BioREFINE-2G Workshop

Bioplastics from 2nd generation Biorefineries

Strain development for diacid production

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This project is co-funded by the European Union within the 7th Frame Programme. Grant Agreement n°613771.

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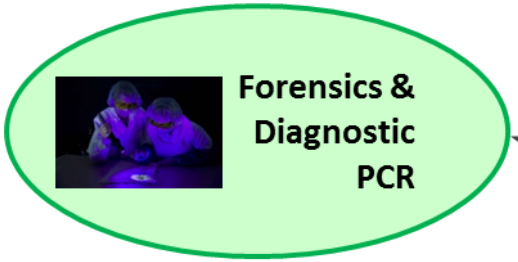

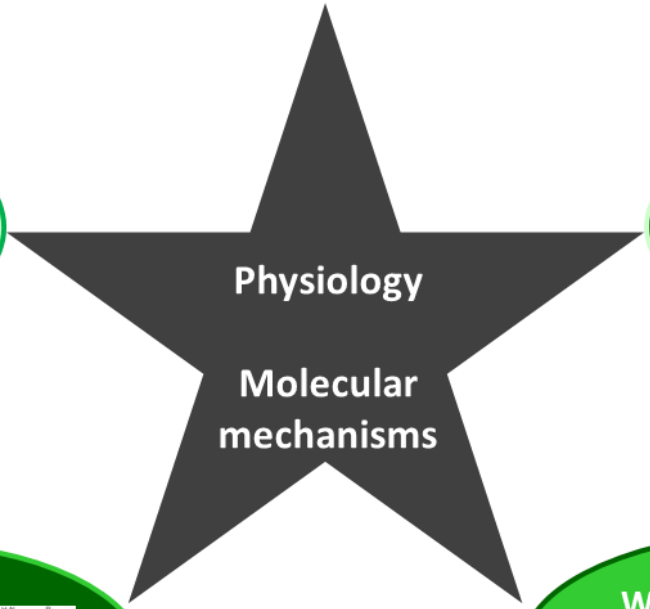

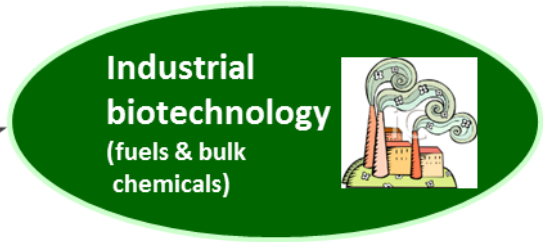

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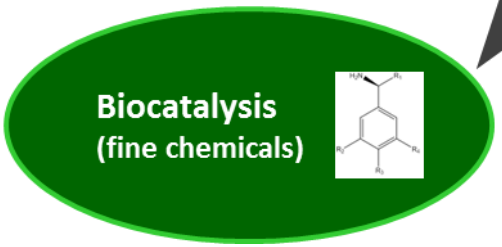


Peter Rådström
Catherine Paul

Carboxylic acid production in 2nd generation biorefineries

AIM: Engineer *Saccharomyces cerevisiae* to produce carboxylic acids from biomass rich in C5 and C6 sugars

Outline

Production of carboxylic acids

- **from lignocellulosic biomass**
- **using *Saccharomyces cerevisiae***

Carboxylic acids – *Why?*

Polymers

Polyethylene Terephtalate : PET

Medicin

Gluconic acid

Food

Acetic acid

Citric acid

Carboxylic acids and plastics

BIOSUSTAINABLE PLASTICS

BIODEGRADABLE Polyhydroxybutyrate (PHB)

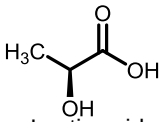
0 – 10 weeks in aerobic sewage sludge (average temperature, 20°C)

L Madison and G Huisman (1999). Microbiol Mol Biol Rev. Mar;63(1):21-53.

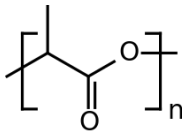
Plastic garbage patches

wastewatchers.com

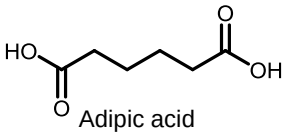
Carboxylic acids and bio-plastics



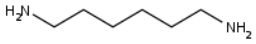
Lactic acid



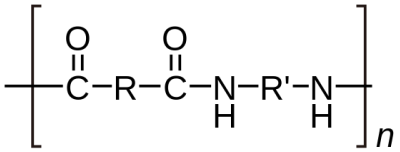
Poly(lactic acid) (PLA)



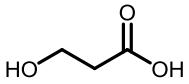
Adipic acid



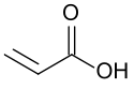
Diiamine



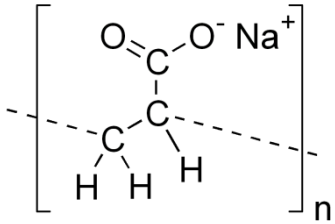
Nylon



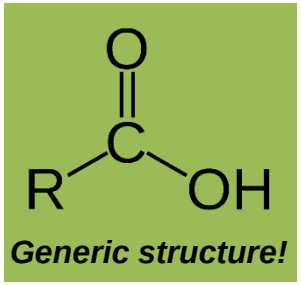
3-Hydroxy-
propionic acid (3-HP)



