CHALMERS UNIVERSITY OF TECHNOLOGY

Microbial robustness 101: tools and applications

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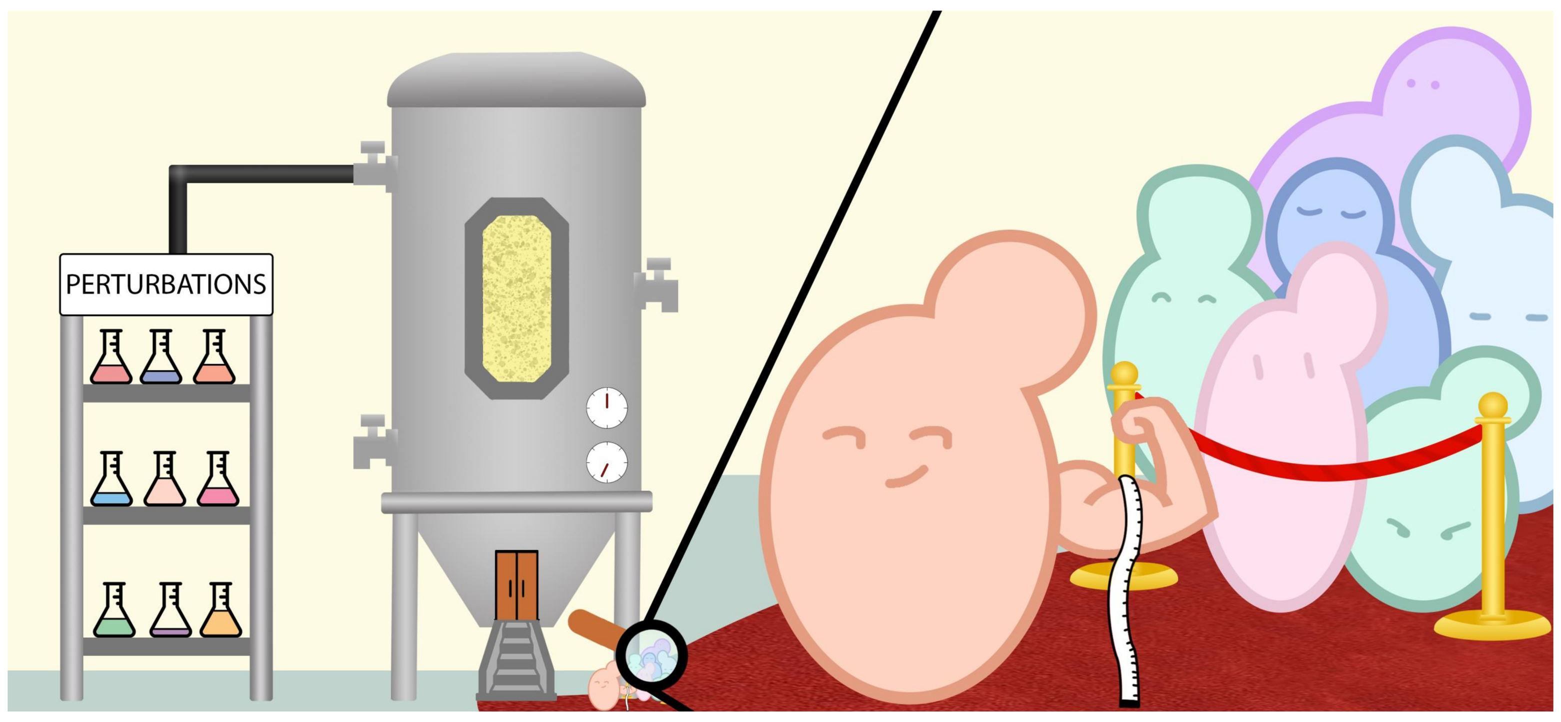
Microbial Robustness

Check the review!

- A broad range of predictable and stochastic perturbations affects the performance and productivity of microorganisms in bioprocesses.
- **Microbial robustness** describes the stability of a phenotype (cellular function) when a system is challenged by different perturbations.
- It **differs** from **tolerance**, which relates to the survival of the cells or growth in the face of perturbations.
- **Lack of tools** to quantify microbial robustness and investigate the physiological traits associated with it under bioprocess-relevant perturbations.



