

Evolutionary capacitance driven by Hsp90 during the *de novo* evolution of multicellularity

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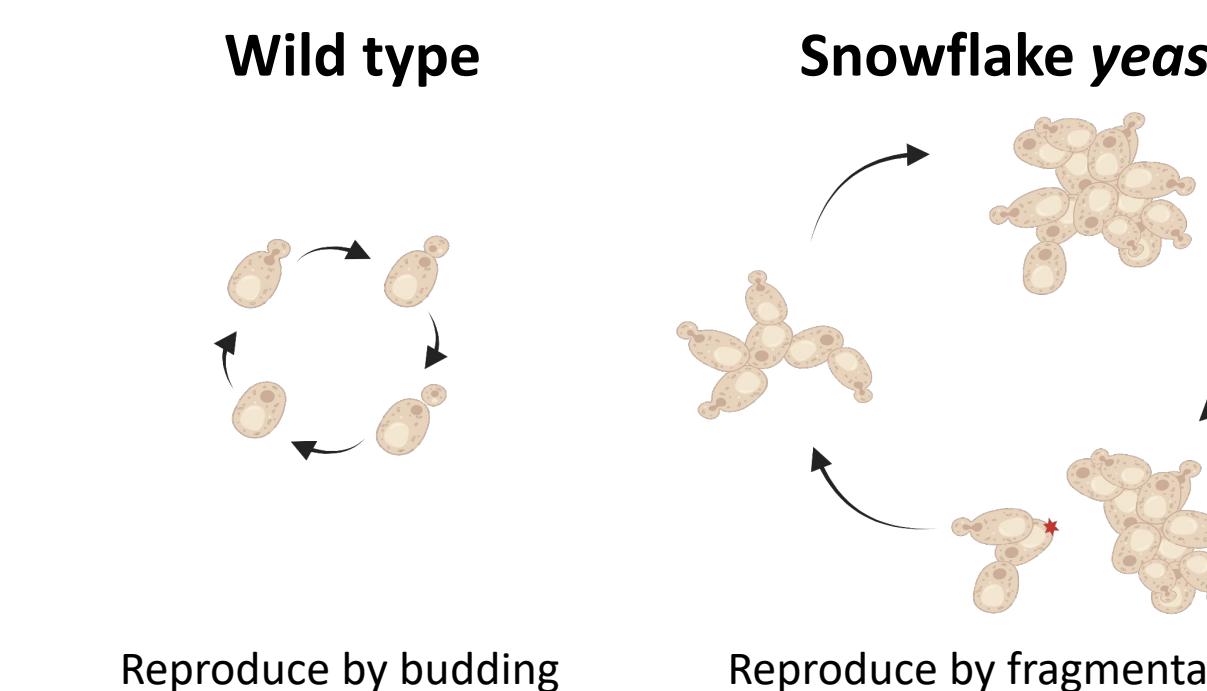


