notes, mash temp? Was OG higher than expected?
- Increase temperature
- Add yeast (from starter)
- Add sugar to kick start yeast
- Add Brett
- Add Beano (enzymes)

# Application: Resources

**WhiteLabs.com**

**WYeastLabs.com**

**Yeast**

- **White and Zainasheff**

**How to Brew**

- **Palmer**

**Brewing (2<sup>nd</sup> Edition)**

- **Lewis and Young**

**Wild Brews**

- **Sparrow**

**Russian River Presentation on Sour Beers**

- **Vinnie Cilurzo**