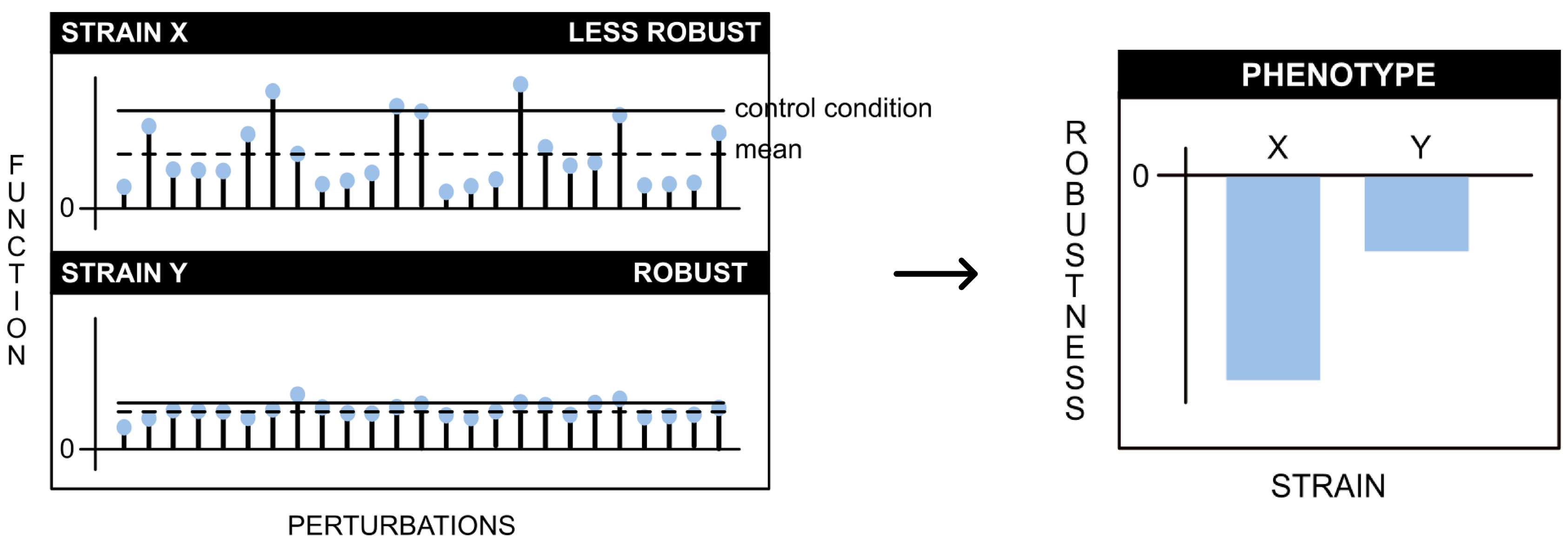
Quantification

Check the publication!

R: robustness

$$R_{i,S,P} = -\frac{Fano\ factor}{mean} = -\frac{\sigma^2}{\bar{x}} \cdot \frac{1}{m}$$

i: cellular function
S: system
P: perturbation space
$\bar{x}$: mean across perturbations
m: mean across strains



