acib and the bioeconomy

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Austrian Centre of Industrial Biotechnology (acib)

acib – an Austria-based, international competence centre for research and development in industrial biotechnology

3M
ABEnzymes
ABiTEP GmbH
ARA consult GmbH
ATOLL GmbH
bisolbi INTER
Bisy GmbH e.U.
BASF The Chemical Company
BIA separations
bio-ferm
BIOCRATES
Biomin
biotenzz
Boehringer Ingelheim
Carbios
CHORUS GmbH
Clariant
CNA DIAGNOSTICS INC
DPx Fine Chemicals
DSM
EVONIK INDUSTRIES
GEROT LANNACH
GALAB Laboratories
glanzstoff industries
HOCUS LOCUS
INFACT
IPUS
Jungbunzlauer
LACTOSAN
Lonza
micro innova
Pfeifer & Langen
pyroscience sensor technology
roal
ROOM BIOTIC
SANDOZ
SYCONIUM
Synovo GmbH
THEMIS
Vivimed
voestalpine
VTU engineering

COMET budget 2015 – 2019: 65 Mio €; 2015: 58 company and 17 strategic projects started; about 250 people at 13 scientific partner universities

Industrial biotechnology tools for bio-based production

Classical substrates

Plant lignocellulosics, algae

Wastes, residues

Nonconventional substrates (CO_2, gases)

Industrial biotechnology

Systems to processes and products

Fuels

Chemicals

Materials

Process robustness of microbial cell factories

Alternative substrate utilization

Tolerance to inhibitory or even toxic substrates and products

Inhibitors, pH and ionic strength tolerance

Osmotolerance and tolerance to (fine) solids loading

Antibiotics independent processes

Morphological robustness

Sufficient (anaerobic) growth and high yield

Robustness engineering requires a multi-level bioprocess engineering approach

Molecular engineering
Protein and metabolic engineering

Evolutionary engineering
Random mutagenesis, adaptation

(Focused) systems biotechnology
Integrated analysis

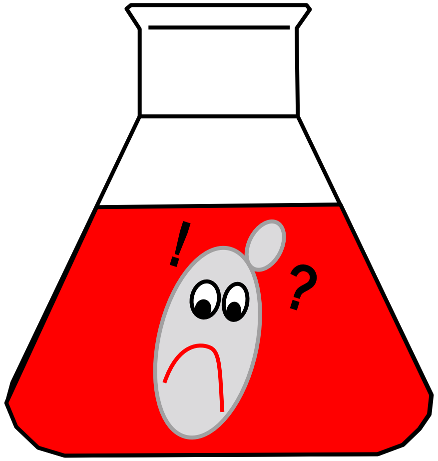
Bioprocess engineering

Factors limiting process robustness of microorganisms

Global metabolic changes required!

