

# A microcosm, leading the world.

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Lallemand Brewing – Technical Sales Manager

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# Who am i?

## Gianmaria Ricciardi

- **Lallemand Brewing**
  - Technical Sales Manager
- **Employed in brewing industry – 8 years**
  - Head Brewer (Italy & the UK)
- **Food Technology and Biotechnology degree**
  - C.E.R.B. (Italian Brewing Research Centre)



# Summary

- The Yeast in the History
- The Yeast in the Brewing Process
- Biochemical Pathways and Metabolism
- ADY Production
- Yeast Management
- Yeast Propagation
- Yeast Harvesting and Repitching
- Yeast Behaviour
  - Flocculation
  - Yeast's Age

# The Yeast in the history

## No Yeast, No Beer. No Beer, No Civilization.

...only yesterday

Mid-1800s, Louis Pasteur discovered that yeast was a living microorganism

Only on the November 12, 1883, Emil Christian Hansen in the Carlsberg Laboratories developed pure culture techniques.

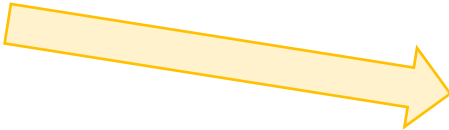
Today, most of the brewers use single strain pure culture yeast!



# What does the yeast do?



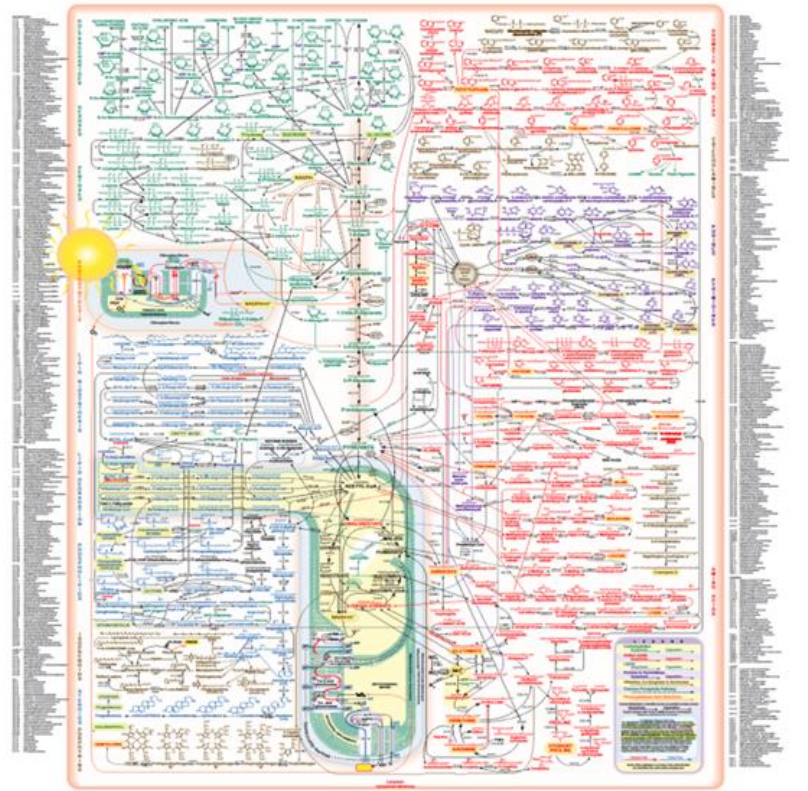
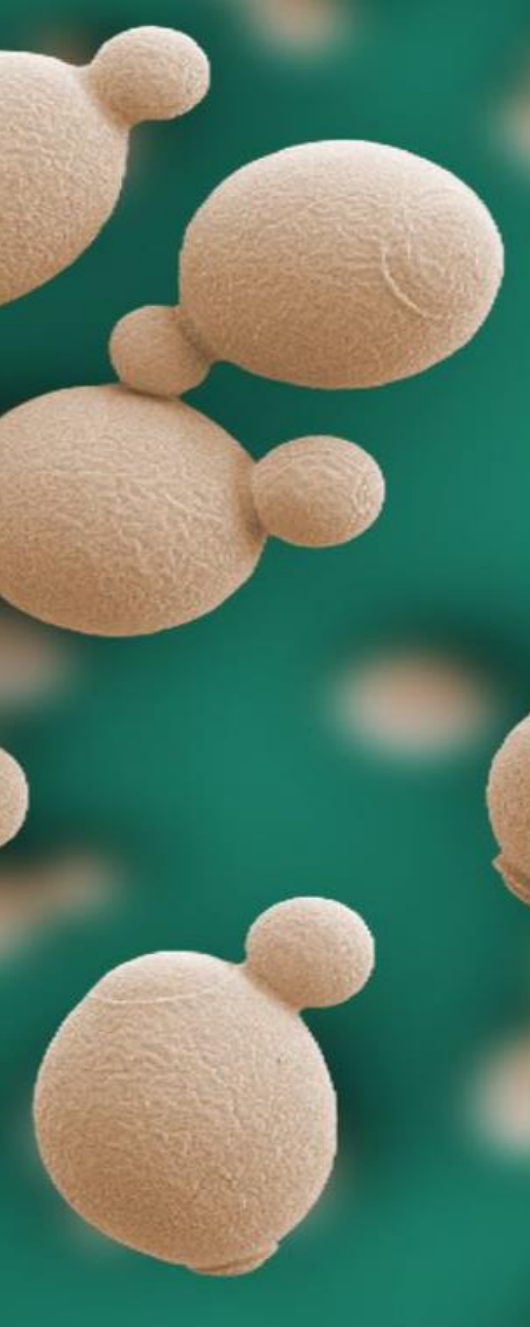
**New Yeast Biomass**