Snowflake yeast

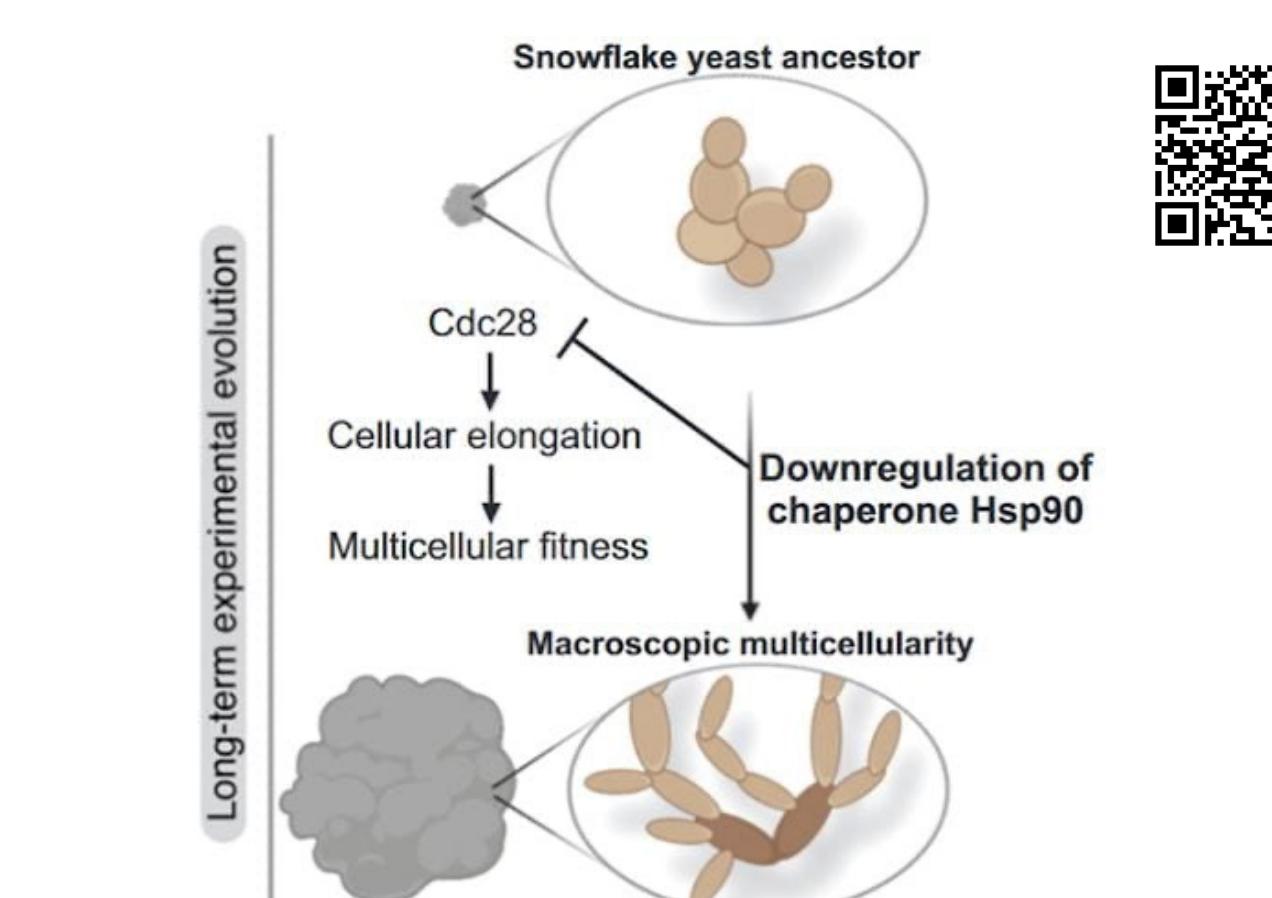
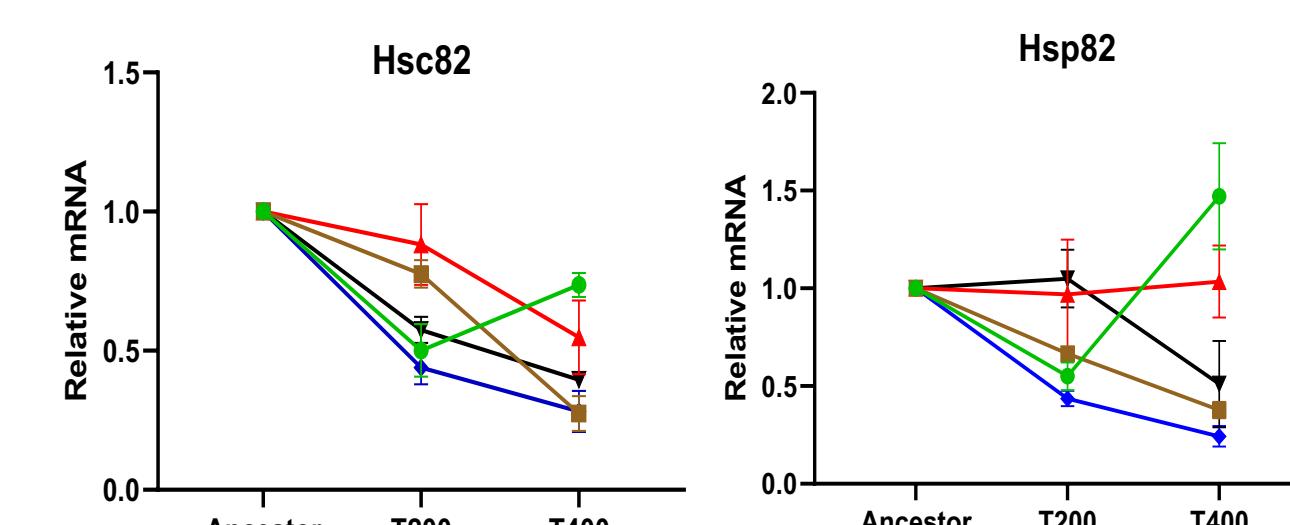
Model system of nascent multicellularity which is capable of *in vitro* evolution [1, 2].

Snowflake yeast
Saccharomyces cerevisiae
ace2::KANMX4/ace2::KANMX4 knockout
Undifferentiated multicellular cluster

Snowflake yeast has evolved into macroscopic size in a long-term evolution experiment of multicellularity (MuLTEE) [3, 4].



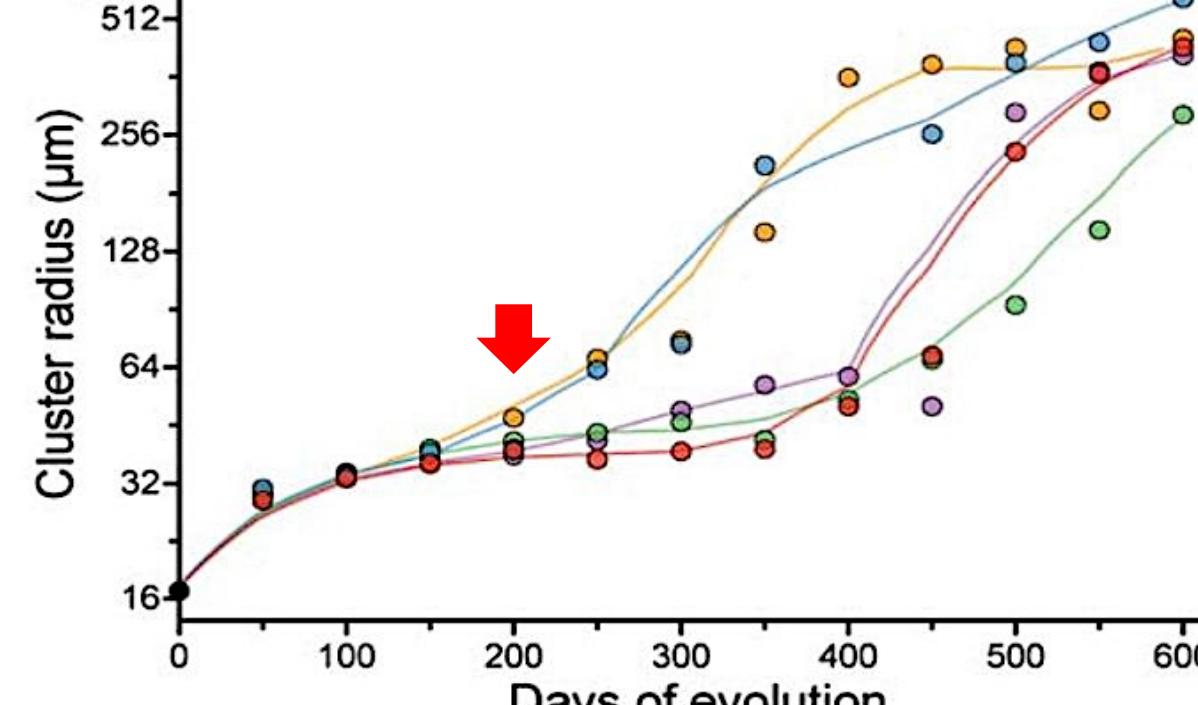
Reduction of Hsp90 expression is an adaptive trait in MuLTEE