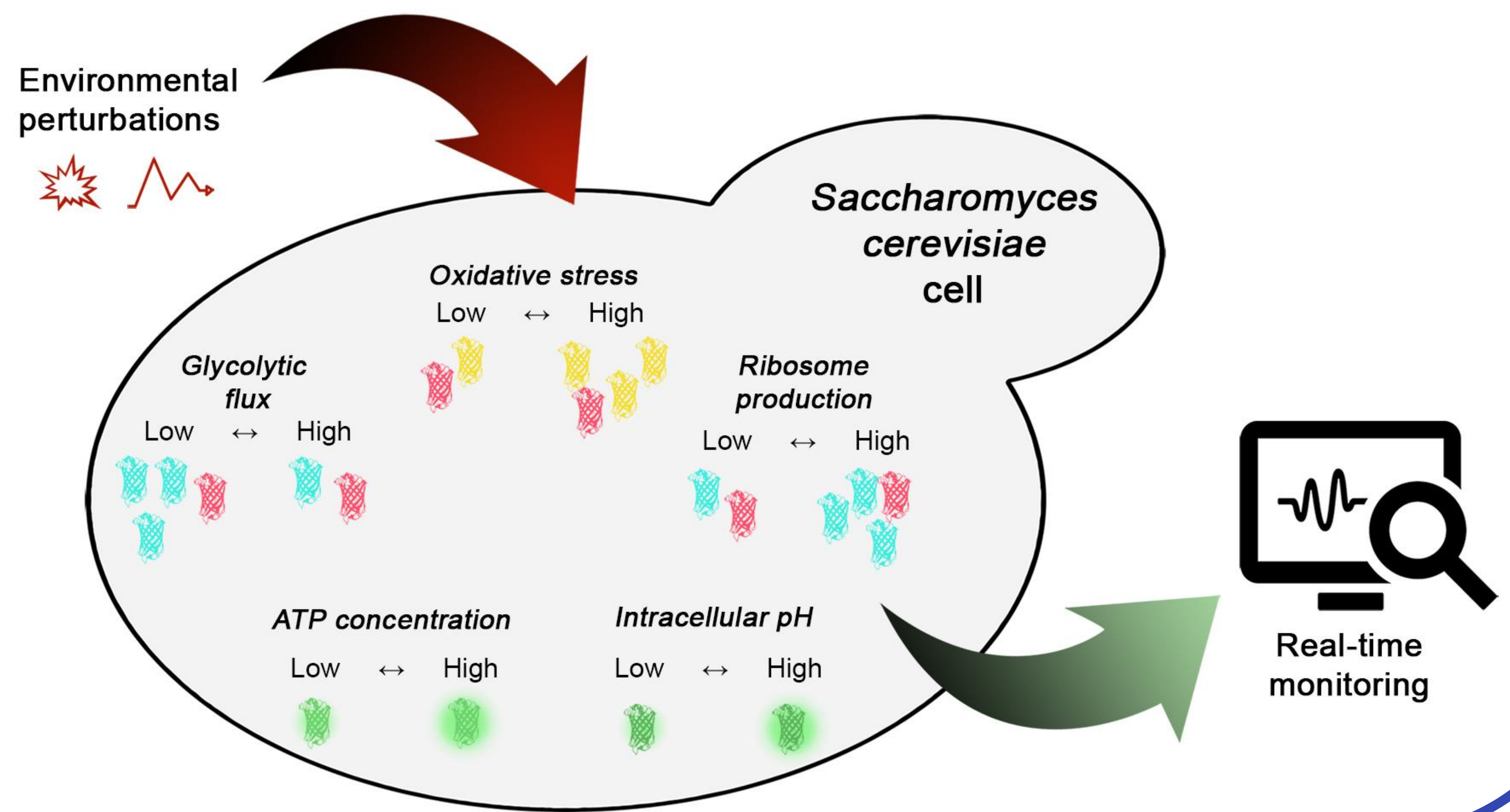
This quantification strategy is:

(1) dimensionless (2) free from arbitrary control conditions (3) frequency independent

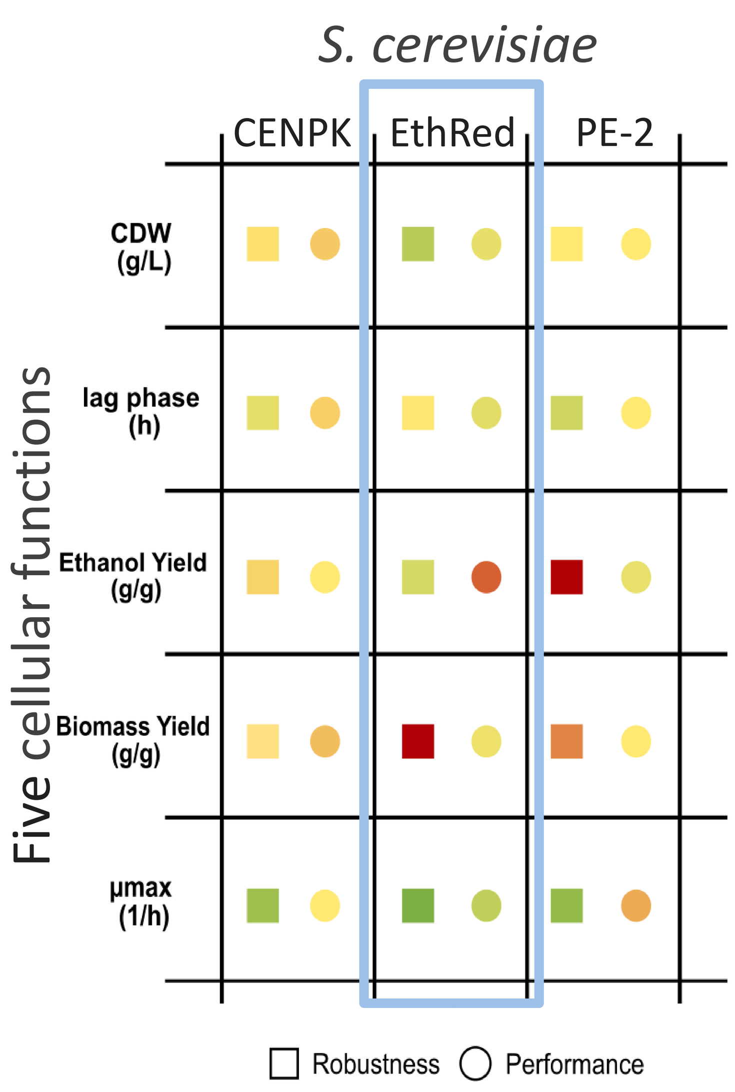
Toolkit

Check the publication!