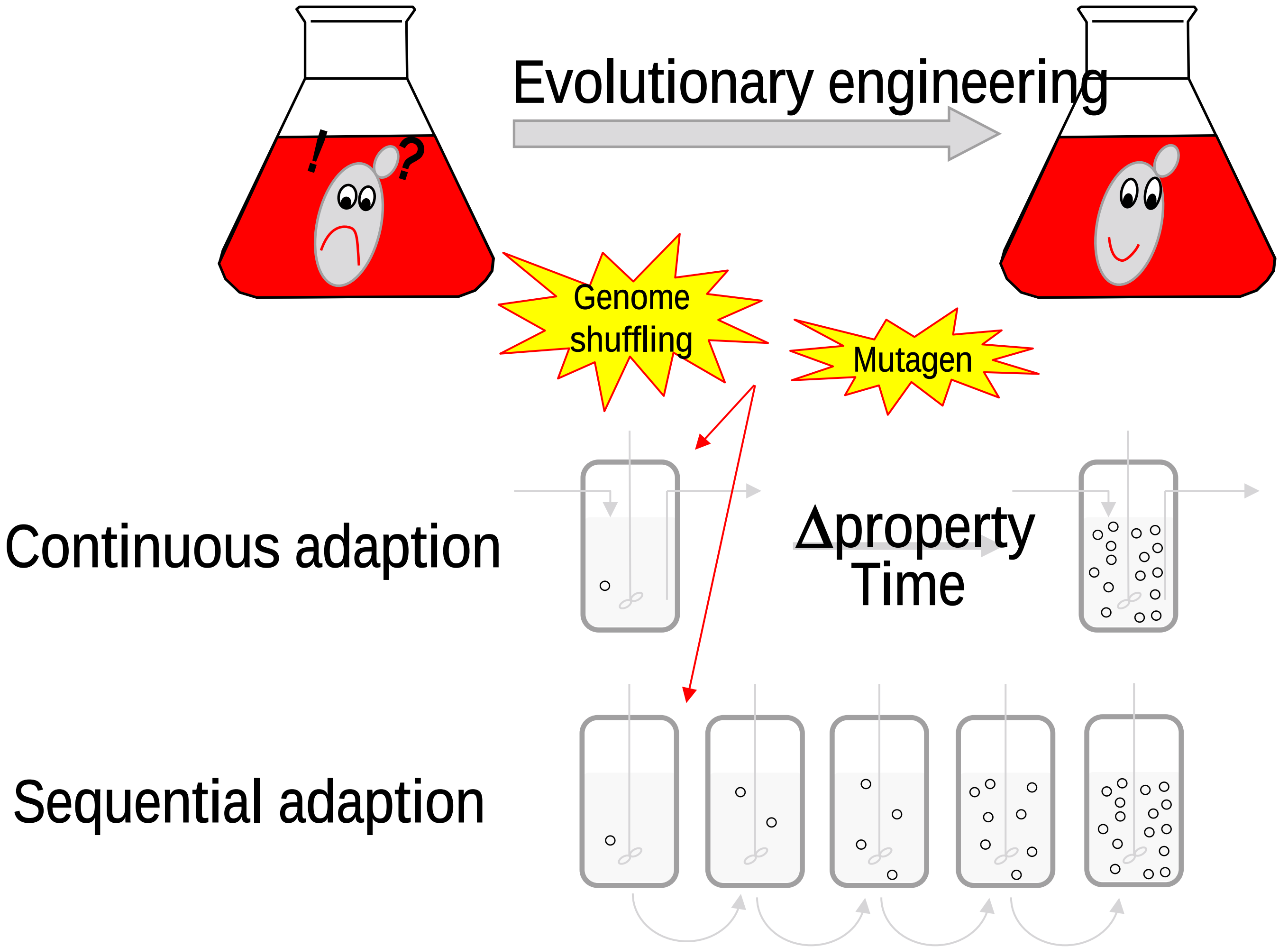
Toxic products

Substrate toxic or not recognized

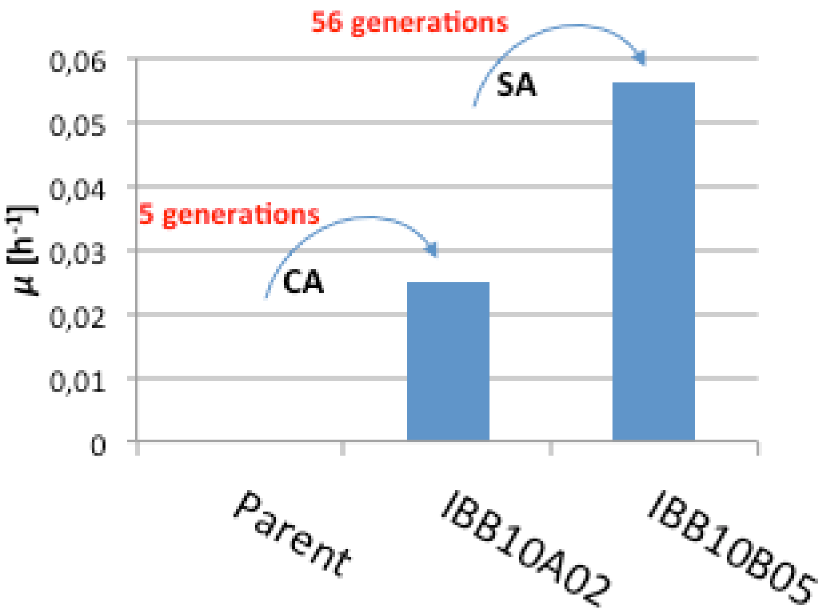


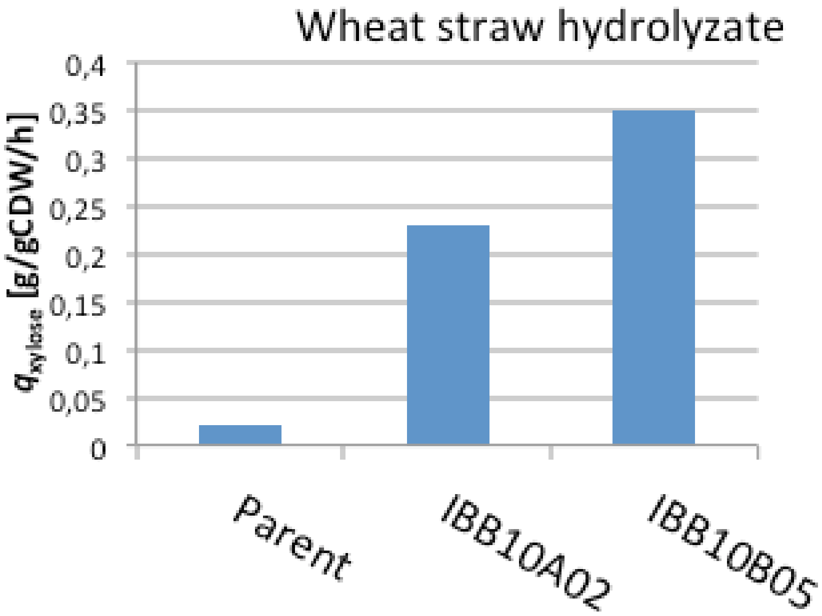
Toxic media compounds

Improving the process robustness of microorganisms



Utilization of lignocellulose hydrolyzates by the yeast *Saccharomyces cerevisiae*

