

# Phenotype variations among *Chlamydomonas reinhardtii* under quorum-sensing conditions

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## Background

- Quorum sensing (QS) is a cell-to-cell communication system that allows unicellular microorganisms like the eukaryote *C. reinhardtii* to regulate phenotypic switching as a function of cell density due to the accumulation of signaling molecules.
- The goal of this study is to evaluate whether QS in *C. reinhardtii* is regulated by nutrient availability.
- We propose that in a nutrient-limited environment (low nitrogen TAP (N-TAP)), cells of *C. reinhardtii* (cc124) would adjust their motility-driven dispersion of cells and upregulate chlorophyll and carotenoid production per cell.

## Methods

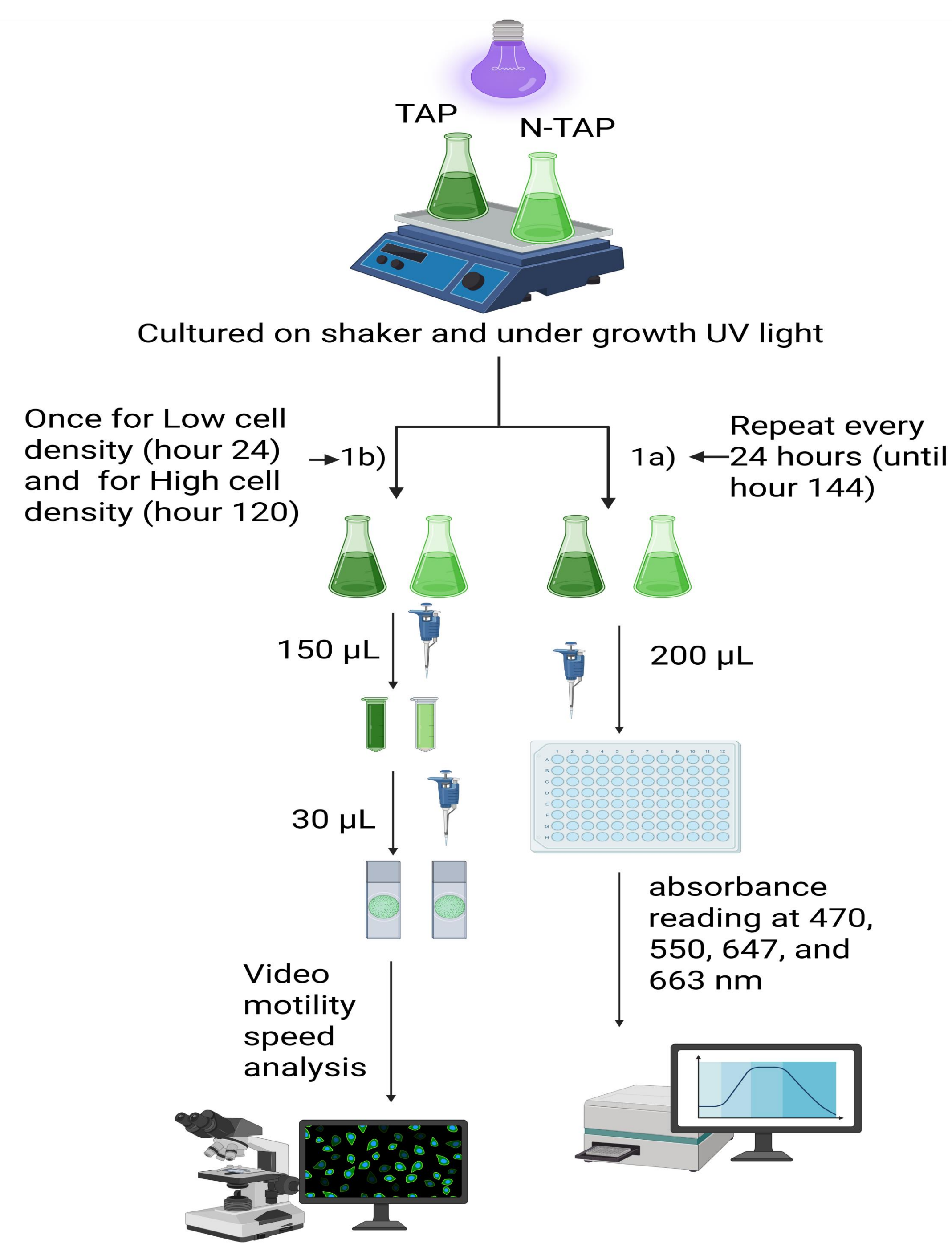


Figure 1: Methodology to obtain the cell density and pigment concentrations over course of 7-day (1a), and motility swim speeds analysis for low cell density (LCD) and High cell density (HCD) (1b).