- Hsc82 and Hsp82 are two isoforms of heat shock protein 90 (Hsp90) with a wide range of clients and impacts on cellular activities [5, 6].
- The expression of Hsp90 declines as the yeast clusters become larger over 600 transfers, with lineages evolving larger and losing Hsp90 expression faster.

Hsp90 drives cellular elongation by modulating the stability and activity of the central cell cycle kinase Cdc28 [7].

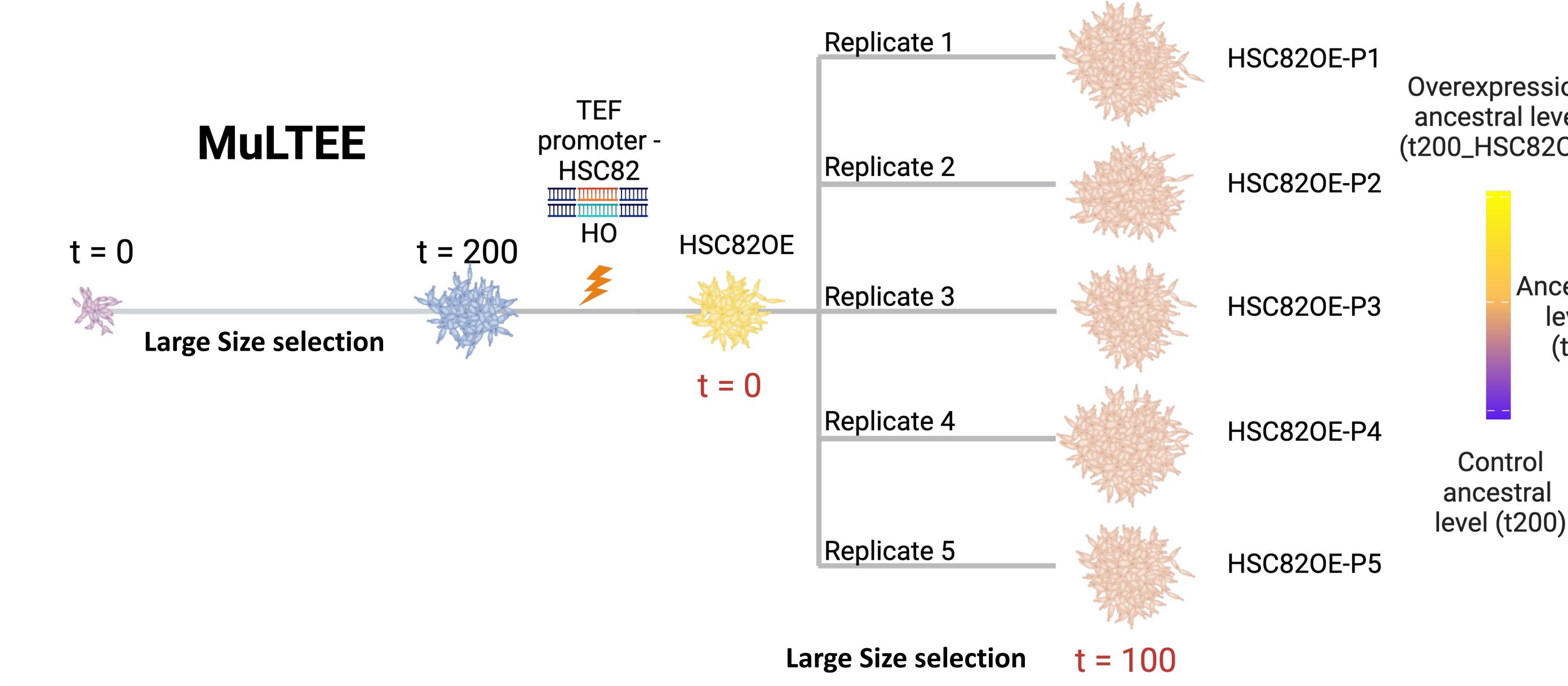
Will over-expressing Hsp90 prevent macroscopic evolution?



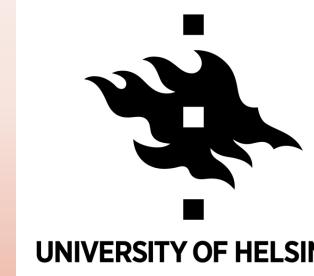
We conducted an evolutionary replay experiment to examine this question:

- HSC82 were overexpressed in evolved snowflake yeast at t = 200.
- Fitness of control, HSC82 overexpression (HSC82 OE) lineage were characterized by fitness assay (competition with GFP-tagged strains).
- The evolutionary replay experiment was conducted for 100 days with large size selection i.e., settling selection.