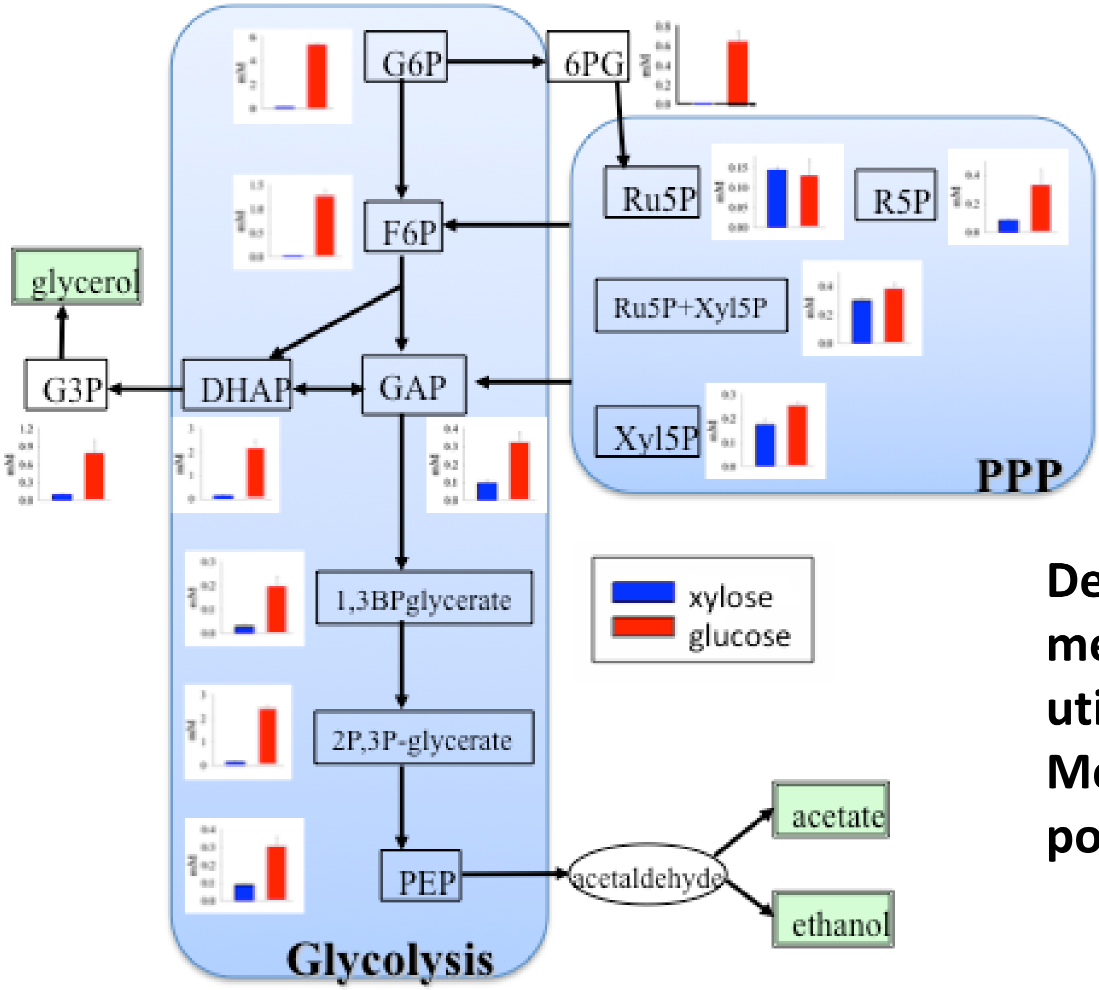




Metabolically engineered for xylose utilization

Klimacek M. et al. (2014), Microbial Cell Fact. 13:37
Novy V. et al. (2014), Biotechnol. Biofuels, 7:49

Systems biology approaches to identify factors limiting conversion of xylose relative to that of glucose