## Results/Data

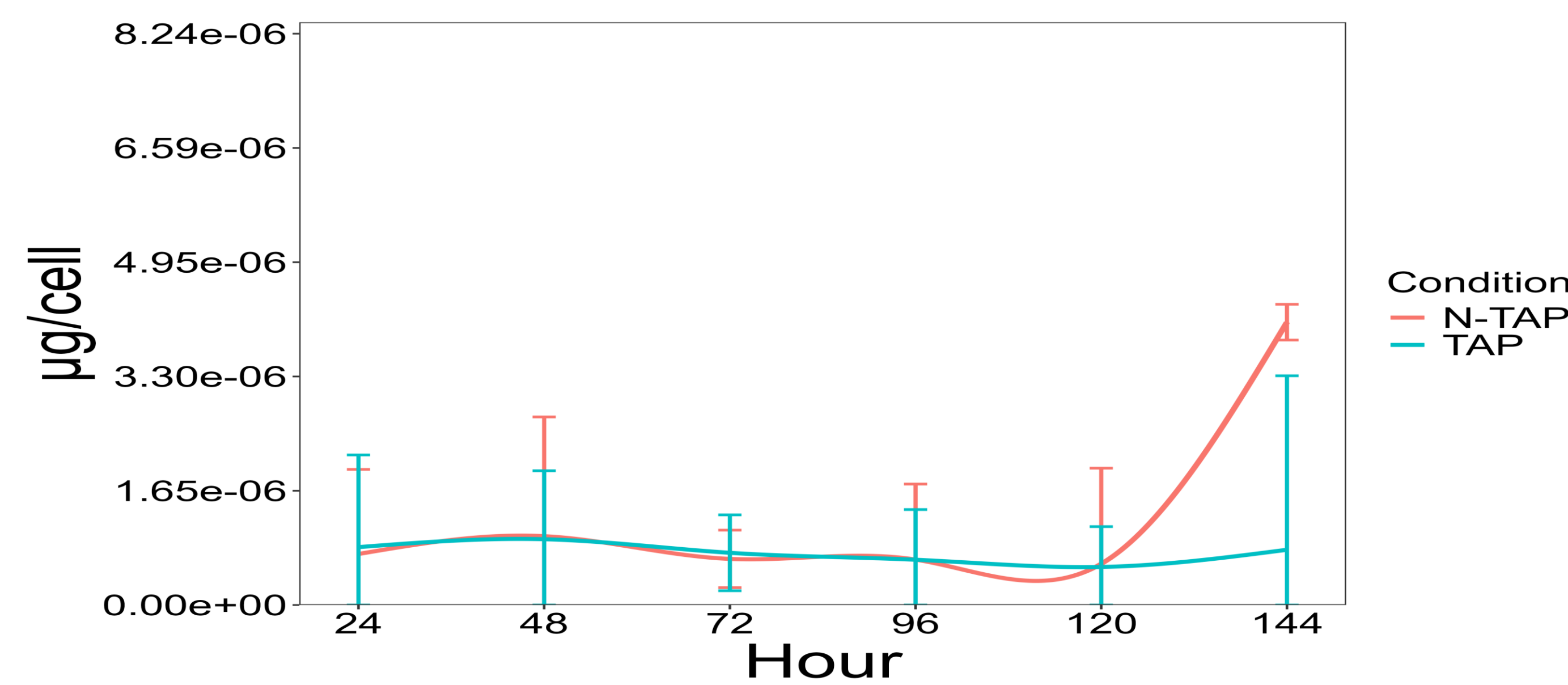


Figure 2: Concentration (µg/cell) of chlorophyll A per cc124 cell in TAP and N-TAP of this trial over course of 7 days (144 hours). Each recorded hour includes an average range of error for concentrations.

