BLUESTONE YEAST

Technical Guide

Yeast Repitching:

Best Practice for Harvesting, Storage and Serial Repitching

A practical guide for production brewers on maximising yeast crop quality and fermentation consistency across multiple generations.

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March 2026 | Version 1.1

1. Introduction

Yeast repitching is fundamental to commercial brewing. The ability to harvest yeast from one fermentation and use it to inoculate the next reduces raw material costs, maintains house character, and keeps production moving. However, the quality of each successive generation depends entirely on how well yeast is managed between batches.

This guide consolidates current best practice on yeast harvesting (cropping), storage, and serial repitching, with a focus on practical recommendations for production breweries operating cylindroconical vessels (CCVs). It draws from published brewing science, large-scale brewery protocols (including Carlsberg and Guinness data presented at ASBC), and Bluestone Yeast's direct experience supporting Australian craft and independent breweries.

The goal is simple: help brewers extract the maximum number of consistent, high-quality generations from every yeast pitch, while knowing exactly when to stop repitching and start fresh.

2. Why Repitch Management Matters

Every time yeast is repitched, it carries the cumulative history of its previous fermentations into the next batch. Cells that were well-nourished, harvested promptly, and stored correctly will perform reliably. Cells that sat under finished beer for days, were starved of nutrients across multiple generations, or were subjected to thermal shock during handling will produce slower fermentations, higher off-flavour risk, and less predictable outcomes.

The commercial cost of poor repitch management shows up in several ways: longer tank residency (reduced throughput), elevated VDK requiring extended diacetyl rests, inconsistent attenuation, increased off-flavour risk (particularly H_2S, acetaldehyde, and diacetyl), and premature yeast dumps that waste a viable crop and require purchasing fresh yeast.

> *Key principle: Yeast viability (the percentage of living cells) tells you how many cells are alive. Yeast vitality (their metabolic fitness) tells you how well those cells will actually perform. A crop can have 95% viability but low vitality if cells are glycogen-depleted, zinc-starved, or stressed from prolonged storage. Both metrics matter, and fermentation data is often the best vitality indicator you have.*

3. Understanding Cone Heterogeneity in CCVs

A critical concept for any brewer harvesting from cylindroconical vessels: the yeast crop in the cone is not homogeneous. Research from Carling (presented at ASBC by Casey, 2005) mapped the stratification of settled yeast in CCV cones and found distinct layers with different characteristics.

3.1 Cone stratification from bottom to top

Layer	Cell characteristics	Implications for repitching
Bottom (first out)	Mixed-age cells, trub and debris, lowest glycogen reserves, larger virgin cell fraction	Dump to drain. This fraction contains cold break, hop debris, and dead cells. Not suitable for repitching.
Middle	Oldest average cell age, highest flocculation, moderate glycogen, peak viability in warm-cropped fractions (91%)	Best fraction for repitching. Highly flocculent, metabolically active cells that have proven fermentation competence.

Top	Youngest cells ("virgin" cells), less flocculent, highest glycogen, higher acetaldehyde production tendency	Virgin cells can struggle with VDK reduction. Acceptable but not ideal for repitching without blending.

This stratification means that how you harvest (which fractions you collect and which you discard) directly affects the performance of your next fermentation. The practical recommendation is always: dump the first portion, collect the middle, stop before the last runnings.

Source: ASBC Yeast Management Seminar, Casey (2005); Carling cone stratification studies.

4. Harvesting Best Practice

4.1 When to harvest

The ideal harvest point is as soon as possible after yeast has flocculated and settled. Research from VTT (referenced in Casey, 2005) demonstrated that maltose transport activity drops off rapidly once attenuation is mostly complete, so harvesting yeast promptly preserves the metabolic machinery needed for the next fermentation.

The BSI Brewers Laboratory Handbook (2019) is unambiguous: yeast should not remain stored in the cone or under beer. Finished beer is a nutrient-poor, high-ethanol environment, and viability can drop precipitously (by more than 50%) within 48 hours of sitting under finished beer, regardless of temperature.

4.2 Conventional vs. warm cropping

There are two main cropping strategies in CCV brewing:

Method	Description	Viability outcome
Warm cropping	Harvest first settled yeast while still at approximately 15°C, once attenuation is complete but before VDK reduction is finished. Collects roughly half the total crop.	First fraction achieves approximately 91% viability. Second fraction (collected cold later) drops to low 80s% and then to low 70s% in last runnings.
Conventional cropping	Remove all yeast from the cone after attenuation and VDK reduction are complete, typically at 2-4°C.	Approximately 83% viability. More practical for most craft breweries as it requires only one harvest event.