Acrylic acid



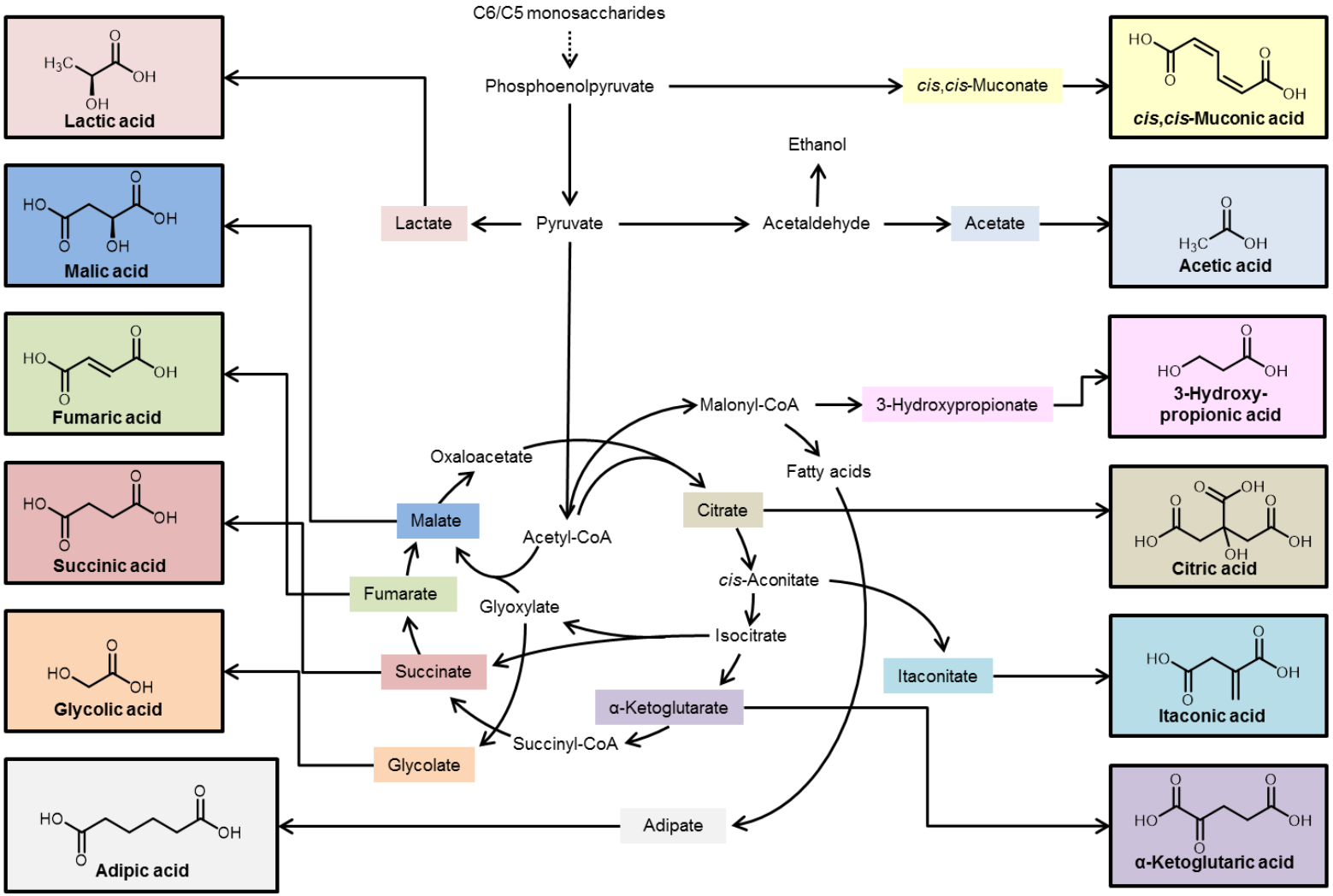
(Sodium) Polyacrylate



Generic structure!

Sandström AG et al., (2014)
Appl Microbiol Biotechnol. 98(17):7299-318.

