# cAMP-dependent protein kinase controls the multifaceted biology of visible light

Mikael Molin[1,3*], Katarina Logg[1,2], Kristofer Bodvard[2], Friederike Roger[1], Annabelle Forsmark[1], Ken Peeters[1], Mikael Andersson[1], Anna Jörhov[1], Neha Mishra[1], Jean-Marc Billod[1], Sabiha Amir[1], Leif Eriksson[1], Jonas Warringer[1], Mikael Käll[2], and Anders Blomberg[1*]

[1]Dept. of Chemistry and Molecular Biology, University of Gothenburg, Sweden
[2]Dept. of Applied Physics, Chalmers University of Technology, Gothenburg, Sweden
[3]Dept of Biology and Biological Engineering, Chalmers University of Technology, Gothenburg, Sweden

## Abstract

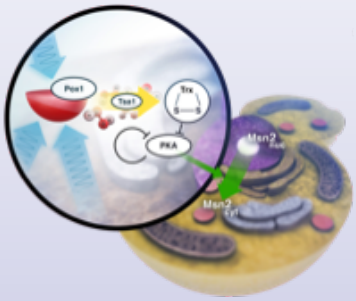
**Background:** Stress from visible light (400-700 nm) is a regular part of the life cycle of many organisms, but remains poorly understood. We developed a high-throughput method for measuring growth under visible light stress and used it to screen the light-sensitivity of the yeast gene deletion collection.

**Results:** We found genes involved in HOG pathway signaling, RNA polymerase II transcription, translation, diphthamide modifications of the translational elongation factor eEF2 and the oxidative stress response to be required for light resistance. Altered nuclear localization of the transcription factor Msn2 and lower glycogen accumulation indicated a higher activity of the yeast cAMP-dependent protein kinase (protein kinase A, PKA) in many light-sensitive gene deletion strains. We therefore used an ectopic fluorescent PKA-reporter and mutants with constitutively altered PKA activity to show that repression of PKA is essential for maintaining normal resistance to visible light.

**Conclusion:** We conclude that yeast photobiology is multifaceted, and that cAMP-dependent protein kinase plays a key role in the ability of cells to grow upon visible light illumination. We propose that visible light impacts on the biology and evolution of many non-photosynthetic organisms and have practical implications for how organisms are studied in the laboratory, with or without illumination.

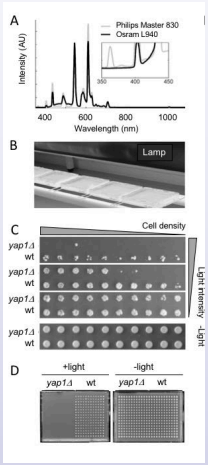
## Background

- Previous studies in the 70-ies have pointed to mitochondria being main light targets
- Lack of modern studies of the response to visible light (400 – 700nm)
- We have recently reported activation of both $Ca^{2+}$ signaling (Crz1) and Msn2 upon illumination with blue light induced generation of hydrogen peroxide

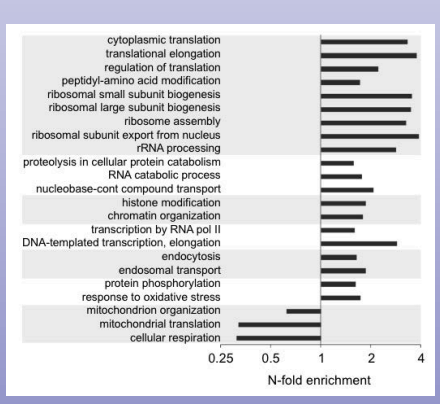



## Experimental setup

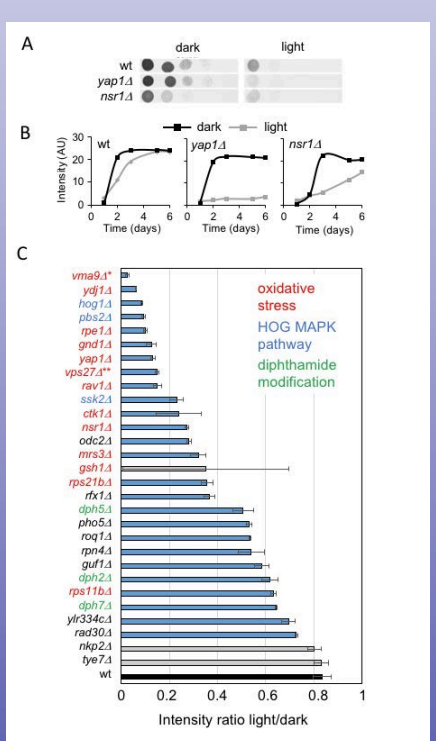
BY4741 deletion mutant collection
~4800 strains



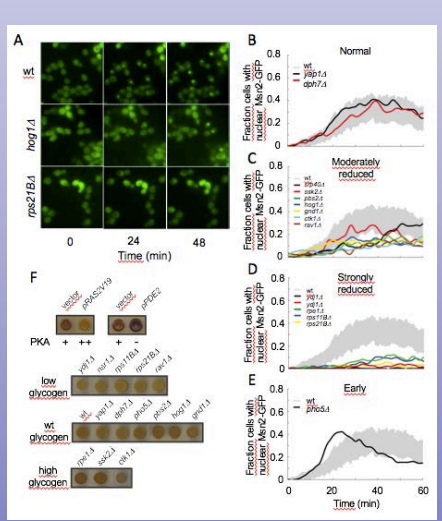

## The 490 light-sensitive mutants are enriched (GO) for genes involved in eg ribosome/translation, oxidative stress and RNA polymerase II transcription



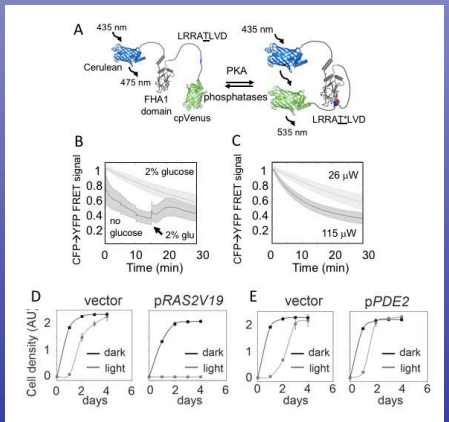

## Validation - top light-sensitive mutants highlight oxidative stress resistance, the HOG MAPK pathway and diphthamide modification of the translational elongation factor EF2




## Indirect PKA reporters (Msn2 nuclear localization and glycogen accumulation) indicate high level of PKA activity in the light-sensitive mutants




## Reduced protein kinase A activity is required for the resistance to visible light




## SUMMARY

- Yeast photobiology is multi-facetted
- cAMP dependent protein kinase controls the major response to visible light
- Speculation - visible light might be a selection-pressure during yeast evolution

*Questions? Please send a mail to anders.blomberg@cmb.gu.se*