Warm cropping produces higher-viability yeast, but requires the process infrastructure and scheduling to collect yeast mid-fermentation. For many craft breweries, conventional cropping after crash cooling is the practical reality. This is workable provided you manage the risks outlined below.

Source: ASBC Cropping reference, Casey (2005); Smart warm cropping studies.

4.3 Practical harvest protocol for CCVs

1. Drain trub approximately 24 hours after filling the fermenter. This separates cold break, hop debris, and dead cells from the yeast that settles later. The volume will vary depending on your batch size, cone geometry, and recipe (heavily dry-hopped beers produce more trub). As a guide, plan to dump approximately 1-2% of your batch volume, or until the flow runs from dark/chunky to smooth and creamy. See the guide table below.

2. Once fermentation has reached terminal gravity and passed the forced diacetyl test, begin cooling. Do not leave yeast sitting at terminal gravity longer than necessary.
3. Cool gradually. The ASBC cropping reference documents that fast cooling causes measurable viability loss: a 3% drop in viability at a cooling rate of 0.1°C/sec versus a 9% drop at 1.5°C/sec. Step cooling in increments of no more than 5°C at a time.
4. Once crash temperature is reached, harvest as soon as practical. Same day or next morning is ideal.
5. Purge the first portion to drain. This removes the trub-heavy bottom fraction that settled during fermentation and crashing. You will see the flow change character: the initial runnings are typically darker, grittier, and contain visible debris. Once the flow becomes smooth and uniformly creamy, you are into the pitchable middle fraction.
6. Collect the middle fraction into a sanitised, pre-cooled container. A typical crop volume is 2 to 3 times the pitched volume. Stop collecting before the last runnings, which become thinner and lighter in colour. The ASBC data is clear: viability drops to the low 70s% in the tail fractions.
7. Control flow rate during harvesting. Gentle, steady flow reduces shear stress on cells. For smaller tanks, gravity flow into a cubitainer is often sufficient. For larger tanks with pumped transfers, use the lowest effective pump speed and avoid cavitation.

4.4 Harvest volume guide by tank size

The table below provides approximate volumes for trub dump, pitchable yeast collection, and tail discard across common tank sizes. These are starting points. Your actual volumes will depend on cone geometry (steep cones concentrate yeast more than shallow cones), recipe (hop load, grain bill), and yeast strain flocculation characteristics. After a few harvests on a given tank and recipe, you will calibrate these numbers for your system.

Batch volume	Trub dump (Day 1)	Pre-harvest purge	Pitchable crop (middle)	Tail (discard)	Visual cue
5 hL	0.5-1 L	0.5-1 L	1-3 L	Stop when flow thins	Dark/gritty to smooth = switch from purge to collect
10 hL	1-2 L	1-2 L	2-5 L	Stop when flow thins	Same visual cues at all scales
20 hL	2-4 L	2-5 L	4-10 L	Stop when flow thins	Colour lightens and flow becomes watery in tail
50 hL	5-10 L	5-10 L	10-25 L	Stop when flow thins	Larger volumes but same principle: middle fraction only
100 hL	10-20 L	10-20 L	20-50 L	Stop when flow thins	At this scale, consider a

					sight glass on the harvest line

Key principle: The visual transition from dark, gritty flow (trub/dead cells) to smooth, creamy, uniformly coloured slurry is your best real-time indicator that you have moved from the bottom fraction into the pitchable middle. Collect from that transition point. When the flow starts to thin out and lighten again, you are into the tail. Stop collecting.

> *Note on shallow-cone tanks: If your fermenter has a shallow cone angle (common in smaller craft CCVs), yeast does not concentrate as tightly in the cone. You may find the transition between fractions is less distinct and volumes are smaller. The same principles apply: dump the first portion, collect the middle, stop before the tail. If in doubt, collect less rather than more. A smaller, higher-quality crop is better than a larger one contaminated with trub or tail cells.*

5. Yeast Storage

The period between harvesting and repitching is where many breweries lose yeast quality without realising it. The ASBC Yeast Storage reference (Casey, 2005) and Carlsberg guidelines identify the following storage stresses: starvation, shear, pH, ethanol toxicity, CO_2 toxicity, and cold shock.