Diversity of the metabolism

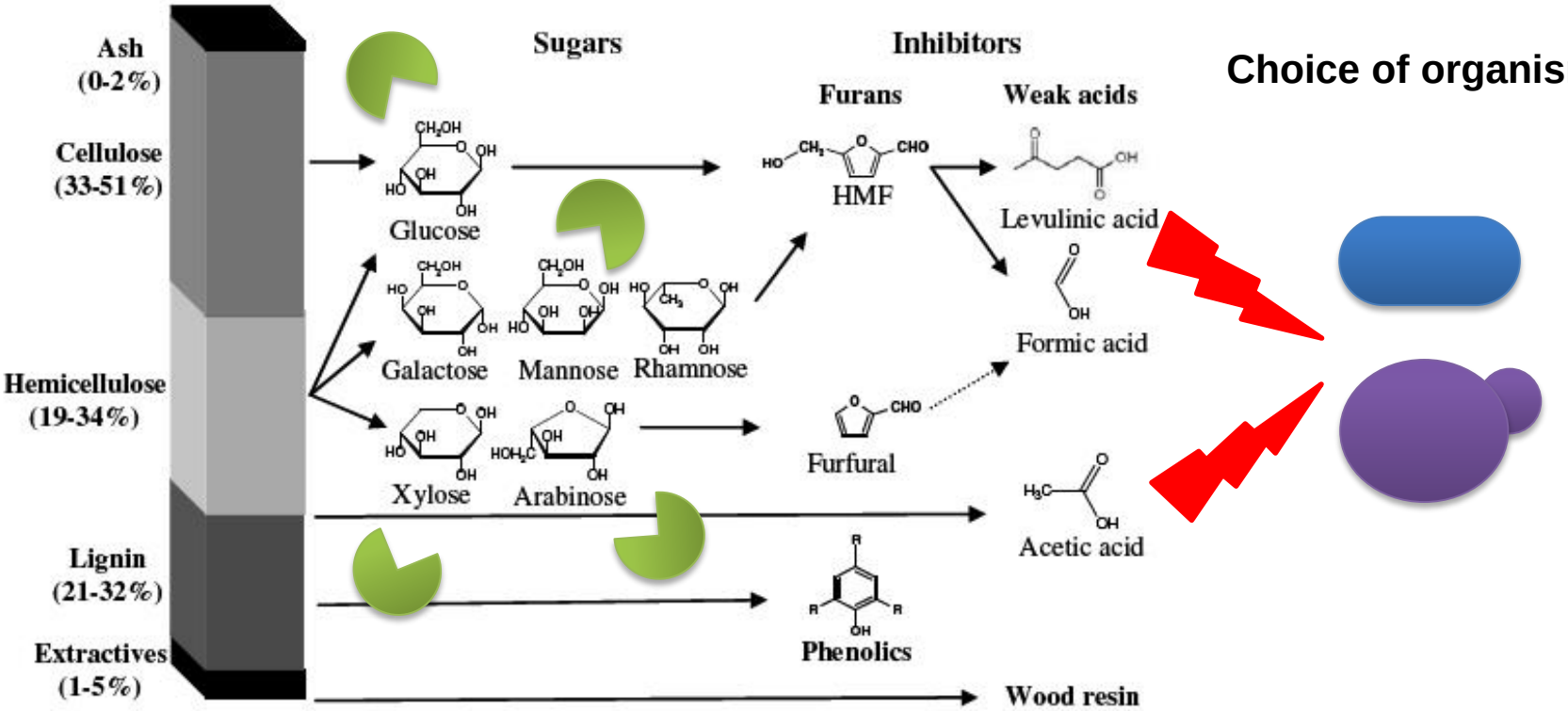


Sandström AG et al., (2014)
Appl Microbiol Biotechnol. 98(17):7299-318.