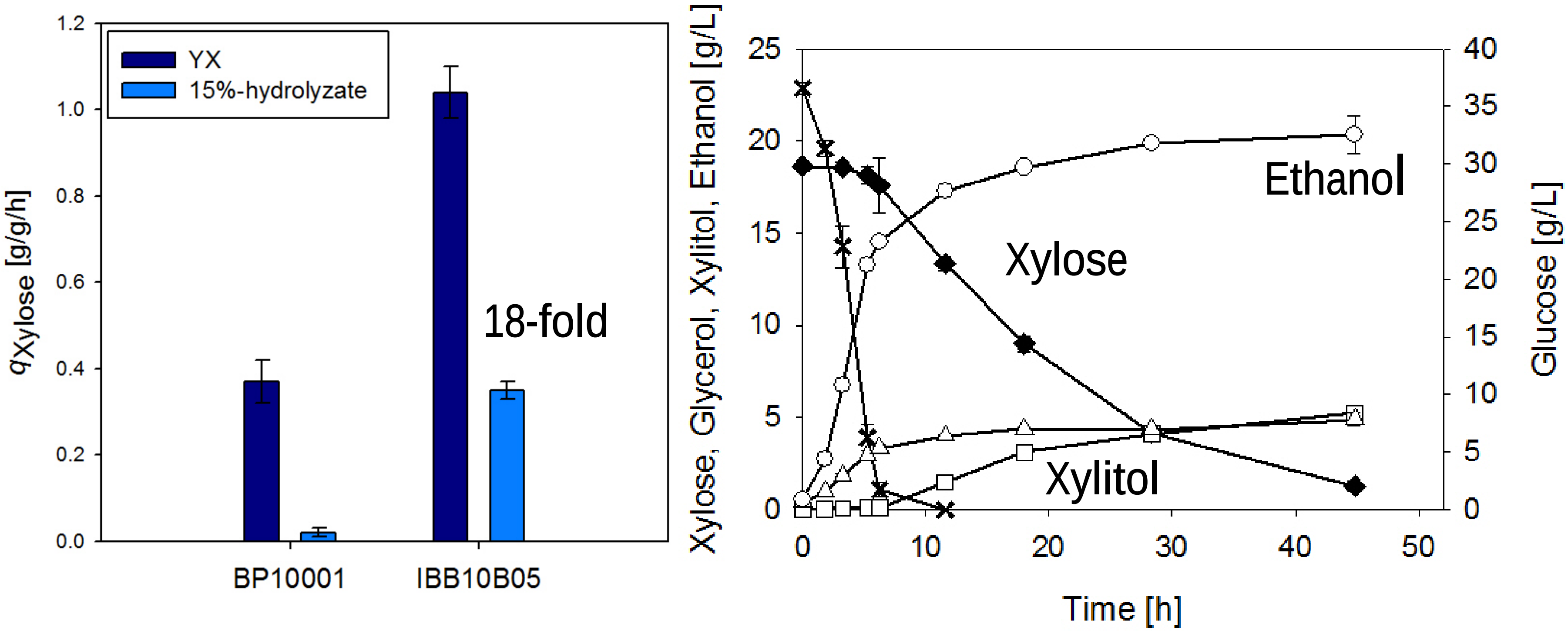


Depletion of glycolytic metabolites during xylose utilization

Metabolic control analysis possible at each point

Appl. Environm. Microbiol. 2010, **76**:7566

Laboratory evolution enhances the xylose utilization rate and confers the ability of anaerobic growth

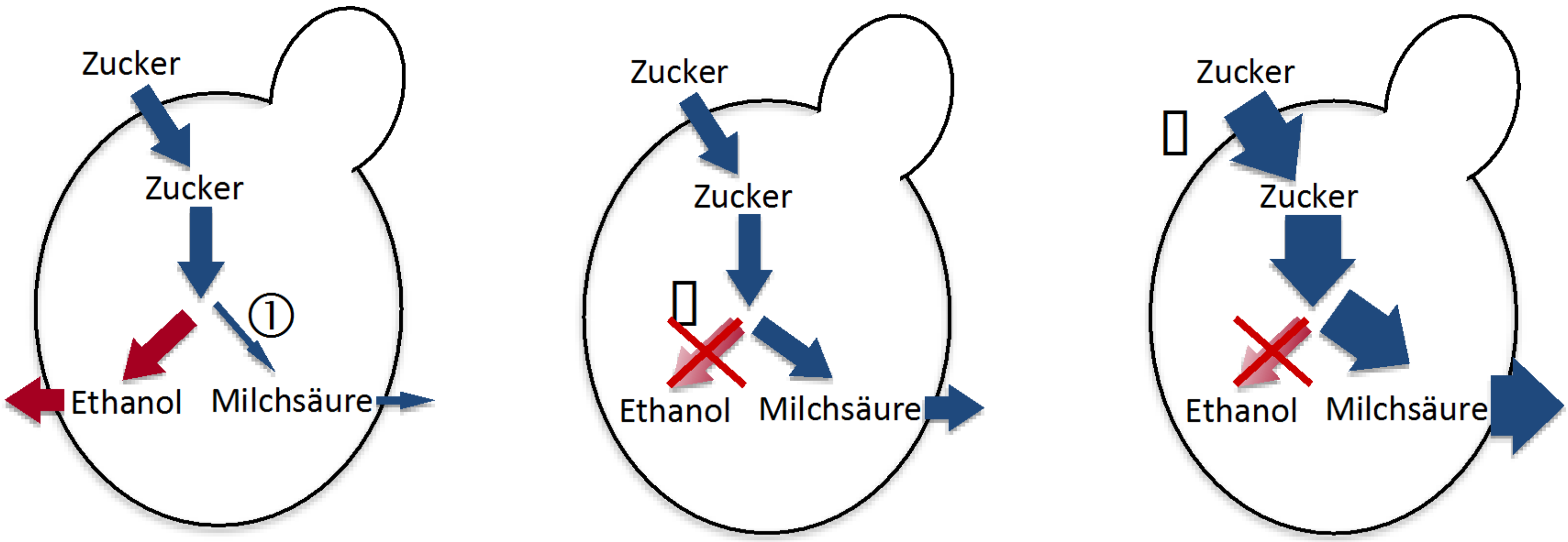


The evolved *S. cerevisiae* strain IBB10B05 is a robust (inhibitor-tolerant) organism for mixed glucose-xylose fermentation.