Replay evolutionary experiment



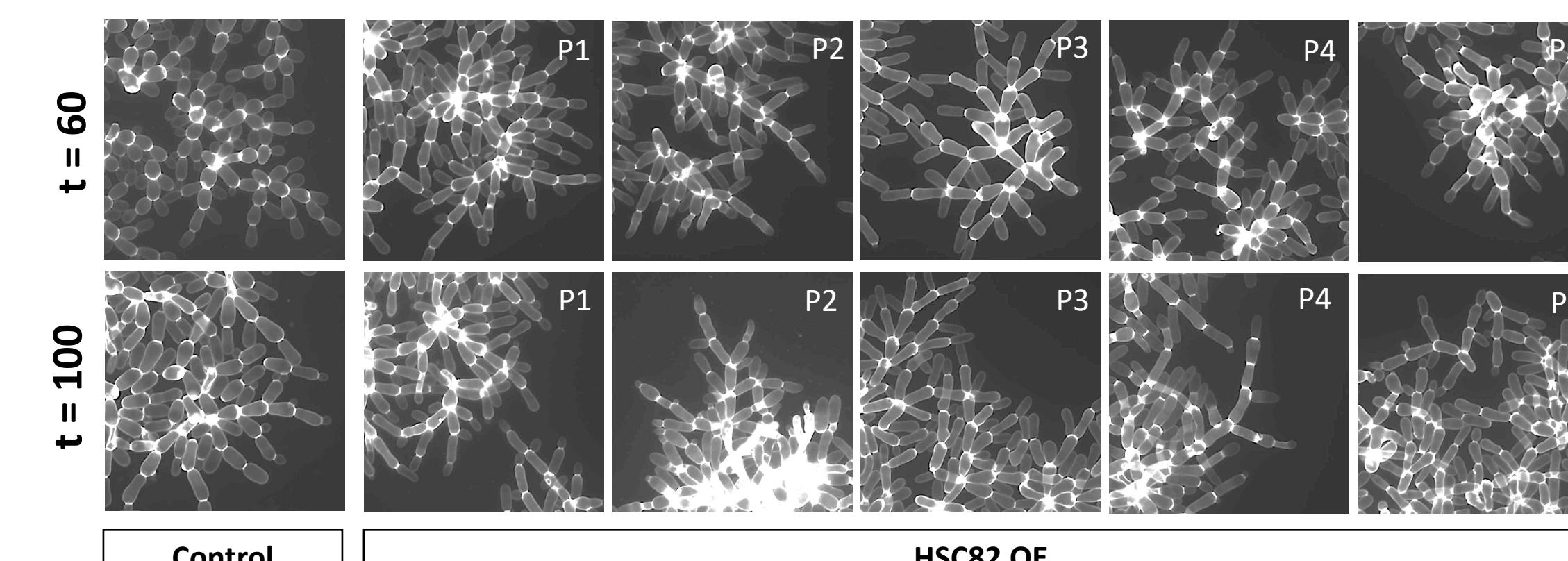
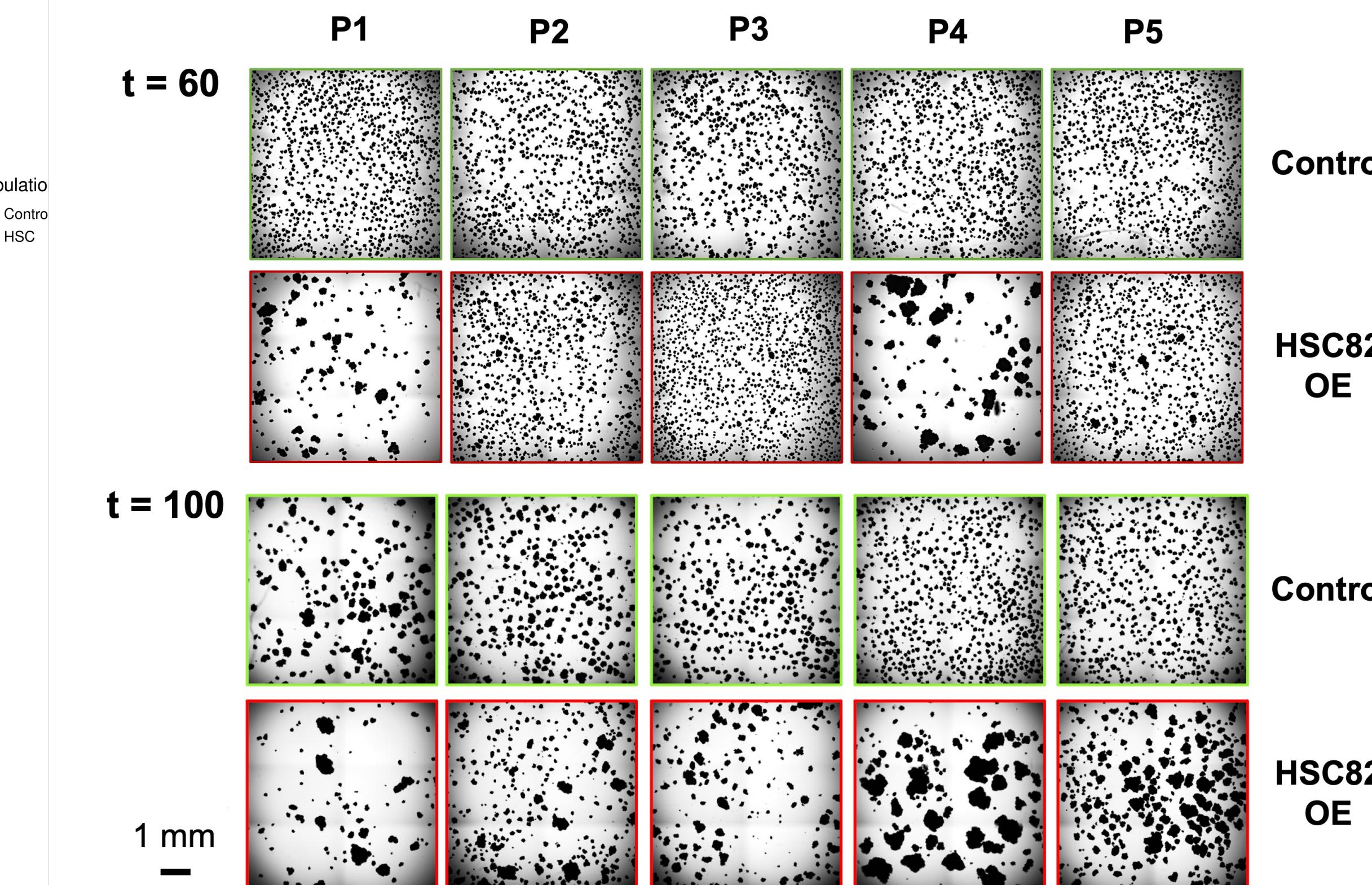
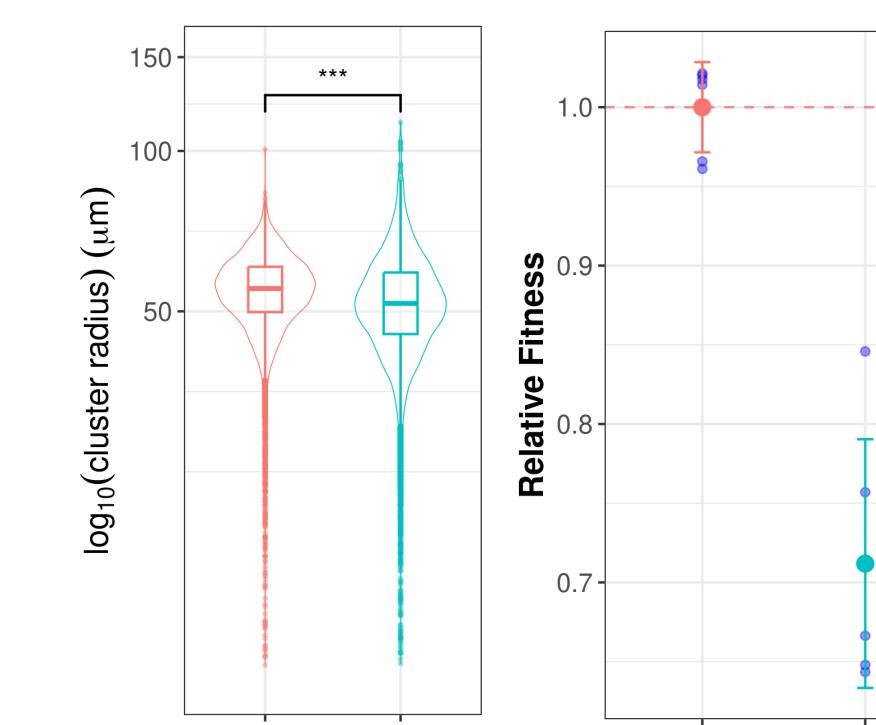
Acknowledgment