Lignocellulosic biomass – *Why?*

2nd generation Biorefineries

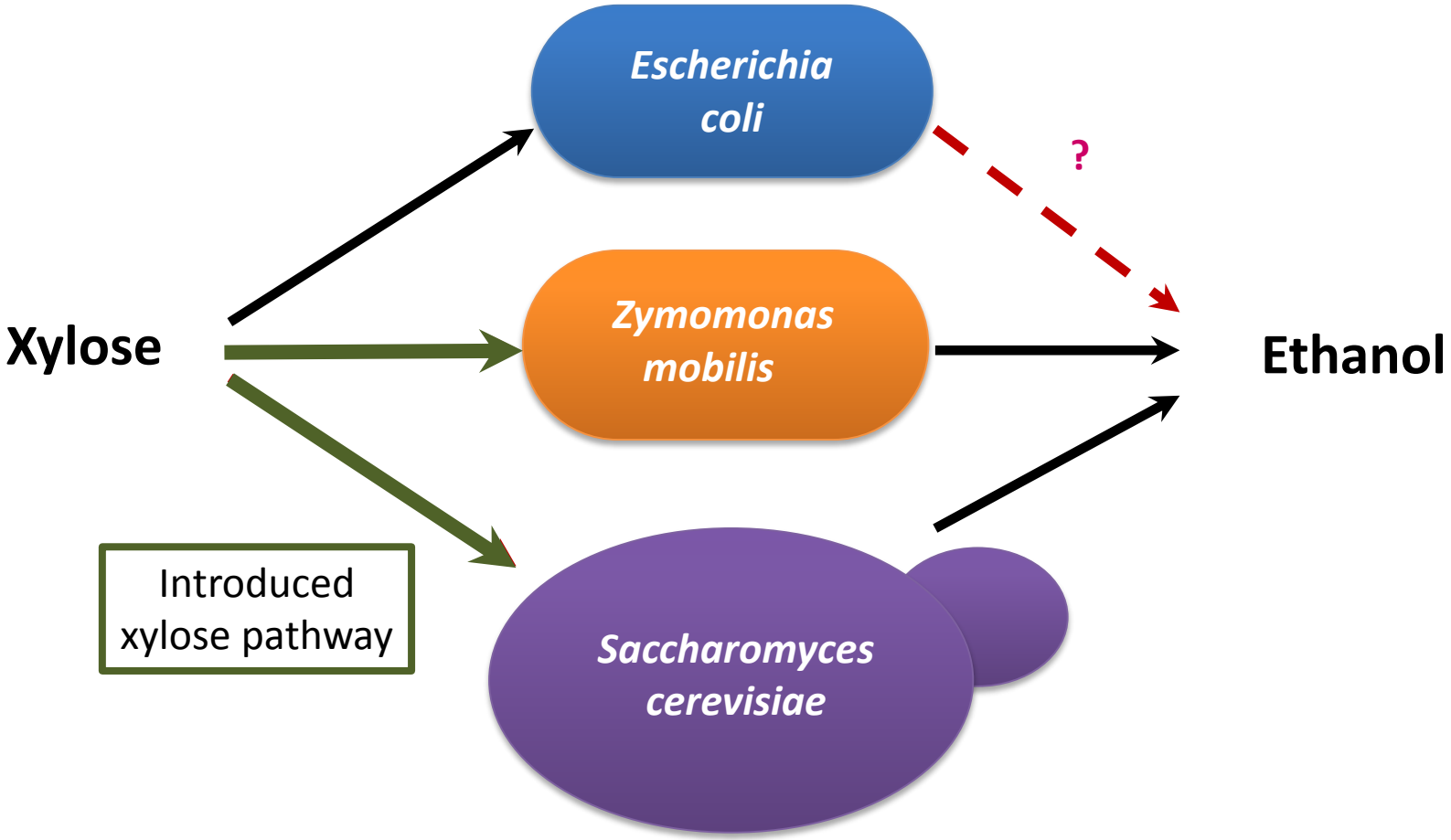
Lignocellulose



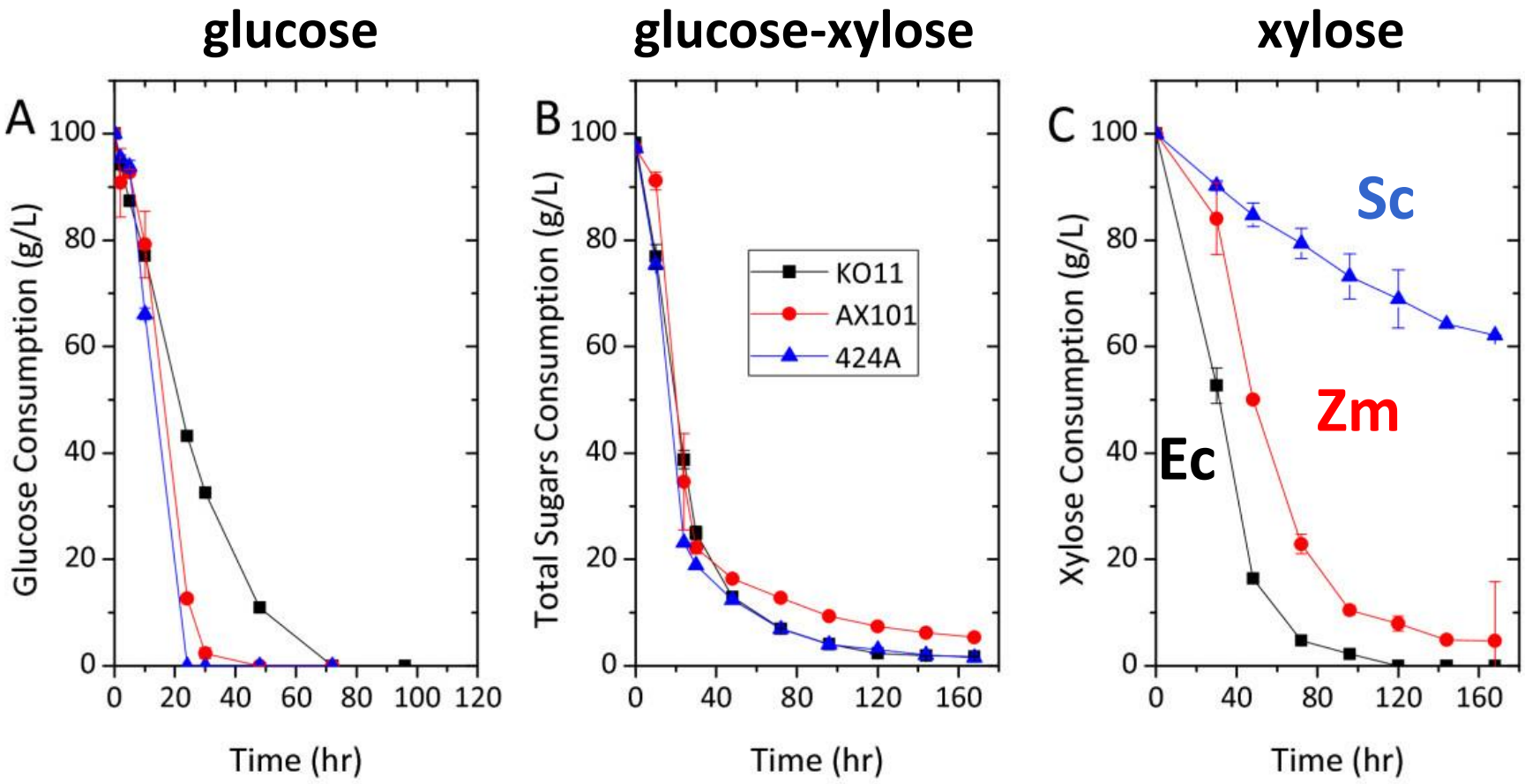
Choice of organism

Almeida et al., (2007)
Chem Technol Biotechnol. 82: 340-349