- **Versatile toolbox** for investigating the intracellular environment in yeast *Saccharomyces cerevisiae* using genetically-encoded **fluorescent biosensors**.
- **Features:** easy to use, to implement with new biosensors, efficient marker-free genome integration, allowing for both population and single-cell studies.

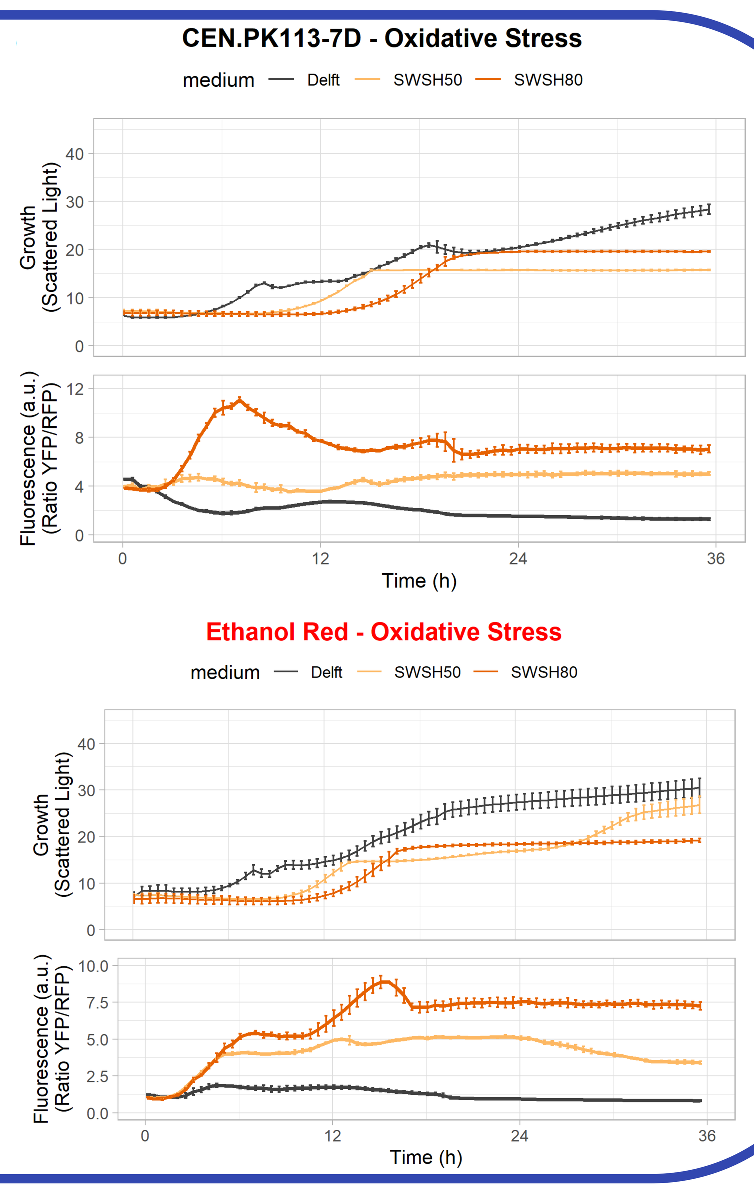


Application



- Case study for **bioethanol production from lignocellulosic materials.**
- R was calculated for each function and strain with the Fano factor-based method.
- **EthanolRed** exhibited the **highest** values for **robustness** and **performance**.
- **Trade-offs** were identified **between robustness and performance**, for example in the case of the ethanol yield of EthanolRed.
- **Possible to apply in other fields and organisms.**

- **Investigation of the physiological response** of laboratory and industrial *S. cerevisiae* strains in a high-throughput setup.
- Implementation of **new sensors for metabolic statuses.** (ONGOING)
- Study at the **single-cell** level the cell **physiology in changing environments** in microfluidics chips. (ONGOING)
- Exploration of **subpopulation formation** and population heterogeneity in **large-scale fermentations.** (ONGOING)
- **Combination** and correlations with **Robustness quantification**.



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