**Beer**

# Brewing: is it a simple process?





### Yeast Metabolism:

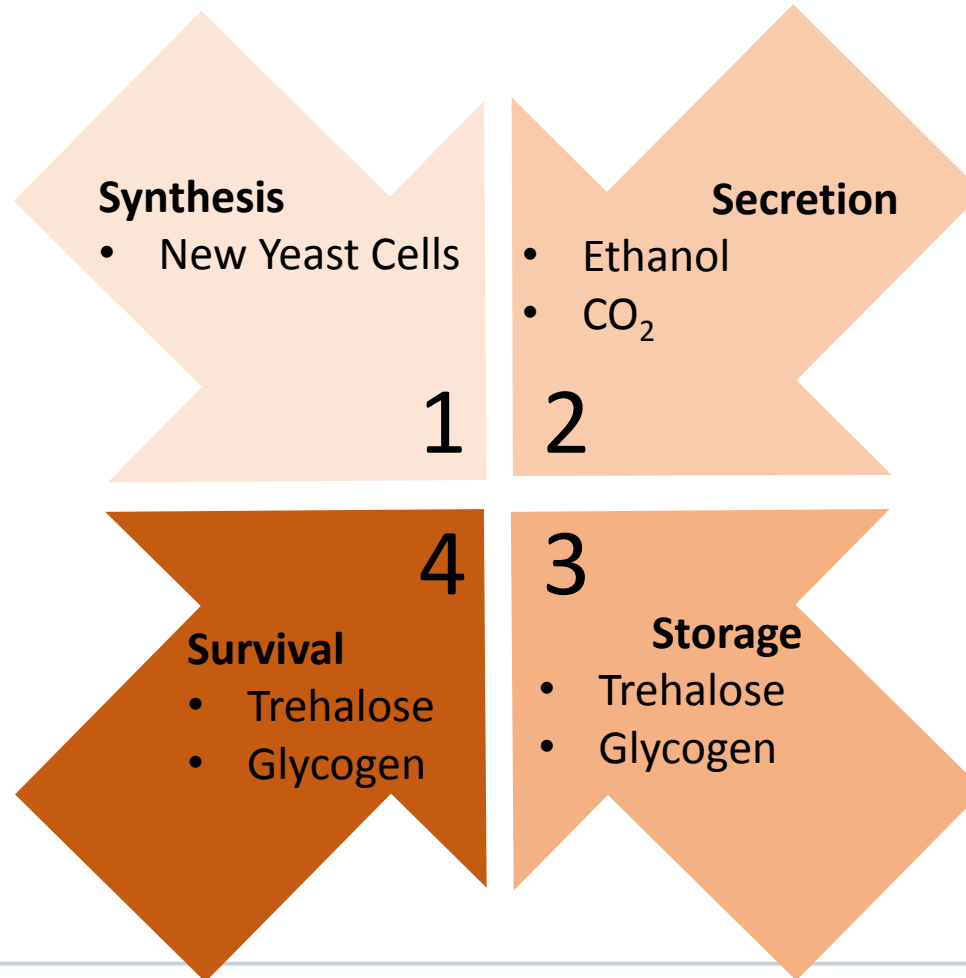
- Sum of all enzymatic reactions
- Organization and regulation

### Biochemical Pathways:

- Individual aspects
- Part of a whole metabolic process



# Destination of wort sugars in brewing yeast





**Glycolysis**

Wort Sugars



Pyruvate

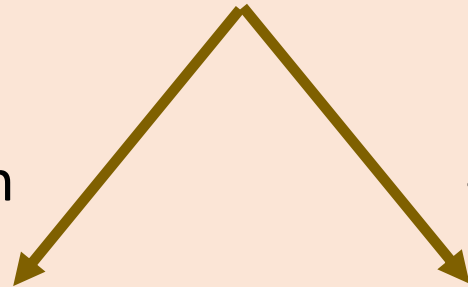


+ Oxygen

**Respiration**

- Oxygen

**Fermentation**



# Fermentation or respiration?

## Influential Factors

- Availability and/or Quantity:
  - Oxygen
  - Glucose

## Pasteur Effect

- Faster Fermentation without O<sub>2</sub>

## Crabtree Effect

- Fermentation predominates:
  - Even in presence of O<sub>2</sub>
  - High sugars inhibits respiration

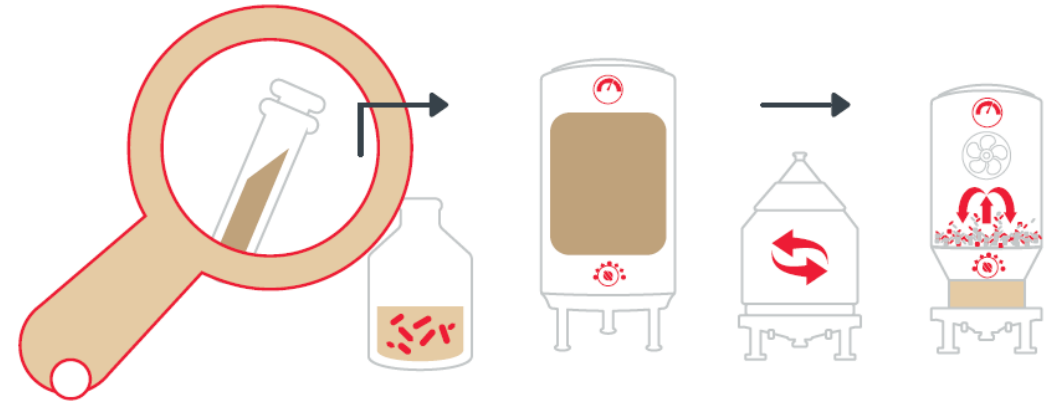
## 10 steps to obtain a high quality brewing yeast