Potential microorganisms for several bioprocesses



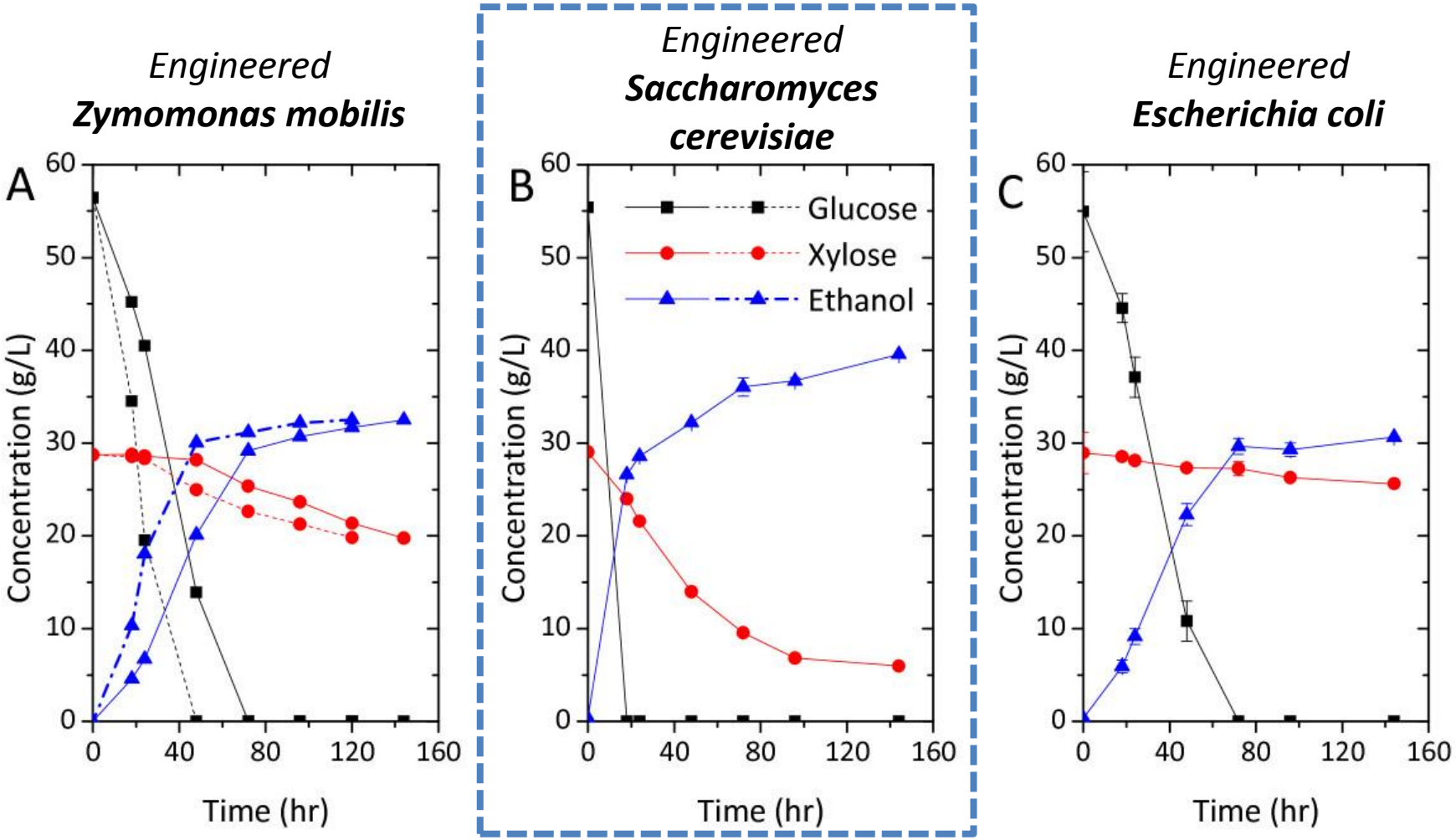
Organism comparison



Lau et al 2010 Biotech Biofuels 3:11

Performances in <u>defined medium</u>