It is a **platform** for further metabolic engineering and serves as mechanistic reference.

Bioresour Technol. 2013, **130**:439; Microb. Cell Fact. 2014, **13**:37; Biotechnol. Biofuels 2014, **7**:49; ibidem 2015, **8**:46; ibidem 2015, **8**:157; ibidem 2016, **9**:169.

Lactic acid production by *S. cerevisiae* (metabolic engineering)



① Lactatdehydrogenase ermöglicht die Produktion von Milchsäure

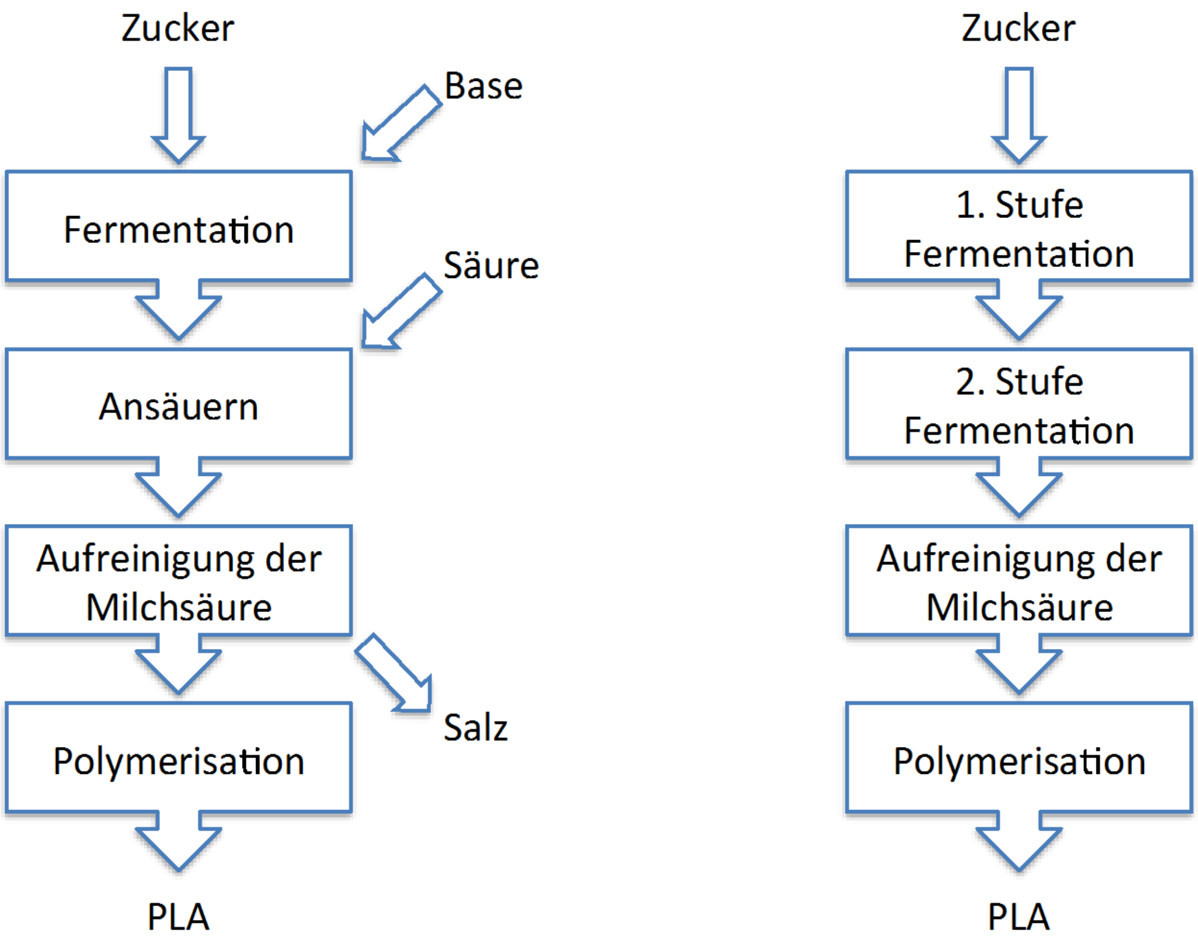
▯ Deletion der Pyruvatdecarboxylase erhöht die Produktion von Milchsäure