5.1 Storage rules

- Store at 0-4°C. Yeast vitality decreases twofold with every 10°C increase in storage temperature (Arrhenius relationship, cited in Casey 2005). Carlsberg confirms storage below 5°C.
- Maximum storage time: Carlsberg guidelines specify 5 days at below 5°C as the maximum. The Bluestone Clean Repitch System recommends a maximum of 2 weeks. Shorter is always better.
- Glycogen reserves deplete significantly during prolonged storage, removing the energy reserve yeast needs for a fast fermentation start.
- Do not store yeast under beer in the fermenter cone. Guinness data shows that metabolic heat in unmixed yeast creates temperature gradients of up to 11°C within hours of unmixed storage, even when the beer is at 0°C.
- Decarbonate before storage if possible. CO_2 is toxic to yeast in storage.
- Minimise shear during transfer. Excessive agitation and pump shear damage cell membranes. Limit agitation to no more than 2 hours per day in storage.

5.2 Viability thresholds

Carlsberg guidelines set clear boundaries: normal dead cell levels in healthy yeast should be below approximately 5%, with a maximum of 10%. If viability drops below 90%, the crop should be evaluated critically before use. If slurry pH rises above 4.9, discard the yeast as this indicates autolysis.

6. Pitching Repitched Yeast

6.1 Pitch rate

Pitch rate calculations must be based on viable cell counts, not total slurry volume. Slurry density and viability vary between crops, so counting cells and adjusting volume accordingly is essential for fermentation consistency.

Carlsberg cites standard pitching rates of 10-12 million viable cells/mL for lager fermentations, with lower rates becoming increasingly common in their system. The ASBC pitching reference (Casey, 2005) documents that increasing pitching rate from 5 to 30 million cells/mL reduced fermentation time from 10 to 4 days in one study.

> *Underpitching carries particular risk: slow starts (extended lag phase), higher risk of contamination during the vulnerable lag period, minimal pH drop, and elevated off-flavour potential including diacetyl, acetaldehyde, and burnt rubber notes.*

6.2 Oxygenation

Wort oxygenation is required for sterol and unsaturated fatty acid (UFA) synthesis, without which cell division cannot occur. Traditional targets are 4-8 mg/L (ppm) of dissolved oxygen at pitching (Viability and Vitality, MBAA TQ 2015). Repitched yeast is particularly sensitive to oxygenation levels because cells from a previous anaerobic fermentation may already have lipid levels near growth-limiting concentrations.

6.3 Wort temperature at pitching

For lager fermentations, pitch at or slightly below your target fermentation temperature (typically 10-13°C). Carlsberg data notes that rapid temperature changes above 5°C cause cold shock stress. If your yeast has been stored at 2°C and your wort is at 12°C, the thermal step is within acceptable range.

7. Nutrient Supplementation: Restoring What the Boil Takes Out

Every time wort is boiled, heat-sensitive nutrients are destroyed or rendered unavailable. More than 90% of zinc added hot-side is lost during the boil, primarily through binding to spent grain husks, phytate complexes, and denatured protein/trub (De Nicola & Walker, Enzyme and Microbial Technology, 2009). B-vitamins are similarly degraded or bound. Vitamins that survive can bind to hot break or partition during whirlpool, reducing bioavailability. By the time fermentation is underway, vitamin headroom is often depleted.

On the first pitch with fresh propagated yeast, these losses may not be immediately obvious because the yeast starts with full nutrient reserves from propagation. But on subsequent generations, yeast is carrying forward the stress of fermenting in nutrient-depleted wort. Intracellular zinc stores decline, enzyme activity drops, and fermentation performance trends downward. This is not a process mistake. It is a consequence of how wort has always been made. Cold-side supplementation solves the timing and loss problem.

7.1 The Bluestone Nutrient Booster Range

Bluestone Yeast manufactures three sterile liquid nutrient products specifically designed for cold-side dosing during fermenter fill. All three are sterile-filtered, laboratory tested, and packaged under sterile conditions. Dosing method is the same for all: in-line during fermenter filling for even distribution throughout the wort. Do not add just prior to yeast pitching (uneven distribution) and do not add to boiling wort (defeats the purpose).