S.c preforms best in hydrolysate

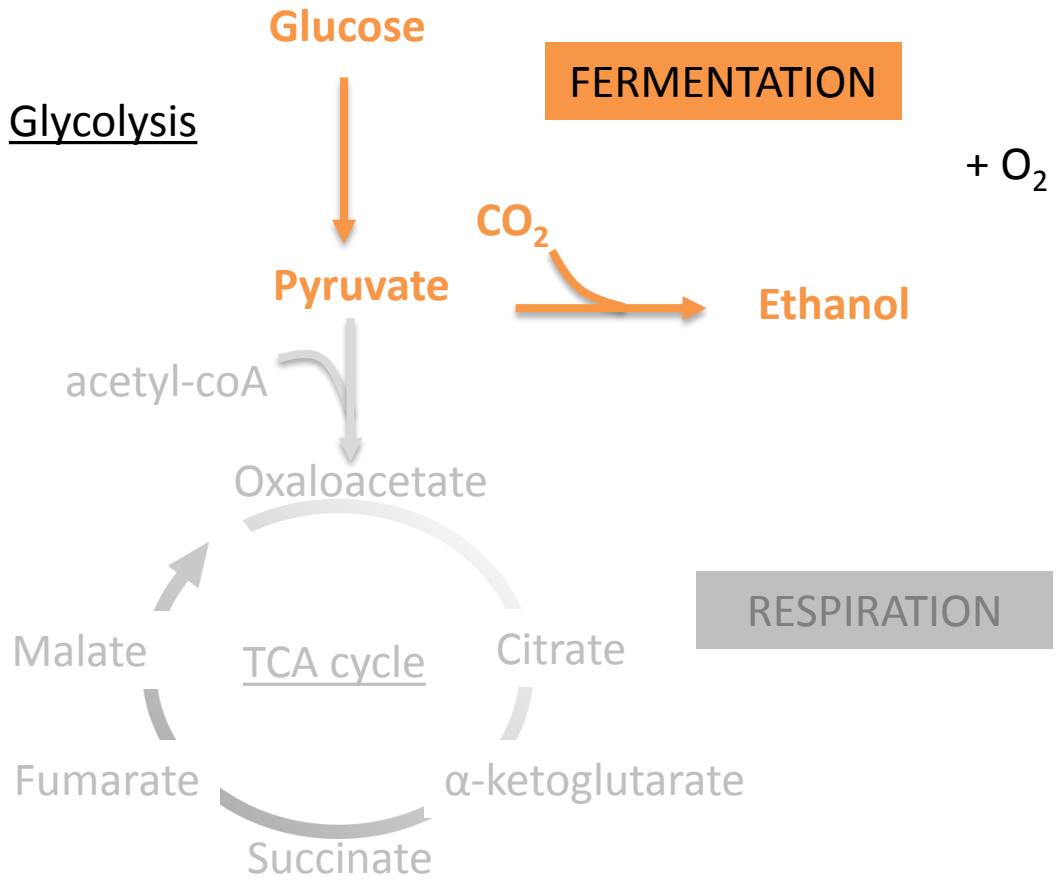


Corn stover hydrolysate

(From Lau et al 2010 Biotech Biofuels 3:11)

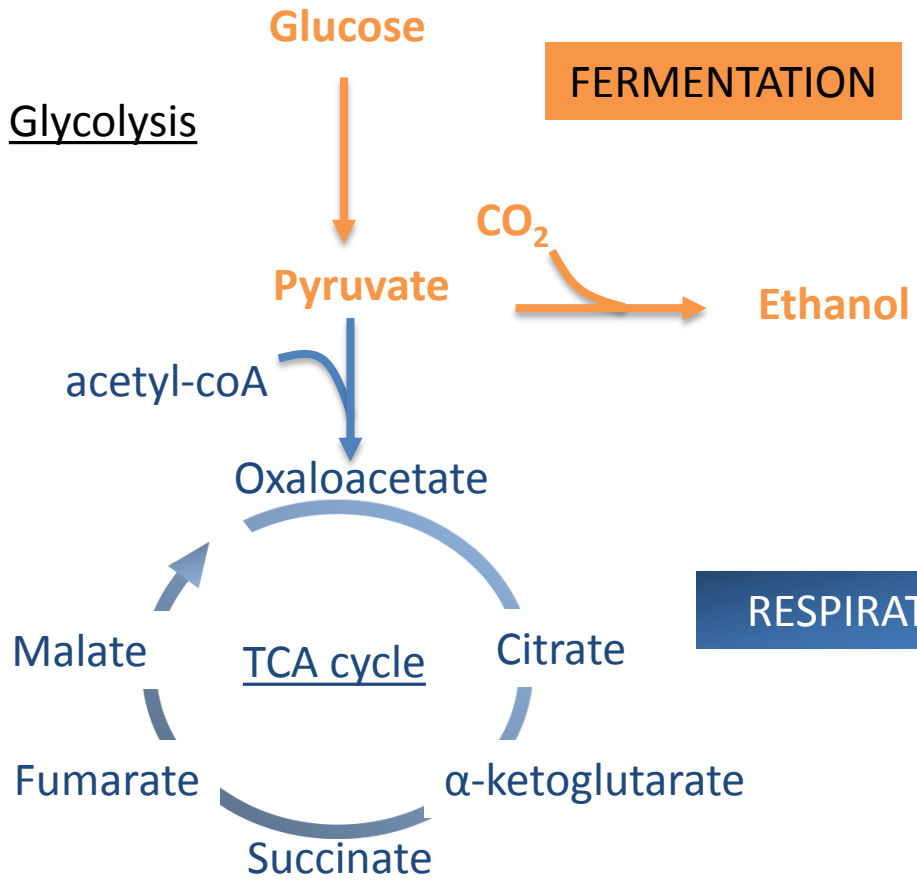
Alcoholic fermentation even under aerobic conditions