▯ Zusätzliche Hexosetransporter verstärken die Produktion von Milchsäure weiter

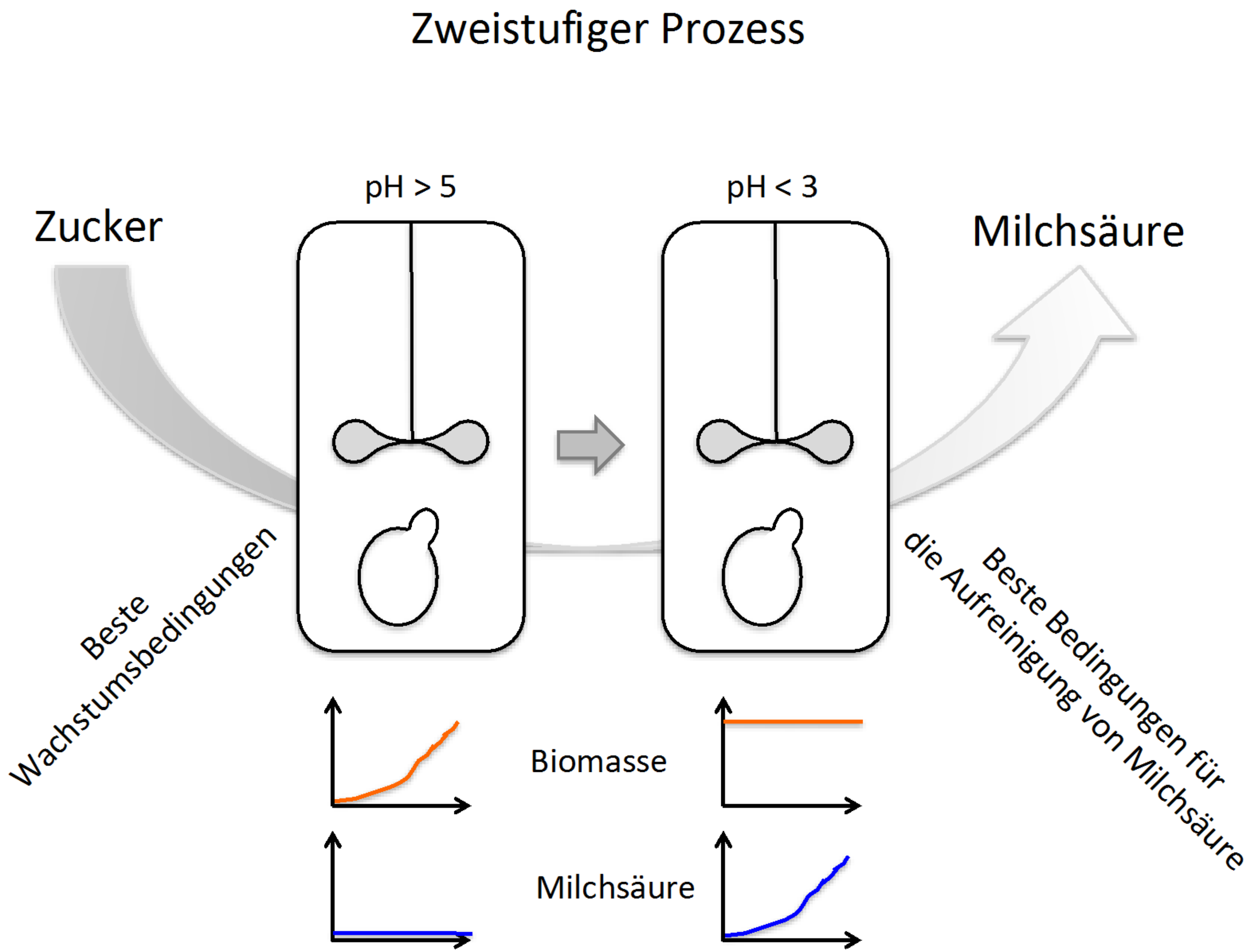
Strain development for lactic acid production at low pH