References:

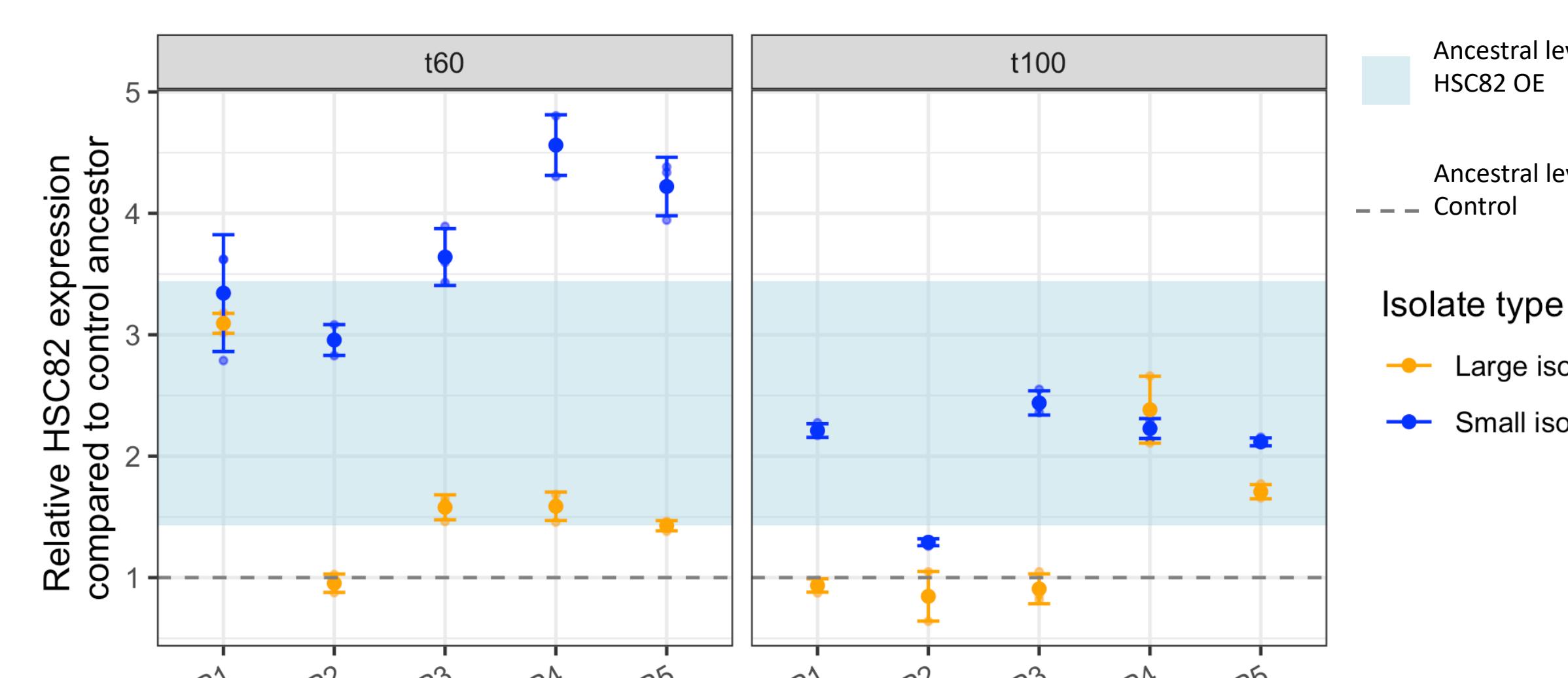
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Overexpressing Hsc82 surprisingly accelerates the macroscopic transition