Saccharomyces cerevisiae



Alcoholic fermentation even under aerobic conditions

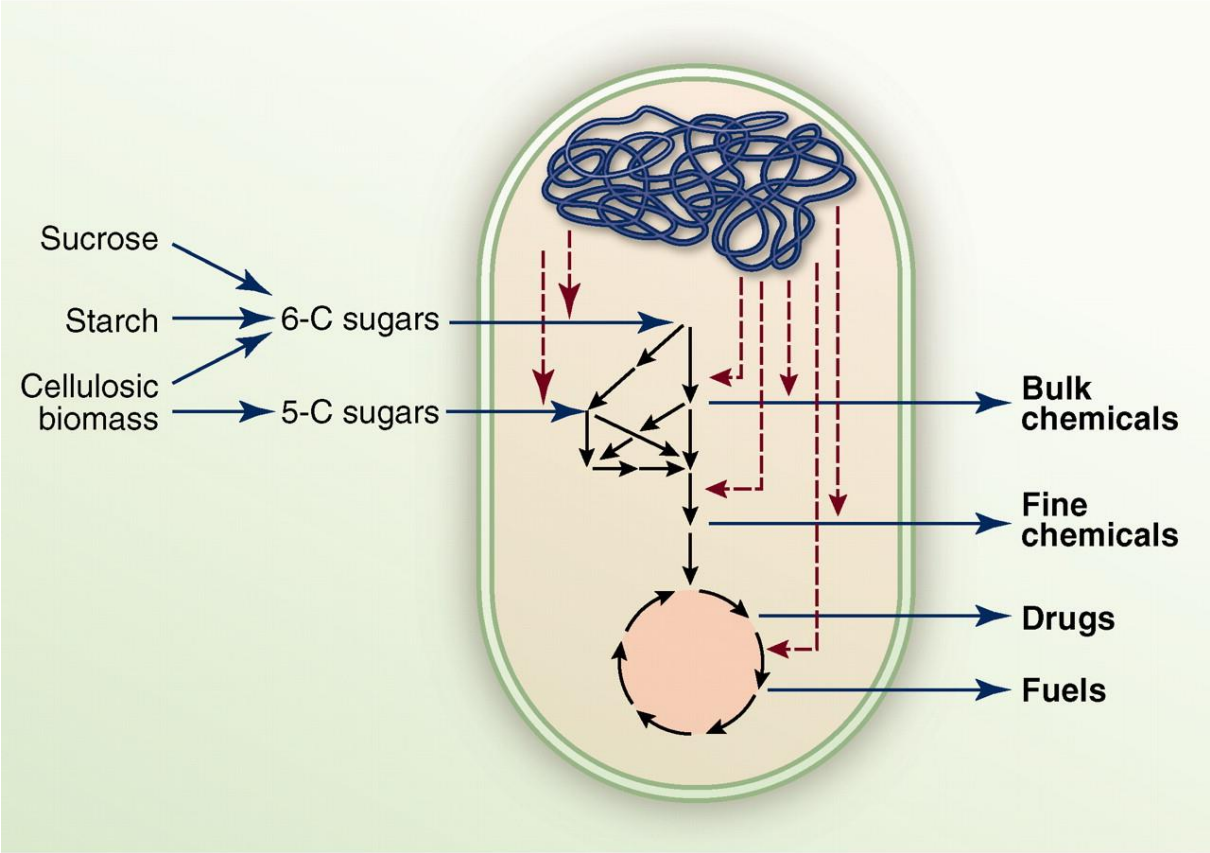
Saccharomyces cerevisiae



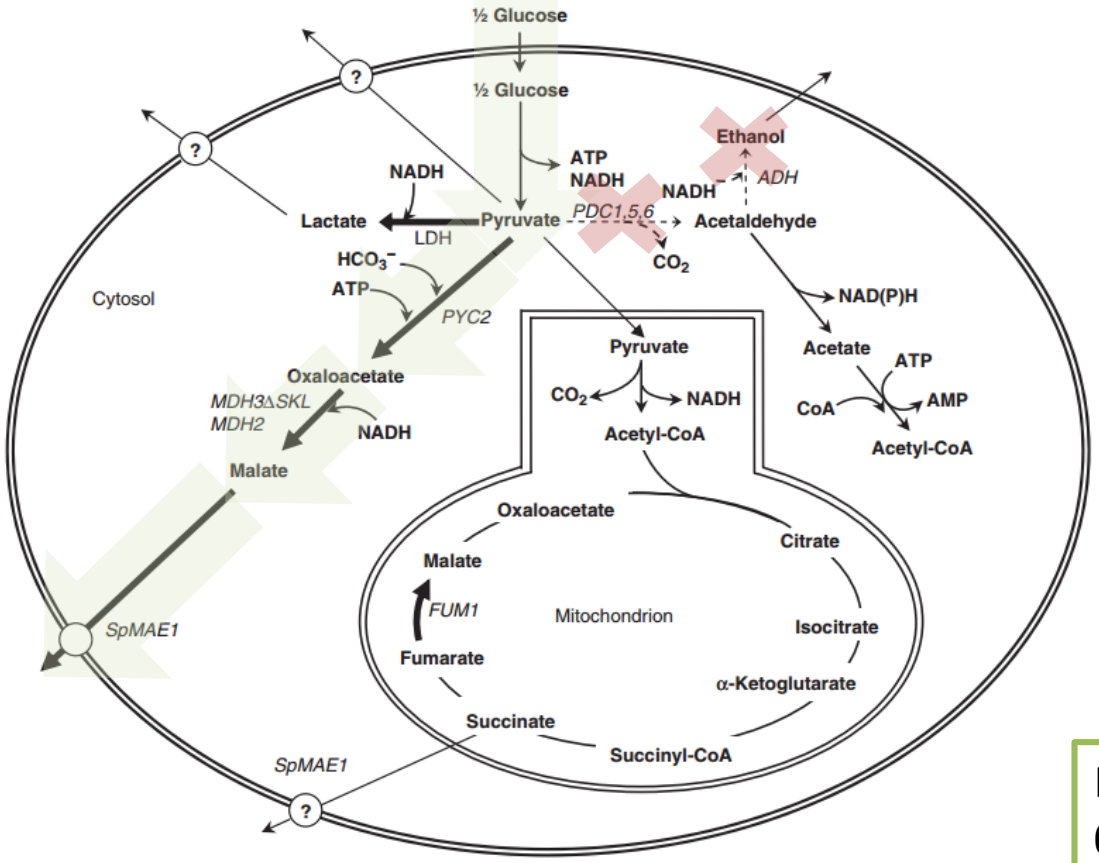
Require metabolic engineering

What is metabolic engineering?