	Zinc Booster (BSY-N01)	Vitamin Booster (BSY-N03)	High Gravity Booster (BSY-N04)
Active content	8.79 g/L zinc (as zinc salt in 0.5% phosphoric acid)	Proprietary B-complex vitamins and yeast growth factors	Vitamins and growth factors formulated for high-gravity environments
Standard dose	10 mL/hL (target 0.2 ppm)	10 mL/hL	10 mL/hL
Use case	All fermentations. Especially lagers, high gravity, repitching.	Standard gravity fermentations (below ~1.070 OG)	High gravity fermentations (above ~1.070 OG / 17°P)
Pairing rule	Always pair with Vitamin or HG Booster	Always pair with Zinc Booster	Always pair with Zinc Booster
Sizes available	250 mL (~25 hL tanks), 500 mL (~50 hL), 1L (~100 hL)	250 mL, 500 mL, 1L	250 mL, 500 mL, 1L
Storage	18-25°C ideal; cool room also fine. Do not freeze.	1-4°C recommended; room temp OK for 1-2 weeks. Do not freeze.	1-4°C recommended; room temp OK for 1-2 weeks. Do not freeze.
Shelf life	Extended (check label)	12+ months (check label)	12+ months (check label)

7.2 Why zinc matters for repitching

Zinc is a cofactor for more than 300 yeast enzymes, including alcohol dehydrogenase (ADH), the terminal enzyme of the fermentation pathway. Zinc also governs protein synthesis and phospholipid membrane composition. These processes are strongly diminished at low zinc levels, resulting in impaired cell growth and fermentation performance (De Nicola & Walker, Journal of the Institute of Brewing, 2009).

Yeast scavenges zinc from wort rapidly. De Nicola and Walker (2009) documented that zinc at 0.32 μg/mL was completely removed from the fermentation medium within one hour under laboratory conditions. At higher zinc concentrations, complete uptake takes longer (48-96 hours at 1.0-4.85 ppm in their 2011 JASBC brewing study). The practical point holds: zinc must be present in wort at the start of fermentation to be available to yeast. Hot-side additions are largely wasted. For repitching breweries, this is compounded: each generation ferments in wort that was boiled (zinc destroyed), and the yeast itself is carrying forward zinc depletion from the previous batch.

Optimal wort zinc requirements are strain-dependent, generally in the range of 0.15-0.30 mg/L. Concentrations below 0.1 mg/L are considered deficient and may lead to sluggish or stuck fermentations. Malt typically contributes only 0.05-0.40 ppm zinc to wort, and water contributes less than 0.02 ppm.

7.3 Why vitamins matter for repitching

- **B1 (Thiamine):** Functions at the pyruvate node and pentose phosphate pathway. Governs how crisply fermentations start. Degraded by boiling.
- **B5 (Pantothenate):** Precursor to Coenzyme A. When B5 is marginal, sulfur metabolic pathways produce more H_2S. Correct B5 availability suppresses H_2S risk.
- **B7 (Biotin):** Required for the carboxylase steps in fatty acid synthesis. Supports sterol and UFA production, therefore membrane integrity and cell division capacity.

The net effect of adequate B-vitamin availability: faster fermentation starts, cleaner flavour profiles (lower VDK and H_2S risk), improved stress tolerance, and better repitch durability.

7.4 Pricing and cost per batch

The Bluestone Booster Range is designed to be economically accessible. All bottles are single-use: open, pour the entire contents into the fermenter during fill, and discard the bottle. This maintains sterility and removes the need for measuring. Each bottle size is matched to a tank size range so the dose rate is built in.

Per-bottle pricing (all prices ex GST):

Bottle size	Tank guide	Zinc Booster (per bottle)	Vitamin or HG Booster (per bottle)	Twin pack (1 Zinc + 1 Vit/HG)	Saving vs buying separately
250 mL	~25 hL	$29.95	$39.95	$65.00	$4.90 saved per batch
500 mL	~50 hL	$44.95	$54.95	$90.00	$9.90 saved per batch
1000 mL	~100 hL	$69.95	$79.95	$135.00	$14.90 saved per batch

Box of 12 pricing (per bottle when buying a box of 12, with additional savings when ordered alongside a yeast order):

Bottle size	Zinc per bottle (in box)	Vit/HG per bottle (in box)	Twin pack per pair (in box)	Twin pack per pair (box + yeast order)
250 mL	$28.00	$38.00	$60.00	$50.00
500 mL	$40.00	$50.00	$80.00	$70.00
1000 mL	$60.00	$70.00	$120.00	$100.00

A box of 12 covers 12 batches. Order alongside your regular yeast order for the best per-bottle pricing.