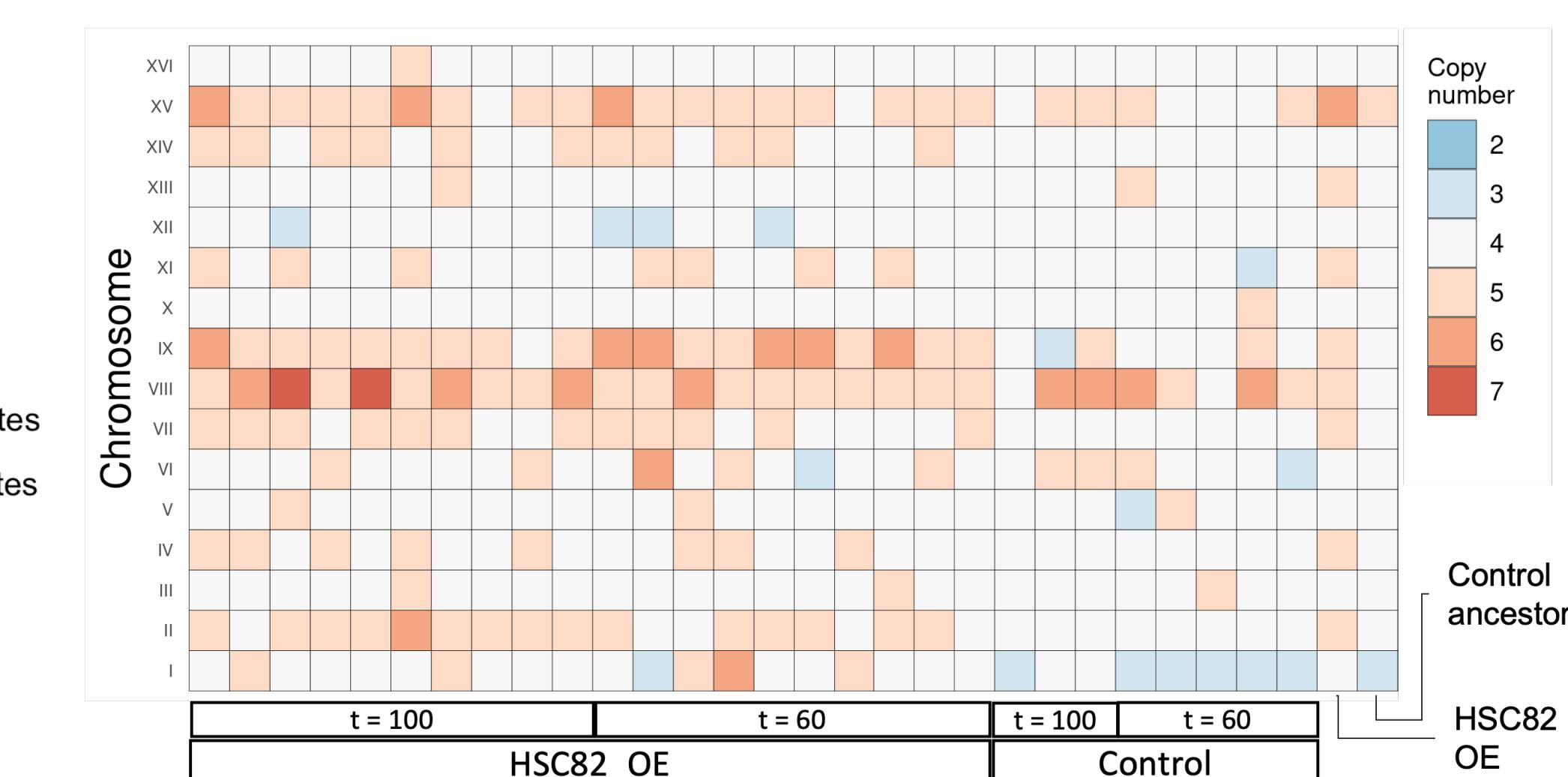


Rather than staying small, Hsc82 overexpression populations rapidly evolved into macroscopic clusters throughout the evolutionary replay experiment. Elongated cellular morphology and side budding behavior, two entanglement-underpinned cellular traits in snowflake yeast, were observed in large isolates.