"optimizing genetic and regulatory processes within cells to increase the cells' production of a certain substance"



Example of malic acid production in Yeast



IMPORTANT FEATURES

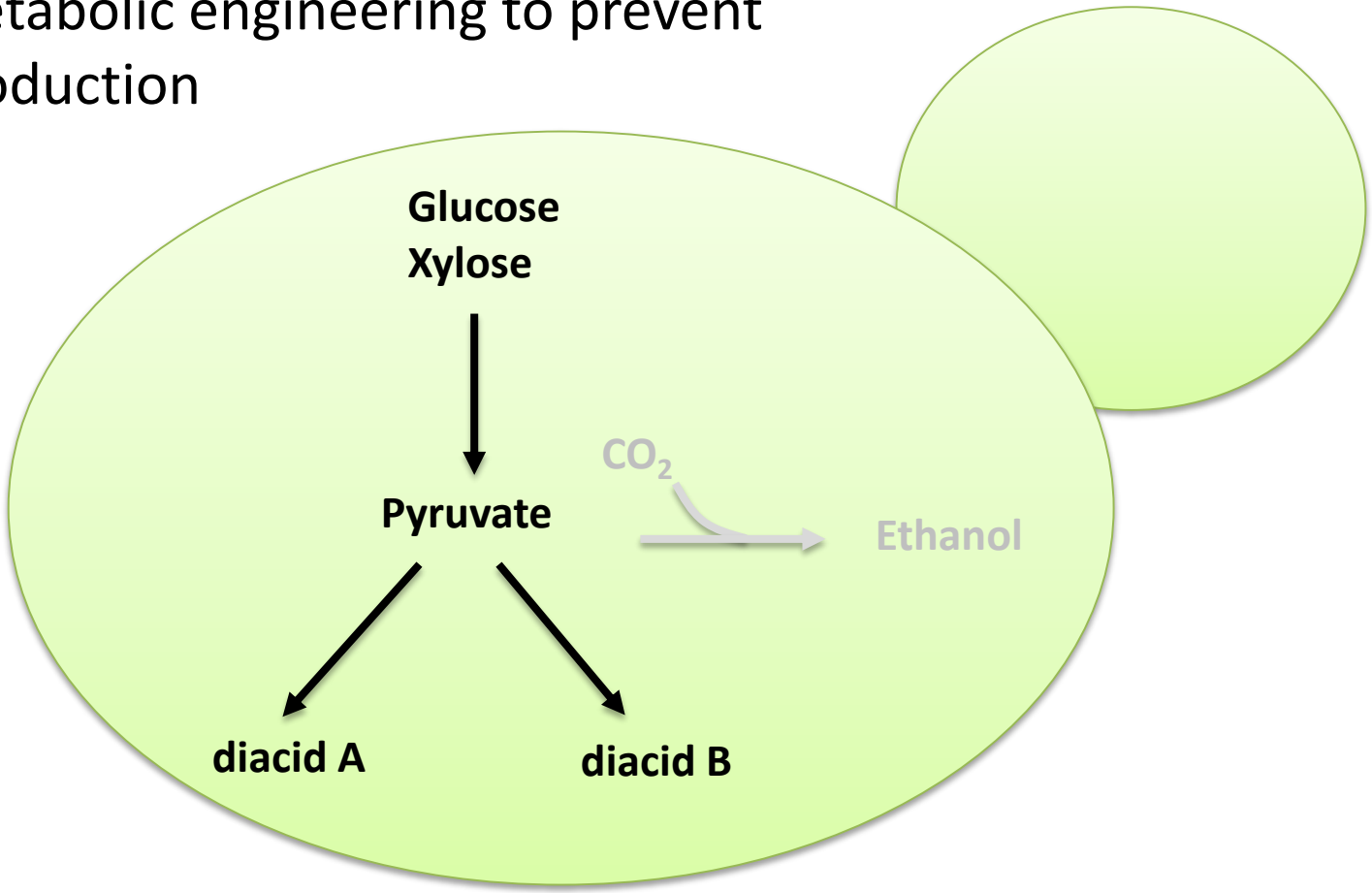
1. No ethanol production (Δ *pdc*1,5,6)
2. Overexpress pyruvate carboxylate (*PYC2*)
3. Overexpress cytosolic malate dehydrogenase (*MDH3*ΔSKL)
4. Malate transporter *SpMAE1*

RESULT
0.42 mol malate/mol glucose
59 g/L

Zelle et al., (2008). Appl Enivron Microbiol 74(9) : 2766-2777
Derek A. Abbott et al., (2009) FEMS Yeast Res 9 : 1123–1136

Outline of BioREFINE-2G

- *S. cerevisiae* best host since tolerant to low pH and inhibitors
- Require metabolic engineering to prevent ethanol production



Thank you for your attention !!

Acknowledgments

Dr. Anders Sandström, Post Doc
Nina Bjurman, 15 ECTS project
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This project is co-funded by the European Union within the 7th Frame Programme. Grant Agreement n°613771.