# 24 TESTING STEPS

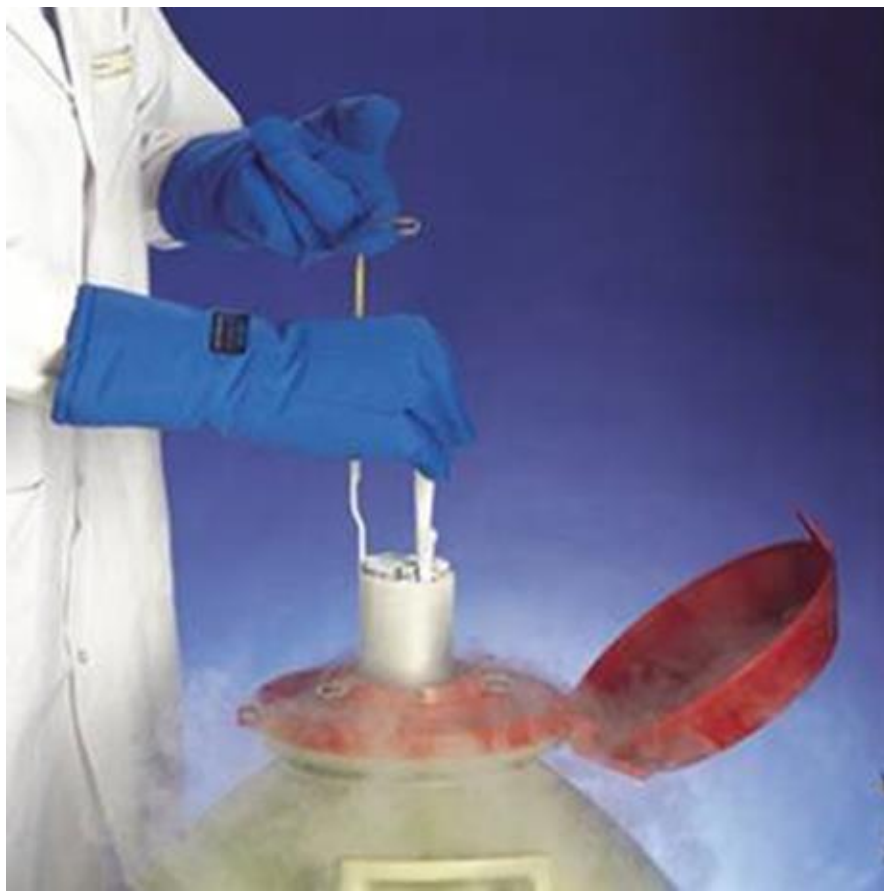
THE STABILITY OF DRIED YEAST ALLOWS TIME TO GO THROUGH EACH OF THE FOLLOWING 24 TESTS WITH EVERY PRODUCTION.

In addition, retention samples of every production and packaging operation are kept in the lab at both 4°C (39°F) and room temperature. These samples can be re-analyzed when required to assist troubleshooting potential QC issues at the brewery.