What does this actually cost per batch? The table below shows the cost per batch at each pricing tier. At 500 mL and 1000 mL sizes, each individual product (Zinc or Vitamin Booster) costs less than 1 cent per litre. The twin pack (both products together) comes in at 1-2 cents per litre depending on tank size.

Your tank size	Bottle size	Zinc only per batch	Vit/HG only per batch	Twin pack per batch	Twin pack cost per litre
~25 hL (2,500 L)	250 mL	$25	$35	$50	$0.020 / L
~50 hL (5,000 L)	500 mL	$35	$45	$70	$0.014 / L
~100 hL (10,000 L)	1000 mL	$50	$60	$100	$0.010 / L

Prices shown at box + yeast order tier. At standalone single-bottle pricing, costs are slightly higher but still a fraction of the cost of a stuck ferment, an extra tank day, or an early yeast dump.

7.5 Customer results

The following results are from Australian breweries that have given permission for their data to be shared:

- **Range Brewing:** reported approximately 4 days faster fermentation after zinc addition.
- **Kaiju Beer WCIPA (OG 1.057):** zinc batch reached FG 1.007 in 21 days vs 29 days without zinc. 8-day improvement to terminal gravity.

These are specific brewery results, not generalised averages. Your outcomes will depend on your wort composition, yeast strain, and existing zinc levels. The best way to evaluate is a controlled comparison: run one batch with zinc and vitamins alongside your standard process on the same wort and compare gravity curves.

8. Generation Tracking and Knowing When to Stop

Carlsberg guidelines indicate a maximum generation count of approximately 10, with slightly higher generations (12-15) sometimes achievable without problems. However, setting an arbitrary generation limit is less useful than tracking actual performance metrics across generations.

The ASBC pitching reference (Casey, 2005) documents that serially repitched yeast is less resistant to storage stresses than freshly propagated slurries. Petite mutant induction (cells lacking functional mitochondrial DNA) increases with serial repitching, high temperatures, high ethanol exposure, and long storage periods.

8.1 What to track

Metric	How to measure	Warning signal
Lag time	Hours from pitch to first 1°P drop (or first visible CO_2 activity)	Increasing lag time across generations, especially if >2 hours longer than Gen 1
Attenuation rate	Gravity drop per 24 hours through active fermentation	Slowing rate compared to previous generations on the same wort
VDK cleanup time	Days from FG to passing forced diacetyl test	Increasing cleanup time adds tank days and costs money directly
Terminal gravity	Final gravity of each batch on the same recipe	Rising FG suggests declining fermentative capacity
Slurry viability	Cell count and viability stain at harvest	Below 90% viability, or slurry pH above 4.9 (indicates autolysis)
Flocculation behaviour	Visual observation and time to clear	Changes in flocculation pattern (early dropout or failure to flocculate)

8.2 Decision framework

- If all metrics are stable or improving: continue repitching.

- If one metric is trending negatively: investigate (check process variables first, then yeast health). Consider whether nutrient supplementation addresses the root cause.
- If two or more metrics are trending negatively: repitch with fresh yeast. The cost of a new pitch is far less than the cost of a slow, off-spec fermentation tying up a tank.

> *Important: Before blaming the yeast, check the process. Underpitching, poor oxygenation, wort composition changes, CIP residue, and temperature control errors can all produce symptoms that look like yeast decline but have nothing to do with generation count.*

9. Special Considerations for Lager Repitching

Lager fermentations present additional challenges for repitch management because of the lower fermentation temperatures (typically 10-13°C), longer fermentation timescales, and the critical importance of VDK cleanup for style quality.

- Longer fermentation times mean yeast sits in contact with beer for longer before harvesting. This increases the urgency of harvesting promptly once FG and VDK targets are met.
- Lower temperatures slow VDK reduction by yeast enzymes. A diacetyl rest (raising temperature to 15-18°C near the end of fermentation) accelerates VDK cleanup and can also serve as a warm-cropping opportunity.
- Lager strains can be more zinc-sensitive than ale strains. The relatively lower metabolic rate at lager temperatures means any nutritional deficiency has proportionally more impact on total fermentation time.
- The extended cold conditioning period typical of lagers means the yeast crop has been cold for longer before it reaches the cone. Harvest timing is even more critical.