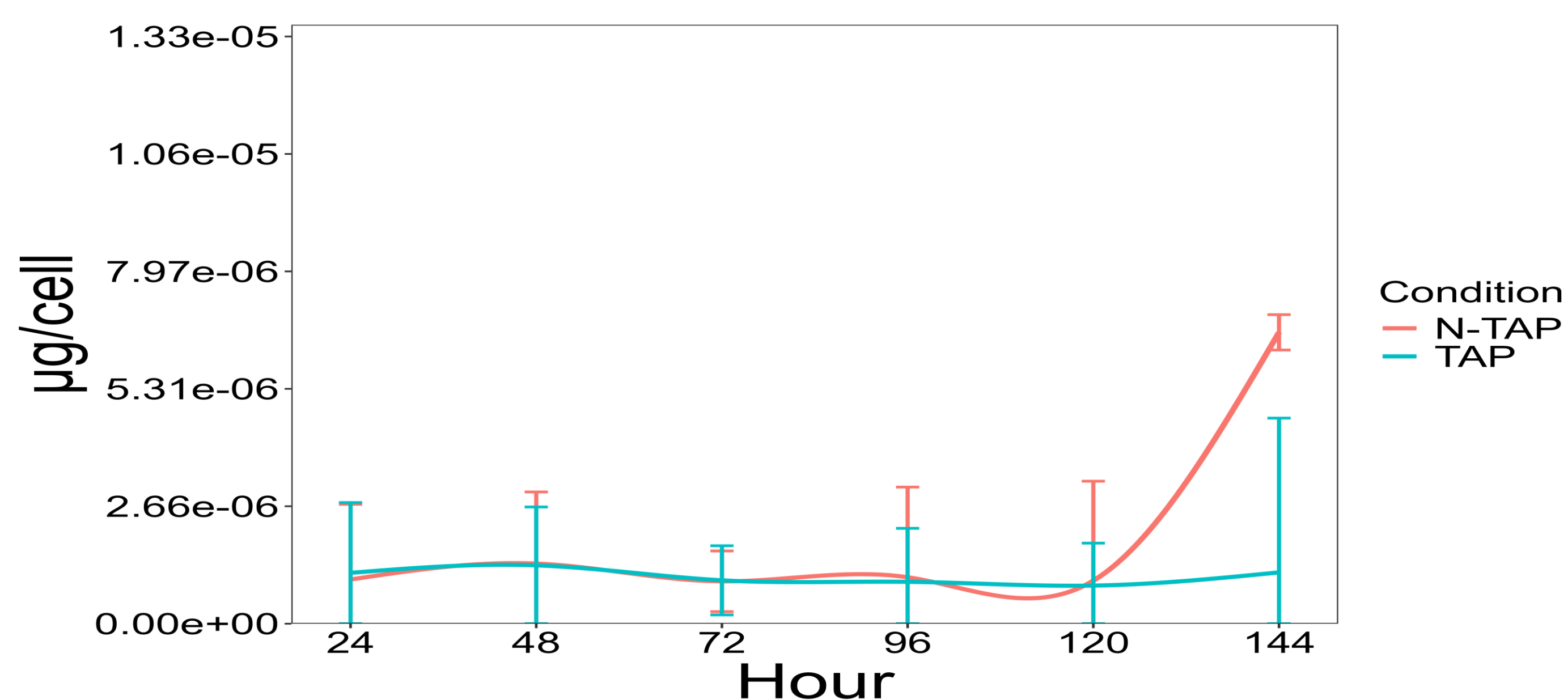


Figure 3: Concentration (µg/cell) of chlorophyll B per cc124 cell in TAP and N-TAP of this trial over course of 7 days (144 hours). Each recorded hour includes an average range of error for concentrations.