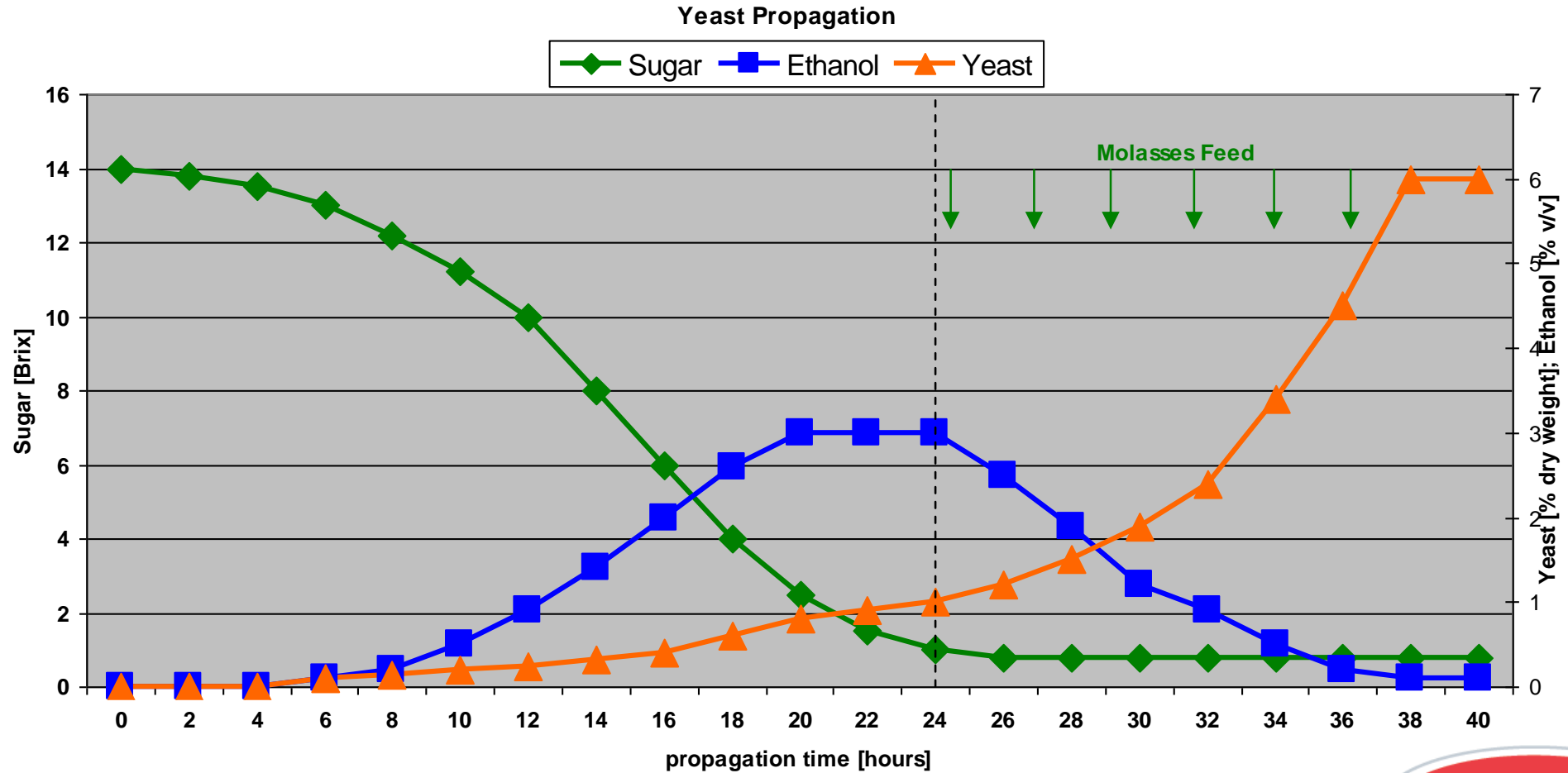


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# Lab propagation

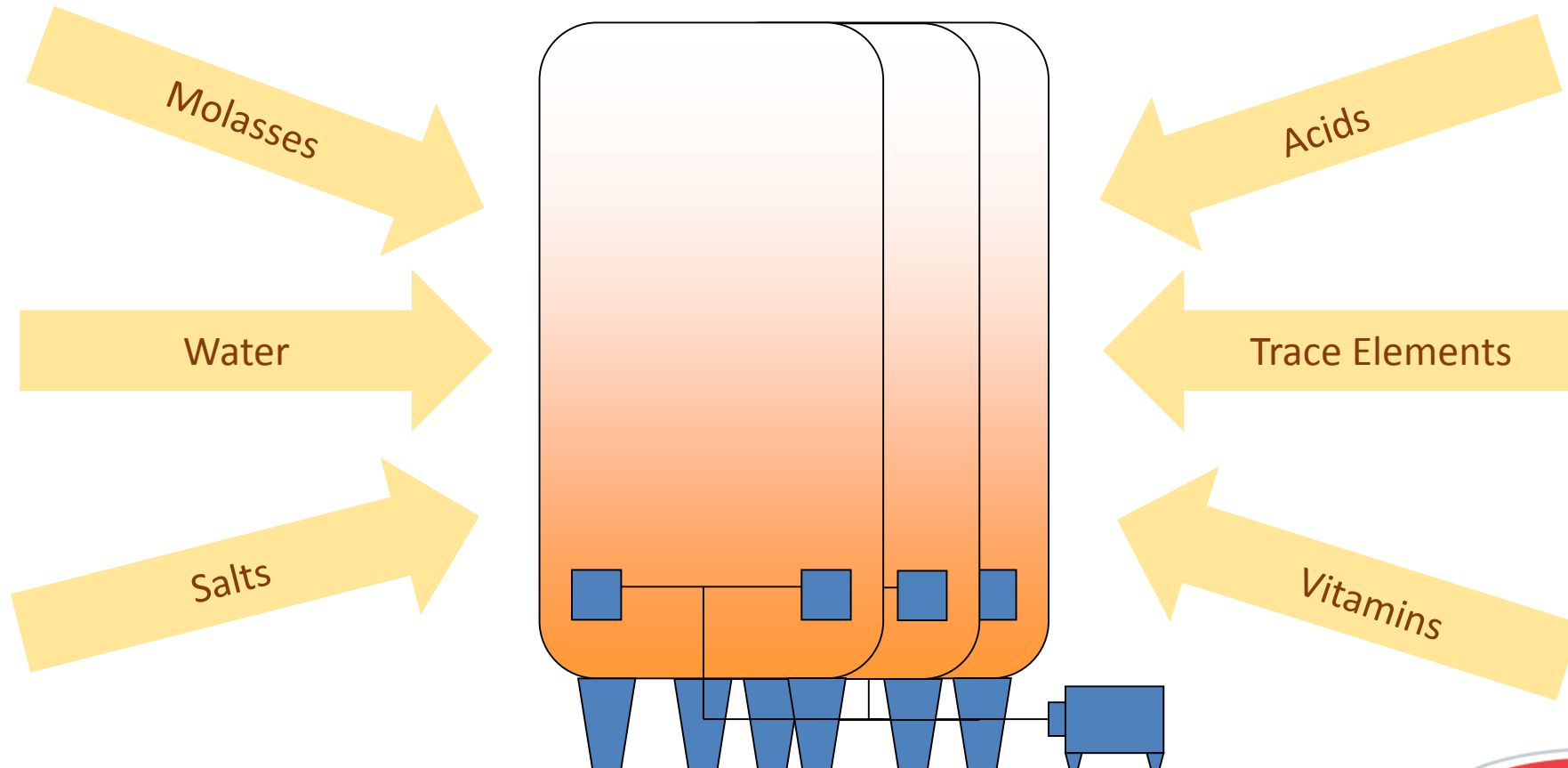


# Seed yeast

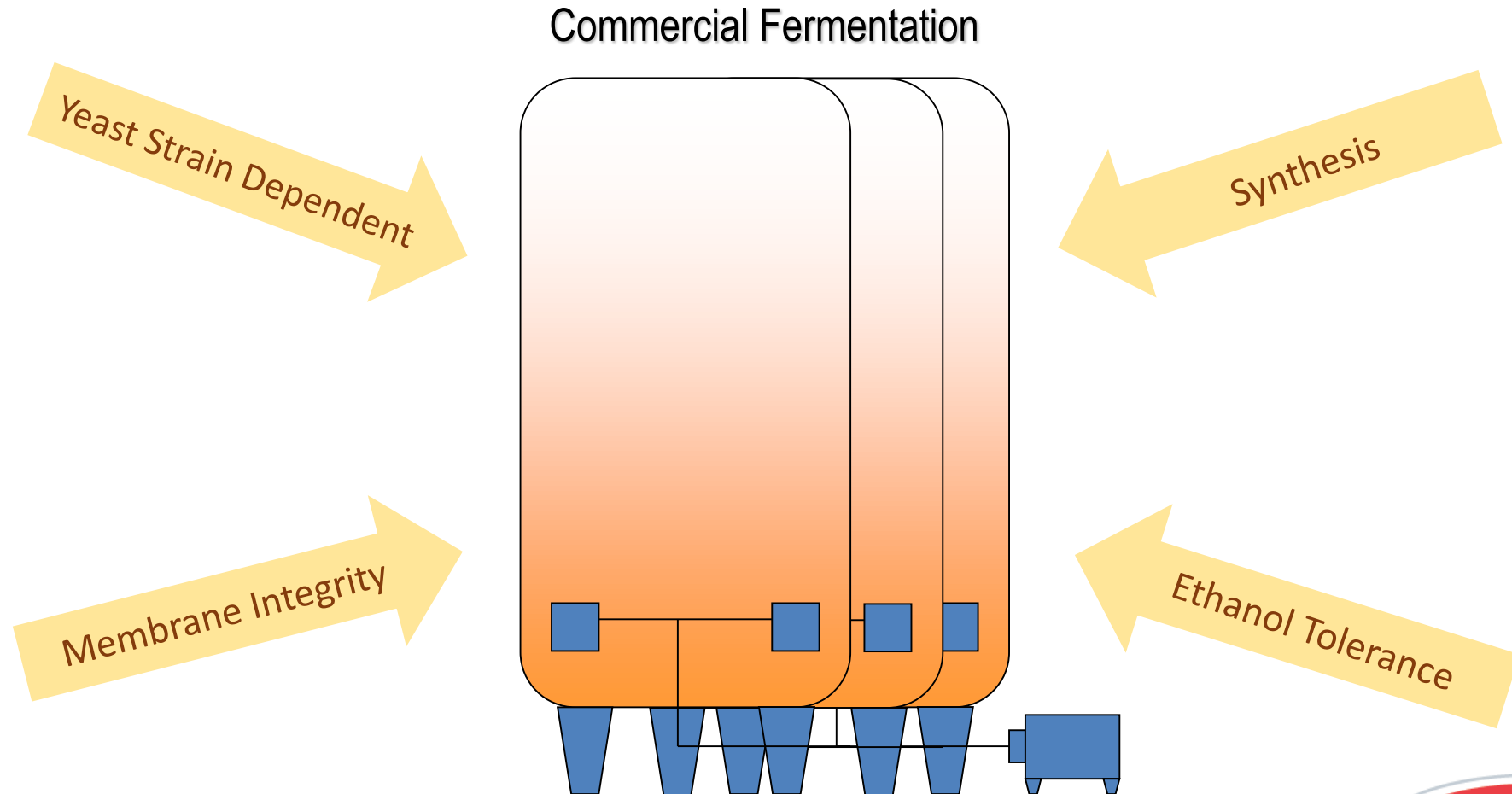


# Growth substrate

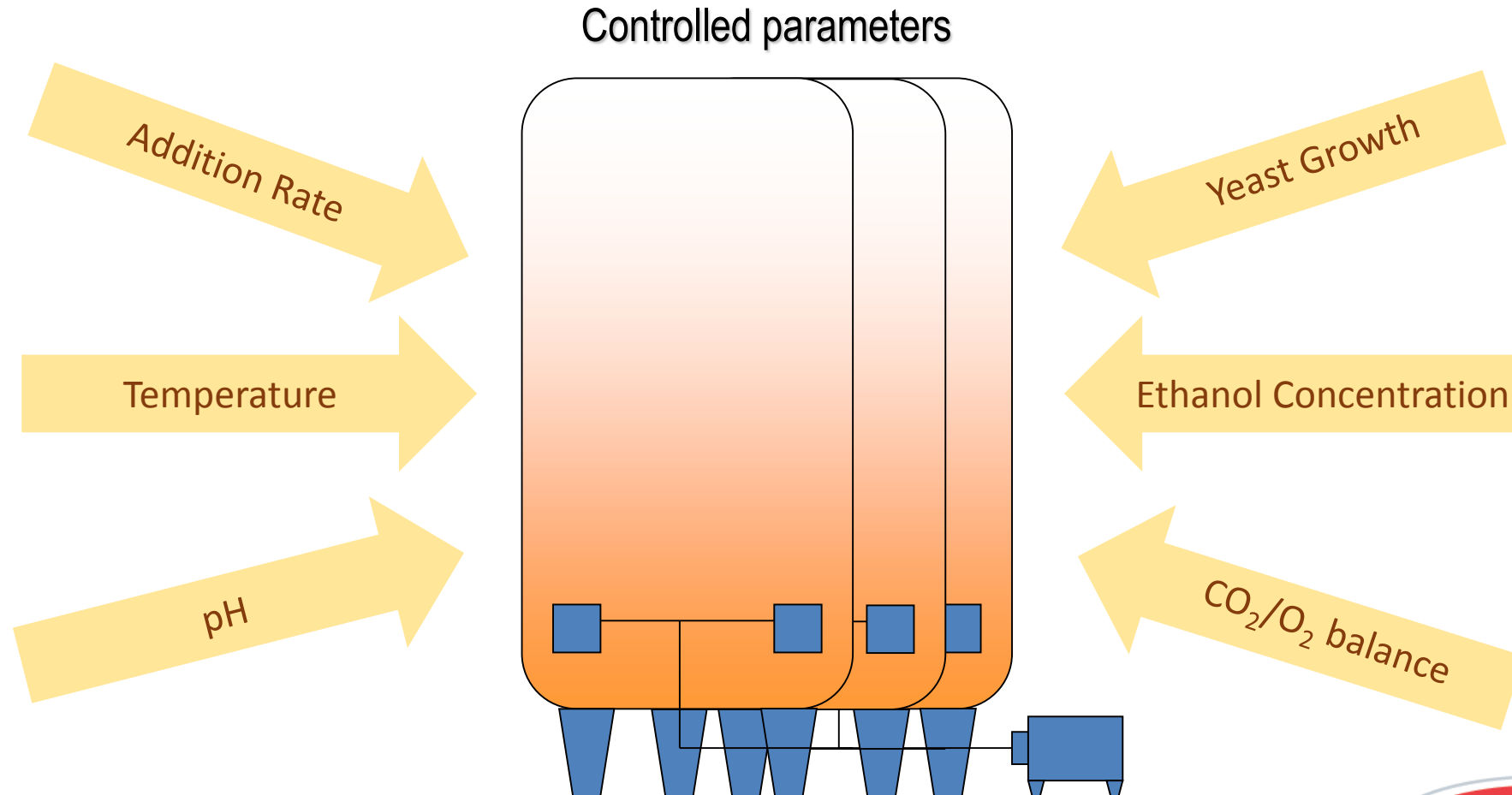
## Commercial Fermentation



# Growth substrate – oxygen requirements

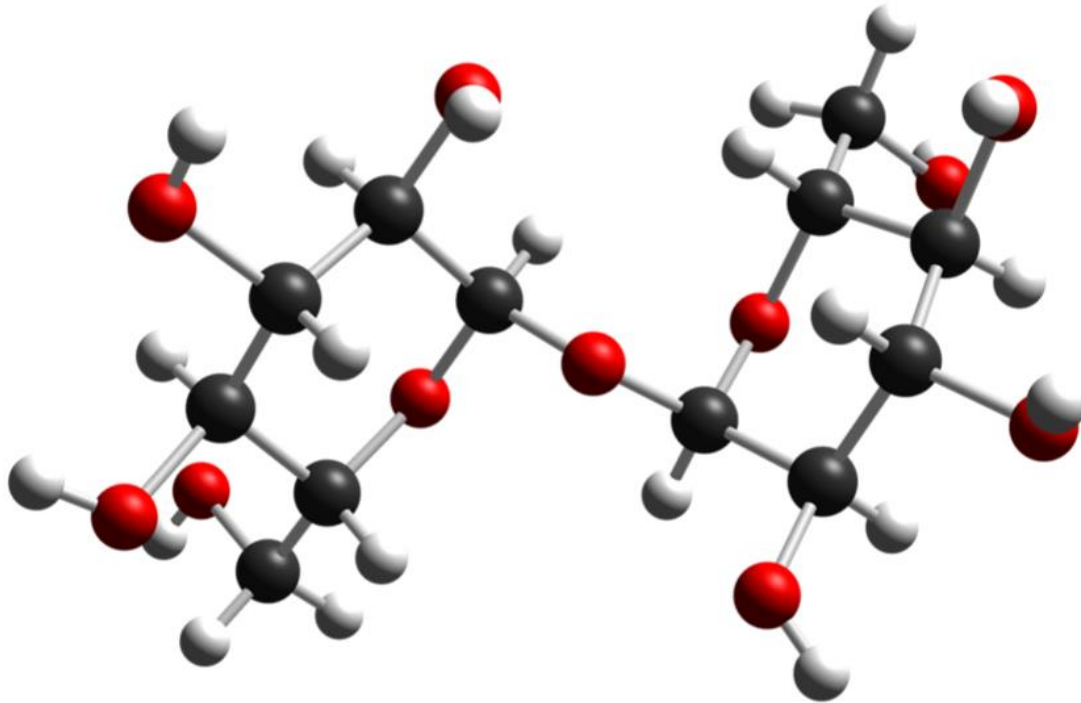