For breweries running a lager programme, the combination of good repitch hygiene, cold-side nutrient supplementation (Zinc Booster + Vitamin Booster at 10 mL/hL each), and careful generation tracking provides the foundation for consistent production. Australian breweries including KAIJU! and Stomping Ground have achieved AIBA award-winning results brewing with Bluestone yeast and this approach.

10. Getting Started: The Bluestone Clean Repitch System

If your brewery is not currently repitching, or if you are repitching but without a controlled, hygienic collection method, this is the place to start. The Bluestone Clean Repitch System is a purpose-designed kit for harvesting yeast from your CCV into pre-sterilised containers, keeping it clean and viable until the next pitch.

10.1 How it works

1. A tri-clover fitting connects to the bottom of your tank via a 1.5" tri-clover and modified DIN fitting.
2. After draining trub, clean and sanitise the fitting.
3. Connect a pre-sterilised Bluestone cubitainer to the fitting.
4. Fill with the middle yeast fraction (following the harvest protocol in Section 4).
5. Seal, label with strain, generation, date, and batch number.
6. Store in your cool room at 0-4°C. Repitch within 2 weeks maximum (5 days ideal).

A video walkthrough of the full process is available at: youtube.com/watch?v=j1UYkR7sKTw

10.2 What's included and pricing

4L Cubitainers	10L Cubitainers	20L Cubitainers
Connector only: $270	Connector only: $270	Connector only: $270
10 cubes + 1 connector: $465	10 cubes + 1 connector: $490	10 cubes + 1 connector: $500
10 cubes only (refill): $195	10 cubes only (refill): $220	10 cubes only (refill): $260

All prices ex GST. Repitch freight is approximately $30, charged at cost.

10.3 Why start here

The economics of repitching are straightforward. A 2L pitch of Bluestone liquid yeast costs approximately $415 (at the 2-3L price tier). If you repitch that yeast 8 times, the cost of the original yeast is spread across 9 batches, bringing your yeast cost per batch down to under $50. Compare that to buying fresh yeast or a new sachet of dry yeast for every batch.

The Clean Repitch System is the equipment that makes this possible hygienically. Combined with the Nutrient Booster Range (Zinc + Vitamins dosed cold-side on every batch, including repitch batches), you protect your yeast investment by keeping cells well-nourished and viable for as many generations as the biology supports.

> Recommended starting setup for a brewery new to repitching: 1x Clean Repitch System starter kit (10 cubes + connector in your preferred size), 1x box of Zinc Booster twin packs (12 bottles), matched to your tank size. Total investment from $515 for the repitch system + $600-$1,200 for a box of twin packs depending on size. This equips you for months of repitching with proper nutrient support from day one.

11. Putting It All Together: Repitch Workflow Summary

Stage	Action	Key reference
Day 0	Pitch yeast into oxygenated wort (4-8 ppm DO). Dose Zinc Booster (BSY-N01) + Vitamin Booster (BSY-N03) or HG Booster (BSY-N04) at 10 mL/hL each, in-line during fill. Record pitch rate.	Product Truth Table; MBAA TQ 2015
Day 1	Dump trub from cone approximately 24 hours after fill.	Carlsberg guidelines
Active ferm	Monitor gravity, pH, temperature. Record attenuation rate per 24h.	Standard practice
At FG	Confirm terminal gravity. Run forced diacetyl test. If lager, diacetyl rest at 15-18°C if VDK still above threshold.	JIB Diacetyl Review 2013
VDK pass	Begin crash cooling. Cool gradually (max 5°C steps). Do not delay.	Carlsberg; ASBC Cropping
At crash temp	Harvest same day or next morning. Purge first portion to drain. Collect middle fraction into Clean Repitch cubitainer. Stop before last runnings.	ASBC Cropping; BSI 2019
Storage	Store cubitainer at 0-4°C. Use within 5 days (ideal) to 2 weeks (maximum). Record viability before repitching.	Carlsberg; ASBC Storage

Next pitch	Calculate pitch rate from viable cell count. Dose Zinc + Vitamin Booster cold-side again. Compare lag time and attenuation rate to previous generation.	Generation tracking

12. References

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