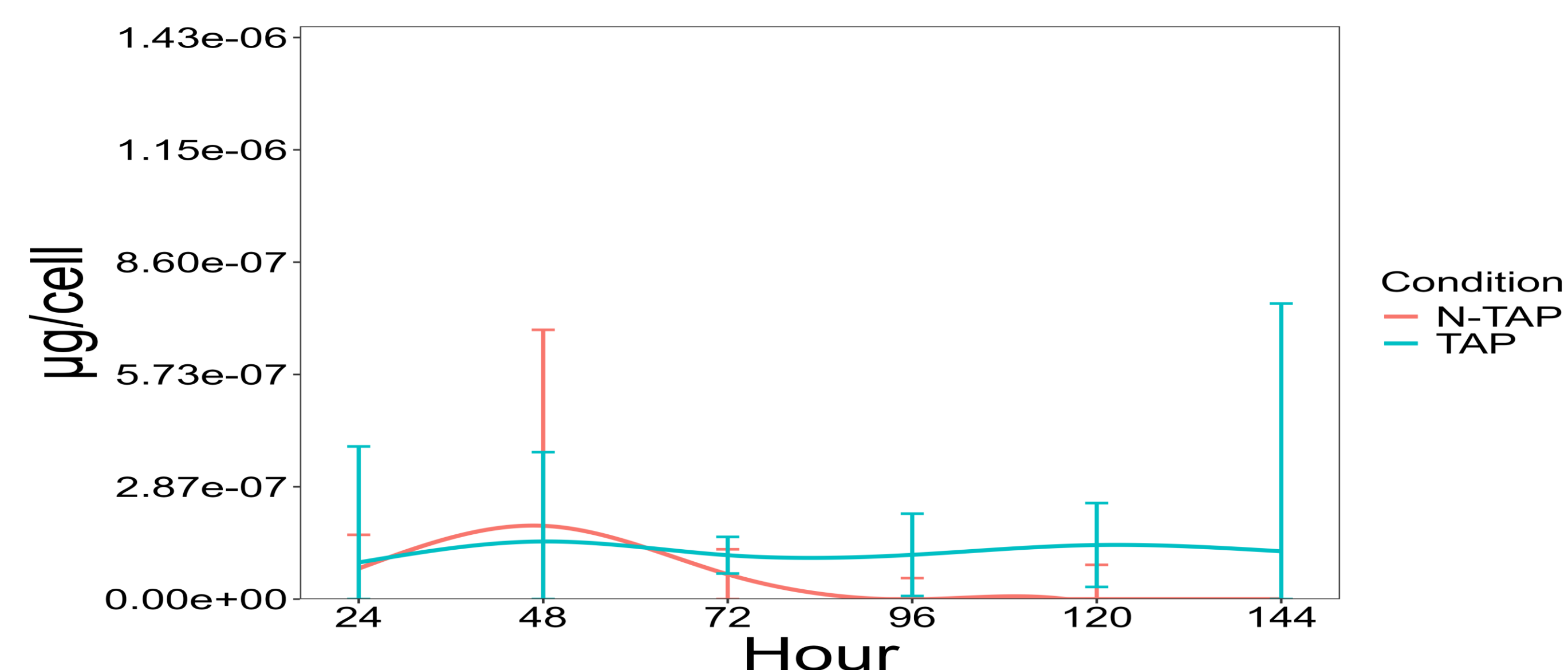


Figure 4: Concentration (µg/cell) of carotenoid per cc124 cell in TAP and N-TAP of this trial over course of 7 days (144 hours). Each recorded hour includes an average range of error for concentrations.