# Growth substrate – fed batch



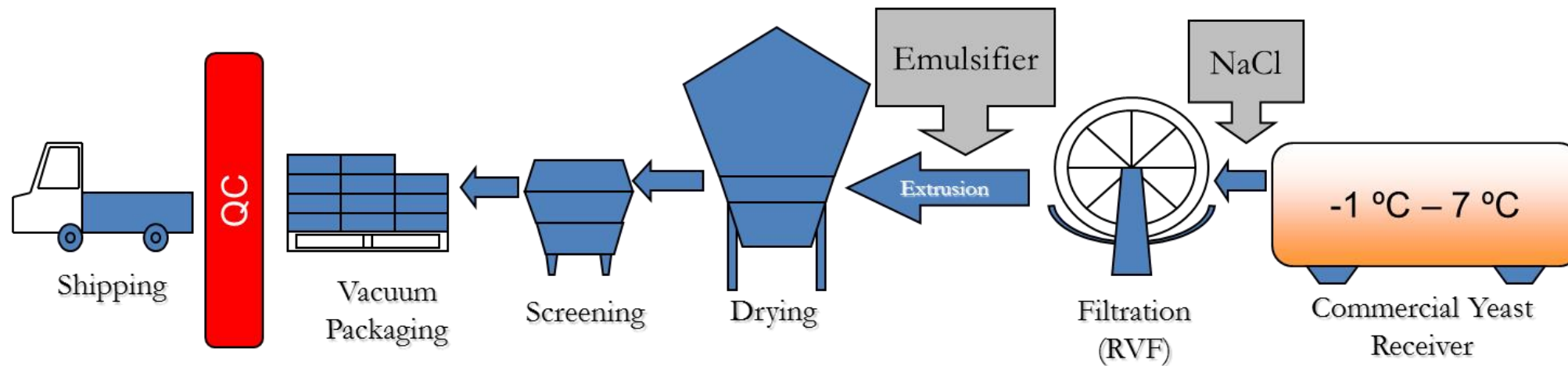


# Trehalose structure -disaccharide



## Stress Inducers:

- Starvation
- Temperature Shock
- Toxic Compounds
- Pressure
- pH



# QC/QA



- Viability
- Vitality
- Bacteria
- Wild yeast
- Fermentation performance
- Taste/ off-flavor
- Genetic profile

# Yeast management

Yeast management is the careful control across all operations handling yeast culture to maintain the highest possible quality and its overall health, and to provide timely and repeatable fermentation within standards and specifications, both quantitatively and organoleptically.