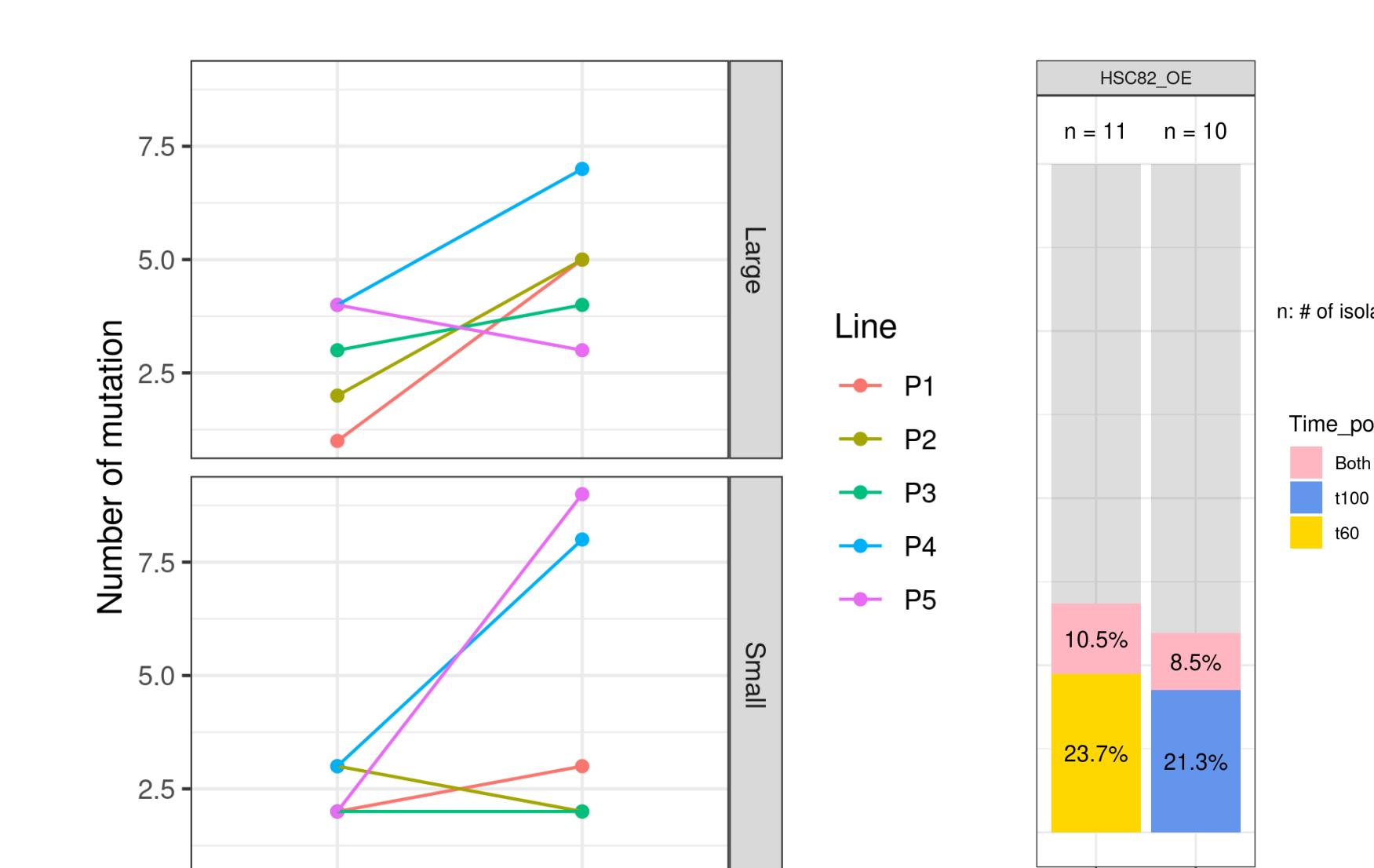
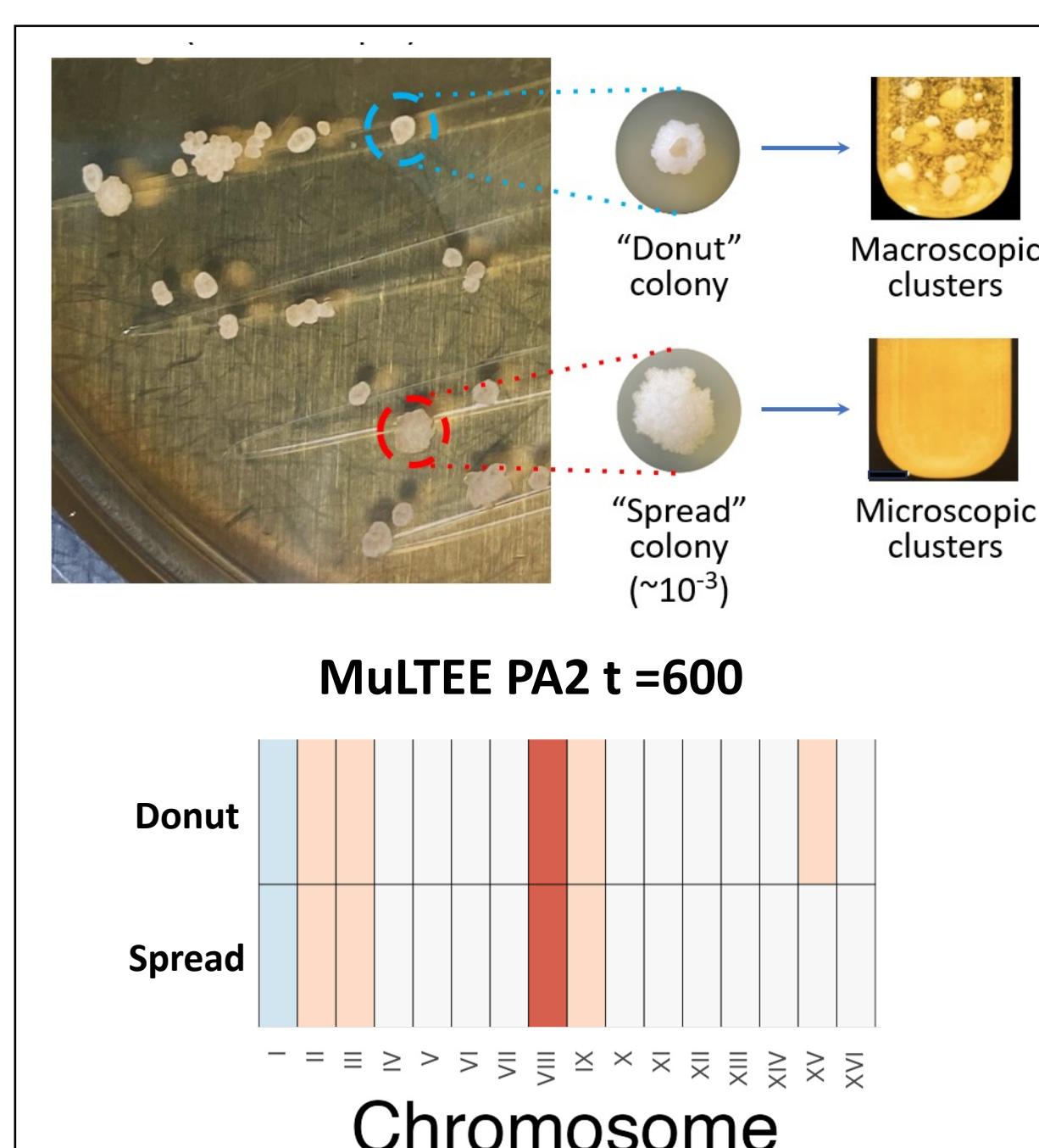
The transient expression of Hsc82 facilitates multicellular adaptation