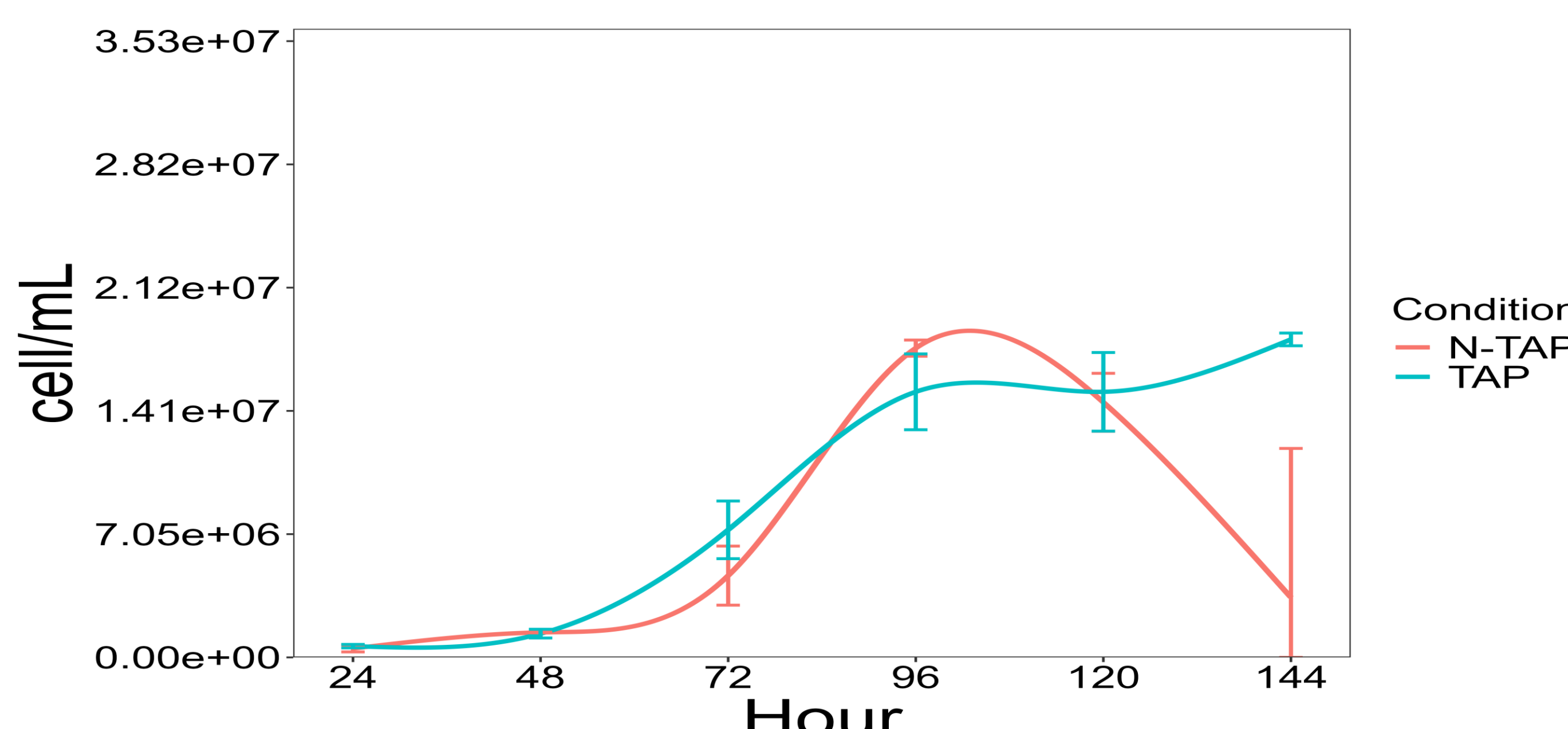


Figure 5: Cell density (cell/mL) of cc124 in Tap and N-Tap of this trial over course of 7 days (144 hours). Each recorded day includes an average range of error for density.