# Yeast propagation

BREW VOLUME	10HL	100HL
OG	12°P	12°P
Ideal pitch rate (1.5 million cells / mL / °P)	18 million cells per mL	18 million cells per mL
Propagation volume (5-10% of brew volume)	50-100L	500-1000L
Propagation pitch rate (1g/L)	50-100g Diamond (5-10 11g sachets)	500-1000g Diamond (1-2 packs of 500g)
Total yield from propagation	1-2 x 10 <sup>13</sup> viable cells (100-200 million cells per mL)	1-2 x 10 <sup>13</sup> viable cells (100-200 million cells per mL)
Pitch rate from propagation	10-20 million cells per mL	10-20 million cells per mL

- 1 YEAST REHYDRATION**  
 Rehydrate according to instructions on the package or technical data sheet. For better results, add Go-Ferm\* (30g/hL of propagation) to 20x its weight of sterile water at 43°C, stir well, let cool to 30-35°C and use this mixture to rehydrate the yeast.
- 2 YEAST INOCULATION**  
 Add rehydrated yeast to 50-100L of wort at 12°P
- 3 YEAST PROPAGATION**  
 24h at 18-20°C with aeration at 1-1.2LPM/L
- 4 DECANT**  
 Decant the propagation media and resuspend in sterile water
- 5 QUALITY CONTROL**  
 Perform a cell count to confirm the yield and viability. Normal results are 100-200 million cells per mL at >95% viability.
- 6 FERMENTATION**  
 Inoculate in 10hL of wort to obtain an average concentration of 20 million cells per mL

## External Sourcing Propagation

- Quantities from Supplier
- Stepping up Procedures

## Yield Factor

$$\frac{\left(\frac{\text{cells}}{\text{ml}}\right)_{\text{Final}} - \left(\frac{\text{cells}}{\text{ml}}\right)_{\text{Initial}}}{(OG - FG \text{ } ^\circ P)}$$

- Inoculation Rate

# Repitching using dry yeast

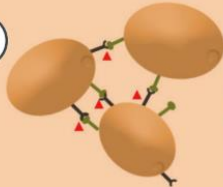
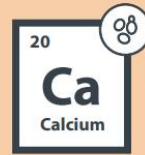
## KEEP GOOD RECORDS

Record the original lot number, generation number, fermenter source for harvest, storage vessel number, viability, pitch rate, fermentation time, attenuation and microbiology results.



## ENCOURAGE FLOCCULATION

Choose a flocculent strain and promote flocculation by addition of calcium (50-150 ppm in the mash).



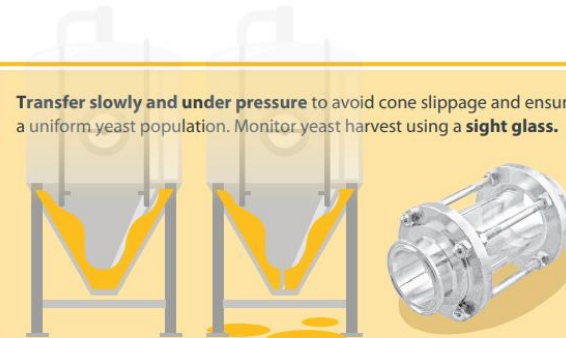
Y  
Zymolectin Protein  
(mannose specific)  
Mannose  
Ca<sup>2+</sup>

## HARVEST HEALTHY YEAST POPULATION

**Purge the bottom of the cone** (dark brown slurry) every 24-48 hrs to remove early flocculating cells and trub. **Harvest yeast from the middle of the cone** (creamy, light brown yeast) within 24 hrs of reaching terminal gravity. **Avoid harvesting the top of the cone**, which contains slow fermenters and mutated cells.



**Transfer slowly and under pressure** to avoid cone slippage and ensure a uniform yeast population. Monitor yeast harvest using a **sight glass**.



## TEST YEAST VIABILITY, VITALITY AND PURITY

Assess yeast viability using a microscope and viability stain (i.e. methylene blue or trypan blue). Perform vitality test, e.g. acidification power. Test for contamination of bacteria and wild yeast according to standard QC protocols.



## STORAGE

Cool yeast storage vessel rapidly to 4°C for storage up to one week. Avoid air ingress and excessive CO<sub>2</sub> pressure during storage.



## YEAST PITCH



The amount of slurry required for yeast pitch **will depend on the viability and cell density**. Volume can be determined based on the volume of the yeast brink or storage vessel or by **using a flow-meter** designed for dense liquids.



If pitching by weight, the yeast density (% solids) may be assessed using **ASBC method Yeast-5**.

For more information, you can reach us via email at [brewing@lallemand.com](mailto:brewing@lallemand.com)

[www.lallemandbrewing.com](http://www.lallemandbrewing.com)

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# Yeast behaviour - Flocculation