The expression level of HSC82 declined rapidly in the HSC82 OE lineage, and large isolates lost HSC82 expression quicker than small isolates



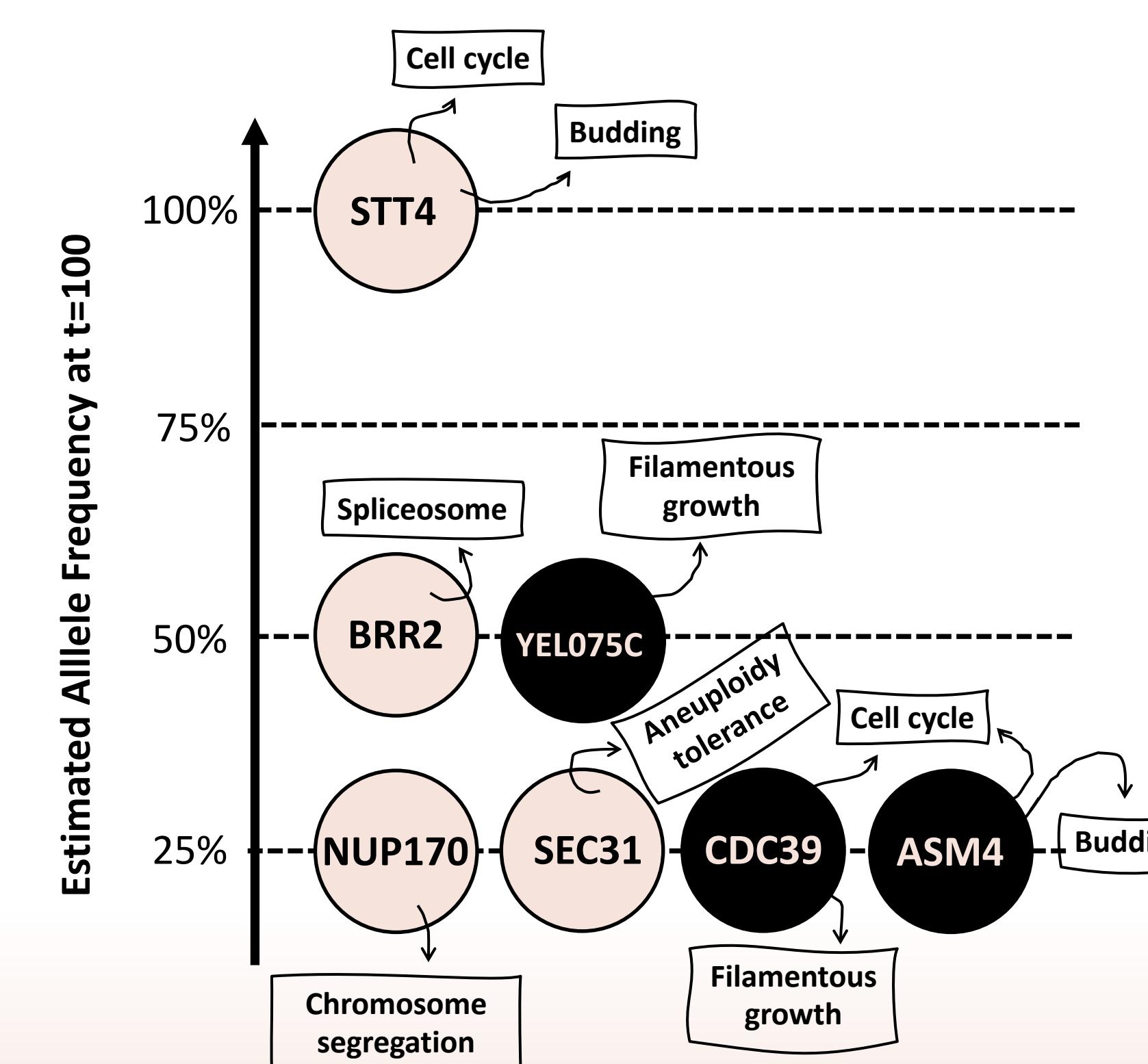
Aneuploidy level remained higher in the Hsc82 OE isolates. Large isolates show more aneuploidy than small isolates



In Hsc82 OE isolates, the number of mutations increased as the Hsc82 decreased.

~30% mutations with known interactions with Hsc82

- 7 mutations preserved over time with morphological and cell cycle-related phenotypes
4 mutations with known interactions with Hsc82



Next step:
Reconstruct these mutations and investigate their fitness effect in different Hsc82 expression background

This poster includes unpublished data.
If you have further discussion, let me know!