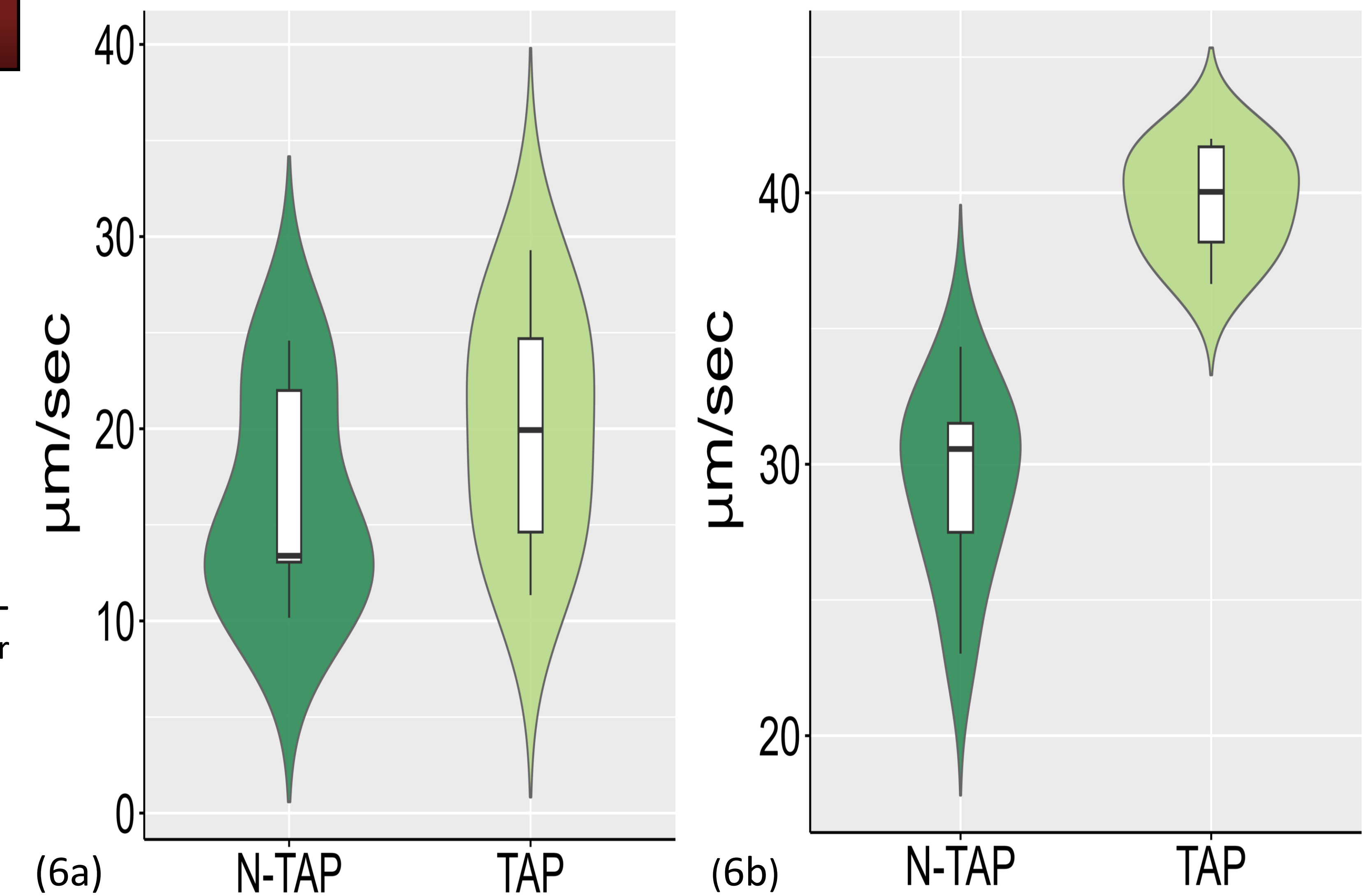


Figure 6: Swim speed (µm/sec) of LCD and HCD of cc124 in TAP and N-TAP of this trial. (6a) Violin plot represent swim speed range collect from LCD population on hour 24 (3/22/26). (6b) Violin plot represent swim speed range collected from HCD population on hour 120 (3/26/26). Each have a boxplot with a median line and whiskers, to display swim speed range of cell population.

## Discussion

- Between 120-144hrs, CC-124 in N-TAP shows increased chlorophyll A & B per cell, and reduced carotenoid production relative to TAP controls.
- This coincides with cells entering the 'death' phase for N-TAP. However, the collected cells are planktonic and therefore part of the remaining viable population.
- At HCD N-TAP cultures appear to have dis-regulated QS regulation of motility. Whether QS is now regulating photosynthetic pigment production is unclear and will be further looked at.

## Future Work

- Further studies into *C. reinhardtii*, will examine how its QS response to environment conditions, is affected by interchanging day-night cycle as they do have a natural circadian rhythm, which play a role in gene regulation.

## References

- Haire, T. C., Bell, C., Cutshaw, K., Swiger, B., Winkelmann, K., & Palmer, A. G. (2018). Robust microplate-based methods for culturing and in vivo phenotypic screening of *Chlamydomonas reinhardtii*. *Frontiers in Plant Science*, 9. <https://doi.org/10.3389/fpls.2018.00235>
- Lee, D. Y., Park, J.-J., Barupal, D. K., & Fiehn, O. (2012). System response of metabolic networks in *Chlamydomonas reinhardtii* to total available ammonium. *Molecular & Cellular Proteomics*, 11(10), 973–988. <https://doi.org/10.1074/mcp.m111.016733>
- Virtanen, O., Khorobrykh, S., & Tyystjärvi, E. (2020). Acclimation of *chlamydomonas reinhardtii* to extremely strong light. *Photosynthesis Research*, 147(1), 91–106. <https://doi.org/10.1007/s11120-020-00802-2>
- Figure 1 created in <https://BioRender.com>