Herkömmlicher Prozess mit Milchsäurebakterien

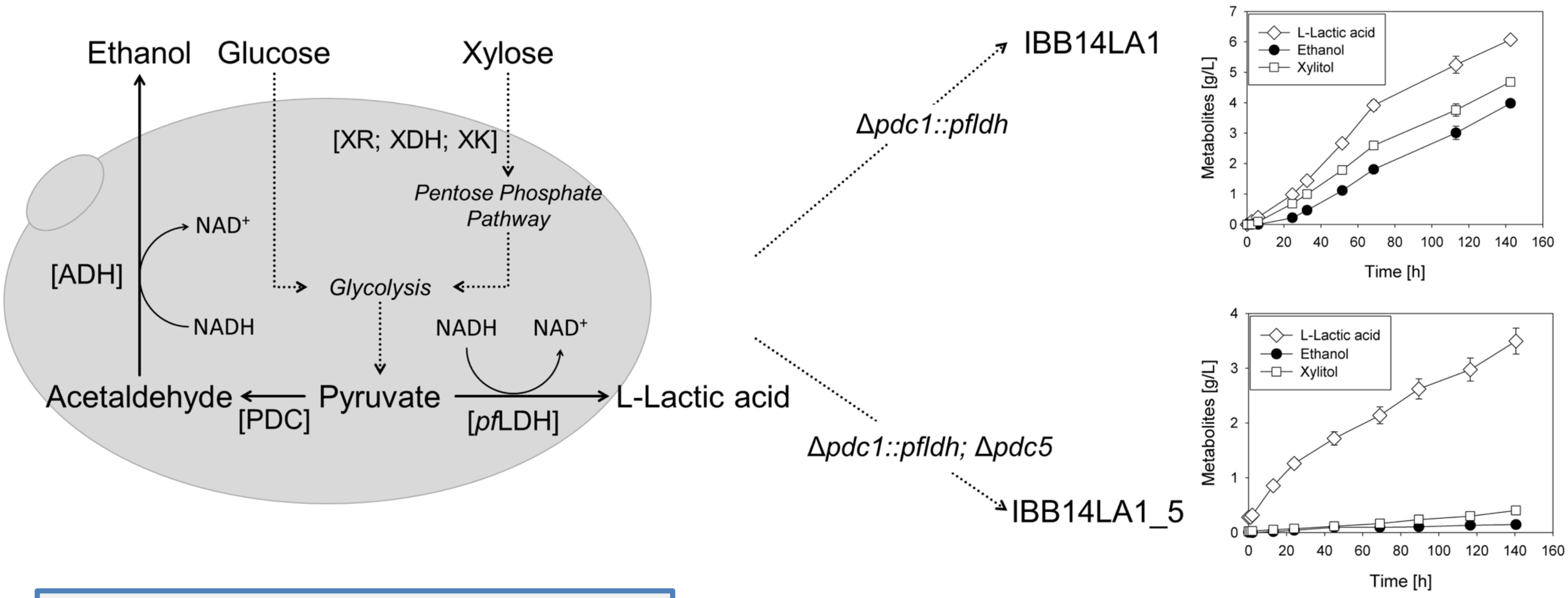
2 stufige Hefefermentation Mit Produktion bei tiefem pH



Two-step process of lactic acid production



Xylose to L-lactic acid



L-lactate dehydrogenase from

Plasmodium falciparum

- k_{cat}/K_M (pyruvate) 15000 s^{-1} mM^{-1}

Anaerobic conversions
$Y_{LA/Xyl}$ = 0.80 (slow)
$Y_{LA/Glc}$ = 0.70 (fast)

Biotechnol. Bioeng. 2016, in press (doi: 10.1002/bit.26048)

CBM12
12th Carbohydrate
Bioengineering Meeting,
April 23-26, 2017, Vienna

forum for the broad research community in carbohydrate bioengineering

www.cbm12.org