## Mechanisms of Flocculation

### FLO Genes and other phenotypes

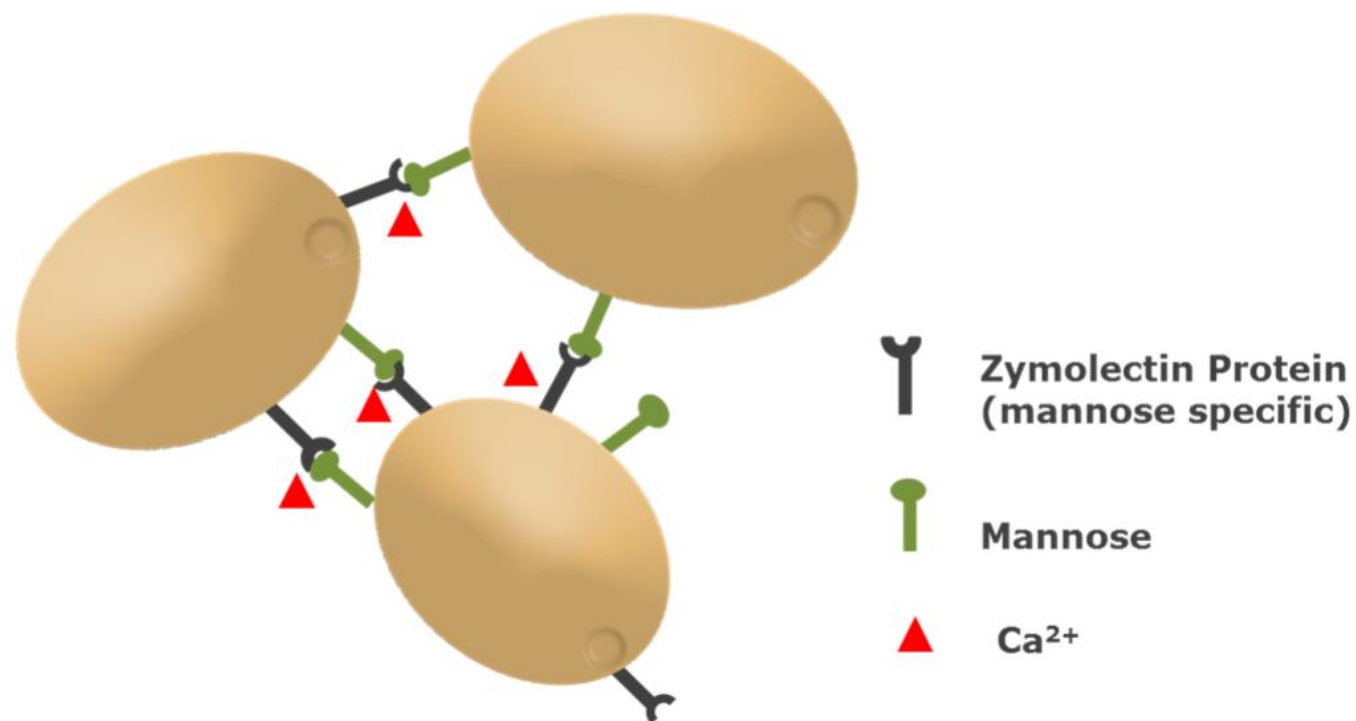
#### Surface Forces

- Electrostatic
- Hydrophobicity
- Fimbriae
- Slat Bridges

#### Lectin Hypothesis

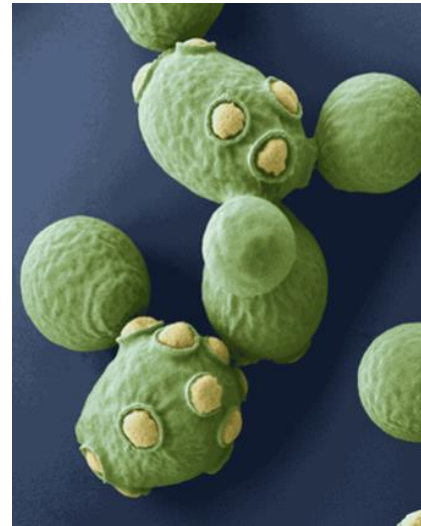
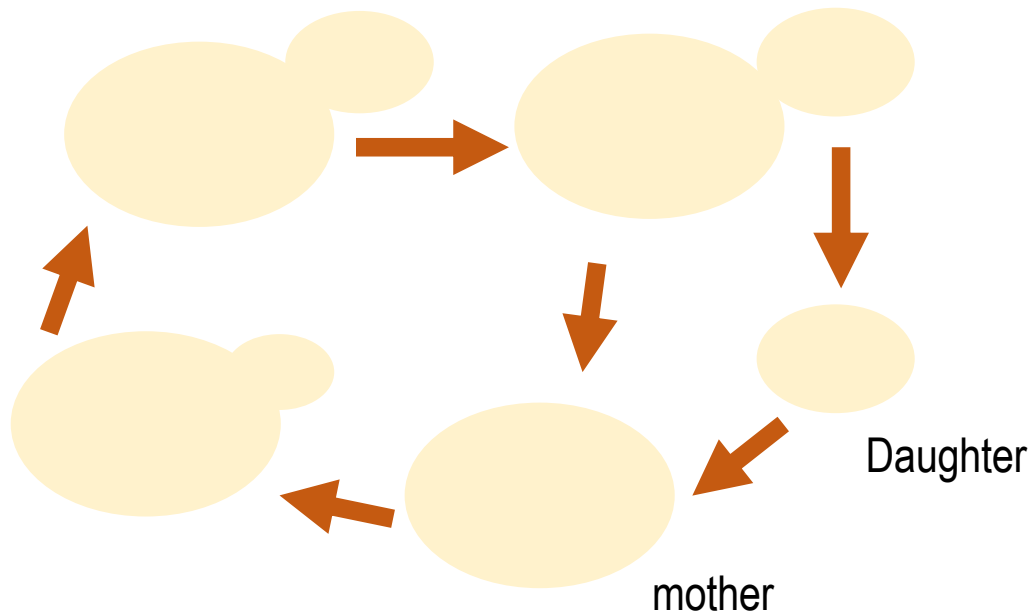
- Main mechanism of flocculation

# Yeast behaviour - Flocculation (lectin hypothesis)





# Yeast behaviour - yeast's age



Coloured scanning electron micrograph

Bud Scars	Proportion (%)
0	50
1	25
2	12.5
3	6.25
10	0.05
15	0.002
20	0.00005

**Yeast is the brewer  
best friend, so  
take care of it!**

# Thanks for your attention

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